EPA REGION 8'S RESPONSE TO PETITION FOR REVIEW

ATTACHMENT GG - Part 1

Letter dated June 19, 2017 from Oglala Sioux Tribe President Weston to EPA Administrator Scott Pruitt

Administrative Record Document No. 864

Shea, Valois

From: Jennifer Bear Eagle <jbeareagle.ost@gmail.com>
Sent: Monday, June 19, 2017 3:28 PM
To: Shea, Valois
Cc: Trina Lone HIll; Jeffery C. Parsons; ostnrrawrd@gwtc.net; suzym@oglala.org; Tiger Brown Bull; Anne Eagle Bull - OST President- PZ (ann.eaglebull@oglala.org); president.weston@oglala.org; Russell Zephier
Subject: Oglala Sioux Tribe comments re Dewey-Burdock
Attachments: 2017-06-19 OST Comment Letter re Dewey-Burdock with Addendum (final signed).pdf; OST Ordinance 11-10.pdf; OST Ordinance 07-40.pdf

Please find attached comments from the Oglala Sioux Tribe regarding the Dewey-Burdock Class III and Class V UIC draft area permits. These comments includes a letter and addendum. Copies of OST Ordinance No. 07-40 and Ordinance No. 11-10 are also included. There are several attachments to the addendum and referenced therein. These attachments are submitted in a separate email.

Please let me know if you have any trouble opening the attached documents.

Thank you,

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Troy "Scott" Weston

June 19, 2017

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Via email to shea.valois@epa.gov

RE: Oglala Sioux Tribe Comment in Opposition of the Dewey-Burdock Class III and Class V Underground Injection Well Draft Area Permits

Dear Ms. Shea:

I serve as President of the Oglala Sioux Tribe, and I write to submit testimony on behalf of the Oglala Sioux Tribal Council, in opposition to the application by Powertech, Inc. for a Class V Underground Injection Control (UIC) permit, for uranium mining waste at the proposed Dewey-Burdock project site.

An overview of our concerns is as follows:

The proposed waste injection site is within the boundaries of the Great Sioux Reservation, as defined in the Treaty of Fort Laramie of April 29, 1868. (15 Stat. 635). The United Nations Declaration of the Rights of Indigenous peoples prohibits approval of the permits without our consent, and we do not consent. In fact, the Oglala Sioux Tribe adopted Ordinance No. 07-40 explicitly declaring the Pine Ridge Indian Reservation, including its aboriginal territory boundaries, to be a nuclear-free area. Executive Order 13175 on Consultation and Coordination with Indian Tribal Governments requires all agencies to respect Treaty rights, and approval of the Dewey-Burdick permit violate the 1868 Fort Laramie Treaty. Under the Fort Laramie Treaty, and applicable principles of federal and international law, the permit must be denied.

The Oglala Sioux Tribe possesses reserved water rights to the Cheyenne River, under the legal principles established in *United States v. Winters*, 207 U.S. 564 (1908). The interconnection of the Madison and Minnelusa aquifers and of ground and surface water at artesian springs threatens the Cheyenne headwaters with contamination. The EPA lacks adequate data to demonstrate that our waters will remain protected.

Under section 106 of the National Historic Preservation Act, the EPA must consult with the Oglala Sioux Tribal Historic Preservation Office in the identification, evaluation and determination of potential impacts to historic properties by the proposed Dewey-Burdock injection wells. (54 U.S.C. §306108). Under Executive Order 13175, the EPA must also engage in government-to-government consultation with the Oglala Sioux Tribal Council on the proposed UIC permit. (65 Fed. Reg. 67249). The attempt by EPA to combine Section 106 consultation meetings with government-to-government consultation resulted in confusion and lack of compliance with either consultation requirement.

As discussed in more detail below, for these reasons, the permit application must be denied.

THE PROPOSED DEWEY BURDOCK PERMIT VIOLATES THE
1851 FORT LARAMIE TREATY AND 1868 FORT LARAMIE TREATY

In 1848, the United States needed the permission of the *Oceti Sakowin Oyate* to establish the Oregon Trail. This resulted in the Fort Laramie Treaty of 1851, in which the United States recognized as Sioux Country a vast territory in the northern plains. (11 Stat. 749). Article V defines the territory of the Great Sioux Nation as follows:

> The territory of the Sioux or Decotah Nation, commencing at the mouth of the White Earth River on the Missouri River: thence in a southwesterly direction to the forks of the Platte River; thence up the north fork of the Platte River to a point known as the Red Butte, or where the road leaves the river; thence along the mountain range known as **the Black Hills**, to the headwaters of the Heart River; thence down Heart River to its mouth and thence down the Missouri River to the place of beginning.

(11 Stat. 749).

The proposed Dewey-Burdock underground injection wells are clearly within the boundaries of Sioux Country as defined in Article V of the 1851 Fort Laramie Treaty. The permit application, if granted, will violate the Treaty rights of the Oglala Sioux Tribe under the 1851 Treaty.

Soon after the Treaty was ratified by Congress, the 1863 Montana gold rush resulted in trespassers entering Sioux Country. The United States began building military outposts in Wyoming Territory, in violation of the 1851 Fort Laramie Treaty. Oglala Lakota forces led by Chief Red Cloud defeated the United States in the Powder River War of 1866-1867, forcing closure of the military forts. The United States then negotiated the Fort Laramie Treaty of April 29, 1868.

In the 1868 Treaty, the Oglala and other bands of the *Oceti Sakowin Oyate* reserved the Great Sioux Reservation, as described in Article II:

> The United States agrees that the following district of country, to wit, viz: commencing on the east bank of the Missouri river where the 46th parallel of north latitude crosses the same, thence along low-water mark down said east bank to a point opposite where the northern line of the State of Nebraska strikes the river, thence west across said river, and along the northern line of Nebraska to the 104th degree of longitude west from Greenwich, thence north on said meridian to a point where the 46th parallel of north latitude intercepts the same, thence due east along said parallel to the place of beginning; and in addition thereto, all existing reservations of the east back of said river, shall be and the same is, set apart for the absolute and undisturbed use and occupation of the Indians herein named, and for such other friendly tribes or individual Indians as from time to time they may be willing, with the consent of the United States, to admit amongst them; and the United States now solemnly agrees that **no persons**, except those herein designated and authorized so to do, and except such officers, agents, and employees of the government as may be authorized to enter upon Indian reservations in discharge of duties enjoined by law, **shall ever be permitted to pass over, settle upon, or reside in the territory described in this article**.

(15 Stat. 635).

Thus, the Great Sioux Reservation comprised all of present-day South Dakota west of the Missouri River (to the east bank), including the Black Hills. Article II recognizes the right of our Tribe to exclude PowerTech. The sacred nature of the Black Hills to the *Oceti Sakowin Oyate* is well documented – these are sacred lands that should not be desecrated in the manner described in the draft UIC permit. The Black Hills are integral to our creation story, and remain an important place for pilgrimage and ceremony by our Tribal members. Ultimately, the proposed permit violates Article II of the 1868 Fort Laramie Treaty and must be denied.

The recharge area for the Black Hills aquifers affected by the proposed DeweyBurdock permit is also protected under the 1868 Treaty. The Powder and Platte River basins were identified as Sioux Country in the 1851 Treaty. Although they lay outside of the Great Sioux Reservation as described in Article II of the 1868 Treaty, we retained title to these lands for hunting. Under Article XVI of the Fort Laramie Treaty of 1868, these areas are defined as unceded, and remain in Sioux ownership:

> The United States hereby agrees and stipulates that the country north of the North Platte River and east of the summits of the Big Horn mountains shall be held and considered to be **unceded**. Indian territory, and also stipulates and agrees that no white person or persons shall be permitted to settle upon or occupy any portion of the same; or without the consent of the Indians, first had and obtained, to pass through the same.

(15 Stat. 639).

Article XI of the 1868 Treaty established a process by which a Commission would be formed, to include our head men, prior to approval of "works of utility or necessity" that may affect the Great Sioux Reservation. The Dewey-Burdock permit application may not be approved by EPA in the absence of the formation of a commission as required by Article XI of the 1868 Fort Laramie Treaty.

Under Article XII of the 1868 Treaty:

> No treaty for the cession of any portion or part of the reservation herein described which may be held in common shall be of any validity or force as against the said Indians, unless executed and signed by at least three-fourths of all the adult male Indians.

15 Stat. 638.

The United States violated Article XII in every unilateral land taking against the *Oceti Sakowin Oyate*.

In any event, these treaty obligations remain in effect today. As explained by the Chief Justice John Marshall –

> The Indian nations had always been considered as distinct, independent communities, retaining their original natural rights, as the undisputed possessors of the soul from time immemorial... The very term 'nation," so generally applied to them, means "a people distinct from all others." The constitution, by declaring treaties already made, as well as those to be made, the supreme law of the land, has adopted and sanctioned the previous treaties with the Indian nations, and consequently admits their rank among those powers who are capable of making treaties. The words "treaty" and "nation" are words of our own language, selected in our diplomatic and legislative

> proceedings by ourselves, having each a definite and well understood meaning. We have applied them to Indians as we have applied them to other nations of the earth. They are all applied in the same sense.

(*Worcester v. Georgia*, 31 U.S. (6 Pet.) 515, 559-560 (1832)).

Consequently, the obligations of the United States to the Oglala Sioux Tribe under the 1851 and 1868 Fort Laramie Treaties remain in effect today. The Fort Laramie Treaties enjoy a legal status comparable to treaties with foreign nations. For this reason, the requirements of the United Nations Declaration of the Rights of Indigenous Peoples apply to the Dewey-Burdock UIC permits. Article 29 paragraph 2 prohibits approval of the proposed permits without the consent of the Oglala Sioux Tribe:

> States shall take effective measures to ensure that no storage or disposal of hazardous materials shall take place in the lands or territories of indigenous peoples without their free, prior and informed consent.

(U.N. Doc. A/RES/61/295, Sept. 13, 2007).

In Article 37, paragraph 1, the U.N. Declaration requires compliance with our Treaty rights:

> Indigenous peoples shall have the right to the recognition, observance and enforcement of treaties.

These requirements gain special significance under international law where, as here, sacred lands are at risk. Article 25 of the U.N. Declaration provides that:

> Indigenous people have the right to maintain and strengthen their distinctive spiritual relationship with their traditionally owned or otherwise occupied lands.

The Dewey-Burdock UIC permit application threatens Treaty land and water of the Oglala Sioux Tribe. The applicable principles of international law require EPA to deny the permit.

These requirements are incorporated into the laws of the United States, pursuant to Executive Order 13175 on *Consultation and Coordination with Indian Tribal Governments*. E.O. 13175 provides that:

> The United States continues to work with Indian tribes on a government-to-government basis to address issues concerning

> Indian... treaty and other rights. **Agencies shall... honor treaty rights** and other rights.

(65 Fed. Reg. 67249).

The title to the Dewey-Burdock project area remains disputed by the Oglala Sioux Tribe. In the case of *United States v. Sioux Nation of Indians*, 448 U.S. 371, 387 (1980), the United States Supreme Court ruled that the taking of Sioux Nation treaty lands under the Act of February 2, 1877 and other laws violated the 5th Amendment of the United States constitution. In affirming a judgment of $108 million, the Court described the treatment of the Sioux Nation by the United States as "(a) more ripe and rank case of dishonorable dealings will never, in all probability, be found in our nation's history."

The Oglala Sioux Tribe and *Oceti Sakowin Oyate* have not accepted the award of money damages, and have continuously insisted that land restoration be the cornerstone of a settlement of the outstanding Treaty claims under the 1851 and 1868 Treaties. As explained by South Dakota District Judge Lawrence Piersol, "If there is to be any other resolution for these past wrongs... then (it) must come from Congress." (*Different Horse v. Salazar*, Civ. 09-4049, Memorandum Op. and Order p. 9, (D.S.D. 2009)).

Legislation has been introduced in past Congress' to return title to the lands affected by the proposed Dewy Burdock project to the *Oceti Sakowin Oyate*. E.g. 99th Cong., S. 1453 ("Sioux Nation Black Hills Act"). Indeed, the centuries-long efforts of the Oglala Sioux Tribe for the return of our sacred Black Hills has been well documented, and is on-going. Ultimately, as the largest band of the *Oceti Sakowin Oyate*, the Oglala Sioux Tribe retains an unresolved claim under the 1868 Fort Laramie Treaty to the title to the land within and surrounding the project area.

The EPA cannot ignore this claim. The proposed Class V UIC permit violates the 1851 and 1868 Fort Laramie Treaties, the United Nations Declaration of the Rights of Indigenous Peoples and Executive Order 13175. The EPA must deny the Dewey-Burdock permit application.

THE PROPOSED INJECTION WELLS THREATEN WATERS OF THE OGLALA SIOUX TRIBE

Under the principles enunciated by the United States Supreme Court in *Winters v. United States*, 207 U.S. 564 (1908), in the Fort Laramie Treaties, the Oglala Sioux Tribe reserved water rights for all present and future beneficial uses on the Pine Ridge Indian Reservation. The waters sources to fulfill our rights extend to all waters arising upon, flowing over, and bordering our Reservation, as well as to groundwater. Indian water rights are prior and superior to the state law water rights of non-Indians, because they derive from Treaties with an earlier priority date, and are recognized by federal law, and are not dependent upon state law.

Our reserved water rights extend to the Cheyenne River. The proposed injection wells threaten the Cheyenne River watershed near its headwaters. The proposed DeweyBurdock injection wells and potential migration pathways lead to the Cheyenne River. Dewey Burdock directly threatens waters subject to the Winters Doctrine water rights claims of the Oglala Sioux Tribe.

Water rights are property rights, reserved in our Treaties. In addition to our reservation of land, our forefathers reserved the water necessary to transform our remaining landholdings into a permanent homeland for our people. This is specified in Article XV of the 1868 Fort Laramie Treaty:

> The Indians herein named agree that when the agency-house or other buildings shall be constructed on the reservation named, **they will regard said reservation their permanent home**.

15 Stat. 639.

Thus, our water rights extend to all waters needed for a permanent homeland. This includes the right to water free from contamination or degradation (*United States v. Gila Valley Irrigation Dist.*, 920 F.Supp. 1444 (D. Ariz. 1996). Consequently, the risk to water quality posed by approval of Dewey-Burdock will violate the Winters Doctrine water rights of the Oglala Sioux Tribe.

The administrative record fails to support the contention that the Dewey-Burdock injection wells will not result in the release of injectate into the Minnelusa formation, or to surface water in the project area. Available data demonstrates that there is potential communication between the Minnelusa and Madison aquifers, and with the surface water.

The U.S. Geologic Survey has explained:

> Ground and surface-water resources in the Black Hills area are highly inter-connected. The quality of the surface water can affect the quality of ground water, and vice versa... The Madison, Minnelusa, and Minnekahta aquifers are especially sensitive to contamination, because of secondary permeability and potential for streamflow recharge.

(USGS, *Atlas of Water Resources in the Black Hills Area, South Dakota*, Water Resources Investigations Atlas HA-747, 2002, pp. 59, 71).

The EPA acknowledges that there is downward flow from the Minnelusa formation into the Madison formation, but discounts the potential for migration upward. (EPA, *Dewey-Burdock Class V Draft Area Permit Fact Sheet*, p. 30). The Madison aquifer is the source for artesian springs in this area. Contamination of the Madison formation potentially impacts surface water through artesian springs. According to

USGS,

> Aquifer interactions can occur at artesian springs, which discharge about one-half of average recharge to the Madison and Minnelusa aquifers in the Black Hills area. Various investigators have hypothesized that the Madison aquifer is the primary source for many artesian springs.

(Naus et al, *Geochemistry of the Madison and Minnelusa Aquifers in the Black Hills Area, South Dakota*, Water Resources Investigations Report 01-4129, 2001, p. 2).

The potential pathway for migration of injectate into the Madison aquifer (per EPA) and then into surface water (per USGS) is improperly discounted by EPA. The agency has failed to given proper consideration of the potential existence of pathways resulting from unidentified faults or future seismic activity. The EPA finding that "the nearest potential pathway for fluid movement out of the injection zone in the Dewey area is the Dewey fault," is not supported by adequate data, in light of the regional seismology. (EPA, *Dewey Burdock Class V Draft Area Permit Fact Sheet*, p. 26).

Abandoned exploration wells are ubiquitous in the project area, and likewise provide potential pathways for injectate. (*In re PowerTech (USA) Inc.*, LaGarry, Supplemental Written Testimony, ASLB, Doc. 40-9075-MLA, Nov. 21, 2014). The EPA has failed to consider the potential for abandoned or poorly constructed wells to affect the migration of contaminants.

The directional flow of the groundwater confirms our concern with the migration of pollutants. Horizontal flow has been confirmed for the Inyan Kara formation, and is possible for the Minnelusa aquifer. The recharge area from outcroppings flows toward the Cheyenne watershed. There is an interconnection between surface and groundwater in this area, especially at artesian springs.

The EPA lacks adequate data to support a finding of no migration pathways for contaminants that may be released from the injection wells. The proposed permit relies upon future test results and findings by PowerTech Inc. But EPA has already determined that data provided by PowerTech is unreliable.

The *Dewey Burdock Class V Draft Area Permit Fact Sheet* indicates that PowerTech overstated the critical pressure calculations for injectate into the valuable Madison aquifer by 400-500 percent. (EPA, *Dewey Burdock Class V Draft Area Permit Fact Sheet*, p. 26). Yet the proposed permit relies upon data from PowerTech to determine thickness and interconnection of aquifer formations, test results, and corrective action. The reliance upon PowerTech to provide reliable data to determine the impacts of underground injection is a fatal flaw for the protection of public health and the environment.

This actual risk posed to water quality in the Cheyenne River watershed is likewise discounted in EPA's *Draft Cumulative Effects Analysis*. The analysis fails to calculate the combined impact of the risk posed by the Dewey-Burdock wells with the impoundment of the Cheyenne River at the Bureau of Reclamation Angostura Unit. Angostura Dam diminishes the water flows of the Cheyenne River on the Pine Ridge Indian Reservation. It interrupts the high spring flows needed for cottonwood regeneration, diminishing the abundance of important plant species used by the Lakota people in ceremonies. Operation of the dam also degrades wildlife habitat on the Pine Ridge Indian Reservation. The return flows from irrigation contain pesticides, heavy metals, and sodium.

According to the South Dakota Department of Environment and Natural Resources:

> The Cheyenne River water quality continues to be generally poor, due to both natural and agricultural sources... During normal or lower flow periods, the upper Cheyenne often exceeds irrigation water quality standards for specific conductance and sodium absorption ratio.

(SD DENR, 2016 Integrated Report for Surface Water Quality, p. 89).

Dewey-Burdock imposes additional risk to an already-impaired Cheyenne River watershed. The cumulative impact of the risk posed by the injection of waste from in situ Uranium extraction with the degradation caused by the Angostura Unit is necessary. However, the EPA *Draft Cumulative Effects Analysis* fails to do so.

Moreover, the accumulation of heavy metals and radionuclides at Angostura must be taken into account by EPA. According to Sharma, et al:

> Delta sediments of Angostura Reservoir were markedly enriched in V, Zn, and U. Uranium was also elevated from the mine spoil and drainages at near U mines sampled near Dewey... Generally, elevated heavy metal concentration existed in both the upper and lower reaches of the Cheyenne River catchment, with higher concentration in the upper reaches indicative of rapid sedimentation processes.

Rohit Sharma, et al, *Stream Sediment Geochemistry of the Upper Cheyenne River Watershed within the Abandoned Uranium Mining Region of the Southern Black Hills, South Dakota, USA*, ENVIRON. EARTH. SCI. (2016) 75:823.

Thus, researchers from the S.D. School of Mines and Technology have uncovered that uranium and mining waste have contaminated the upper Cheyenne River. Contaminants have migrated to Angostura Reservoir, and the active transportation process threatens the Pine Ridge Indian Reservation downstream. The EPA fails to give adequate consideration to the combined risk posed by this pollution with the proposed injection of mining waste at Dewey-Burdock. As a result, the *Draft Cumulative Effects Analysis* fails to accurately describe the risk posed to the Oglala Sioux Tribe.

Ultimately, the proposed Dewey-Burdock injection wells pose a risk of potential migration of injectate, through faults and secondary porosity in areas connecting with artesian springs. As a result, the proposed waste injection project directly jeopardizes the waters of the Oglala Sioux Tribe. EPA must deny the Dewey-Burdock permit.

EPA FAILED TO COMPLY WITH THE CONSULTATION REQUIREMENTS OF NHPA SECTION 106

Under Section 106 of the National Historic Preservation Act, "The head of any Federal agency... prior to the approval of the expenditure of any Federal funds on the undertaking or prior to the issuance of any license, shall take into account the effect of the undertaking on any historic property." (54 U.S.C. §306108). In the administrative record, EPA has acknowledged that the need to comply with this requirement. However, EPA's *National Historic Preservation Act Draft Compliance and Review Document* fails to demonstrate compliance with NHPA Section 106.

The draft document purports to demonstrate consultation with the OST THPO by reference to a separate document of the Nuclear Regulatory Commission, captioned *Summary of Meeting with OST Regarding the Dewey-Burdock In Situ Uranium Recovery Project. May 19, 2016*. This meeting does not constitute Section 106 compliance by EPA.

The *Summary of Meeting* document states:

> The purpose of the meeting was twofold: (i) to introduce the NRC's new management team responsible for the consultation process with the Oglala Sioux Tribe and the Tribe's new Tribal Historic Preservation Office staff, and (ii) to start the dialogue, on a Government-to-Government basis, regarding a path forward for consultation with the Oglala Sioux Tribe to address the Atomic Safety and Licensing Board's findings...

(www.nrc.gov/docs/ml1618ml16182a069.pdf).

The meeting was about a related action by a separate agency, and not specifically about the identification, evaluation and determination of impacts from the proposed UIC injection wells to be permitted by EPA. It does not constitute compliance by EPA with NHPA Section 106. There were no members of the Oglala Sioux Tribal Council at the meeting. It was not government-to-government consultation in compliance with E.O. 13175. The meeting combined and confused the two separate consultation requirements, and complied with neither requirement.

The Table beginning on page 7 of the *National Historic Preservation Act Draft Compliance and Review Document* likewise combines the issues of section 106 consultations and government-to-government meetings. On page 9, the Table lists "April 28, 2016 Consultation meeting with the Oglala Sioux Tribe," described as "In-person meeting at the Oglala Sioux Justice Center." The EPA totally confused the governmentto-government consultation requirement under E.O. 13175 with the NHPA Section 106 consultation requirement – and complied with neither requirement.

The lack of NHPA Section 106 consultation is evidenced by the failure to address the OST THPOs concerns with the Programmatic Agreement, as discussed in the May 19, 2016 meeting between the Tribe and NRC. The lack of government-to-government consultation is evidenced by EPA's failure to comply with OST Ordinance No. 11-10 (*Ordinance Establishing Procedures for Government-to-Government Consultation Between the Oglala Sioux Tribe and the United States*). Ultimately, EPA failed to comply with the consultation requirements of federal law, and the Dewey-Burdock UIC permit applications must be denied accordingly.

I further express my support for the related concerns of the consolidated intervenors in this docket, as well as the testimonies of the Tribal Historic Preservation Officers of the *Oceti Sakowin Oyate*.

The concerns of the Oglala Sioux Tribe must be fully considered and acted upon by EPA. Approval of the Dewey-Burdock injection well application would violate the 1851 and 1868 Fort Laramie Treaties. Consequently, it violates federal and international law. It poses extreme risk to the waters of the Oglala Sioux Tribe, reserved under the Winters Doctrine. The EPA has given no consideration to these valuable property rights of our Tribe. Important consultation requirements under NHPA Section 106 and E.O. 13175 have been avoided and confused. EPA has failed to comply with these important consultation requirements. Further, the EPA has failed to consider the cumulative impacts of its actions on water quality and impact on the Pine Ridge Indian Reservation. For these reasons and as further described in the attached addendum, the Dewey-Burdock Class V UIC permit application must be denied.

Additional comments of the Oglala Sioux Tribe providing more detail are attached in the addendum hereto and incorporated herein.

Sincerely,

Troy S. Weston, President
Oglala Sioux Tribe

ADDENDUM TO OGLALA SIOUX TRIBE COMMENTS

I. Consultation Under the National Historic Preservation Act and Need for Cultural Resource Survey

The federal courts have addressed the strict mandates of the National Historic Preservation Act:

> Under the NHPA, a federal agency must make a reasonable and good faith effort to identify historic properties, 36 C.F.R. § 800.4(b); determine whether identified properties are eligible for listing on the National Register based on criteria in 36 C.F.R. § 60.4; assess the effects of the undertaking on any eligible historic properties found, 36 C.F.R. §§ 800.4(c), 800.5, 800.9(a); determine whether the effect will be adverse, 36 C.F.R. §§ 800.5(c), 800.9(b); and avoid or mitigate any adverse effects, 36 C.F.R. §§ 800.8[c], 800.9(c)**.** The [federal agency] must confer with the State Historic Preservation Officer ("SHPO") and seek the approval of the Advisory Council on Historic Preservation ("Council").

Muckleshoot Indian Tribe v. U.S. Forest Service, 177 F.3d 800, 805 (9th Cir. 1999). See also 36 C.F.R. § 800.8(c)(1)(v)(agency must "[d]evelop in consultation with identified consulting parties alternatives and proposed measures that might avoid, minimize or mitigate any adverse effects of the undertaking on historic properties and describe them in the EA.").

The Advisory Council on Historic Preservation ("ACHP"), the independent federal agency created by Congress to implement and enforce the NHPA, determines the methods for compliance with the NHPA's requirements. See *National Center for Preservation Law v. Landrieu*, 496 F. Supp. 716, 742 (D.S.C.), *aff'd per curiam*, 635 F.2d 324 (4th Cir. 1980). The ACHP's regulations "govern the implementation of Section 106," not only for the Council itself, but for all other federal agencies. *Id*. See also *National Trust for Historic Preservation v. U.S. Army Corps of Eng'rs*, 552 F. Supp. 784, 790-91 (S.D. Ohio 1982).

NHPA § 106 ("Section 106") requires federal agencies, prior to approving any "undertaking," such as the UIC permits for the proposed Dewey-Burdock Project, to "take into account the effect of the undertaking on any district, site, building, structure or object that is included in or eligible for inclusion in the National Register." 16 U.S.C. § 470(f). Section 106 applies to properties already listed in the National Register, as well as those properties that may be eligible for listing. See *Pueblo of Sandia v. United States*, 50 F.3d 856, 859 (10th Cir. 1995). Section 106 provides a mechanism by which governmental agencies may play an important role in "preserving, restoring, and maintaining the historic and cultural foundations of the nation." 16 U.S.C. § 470.

If an undertaking is the type that "may affect" an eligible site, the agency must make a reasonable and good faith effort to seek information from consulting parties, other members of the public, and Native American tribes to identify historic properties in the area of potential effect. 36 C.F.R. § 800.4(d)(2). See also *Pueblo of Sandia*, 50 F.3d at

859-863 (agency failed to make reasonable and good faith effort to identify historic properties).

The NHPA also requires that federal agencies consult with any "Indian tribe ... that attaches religious and cultural significance" to the sites. 16 U.S.C. § 470(a)(d)(6)(B). Consultation must provide the tribe "a reasonable opportunity to identify its concerns about historic properties, advise on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, articulate its views on the undertaking's effects on such properties, and participate in the resolution of adverse effects." 36 C.F.R. § 800.2(c)(2)(ii).

Apart from requiring that an affected tribe be involved in the identification and evaluation of historic properties, the NHPA requires that "[t]he agency official shall ensure that the section 106 process is initiated early in the undertaking's planning, so that a broad range of alternatives may be considered during the planning process for the undertaking." 36 C.F.R. § 800.1(c) (emphasis added). The ACHP has published guidance specifically on this point, reiterating in multiple places that consultation must begin at the earliest possible time in an agency's consideration of an undertaking, even framing such early engagement with the Tribe as an issue of respect for tribal sovereignty. ACHP, Consultation with Indian Tribes in the Section 106 Review Process: A Handbook (November 2008), at 3, 7, 12, and 29.

Regarding respect for tribal sovereignty, the NHPA requires that consultation with Indian tribes "recognize the government-to-government relationship between the Federal Government and Indian tribes." 36 C.F.R. § 800.2(c)(2)(ii)(C). <u>See also</u> Presidential Executive Memorandum entitled "Government-to-Government Relations with Native American Tribal Governments" (April 29, 1994), 59 Fed. Reg. 22951, and Presidential Executive Order 13007, "Indian Sacred Sites" (May 24, 1996), 61 Fed. Reg. 26771. The federal courts echo this principle in mandating all federal agencies to fully implement the federal government's trust responsibility. <u>See</u> *Nance v. EPA*, 645 F.2d 701, 711 (9^{th} Cir. 1981) ("any Federal Government action is subject to the United States' fiduciary responsibilities toward the Indian tribes").

Whenever there is ambiguity interpreting or applying NHPA, or other laws, the federal agency staff is not entitled to "deference to an agency interpretation of an ambiguous statutory provision involving Indian affairs. In the usual circumstance, '[t]he governing canon of construction requires that 'statutes are to be construed liberally in favor of the Indians, with ambiguous provisions interpreted to their benefit.' This departure from the [normal deference to agencies] arises from the fact that the rule of liberally construing statutes to the benefit of the Indians arises not from the ordinary exegesis, but 'from principles of equitable obligations and normative rules of behavior,' applicable to the trust relationship between the United States and the Native American people." *California Valley Miwok Tribe v. United States*, 515 F.3d 1262 (D.C. Cir. 2008) *quoting Albuquerque Indian Rights v. Lujan*, 930 F.2d 49, 59 (D.C. Cir. 1991); *Cobell v. Norton*, 240 F.3d 1081, 1101 (D.C. Cir. 2001) (*quoting Montana v. Blackfeet Tribe of Indians,* 471 U.S. 759, 766, (1985)).

EPA states that:

> Based on the information we have reviewed to date, and subject to resolving concerns identified in the NRC administrative review process, the EPA believes that the level of work completed under the auspices of the NRC on the Class III Cultural Resources Survey appears thorough and comprehensive for the APE defined by the NRC, provided the PA stipulations are followed concerning the unexpected discovery of additional historical properties.

EPA states that its consideration of the extent of cultural resource issues at the Dewey-Burdock site is based on "Section 3.9.3 of the NRC Supplemental Environmental Impact Statement prepared for the Dewey-Burdock Project (SEIS) and summarized in Appendix B of the NRC PA."

EPA's characterization of the current status of the NRC Staff's National Environmental Policy Act and National Historic Preservation Act compliance is not consistent with the Nuclear Regulatory Commission's recent ruling. See CLI-16-20 (https://www.nrc.gov/docs/ML1635/ML16358A434.pdf). In fact, the result of the Nuclear Regulatory Commission process was an express holding that the Class III archaeological study conducted at the site failed to satisfy any of the requirements associated with either the National Environmental Policy Act (NEPA) or the National Historic Preservation Act (NHPA) with respect to cultural resources.

Specifically, the NRC affirmed the Atomic Safety Licensing Board's express ruling that:

> The Board finds that the NRC Staff has not carried its burden of demonstrating that its FSEIS complies with NEPA and with 10 C.F.R. Part 40. The environmental documents do not satisfy the requirements of the NEPA, as they do not adequately address Sioux tribal cultural, historic and religious resources.

In the Matter of Powertech USA, Inc., LBP-15-16, 81 NRC 618, 708 (2015). Thus, EPA's reliance on the NRC SEIS is entirely misplaced. Indeed, there has never been a cultural resources survey conducted on the Dewey-Burdock site that took into account any Sioux cultural resources. Moreover, NRC has divided its project approval into segments rendering the scope of NRC's consultation inapplicable to EPA's UIC analysis and approvals. As such, EPA simply cannot rely on the NRC SEIS analysis in any way for such a survey.

Further, the NRC affirmed the Board's ruling that "Meaningful consultation as required by [the NHPA] has not occurred." Id. This ruling was made despite the existence of the Programmatic Agreement, which EPA suggests it might sign on to in an effort to fulfill its NHPA obligations. However, EPA appears to be unaware that the PA it references was roundly condemned by every single Sioux tribal government that reviewed it. Indeed, not a single Tribe has agreed to be a signatory on the PA. The critique of the terms of the PA from the Tribes was severe. See attached February 5, 2014 Letter from Oglala Sioux Tribe President Bryan Brewer to NRC Staff; February 20, 2014 email from Standing Rock Sioux Tribe Historic Preservation Officer to NRC Staff (marked Exhibit NRC-016). In these letters, the Oglala Sioux Tribe identifies specific terms in the Agreement that fail to provide any detail or specificity as to future analyses of the project area, methodologies proposed for these analyses, or what mitigation measures may be adopted in the future to address the impacts. Id. at 2. The Standing Rock Sioux Tribe raises similar concerns, but goes into highly specific detail, offering not only a letter describing their frustration in dealing with the NRC Staff on this issue, but also providing multiple substantive line by line comments, questions, and critiques to the Agreement. Id. at 7-20. Unfortunately, NRC Staff did not provide any specific substantive response to either set of tribal concerns, nor did NRC Staff incorporate the changes proposed by either tribe. Instead, NRC Staff and Powertech pushed to finalize the PA without addressing the tribes' concerns.

This type of lack of meaningful consultation, in part, is what led to a NRC ruling finding a failure to comply with the NHPA consultation duties. EPA should not compound and exacerbate this failure by endorsing such a deeply flawed PA. Instead, EPA should seek to conduct a consultation effort that complies with the NHPA and meaningfully involves the Tribes in a discussion of the potentially affected cultural resources, the potential impacts to those resources, and possibly mitigation measures that can be implemented to protect those resources.

In any case, the existing PA is currently the subject of further discussion and negotiation as part of the NRC's finding that the NRC Staff has failed to comply with either NEPA or the NHPA with respect to identifying and evaluating impacts to Sioux cultural resources at the site. *See* attached May 31, 2017 letter from Oglala Sioux Tribe Historic Preservation Office; May 19, 2016 and January 31, 2017 Oglala Sioux Tribe/NRC Staff meeting summaries (all specifically identifying changes to the PA as necessary topics of ongoing NHPA consultation). As such, EPA should increase its involvement and either work to develop an agreement with the affected Tribes, including the Oglala Sioux Tribe, that properly takes into consideration the Tribes' perspectives. In the alternative, EPA should engage in the ongoing discussions between NRC and the Tribes, including the Oglala Sioux Tribe, and work toward a PA that satisfies all parties. The Oglala Sioux Tribe has a formal ordinance in effect regarding consultation, which requires the involvement of the Oglala Sioux Tribal Council. See Ordinance No. 11-10 of the Oglala Sioux Tribal Council of the Oglala Sioux Tribe.

Notably, the record developed during the NRC hearing process demonstrates that the proposed Dewey-Burdock site contains significant cultural resources that could be impacted by the project. This fact is made clear even though no meaningful cultural resources survey has been conducted on the property. Even the Augustana Class III archaeological survey upon which EPA attempts to rely recognizes that "the sheer volume of sites documented in the area is noteworthy." Report at page 7.8. Despite this acknowledgement, no competent Sioux cultural resources survey has ever been conducted on the site.

The NRC hearing record demonstrates that EPA simply cannot rely on the Powertech-produced Class III archaeological survey for purposes of identifying impacts to cultural resource so as to satisfy its environmental impact review or NHPA obligations. Powertech candidly admits "that identifying religious or culturally significant properties in a project area is entirely reliant of the Tribes themselves and the special expertise of the Tribal cultural practitioners…. Simply put, entities such as NRC or Powertech are not equipped with the Tribe-specific knowledge and traditions to adequately instruct a specific Tribe using 'proper scientific expertise' on this subject." <u>See</u> attached Powertech Opening Statement at 34. The record and testimony contains no evidence that NRC Staff successfully equipped itself or acquired the necessary resources to meet NRC's NEPA duties involving religious and cultural resources. The primary reliance by EPA on the Augustana study is not supportable – particularly given the testimony at the NRC hearing. Dr. Hannus, who lead the Augustana study at the behest of the applicant admitted that his team is not "in any way qualified to be conducting TCP surveys" and further conceded that given the heightened cultural issues of the Sioux Tribes that "there will be sites that will need to be addressed archaeologically and there will be probably sites that need to be addressed as traditional cultural properties." <u>See</u> attached August 19, 2014 Transcript at p. 858, lines 4-8; 12-20. <u>See also</u> August 19, 2014 Transcript at p. 859, lines 18-24 (Dr. Hannus) ("And again, that really should clearly, I think, show us that for us to then be able to make some kind of in roads ourselves, being not of Native background, to identification of sites that are traditional cultural properties that have a tie to spirituality and so on, it is not in our purview to do that.").

Applicant witness Dr. Luhman reiterated this point, confirming that "a traditional Level 3 survey may, in fact, encounter some resources that would be associated with Native American groups or which they would identify. But, they wouldn't necessarily identify all of the resources primarily because some of the knowledge is not available to those conducting the Level 3 survey. That would be provided by the Native American groups themselves." August 19, 2014 Transcript at p. 762, line 24 to p.763, line 6. <u>See also</u>, August 19, 2014 Transcript at p. 764, lines 14-18 (OST witness Mr. Mesteth) ("[w]e're the ones that are the experts, not the archaeologists. They make assumptions and hypotheses about our cultural ways and it's not accurate. Some of the information is not accurate. And that's why we object in certain situations."); p. 765, line 25 to p. 766, line 9 (Mr. Mesteth).

Indeed, Dr. Hannus testified that his office has never worked on any projects that considered the cultural resources at a site. August 19, 2014 Transcript at p. 843, lines 4-7. Despite this fact, NRC Staff witness Dr. Luhman testified that NRC Staff relied on Augustana to conduct all of the initial and follow up field survey work at the site, with the exception of the three non-Sioux tribes that submitted reports. August 19, 2014 Transcript at p. 818, lines19-22.

Upon the Sioux Tribes' request as early as 2011 that cultural resource surveys be conducted at the site, NRC Staff prompted the applicant to bring in Dr. Sabastian and her firm to coordinate this review. August 19, 2014 Transcript at p. 784, lines 20-25 (Dr. Sabastian). However, Dr. Sabastian also testified that she also has never been involved in any kind of "actual physical on-the-ground TCP survey-kind of thing that we're talking about." August 19, 2014 Transcript at p. 846, lines 9-21.

Lastly, Mr. Fosha testified that he worked with the applicant and Augustana "from the very start of the project, so the bulk of this material is a result of myself reviewing what Augustana College had been doing in the field." August 19, 2014 Transcript at p. 865, lines 3-6. Mr. Fosha testified that he met with the applicant and between them discussed methods for identification of sites and the methods and steps to take "throughout the process," but only related to the State of South Dakota permit, and having "nothing to do with the NRC permit or anything like that" – even remarking that "up until the point where Augustana was nearly finished I was the only review agency on this project." August 19, 2014 Transcript at p. 865, line 23 to p. 866, line 5. Despite Mr. Fosha being the only person giving any direction to Dr. Hannus' Augustana team, Mr. Fosha testified that his experience and focus was solely "the field of archaeology" and not culturally as to the concerns of the Tribes. August 19, 2014 Transcript at p. 867, lines 14-20.

The only NRC Staff or applicant witness that testified to having any experience in conducting cultural resource field surveys was NRC Staff witness Dr. Luhman. However, as stated, Dr. Luhman admitted to relying exclusively on Augustana for both the initial field work and the follow up field studies, even though Dr. Hannus' testimony had confirmed that Augustana had no culturally relevant experience. August 19, 2014 Transcript at p. 818, lines19-22 (Dr. Luhman). Dr. Luhman did testify that "in those projects in which I have been involved [a cultural survey] it is typically that [the Tribes] are working alongside with the archaeological survey team as they are going about doing the survey. It could be in the preliminary stages of doing the generalized recognizance (sic) of the project area. Oftentimes the federal agency and other parties will be along that process so that there can be discussions while out in the field, and these are for sometimes very large projects. But in my experience it typically is at the same time when there is an ongoing consultative and survey process." August 19, 2014 Transcript at p. 836, line 18 to p. 837, line 2.

Consistent with the admitted lack of any culturally relevant experience or focus by any of the prior analysts in reviewing sites for cultural resource impacts, at the live hearing NRC Staff witness Ms. Yilma admitted that no written cultural resources analysis prepared during any part of the NEPA analysis included <u>any</u> comments or reports from <u>any</u> Sioux Tribes. August 19, 2014 Transcript at p. 821, lines 3-7; *id*. at p. 875, lines 6-11. This is despite testimony from NRC Staff witness Ms. Yilma as to the Staff's recognition of the importance of the area to the Sioux from a cultural perspective from the earliest stages of the application review stage. August 19, 2014 Transcript at p. 774, line 21 to p. 775, line 1. <u>See also</u>, August 19, 2014 Transcript at p. 771, lines 1-7 (Ms. Yilma). NRC Staff witness Ms. Yilma also testified as to the importance and focus at least as early as 2011 by both the Sioux Tribes and within NRC Staff on the need for culturally-based field surveys in order to fulfill the NEPA and NHPA requirements. August 19, 2014 Transcript at p. 776, line 22 to p. 777, line 3; p. 790, lines 1-17. Indeed, NRC Staff witness Ms. Yilma testified that after meeting in 2011 with the Oglala Sioux, Standing Rock Sioux, Flandreau Santee Sioux, Sisseton Wahpeton (Sioux), Cheyenne River Sioux, and Rosebud Sioux (see August 19, 2014 Transcript at p. 810, lines 16-22), NRC Staff specifically deliberated about conducting an ethnographic study of the site to ensure incorporation of Sioux cultural and historic perspectives, but "the ultimate decision was instead of an ethnographic study a field survey was necessary, so we focused our attention on the field survey approach." August 19, 2014 Transcript at p. 846 line 22 to 847, lines 8. Despite admitting that it was "necessary" to the analysis, no cultural resources review or field study incorporating any Sioux cultural expertise was ever conducted at the site or incorporated into any NEPA document. August 19, 2014 Transcript at p. 821, lines 3-7 (Ms. Yilma); id. at p. 875, lines 6-11 (Ms. Yilma).

Taken together, this testimony and evidence establishes NRC Staff's failure to conduct the necessary hard look under NEPA, as by their own admission, despite it being necessary to the analysis, no Sioux comments or reports were incorporated into the cultural resources reviews, and none of the parties that conducted any cultural review of the site, including field surveys, were trained, experienced, or competent to review or survey the area for, let alone determine impacts from the project to, the cultural resources of Sioux origin. In answering a follow-up question by Chairman Froehlich to Dr. Hannus asking whether, as Dr. Sabastian had testified, did Dr. Hannus believe that identification of Sioux traditional sites "depends on the knowledge and traditional culture practitioners," Dr. Hannus responded: "Yes, I mean, I absolutely would have to, because there isn't any other way the framework that I work within functions." August 19, 2014 Transcript at p. 860, lines 1-8. In short, admissions and testimony confirm that NRC Staff deferred to the applicant's unqualified consultants, while rejecting proposals to incorporate Sioux cultural expertise.

As a result of Powertech's and NRC Staff's coordinated inability to fulfill their obligations to properly ensure a competent cultural resources survey of the Dewey-Burdock site before approvals are given and the aquifers are impacted, EPA cannot rely on the NRC's NEPA documents to assess the cultural resources impacts of the proposed mine. Instead, the scope of EPA's consultation must match the scope of the UIC duties, which apply to the full life of the proposed mine, not the initial set of NRC-approved segments. Similarly, because NRC Staff has failed to fulfill its government-to-government consultation duties under the NHPA, EPA also cannot rely on the PA or any other NRC Staff consultation to fulfill its own obligations under the NHPA. Rather, EPA must delay any permitting action until a fully competent cultural resources survey is conducted and the Tribe and the public has an opportunity to review and comment on the potential impacts to those important resources. Additionally, EPA should reject the PA as inadequate and engage in meaningful and good-faith consultation with the Oglala Sioux Tribe professional staff and Tribal Council in order to ensure that, in coordination with the Tribe, all cultural resources are identified, impacts are assessed and mitigation measures are developed and implemented.

II. DE FACTO RULEMAKING

A full review of the documents relevant to the proposed Dewey-Burdock project demonstrate that EPA Region 8 has taken efforts to develop what it has referred to in internal documents as "guidance" with respect to how the agency will implement its permitting authority under the Safe Drinking Water Act ("SDWA"), 42 U.S.C. §§ 300h, *et seq*., Underground Injection Control ("UIC") program, as it relates to ISL mining and processing of uranium. This information came to light in documents obtained via a Freedom of Information Act (FOIA) request submitted in February 2009 on behalf of multiple conservation and Native American organizations in both Colorado and South Dakota. Several significant documents from this period are omitted from the records EPA has made available publicly with respect to this project. The Tribe asserts that all of the documents and records, including all emails, reflecting the coordination between EPA and Powertech and any of its consultants must be made part of the administrative record for this proceeding, and must be disclosed to the public during the public comment process in order to allow for meaningful public review and comment of the proposed Draft UIC permits. Several of these documents are attached, which represent examples of the discussions improperly omitted from the existing public record.

The full set of documents reveal EPA's and Powertech's close coordination in developing regulatory requirements for the UIC permitting process. A draft of the resulting "guidance" is attached. This "guidance" was developed in consultation with the uranium mining industry and without public notice or public involvement. As discussed herein, this process was unlawful. In order to ensure compliance with the federal Administrative Procedure Act ("APA"), 5 U.S.C. §§ 701, *et seq.*, EPA must initiate a national rulemaking to ensure strong involvement from the public and stakeholders for the protection of underground sources of drinking water from the impacts of ISL uranium mining. In the meantime, while this rulemaking process is carried forward, EPA should suspend processing of currently filed applications for ISL uranium mining.

According to the agency's documents, the Dewey-Burdock UIC permit process currently underway through EPA Region 8 is the first instance in the nation where the EPA will be the direct permitting agency for a UIC Class III injection well for the purpose of injecting chemical fluids for dissolving and extracting uranium ores, through ISL uranium mining. The agency's documents also reveal EPA Region 8 staff concern with respect to the adequacy of the existing UIC regulations to provide the specificity necessary to directly implement the program. EPA Region 8's assessment is correct in this regard, which gives rise to serious concerns as to whether the regulations are sufficient to provide protection of underground sources of drinking water from threats posed by ISL uranium mining.

As EPA Region 8 is aware, the proposed Dewey-Burdock ISL project has created considerable controversy and drawn opposition from citizens, local governments, Native American tribal groups and governments, medical organizations, local business, agricultural interests, and conservationists based on the significant threats these ISL uranium mines pose to groundwater, local economies, public health, and cultural resources.

Overall, the documents obtained from EPA Region 8 via FOIA, including extensive email communications between EPA Region 8 staff and mining industry interests, reveal a troubling lack of transparency and public involvement in the development of the so-called "guidance" documents. Importantly, the proposed "guidance" is highly substantive in nature and, at the least, sketches out several policy conclusions with respect to EPA's regulation of ISL uranium mines. For example, the proposed "guidance" effectively defines the terms "area of review" and "aquifer exemption boundary" as they will apply to all future EPA Region 8 UIC Class III applications. Such decisions will not only establish the equivalent of an obligatory policy for Region 8, but also have national policy implications and long-term environmental impacts. Thus, it appears that Region 8 was engaged in drafting needed changes to the UIC regulations without the benefit of the substantive and procedural protections of notice and comment rulemaking. This process neglects the rulemaking requirements of the APA and the SDWA requirement that only the Administrator may promulgate SDWA regulations. See 42 U.S.C. § 300h(a).

As noted above, there has been a lack of transparency and public involvement. The EPA Region 8 documents demonstrate that while the uranium mining industry and its scientists and consultants were extensively involved in the drafting and development of the new policies from the earliest stages, there were no efforts by EPA Region 8 to include the public or any public interest organization in the development of these important policies. An EPA Region 8 description of its activities in relation to its regulation of ISL uranium mining, including the extensive interaction with uranium industry representatives, is attached. This lack of public participation is difficult to harmonize with EPA Region 8's direct acknowledgement in the documents of the high level of public interest and controversy surrounding the subject of Powertech ISL uranium mining proposal, and its potential impact on local communities, economies, and natural resources in South Dakota. Indeed, as evidenced by the EPA's decision to revisit the uranium recovery standards, these are issues of national significance and interest.

In order to comply with both the APA and SWDA, and especially given the controversial impacts of ISL mining and the precedent-setting nature of any new regulations in this area, EPA (Region 8 or Headquarters) must suspend processing of currently filed applications and initiate a Tier 1 Rulemaking. Such an action is well grounded in past agency practice and will provide the benefit of the sound science, public participation, and careful review of available technologies and SDWA standards which are conducted during formal rulemaking. The regulatory changes are required before any further or final permits are issued. The regulatory deficiencies and changes and details included in the Region's proposed guidance represent a substantive and controversial regulatory development that implicate the agency's obligations under the SDWA and the Administrative Procedure Act ("APA"), 5 U.S.C. § 553. As the EPA is no doubt aware, the APA requires public notice and comment rulemaking whenever a federal agency embarks on substantive changes in or development of regulations. Id. The SDWA itself specifically states that "[a]ny regulation under this section shall be proposed and promulgated in accordance with section 553 of title 5 (relating to rulemaking)...." 42 U.S.C. § 300h(a)(2).

While not all federal agency policy pronouncements require APA notice and comment rulemaking, the federal courts have held that the critical factor in whether an agency policy is properly considered an agency rule requiring APA compliance on one hand or mere guidance on the other is the extent to which the policy is binding on future agency conduct. Compliance with the APA's notice and comment rulemaking provisions is required whenever such a policy establishes a "binding norm" that effectively dictates the agency's regulatory discretion with respect to individual permitting decisions. See *Pacific Gas and Electric Co. v. Federal Power Commission*, 506 F.2d 33, 38 (D.C.Cir.1974); ***American Min. Congress v. Marshall***, 671 F.2d 1251 (10th Cir. 1982).

The "guidance" developed by Region 8 constitutes a "binding norm" in this instance. As noted above, EPA Region 8's "guidance" contains detailed analysis defining critical terms in the EPA's UIC regulations, which are to be applied to future UIC Class III permit applications (as evidenced by their application in this instance). Such definitive terms create binding norms, and these concepts must be defined by regulations promulgated through notice and comment rulemaking and approved by the Administrator, as required by law. Such notice and comment rulemaking is critical to the protection of groundwater in any proposed ISL uranium mining area. As such, APA notice and comment rulemaking in this instance is beneficial and legally required. At minimum, given the sharp controversy the Powertech ISL uranium mining project has generated in South Dakota, public involvement and participation in this rulemaking process is essential.

III. BASELINE WATER QUALITY INFORMATION IS LACKING

Powertech relies on the same data regarding the baseline water quality for its EPA permit applications as it did for its NRC license applications. The applicant has provided no significant baseline water quality information since the NRC license proceedings were conducted. Indeed, in response to comments from the Tribe during the NRC process specifically detailing the problems with lack of adequate baseline water quality data, NRC Staff confirmed that the applicant collected data from 2007 to 2009 and that "the NRC staff used this information when drafting the affected environmental section of the SEIS as well as analyzing impacts of the proposed action." FSEIS at E-32; Exhibit NRC-009-B-2.

Exacerbating these problems, NRC Staff stated that:

> the applicant will be required to conduct additional sampling if a license is granted to establish Commission-approved background groundwater quality before beginning operations in each proposed wellfield in accordance with 10 CFR Part 40, Appendix A, Criterion 5B(5). However, this does not mean that the NRC staff lacks sufficient baseline groundwater quality information to assess the environmental impacts of the proposed action.

FSEIS at E-32; Exhibit NRC-009-B. The same problems persist in the EPA UIC permitting process. The admitted data gaps, and the failure to gain additional sampling before the draft permits were issued, establishes that, like NRC Staff, EPA has not required or used the collection of any additional baseline data for its characterization of baseline water quality, but and that EPA will require additional data in the form of "well field packages" in order to establish a credible baseline for use in the regulatory process. Thus, while the existing administrative record contains data from 2007-2009, the background water quality for use in the actual regulatory process for the facility will be established a future date, outside of any public process, and without the benefit of the public's review and comment.

This approach undermines the UIC permitting process, prevents the EPA from accurately assessing the potential impacts from the project, and prevents the public from being able to effectively review and comment on the project. The result is a lack of compliance with the SDWA and the UIC regulations.

The attached Opening Written Testimony of Dr. Robert E. Moran (Exhibit OST-001) submitted during the NRC hearing process demonstrates the failings of EPA's approach. Exhibit OST-001; Dr. Moran Opening Written Testimony at 16-18. Specifically, Dr. Moran notes the lack of analysis of impacts from past mining activities (p. 16), the lack of necessary information as to the chemical compositions and volumes of wastes, among others (p. 17), the potential bias of the data thus far provided (p. 18) along with the scientifically invalid tactic of requiring the Applicant to collect meaningful water quality data to be used in the configuration of mine design in the future and outside of the public review:

> The delayed production of this critical baseline information until after licensing is not scientifically defensible as it prevent establishment of a baseline on which to identify, disclose, and analyze environmental impacts, alternatives, and mitigation measures involved with the Dewey-Burdock proposal. A scientifically defensible monitoring and mitigation of an operating project is not possible based on the baseline data and analyses I have reviewed.

Exhibit OST-001 at 17.

The attached expert Rebuttal Testimony of Dr. Robert Moran also confirms that EPA has not adequately described the baseline conditions at the site using reasonably comprehensive data. Exhibit OST-018. For instance, Dr. Moran specifically opines that despite expectations that post-license collection of data is sufficient to fill in any gaps that currently exist, such a process deprives expert agencies, the public and the parties to this proceeding (and EPA staff) the opportunity to meaningfully review and evaluate the impacts from the proposed project during the permitting process. Exhibit OST-018, Rebuttal Testimony of Dr. Robert E. Moran at 2 (A.2).

Further, any assertions that this additional data cannot be obtained without full construction of final well-fields is unsupported and contradicted by the expert testimony of Dr. Moran. Dr. Moran opines that adequate baseline data can be gathered "without constructing the ultimate wellfield monitoring network." Id. Dr. Moran points to previous studies undertaken by TVA and Knight Piesold that conducted pump tests to gather baseline data prior to NRC approval. Id. Dr. Moran states that Powertech's consultant Mr. Demuth "confuses hydrological testing that is needed to establish, analyze, and disclose the hydrogeological setting as part of the NEPA-based NRC permit-approval with the more specialized production tests Powertech will conduct on constructed wellfields." Id. In short, there is no legal, technical, or practical basis to forgo gathering this needed data as part of the UIC application process, or at minimum the EPA draft permit process.

At the hearing conducted in the NRC licensing process, Dr. Moran's testimony confirmed that additional data is necessary for a "complete" baseline analysis, including the collection of data for water quality constituents not presented in the company's application materials, such as strontium and lithium. See attached August 20, 2014 Transcript at p. 1007, line 24 to p. 1008, line 1. Consistent with Dr. Moran's testimony, applicant witness Mr. Demuth admitted that additional data is necessary to provide complete baseline data. Id. at p. 1012, lines 16-20.

Thus, Dr. Moran's expert opening, rebuttal, and live hearing testimony in the NRC administrative process demonstrates that EPA lacks the necessary information to meet its requirements for demonstrating a competent set of baseline data – and instead defers meaningful collection, disclosure, and analysis until a later date, only after the public have been denied the opportunity to comment on the baseline that reveals the affected environment that will be impacted. This critique is centered on EPA's plan to defer collection of baseline and to rely on future analysis of future baseline analyses conducted as part of the well field packages, to be provided only after license issuance. This is in effect an identical system adopted by NRC Staff, which deferred meaningful review of baseline information through a so-called Safety and Environmental Review Panel (SERP) – outside of its NEPA process and long after the public's opportunities for comment and review have run.

Further buttressing this argument is the attached Declaration of Dr. Richard Abitz detailing the requisite standards for scientific validity in a baseline analysis. Exhibit OST-001, at 2. See also, Moran Suppl. Decl. at ¶58 ("The [NRC Staff evaluation], like the Powertech Application, fails to define pre-operational baseline water quality and quantity—both in the ore zones and peripheral zones, both vertically and horizontally."); *accord* ¶¶ 47-74, 75, 82-84, 92-94, 95.

Overall, the Powertech submittal fails to adequately describe the affected aquifers at the site and on adjacent lands and fails to provide the required quantitative description of the chemical and radiological characteristics of these waters necessary to assess the impacts of the operation, including potential changes in water quality caused by the operations.

IV. INADEQUATE HYDROGEOLOGICAL ANALYSIS TO ASSESS POTENTIAL IMPACTS TO GROUNDWATER

The EPA analysis fails to provide sufficient information regarding the hydrologic and geological setting of the area. As a result, the documents and information provided, including the data included in the application materials, similarly fails to provide sufficient information to establish potential effects of the project on the adjacent surface and ground-water resources, as required.

As with the NRC process, EPA relies on the applicant to submit adequate hydrogeologic data – but only **after** the public process is completed, after a final permit is issued, and with no chance for any public review. This approach violates the SDWA, EPA's UIC regulations, NEPA, and the APA because of the lack (and deferral of collection and review to a later date) of necessary data and analysis to ensure a credible review of impacts to groundwater. The evidence in the record demonstrates that the applicant has not conducted the necessary studies to identify "significant discontinuities, fractures, and channeled deposits."

This issue is addressed head-on by Dr. Moran, who provided expert testimony on the significant contradictory evidence in Powertech's data. Exhibit OST-001, at 18-22. Specifically, Dr. Moran opines on the overwhelming body of evidence undermining the conclusion that the production zone is hydraulically isolated from surrounding aquifers. Id. at 18-19. Dr. Moran further demonstrates that numerous potential pathways for groundwater conductivity, including inter-fingering sediments, fractures and faults, breccia pipes and/or collapse structures, and the 4000 to 6000 unidentified exploration boreholes present at the mine site. Id. at 20. Dr. Moran concludes that "these inconsistencies make clear that Powertech . . . failed to define the detailed, long-term hydrogeologic characteristics and behavior of the relevant Dewey-Burdock aquifers and adjacent sediments." Id.

The lack of data extends to the lack of analysis of evidence of "fault zones" in the proposed mining area (Exhibit OST-001, p. 20-21) as well as the existence of a "trench" in the potentiometric surface of the Fall River aquifer. Id. at 21. Breccia pipe formations and collapse features round out the list of potential migration pathways for which the application fails to address. Id. at 21-22.

Similarly, Dr. Moran's attached Rebuttal Testimony reinforces this issue, pointing out that Powertech's own witnesses in the NRC process have contradicted the scientific integrity of the pump test data which form the basis of the applicant's analysis. Exhibit OST-018 at 4. The Powertech consultants also contradict themselves with regard to the impact of the unidentified boreholes, arguing in some places that they may have closed by themselves, but then also that they are open, and that the effect of the boreholes have rendered the existing pump test data suspect. Id. at 3. Further, Dr. Moran affirms that the data currently forming the basis of the hydrogeological analysis underpinning the EPA's draft permits is "inadequate to establish a hydrogeological … baseline." Id. at 3. Dr. Moran concludes based on an extensive review of the information presented, including conclusions by every other scientist (except Powertech's) that has reviewed the historic pump tests at the site, that the supposed aquitards at the site are indeed leaky. Id. at 6. Dr. Moran goes into extensive detail as to the particular bases for the lack of acceptable industry-standard methodology and assumptions employed by Mr. Demuth in his conclusions as to the lack of confining ability of the formations at the site. Id. at 6-7.

These issues of fluid containment were also explored during the NRC hearing, during which serious question was cast on whether the existing analysis and assumptions relied upon by the applicant could demonstrate an ability to contain the mining fluid. As a starting point, Powertech's witness Mr. Lawrence readily admitted that in order to ensure containment of the fluid, the operator would need for the Fuson Shale to be relatively impermeable. August 20, 2014 Transcript at p. 1047, lines 20-23. However, as observed by Judge Barnett, "[i]nterpretations of both the 1979 and 2008 pumping test results were found to be consistent with a leaky confined aquifer model. … Based on the results of the numerical model, the Applicant concluded that vertical leakage through the Fuson shale is caused by improperly installed wells or improperly abandoned boreholes. So it does appear in the FSEIS that it acknowledges that it is leaky, whether it is coming from boreholes or whatever else, it is leaky." Id. at p. 1050, line 18 to p. 1051, line 5. In response, NRC Staff witness Mr. Prikryl responded: "Yes, that's correct." Id. at p. 1051, line 8. Applicant witness Mr. Lawrence also agreed: "Yes, there were certainly conditions that demonstrated communication." Id. at 1051, lines 15-16.

The applicant witness Mr. Lawrence attempted to explain that such a "leaky" condition would have to be rectified in order to successfully contain the mining fluids. In doing so, applicant witness Mr. Lawrence stated "[t]hat goes back to the development of the wellfield data package. If you run a specific test in the area that you plan to mine, and identify leakage that is occurring, particularly if you can identify that it is an improperly abandoned borehole or improperly constructed well, as was the case in these tests, you can remedy that situation, plug the borehole, rerun the tests and show that basically you have retained confinement." Id. at p. 1051, line 22 to p. 1052, line 5. Critically, however, Mr. Lawrence then admitted that any such additional work of actually demonstrating the ability to contain the fluid would occur "outside of the FSEIS." Id. at p. 1052, lines 6-8. This admission is critical because it demonstrates that, although the applicant has admitted that impermeability of the Fuson shale is critical to effective fluid migration, and that the Fuson shale is leaking, all additional review of that significant problem will be deferred until after the EPA's draft permit process, and after any ability of the public to review and/or comment on this critical information.

Such a scheme negates the ability of the public to provide meaningful comment on the EPA's UIC permitting process. The applicant's materials and EPA draft permits provide no information on where these mysterious leaking boreholes are, or why the applicant and EPA could not have conducted available analyses described by Dr.Moran's written expert testimony to demonstrate whether they in fact could find and plug the boreholes, rerun the test(s) and demonstrate the ability to retain confinement. This lack of analysis unacceptably leaves the public in the dark as to whether this mitigation will work or what the potential impacts may be should the remedy not be successful.

Upon further questioning by Judge Barnett, the applicant witness Mr. Demuth admitted that the applicant's test data did show a lack of sufficient confinement at least in portions of the project area "where we have a well which is completed in both zones and allows it to communicate." Id. at p. 1054, lines 11-13. In that case, Mr. Demuth states, "there may be one or two unplugged exploration boreholes which are identified in the application. So in that area, the wellfield, any wellfield test is going to have to be examined very carefully." Id. at 1054, lines 12-17. Thus, the applicant witnesses admit that sufficient study has not been completed to demonstrate the ability to contain the mining fluids, but rather a later, post-permit, detailed scientific review will be necessary to "examine" this issue "very carefully." Where such serious questions exist as to such fundamental issues as the ability to contain mining fluids, those issues must be explored and resolved prior to the close of the public's ability to comment on EPA's draft permits.

Tellingly, when NRC Staff witness Mr. Prikryl was asked the same question about how NRC Staff reconciles the past tests, admitted into evidence in that proceeding and attached here, which show leaks in the supposed confining layers at the site, Mr. Prikryl responded: "Well, I'm not familiar with this pump test, what shaft they're talking about or what the location of the pump test itself." Id. at p. 1056, lines 5-12. When queried further as to whether NRC Staff had reviewed this fundamental piece of evidence, NRC Staff witness Mr. Lancaster could not give a satisfactory answer, stating that "we requested this information is our [RAIs] and I think as I recall their conclusions were it's leaky because of a variety of reasons. And one could be the boreholes not being properly abandoned or not being abandoned at all with the correct procedure for plugging and that sort of thing. We recognize that the pump tests show that there is leakiness." Id. at p. 1056, line 25 to p. 1057, line 8.

Consistent with the admissions of NRC Staff and applicant witnesses, the FSEIS fails to conduct the analysis necessary to determine the actual cause of this leakiness or verify the borehole theory. For this reason, EPA's reliance on the NRC Staff environmental and hydrogeologic reviews is unfounded. See also Exhibit OST-018 (Rebuttal Testimony of Dr. Moran) at 3(opining that such lack of investigation fails to meet accepted scientific standards). At minimum, the Board questioning at the hearing confirms that significant questions still remain as to the hydrogeology at the site, and that instead of addressing them prior to issuing the draft permits, EPA Region 8 appears to be content to issue final permits and make these determinations only after the applicant submits its wellfield hydrogeologic data packages – long after all opportunities for public review and comment have expired. Deferring the collection and review of this critical, and admittedly necessary, information until after the permits are issued violates the SDWA, UIC regulations, NEPA, and the Administrative Procedure Act.

Similarly, testimony given by Dr. LaGarry at the NRC hearing demonstrated that the applicant's analysis, which also forms the basis of its UIC application materials, failed to account for faults and fractures in the geology at the site which could cause similar leaky conditions as have been confirmed in the confining layers at the site. See August 20, 2014 Transcript at p. 1065 line 7 to p. 1067, line 10. Upon follow up from Judge Cole, Dr. LaGarry confirmed that in his professional opinion, "that one [report] that was just shown that we were just discussing, the TVA concluded that the leakage might have been caused by an unplugged borehole or some previously as yet undescribed structural feature in that very page we were just reviewing." *Id*. at p. 1069, line 24 to p. 1070, line 4. Indeed, the TVA report referenced demonstrates faults and fractures are prevalent in the area. Exhibit OST-009 at 60. Applicant witness Mr. Lawrence responded that the study does not conclusively demonstrate fractures in the precise permit area at issue, but his testimony falls far short of demonstrating the absence of such fractures. August 20, 2014 Transcript at p. 1071, lines 2-3. Thus, Mr. Lawrence's testimony confirms that applicant's data and analysis provided to date fails to provide a credible explanation for the TVA's leakage conclusions.

Dr. LaGarry credibly opines that "[s]o this TVA report recognizes that the whole area is fractured and that breccia pipes form along these fractures, but they didn't make it into the scientific literature for maps. But if I was to take a geological mapping field crew out there, we would find them because we're looking for them." Id. at p. 1074, lines 4-9. See also, id. at p. 1074, line 14 to p. 1077, line 23 (Dr. LaGarry discussing the commonly overlooked faults and fractures in the area); p. 1109, line 15 to p. 1111, line 2 (discussion of USGS report (attached, and referenced therein as Exhibit NRC-081 at 7) demonstrating extensive breccia pipe formation in the area).

Dr. LaGarry's (and Dr. Moran's) testimony is consistent with the attached TVA report (Exhibit OST-009), the USGS report (Exhibit NRC-081), the USGS-derived Gott map (Exhibit APP-015(f)), all of which show faults, fractures, and breccia pipes in the immediate area of the proposed project, and thus is far more credible testimony that the geology is highly variable in the area given the scientific evidence. At minimum, this corroboration between the Tribe's expert testimony and the extensive geological reports demonstrates EPA's failure to conduct the necessary physical surveys to confirm or deny the presence of these geological features – especially considering the applicant's pump tests proving leaky confining layers. Instead, EPA's draft permit materials rely on the applicant's assumptions, unsupported by empirical data or detailed site investigation, that somehow in a sea of geological fractures and faults surrounding the Black Hills and particularly in this area, the applicant's chosen site is free of geological irregularity that would affect fluid containment simply because there is no "smoking gun" in the reports showing a major fault directly crossing the site. In this case, the SDWA, UIC regulations, NEPA, and the APA require EPA to do more to reconcile the evidence in order to meet its statutory obligations. Deferring this analysis to a later date through wellfield hydrogeologic data packages or injection authorization data packages is not lawful.

Instead of conducting the rigorous scientific review necessary to determine the hydrogeology conditions of the area, as noted by Dr. Moran, Dr. LaGarry, and others in testimony and during the hearing, EPA simply proposes to allow the applicant to collect this information in the future, after all public commenting is complete and after the permits are issued, through the use of a Safety and Environmental Review Panel (SERP). Notably, this post-permit SERP review is not just a confirmation of information already in existence – including production and injection well patterns and location of monitor wells; documentation of wellfield geology (e.g., geologic cross sections and isopach maps of production zone sand and overlying and underlying confining units); pumping test results; sufficient information to demonstrate that perimeter production zone monitor wells adequately communicate with the production zone; and data and statistical methods used to compute NRC-approved background water quality. As Dr. Moran testifies, this approach to defer the meaningful collection of data to a future, post-permit, non-public process is not scientifically-defensible. Exhibit OST-001, at 22-23.

The only additional information the applicant appears to have provided is a 2012 report from Petrotek regarding numerical modeling of the hydrogeology and the bore hole data. As EPA is aware, the NRC Staff's FSEIS, upon which EPA relies heavily, in turn relies heavily on the Petrotek report throughout its discussion of confinement issues, as well as geology and water usage impacts. Dr. Moran discusses this Petrotek modeling report and shows that it is not sufficient to resolve the issues with the existing project data. See Exhibit OST-001, Moran Opening Testimony at 23-26. Specifically, the Petrotek Report relies on inadequately detailed inputs into its model, including for hydraulic conductivity and assumptions of no water flows vertically, which is contradicted by the scientific literature, and unsupported assumptions as to the effect of unplugged boreholes in the area and the lack of any faults or fractures. Id. at 23-24. Dr. Moran further points out the contradictions between the Petrotek Report and NRC Staff conclusions in the FSEIS, upon which EPA relies, with regard to the existence of fractures or other flow paths. Id. at 24. Dr. Moran completes his review with a litany of unsupported assumptions made in the Petrotek model that skew the results and render it unreliable as a scientific tool to predict hydraulic conductivity at the site – the ability of the hydrogeology to contain the contamination associated with ISL mining. Id. at 24-26.

At the conclusion of the NRC hearing, it was divulged that Powertech had withheld significant data regarding bore holes at the proposed mine site. EPA must affirmatively request and conduct a comprehensive review of this data in order to make any conclusions regarding bore holes with regard to the SDWA and UIC requirements. Any failure by EPA to conduct its own review of this information would violate its statutory and regulatory responsibilities under the SDWA, UIC regulations, NEPA, and APA.

Regarding this post-hearing bore hole data, Dr. LaGarry provided a detailed expert review of that information which confirms his hearing testimony that there are substantial questions as to the hydrogeologic conditions at the site that warrant additional investigation and analysis. Exhibit OST-029 (Written Supplemental Testimony of Dr. Hannan LaGarry). In that document, Dr. LaGarry testifies that his review of the bore hole data demonstrates that the data discloses, at minimum: 140 open, uncased holes; 16 previously cased, redrilled open holes; 4 records of artesian water; 13 records of holes plugged with wooden fenceposts; 6 records of holes plugged with broken steel; 12 records of faults within or beside drilled holes; and 1 drawing of 2 faults and a sink hole within a drilled transect. Exhibit OST-029 at 2. Dr. LaGarry goes on to testify as to the likely consequence of these conditions, all of which support the Tribe's assertions that additional investigation of the site is necessary in order to satisfy the SDWA and UIC statutory and regulatory requirements, and in order for the applicant to demonstrate an ability to contain the mining fluids.

Lastly, the cumulative impacts analysis prepared by EPA does not appear to account for (1) the September 2014 two-page announcement from U.S. EPA stating that it has completed a Preliminary Assessment (PA) of the Darrow/Freezeout/Triangle abandoned uranium mines located within the area of the proposed Dewey-Burdock project; and (2) the September 24, 2014 document from Seagull Environmental Technologies captioned as "Preliminary Assessment Report regarding the Darrow/Freezeout/Triangle Uranium Mine Site near Edgemont, South Dakota, EPA ID: SDN000803095." Attached, labeled Ex. OST-026.

Specifically, EPA's analysis must analyze the causation link not just between the unreclaimed surface mines and surface water contamination, but also ground water contamination. These EPA documents raise the issue of a causal link to the contamination of ground water and nearby ground water wells. The lack of analysis of these issues demonstrates a lack of basis for any findings regarding the baseline hydrogeology, and particularly groundwater connectivity issues at the site.

EPA concedes in these documents that additional data and sample collection for soils and surface waters is needed beyond what NRC Staff required or EPA has yet obtained. EPA states further that this data collection is necessary to better characterize and define source areas at the unclaimed uranium mines. Ex. OST-026 at 30. Importantly, these are the "source areas" for the "observed release to groundwater" that "has occurred at the site." Id. Thus, the fact that the proposed new sampling includes only soil and surface waters does not disconnect this issue from the "observed" ground water contamination.

Further, EPA's analysis reveals that "[s]ome significant data gaps exist within the information reported." Exhibit OST-026 at 29. BEPA analysis reveals for the first time that while "[g]roundwater samples were collected within the area of the Site from various wells; however, lack of ground water sampling data from near and upgradient of the Site limited availability of reliable background concentrations." Id. Also, EPA points out that although soil samples were collected at the site by Powertech, "of the 25 samples collected, only three were analyzed for additional radionuclides including uranium, Pb-210, and Th-230 – the other known contaminants on site." Id. Together, these EPA documents demonstrate that additional investigation is necessary at the site in order to establish the scientifically credible baseline analysis required by the SWDA, UIC regulations, NEPA, and the APA.

All considered, the discussion presented herein demonstrates that the applicant, and EPA, have failed to provide an adequate baseline geology and hydrogeology analysis and as a result fails to adequately analyze the impacts associated with the proposed mine, particularly on groundwater resources and with respect to the applicant's ability to contain mining fluid.

V. FAILURE TO ADEQUATELY DESCRIBE OR ANALYZE PROPOSED MITIGATION MEASURES

Although EPA lists various mitigation measures that may be used to lessen the impacts from the proposed mining operations, these lists lack any detail necessary for the decisionmakers or public to assess the likely effectiveness of these measures. Further, many of the most crucial mitigation proposals are simply proposals to develop mitigation plans in the future. Reliance on a future, as yet-unsubmitted, mitigation to prevent/mitigate adverse impacts to the resources at the site fails to provide the detail necessary to gauge the impacts of the proposed mining operation.

The as-yet developed mitigation relied upon in the EPA's analysis even includes such basic and critical things as post-permit issuance pump tests and hydrologic wellfield packages to determine the ability to contain mining fluids and future consultation under the National Historic Preservation Act to develop and evaluate alternatives or modifications to the undertaking that could avoid, minimize or mitigate adverse effects on historic properties. These represent fundamental aspects and impacts of the mining and in order to assess the impacts of the mine proposal cannot be simply deferred to a later date.

Similarly, the application material and EPA analysis inappropriately defers meaningful review of mitigation until later permits to be considered by the State of South Dakota. These deferred analyses include detailed monitoring and mitigation plan for the state of South Dakota permits associated with the potential land application of wastes, as well as the groundwater discharge permit for the land application. Definition of critical features are left to the future, such as the monitoring program with wells that define the perimeter of operational pollution.

Other mitigation plans left to future development include an avian and wildlife impact and mitigation plans that are being developed in concert with state and federal agencies necessary to keep wildlife from risking contamination from mine site facilities. However, the details of these plans are not proposed to be developed until approved by the South Dakota Department of Environment and Natural Resources and Game and Fish as a permit condition before any construction begins. Thus, instead of analysis in the EPA documentation, the agency simply lists possible mitigation measures without a meaningful review of the details or the effectiveness of the proposed measures. This in turn leaves the public without the ability to provide meaningful input on the mitigation plans.

Instead of presenting well-developed mitigation plans and analyzing their effectiveness in eliminating impacts, the EPA and applicant simply list and mention mitigation measures, and assert that they may be successful in eliminating or substantially reducing the Project's adverse impacts. Under relevant administrative law, a competent cumulative impact review requires that assertions of effectiveness must be supported by substantial evidence in the record. Without the necessary analysis in the impact review, EPA conclusions are arbitrary and capricious in relying on mitigation to conclude that there would be no significant impact to impacts resources.

Review of EPA's impact reviews reveals that disclosure and analysis of impacts are insufficient where the mitigation analysis consists largely, if not exclusively, of a list of plans to be developed later, outside the permitting process and the public review. For instance, with regard to the cultural resources impacts, the agency concedes that consultation is not complete, although that is the process through which impacts are assessed and mitigated. As discussed herein, reliance on a discredited Programmatic Agreement ("PA") is insufficient. Indeed, the PA itself simply defers mitigation planning to some future time.

Instead of providing a reasonably complete discussion of mitigation and providing an analysis of the effectiveness of those mitigation measures, the EPA analysis repeatedly refers to various commitments by the applicant to mitigate impacts by submitting plans in the future as a result of license conditions imposed by the draft permits and the NRC process. These future plans encompass mitigation for a broad scope of impacts, including such basic elements as requiring the applicant to conduct hydrogeological characterization and aquifer pumping tests in each wellfield to examine the hydraulic integrity of the Fuson Shale, which separates the Chilson and Fall River aquifers; a commitment from the applicant to locating unknown boreholes or wells identified through aquifer pump testing, and committing to plugging and abandoning historical wells and exploration holes, holes drilled by the applicant and any wells that fail mechanical integrity tests.

However, no discussion or analysis is provided to explain how an applicant might go about identifying abandoned holes or analyzing the effectiveness of long-after-the-fact plugging and abandonment, nor is any discussion given to what methodology or effectiveness criteria accompanies the pump tests or monitoring well systems. Similar gaps in the analysis exist in the failure of the EPA analysis to assess a plan to review groundwater restoration only for a period of 12 months. There is no support of basis for this time period, nor any discussion of the basis or effectiveness of such a time period. Further, no alternative time periods were analyzed.

Other proposed groundwater impact mitigation that lacks reasonably complete review and analysis as to effectiveness include a proposed, but unevaluated, monitoring well network for the Fall River aquifer in the Burdock area for those wellfields in which the Chilson aquifer is in the production zone in order to address uncertainties in confining properties of the Fuson Shale because leakage may occur through the Fuson Shale and draw-down induced migration of radiological contaminants from abandoned open pit mines in the Burdock area. Despite having none of this information or plans developed, the EPA nevertheless concludes that the risks of this type of contamination are expected to be small. Such unsubstantiated conclusions based on unsubmitted, unreviewed, and even undeveloped mitigation plans are not allowable under the SDWA, UIC regulations, NEPA, or APA.

Historic evidence demonstrates that ISL uranium mines have a very poor record of restoring ground water aquifers – in fact, none have ever actually restored an aquifer used to conduct ISL uranium mining. <u>See</u> J.K. Otton, S. Hall, “In-situ recovery uranium mining in the United States: Overview of production and remediation issues,” U.S. Geological Survey, 2009 (IAEA-CN-175/87), Hall, S. “Groundwater Restoration at Uranium In-Situ Recovery Mines, South Texas Coastal Plain,” USGS Open File Report 2009-1143 (2009), Darling, B., “Report on Findings Related to the Restoration of In-Situ Uranium Mines in South Texas,” Southwest Groundwater Consulting, LLC (2008). The EPA cannot provide information to the public concerning unmitigated impacts where groundwater mitigation plans have not been developed or analyzed for effectiveness.

The same problems exist where the EPA analysis lacks sufficient detail and simply requires plans to be submitted in the future to address other impacts, including air impacts, land disposal of radioactive waste, wildlife protections, and BMPs for storm water control. As discussed, for the most part, these mitigation measures are simply plans to make plans at some point in the future – outside of the public process and shielded from public review or comment. Such assurances, without any details as to the mitigation to be proposed and without evaluation of how effective these restorations efforts are expected to be, do not satisfy EPA's obligations.

Other aspects of the EPA and applicant analysis suffer from the same frailty. Specific examples of mitigation measures that are vaguely and inadequately referenced include:

- Reliance on the future submission and potential issuance of a National Pollution Discharge Elimination Standards ("NPDES") permit to specify mitigation measures and best management practices ("BMPs") to prevent and clean up spills.

- A Fish and Wildlife Service ("FWS") raptor monitoring and mitigation plan has not been developed despite confirmed raptor activity in the project area.

- FWS permits to avoid and mitigate impacts to Bald Eagles' use of three existing Bald Eagle nests.

- Ongoing development of mitigation plans for listed species.

- Generic reference to working BLM mitigation and reclamation guidelines.

- Vaguely referenced and unspecified sound abatement controls.

- Generically referenced mitigation of evaporation pond impacts that are and deferred to later analysis under the Clean Air Act's Hazardous Air Pollution provisions.

- Groundwater mitigation where Powertech excluded such mitigation measures from its proposal or merely assumed compliance with applicable requirements.

In summary, EPA has not met its duty to analyze the impacts of the proposal, cumulative and otherwise.

Lastly on this point, the EPA and Powertech documents continues to rely on Powertech's intent to dispose of its liquid chemical waste via a Class V underground injection control permit. However, the disposal of waste, and particularly radioactive waste, below the lower-most aquifer that serves as an Underground Source of Drinking Water (USDW), as proposed here, is not a Class V activity. Rather, such disposal is a

Class I underground disposal well. Compare, 40 C.F.R. § 144.80(a) (Class I – deep injection) with 40 C.F.R. § 144.80(e) (Class V – shallow injection). Further demonstrating this fact is the State of South Dakota's Department of Environment and Natural Resources, which classifies any well that proposes to be used for injection of either hazardous or non-hazardous liquid waste, or municipal waste, as a Class I UIC well. See, Chart located on the State of South Dakota's website: http://denr.sd.gov/des/gw/UIC/UIC_Chart.aspx. Importantly, the State of South Dakota specifically and unambiguously precludes operation or construction of any Class I UIC wells within its borders. Indeed, the applicable regulatory provision is even broader, stating in its entirety: "Class I and IV disposal wells prohibited. No injection through a well **which can be defined as** Class I or IV is allowed." S.D. Admin. R. § 74:55:02:02 (emphasis added). This is a significant issue, which the EPA analysis must address.

VI. INADEQUATE ANALYSIS OF DISPOSAL OF SOLID 11E2 BYPRODUCT MATERIAL

The EPA and applicant documentation indicate an intent to use the White Mesa Uranium Mill near the White Mesa Ute Community in Utah as the site for disposal of the radioactive wastes (known as 11e2 Byproduct material) generated by at the proposed Powertech Facility. The EPA analysis fails to acknowledge that the White Mesa Mill is not licensed to receive or dispose of all forms of Powertech's 11e2 Byproduct Material. EPA's draft permits do not, and cannot, authorize Powertech to dispose of 11e2 Byproduct Material at White Mesa. EPA appears to have failed to compare the impacts of transporting and disposing of the solid 11e2 Byproduct Material in Utah against any other alternative disposal site. Further, EPA's cumulative impact report fails to address the cumulative impact or alternatives to Utah licensing the White Mesa Mill as the disposal facility for the ISL wastes.

The EPA documents fail to provide a meaningful review of foreseeable impacts of generating many tons of solid 11e2 Byproduct Materials. Instead, EPA relies on blanket statements that permanent disposal will simply occur in conformance with applicable laws. This uncritical approach does not analyze any of the applicable criteria of regulations applicable to such 11e2 Byproduct Material disposal.

A proper review by EPA must ensure that the impacts and alternatives of creation, storage, and disposal of mill tailings – aka 11e2 Byproduct Material - are fully analyzed and addressed. Permanent disposal of solid 11e2 Byproduct material is a central feature of the proposed mining operation and a competent review must include an analysis of the impacts or alternatives to shipment and disposal at White Mesa. The NRC environmental documents confirm that White Mesa lacks a license approval from Utah to accept and dispose of the wastes created by the draft license or other NRC-licensed ISL facilities in the region. However, neither NRC's nor EPA's analysis includes a review of the impacts such disposition would entail, compares those impacts to other reasonable disposal alternatives, or assess whether disposal at White Mesa facility can be accomplished in accordance with applicable State and federal requirements.

The EPA's cursory discussion of the disposal of Powertech's 11e2 material contains no analysis of whether or not Utah law or the Mill owner's (Energy Fuels) license would allow the interstate transport and disposal of this waste given the history of leaks and violations at the White Mesa facility. Interstate transportation impacts across the Intermountain West are evident, but are dismissed without specific analysis. The EPA presents no information on the type of containers that would be required for the shipments to White Mesa and no corresponding information on the moisture content of the solid 11e2 Byproduct Materials or the anticipated decommissioning wastes.

EPA identifies no other site that is currently licensed to dispose of 11e2 Byproduct Material, implying that no other licensed facility exists in the United States that could accept the Powertech 11e2 Byproduct Material. Whether or not this is the case, White Mesa is not currently licensed to accept Powertech wastes.

The failure to address and license the disposal of solid 11e2 Byproduct Material is not a technical deficiency that can be ignored or pushed off until a later time. EPA has a duty to provide specific information, analysis, and alternatives regarding this major feature of an ISL operation in order to allow the Tribe, the Ute Mountain Ute Tribe, the public, and other government decisionmakers to conduct a meaningful analysis of the full scope of environmental impacts involved with Powertech's proposal.

Upon selecting the White Mesa Mill as the proposed destination for the waste from this proposal and the region, as the EPA documentation has done, EPA must follow through with the necessary analysis. The cumulative impacts report lacks analysis of disposal alternatives, including, but not limited to, access, geology, hydrogeology, quantitative impacts upon water supplies for domestic use, livestock, agriculture, non-domesticated plants and animals, and qualitative on-going and subsequent impacts to water supplies due to releases of chemicals into the surface, groundwater and aquifers flowing through the disposal site. Without such an analysis, EPA, the public, other governmental entities, and the Tribe have no basis to identify and assess alternatives to the license application and find ways to avoid or mitigate possible adverse environmental impacts of the proposed mine.

EPA must provide extra scrutiny to the packaging and transport of these wastes. Other NRC-licensed ISL projects have sent unspecified liquid radioactive wastes in leaking trucks.

The apparent violations involving the Smith Ranch include:

1. the failure to accurately assess the activity of pond sediment and barium sulfate sludge waste shipments;
2. the failure to adequately report the total activity for waste and resin shipments on the associated shipping documents;
3. the failure to accurately label waste shipment packages;
4. the failure to classify and ship the waste packages as Low Specific Activity level two (LSA-II) material;

5. the failure to ship LSA-II waste material in appropriate containers;
6. the failure to ensure by examination or appropriate tests that packages were proper for the contents to be shipped and closure devices were properly secured;
7. the failure to perform evaluations or perform tests that ensured the transportation package would be capable of withstanding the effects of any acceleration and vibration normally incident to transportation;
8. the failure to provide the name of each radionuclide listed and an accurate chemical description of contents; and
9. the failure to provide function specific training to a hazmat employee concerning the requirements that are specifically applicable to the functions the employee performed.

http://www.wise-uranium.org/umopuswy.html#SMITHR (NRC Inspection Report Apr. 3, 2017) The WISE-Uranium site reports a series of problems indicating the ISL industry appears to be plagued with irregularities and other problems that question NRC's licensing and regulatory diligence. Id., see also http://www.wise-uranium.org/new.html (ISL Spill of the Day). Under these circumstances, EPA must not simply rely on NRC's assumptions and must instead diligently investigate and carry out its own analysis of the radioactive and hazardous waste stream involved with the SDWA permitting.

VII. THE EPA HAS AN INDEPENDENT DUTY TO CARRY OUT WILDLIFE SURVEYS AND TO COMPLY WITH THE ENDANGERED SPECIES ACT AND MIGRATORY BIRD TREATY ACT.

Even though the federal approval process has been segmented into individual approvals by NRC, BLM and EPA over the course of a decade, each federal agency (and staff) must satisfy out its independent duties to comply with the Endangered Species Act (16 U.S.C. § 1531 et. seq) ("ESA"), Migratory Bird Treaty Act ("MBTA"), and Bald and Golden Eagle Protection Act (BGEPA) (16 U.S.C. §§ 668-668d). Each agency must demonstrate compliance before taking action that could take, kill, harm, or otherwise impact the protected species. Failure to comply with these laws can subject the agency and its staff to civil and criminal penalties, unless the harm to the protected species is allowed by a lawfully approved permit issued by the U.S. Fish and Wildlife Service ("U.S. FWS"). EPA lacks U.S. FWS's special expertise in wildlife, and it is U.S. FWS that has permitting authority under federal wildlife laws. For ESA-listed species, EPA and must use "all methods and procedures which are necessary" to "prevent the loss of any endangered species, regardless of the cost." Roosevelt Campobello Intern. Park v. U.S. E.P.A., 684 F.2d 1041, 1048-49 (1st Cir. 1982), *quoting* TVA v. Hill, 437 U.S. at 185, 188 n.34 (1978).

Powertech and NRC prepared biological surveys that were wholly inadequate and limited in scope. Over the course of a decade, those surveys have become stale and do not correspond to current ecological baselines and status of current listings. Even with the limited survey methods, NRC determined that the Powertech project may affect and even cause prohibited take to listed species, including Whooping Cranes, Greater sage grouse (active leks), Bald Eagles, and Golden Eagles. Courts have set aside agency action that lacks accurate and current data on Greater sage grouse because "inaccurate information and unsupported assumption materially impeded informed decisionmaking and public participation. Or. Nat. Desert Ass'n v. Jewell, 840 F.3d 562, 570 (9th Cir. 2016). EPA cannot simply turn a blind eye to the protected wildlife that may be affected by the activities subject to SDWA permitting.

NRC's FSEIS confirms impacts to MTBA-listed species. See, e.g., FSEIS at 4-97 to 4-98 ("All of these birds are BLM sensitive species and protected by the MBTA."). NRC's FSEIS confirmed that prohibited take of protected species:

> NRC staff expect that similar potential impacts described in SEIS Section 4.6.1.1.1.1.2, including injury or mortality from vehicles and electrical lines, fragmentation, vegetation conversion, and loss of breeding habitat, for nongame and migratory birds will also potentially impact chestnut-collared longspur, dickcissel, loggerhead shrike, and blue-grey gnatcatcher.

FSEIS at 4-98.

EPA's ESA consultation duties, 16 U.S.C. § 1536(a)(2) ("Section 7") are triggered because Section 7 "appl[ies] to all actions in which there is discretionary Federal involvement or control." 50 C.F.R. § 402.03. "Action" is defined as "all activities or programs of any kind authorized or carried out, in whole or in part, by Federal agencies…." 50 C.F.R. § 402.02. EPA is carrying out agency action, and therefore must carry out Section 7 consultation duties or risk civil and criminal penalties for take. Similarly, Powertech does not appear to have applied for a Section 10 permit, and similarly faces ESA penalties for any "take" it may cause. 16 U.S.C. § 1539(a)(1)(B); 50 C.F.R. § 17.32(b).

NRC's FSEIS reveals that active bald eagle and other raptor nests are known to exist in and near the proposed project site. FSEIS at 4-147, *accord* at 3-46 ("Five confirmed, intact raptor nests and one potential nest site were observed within the proposed project area, and the applicant identified two additional nests within a 1.6-km [1-mi] radius of the study area (Powertech, 2009a)"). EPA's SDWA permitting thus is likely involves prohibited take under federal wildlife laws, including direct and cumulative impacts on normal breeding, feeding, and/or sheltering behavior of bald eagles due to at least one confirmed, active nest in the project area. FSEIS at 3-46 to 3-47. Similarly, MTBA-listed raptor species, including "red-tailed hawk, American kestrel, and northern harrier [which] were the most commonly seen raptor species in the proposed project area and will be the primary raptor species impacted by project activities." FSEIS at 4-149.

EPA's SDWA duties independently trigger compliance with federal wildlife laws before any decisions can be issued on Powertech's application.

ORDINANCE NO. 07-40

ORDINANCE OF THE OGLALA SIOUX TRIBAL COUNCIL
FOR THE OGLALA SIOUX TRIBE
(An Unincorporated Tribe)

ORDINANCE OF THE OGLALA SIOUX TRIBAL COUNCIL ENACTING THE OGLALA SIOUX TRIBE NATURAL RESOURCES PROTECTION ACT OF 2007.

WHEREAS, the Oglala Sioux Tribe has adopted its Constitution and By-Laws by referendum vote on December 14, 1935, in accordance with Section 16 of the Indian Reorganization Act of 1934 (25 U.S.C. § 476), and under Article IV of the Oglala Sioux Tribe Constitution the Oglala Sioux Tribal Council is the governing body of the Pine Ridge Indian Reservation, and

WHEREAS, the Oglala Sioux Tribal Council is vested with authority "to protect and preserve the natural resources of the Tribe, and to regulate the use and disposition of property upon the reservation" under Article IV, Section 1(m) of the Oglala Sioux Tribal Constitution, and (n) "to protect the health and general welfare of the Tribe", and

WHEREAS, the purpose of the Oglala Sioux Tribe's Natural Resources Protection Act of 2007 is to ensure that no damage will come to the people, the culture, the environment, including the air and water, and economy of the Oglala Sioux Tribe because of uranium mining or processing in the region of the Upper Midwestern United States, and

WHEREAS, the Oglala Sioux Tribal Council finds that the wise and sustainable use of the Natural Resources traditionally has been and remains a matter of paramount governmental interest to the Oglala Sioux Tribe and a fundamental exercise of Oglala Sioux Tribal sovereignty, and

WHEREAS, the Oglala Sioux Tribal Council supports preserving and protecting all of the natural resources within the confines of the Pine Ridge Indian Reservation especially the air, water, and earth as these resources are the foundation of life, and

WHEREAS, the Oglala Sioux Tribal Council affirms that it is the duty and responsibility of the Oglala Sioux Tribe to protect and preserve the natural world in its purest form for the life of future generations, and

WHEREAS, the Oglala Sioux Tribal Council upholds the right and freedom of the people to be respected, honored and protected with a healthy physical and mental environment, and

WHEREAS, the Oglala Sioux Tribal Council finds that there is a reasonable expectation that future mining and processing of uranium in the region of the Upper Midwestern United States will generate

ORDINANCE NO. 07-40
Page Two

economic hardships to the Oglala Sioux Tribe. These economic hardships include but are not limited to the potential damage to the land, air, water, vegetation, and other natural resources of the Oglala Sioux Tribe, now

THEREFORE BE IT ORDAINED, that the Oglala Sioux Tribal Council does hereby declares the Pine Ridge Indian Reservation, including it aboriginal territory boundaries to be a nuclear-free area for the protection of the people and the Natural Resources of the Oglala Sioux Tribe. Any person, agency or entity, including federal, state, and county governments, or corporations, businesses, or companies who shall cause any nuclear pollution or contamination to enter the confines of the Pine Ridge Indian Reservation, including its 1851 & 1868 Treaty boundaries and aboriginal territory boundaries, shall be prosecuted to the fullest extent of the law.

C-E-R-T-I-F-I-C-A-T-I-O-N

I, as the undersigned Secretary of the Oglala Sioux Tribal Council of the Oglala Sioux Tribe hereby certify that this Ordinance was adopted by the vote of: 16 for; 0 against; 0 abstaining; 1 not voting during a REGULAR SESSION held on the 7th day of AUGUST 2007.

Elizabeth Waters

ELIZABETH WATERS
Secretary
Oglala Sioux Tribe

A-T-T-E-S-T:

John W. Yellow Bird Steele

JOHN W. YELLOW BIRD-STEELE
President
Oglala Sioux Tribe

RECEIVED
AUG 9
BIA SUPERINTENDENT
PINE RIDGE AGENCY, SD

ORDINANCE NO. 11-10

ORDINANCE OF THE OGLALA SIOUX TRIBAL COUNCIL
OF THE OGLALA SIOUX TRIBE
(An Unincorporated Tribe)

ORDINANCE OF THE OGLALA SIOUX TRIBAL COUNCIL ESTABLISHING PROCEDURES FOR GOVERNMENT-TO-GOVERNMENT CONSULTATION BETWEEN THE OGLALA SIOUX TRIBE AND THE UNITED STATES GOVERNMENT, AND OTHER GOVERNMENTS.

WHEREAS, the Government-to-Government relationship between the Oglala Sioux Tribe was established in the United States Constitution, Article 6 (Supremacy Clause); the Treaty of July 2, 1825, United States-Oglala Band of Sioux Nation, 7 Stat. 252; Rev. Stat. § 2116, 25 U.S.C. § 177 (*codifying* section 12 of the Trade and Intercourse Act of June 30, 1834, ch. 161, 4 Stat. 730); the Treaty of September 17, 1851, United States-Teton Division of Sioux Nation, *et al.*, 11 Stat. 749; the Treaty of April 29, 1868, United States-Sioux Nation,15 Stat. 635; Rev. Stat. § 2079, 25 U.S.C. § 71 (*codifying* the Act of March 3, 1871, ch. 120, § 1, 16 Stat. 566), the Indian Reorganization Act of June 18, 1934, ch. 476, 48 Stat. 984, 25 U.S.C. § 461 *et seq.*, the Indian Self-Determination and Education Assistance Act of January 4, 1975, P.L. 93-638, 88 Stat. 2203, 25 U.S.C. § 450, *et seq.*, and other Congressional enactments, and

WHEREAS, the 1851 Treaty recognized title in the Oglala Band to 60 million acres of territory currently in the States of North Dakota, South Dakota, Nebraska, Montana and Wyoming for the Oglala Sioux Tribe and other Sioux tribes, and

WHEREAS, a permanent homeland was established within the 1851 Treaty territory for the "absolute and undisturbed use and occupation" of the Oglala Sioux Band and other Sioux bands, which homeland has been referred to as the "Great Sioux Reservation" and comprises substantially all of present day South Dakota west of the east bank of the Missouri River, and

WHEREAS, the Indian Claims Commission also found that the Oglala Band and other Sioux bands held aboriginal (non-treaty) title to 14 million acres east of the Missouri River in the States of North Dakota and South Dakota, and

WHEREAS, uncontested encroachments on the 1851 Treaty territory by the United States and its citizens resulted in the Powder River War of 1866-1868 between the United States and the Oglala band and other bands of Sioux Indians. as a result of which, peace was concluded between the United States and the Oglala Band and other Sioux bands by treaty on April 29, 1868, 15 Stat. 635 ("1868 Fort Laramie Treaty," which treaty was duly ratified by the United States on February 16, 1869 and proclaimed by the President on February 24, 1869, and

WHEREAS, the 1868 Treaty provided for a mutual demobilization of the United States and Oglala Band and other Sioux bands without terms of surrender on either side, and as a result thereof, the Oglala Band and other Sioux bands were never militarily conquered by the United States, and the Oglala Band has abided by the 1868 Treaty and resided on its reservation in accordance of the terms of the treaty since 1868, except for incidences in Montana in 1876 where the Oglala Band and other Sioux bands were legally exercising its 1868 Treaty, Article 11, hunting rights and yet had to defend themselves from attack by the United States Cavalry in violation of Articles 1 and 11 of the 1868 Treaty, and

WHEREAS, subsequent to ratification of the 1868 Treaty, no aboriginal or treaty territory of the Oglala Band was ever acquired by the United States in accordance with 25 U.S.C. § 177 or Article 12 of the 1868 Treaty, and all acquisitions of Oglala Band's territory was either confiscated by the United States or acquired with the requisite consent of the Band, and

WHEREAS, the "Oglala Band" reorganized in 1936 as the "Oglala Sioux Tribe of the Pine Ridge Indian Reservation" under Section 16 of the 1934 Indian Reorganization Act of June 18, 1934, ch. 576, 48 Stat. 987, 25 U.S.C. § 476, by adopting a constitution and bylaws approved by the Secretary of the Interior, and presently enjoys all of the rights and privileges guaranteed under its existing treaties with the United States in accordance with 25 U.S.C. § 478b

WHEREAS, as a result of its unique government-to-government relationship with the United States, and because the Oglala Band (now Oglala Sioux Tribe) is one of the few militarily unconquered Sioux tribes in the United States and all of its territory now in the possession of the United States was acquired without its consent, the Oglala Sioux Tribe still possesses very strong aboriginal rights within all the territory that comprised its aboriginal homeland, and as a result thereof, the Tribe has both a domestic and international rights to government-to-government consultations with the United States on the formulation of federal policies, or on all federal actions or undertakings that adversely affect its aboriginal and treaty territories, and

WHEREAS, the Executive Branch of the united States Government has recognized the right of government-to-government consultations with Indian Tribes in:

a. President Clinton's Memorandum of April 29, 1994, which, among other things, directed agencies to:

(i) "ensure that the department or agency operates within a government-to-government relationship with Federally-recognized Trial government,"

(ii) "consult, to the greatest extent practicable ad to the extent permitted by law with Tribal governments prior to taking actions that affect Federally recognized tribes, to be open and candid so that all interested parties may evaluate for themselves the potential impact of relevant proposals," and

(iii) "assess the impacts of Federal government plans, projects, programs, and activities on tribal trust resources to assure that Tribal government rights and concerns are considered during the development of such plans, projects, and activities."

b. President Clinton's Executive Order No. 13084 of May 19, 1998, which directed federal agencies to respect tribal self-government and sovereignty, tribal rights, and tribal responsibilities whenever they develop policies "significantly affecting Indian tribal governments,"

c. President Clinton's Executive Order No. 13175 of November 6, 2000, which directed all federal agencies to establish consultation and collaboration with tribal officials in the development of federal policies that have tribal implications, and

d. President Barak Obama Memorandum of November 5, 2009, to the heads of the Executive Department and federal agencies to submit plans of actions that the agencies will take to implement the policies and directives of President Clinton's Executive Order 13175,

and

WHEREAS, Congress has also mandated government-to-government consultation with Indian tribes, which have been implemented in statutes, orders, regulations, rules, policies, manuals, protocols and guidance, most of which are described in a document issued by the White House- Indian Affairs Executive Working Group (WH-IAEWG), dated January, 2009, and entitled "List of Federal Tribal Consultation Statutes, Orders, Regulations, rules, Policies, Manuals, protocols and guidance," and

WHEREAS, the Oglala Sioux Tribe has never enacted legislation (ordinances) establishing procedures for government-to-government consultation between the Tribe and the United States, and believes that such procedures are necessary to establish a clear process for documenting the nature and results of consultations between the Tribe and the United States and its agencies, now

THEREFORE BE IT ORDAINED, that the following sections relating to government-to-government consultations are hereby adopted for the Oglala Sioux Tribe.

Section 1. **Title.** This ordinance shall be known and referred to as the Oglala Sioux Tribe Consultation and Coordination Ordinance of 2001.

Section 2. **Definitions.** The following words and phrases used in this Election Code shall have the following meanings:

"Consultation" and/or "government-to-government" consultation shall mean the formal process of cooperation, negotiation, and mutual decision making between the Oglala Sioux Tribe and the United States Government, and other governments. It is the process through which sovereign governments develop a common understanding of technical and legal issues and use this understanding to formulate mutually agreeable decisions.

Section 3. **Scope.** This ordinance is intended to extend to:

a. All of the aboriginal homeland of the Oglala Sioux Tribe, including, the 60 million acre territory Sioux territory described in Article 5 of the 1851 Ft. Laramie Treaty; the territory and the expanded hunting rights territory described in Articles 2, 11 and 16 of the 1868 Ft. Laramie Treaty;

b. All of the aboriginal title (non-treaty) Sioux territory comprising 14 million acres located east of the Missouri River in the present states of North Dakota and South Dakota; and

c. All undertakings and actions that adversely affect the Oglala Sioux Tribe's aboriginal, treaty or statutorily recognized rights and interests within its aboriginal and treaty recognized territories.

Section 4. Purpose. The primary purpose and intent of this ordinance is to:

a. Establish a clear process for documenting the nature and results of government-to-government consultations between the Oglala Sioux Tribe and Federal Government and its agencies;

b. Provide a consistent, orderly process to government-to-government consultation to make and ensure that government-to-government consultations are meaningful and effective, and

c. Be applicable, to the fullest extent possible, for documenting the nature and results of government-to-government consultations between the Oglala Sioux Tribe and other Indian tribes, inter-tribal organizations and state governments and agencies.

Section 5. Authority. This ordinance is adopted pursuant to the Oglala Sioux Tribe's inherent sovereignty and Article IV, Section 1 (a) of the Amended Constitution of the Oglala Sioux Tribe, which empowers the Tribal Council "(a) To negotiate with the Federal, State, and local governments, on behalf of the tribe, and to advise and consult with representatives of the Interior Department on all activities of the Department that may affect the Pine Ridge Indian Reservation."

Section 6. Principles and guidelines. All government-to-government consultations between the Oglala Sioux Tribe and the Federal Government, and State or other tribal governments, shall be conducted with the Oglala Sioux Tribe under the following principles and guidelines:

a. The Oglala Sioux Tribe is a sovereign government with attendant powers;

b. All treaties between the Oglala Sioux Tribe and the United States must be honored and enforced to the fullest extent possible;

c. The Oglala Sioux Tribe has never been militarily conquered by the United States, and has existed in a peaceful relationship with the United States since 1868, pursuant to Article I of the 1868 Ft. Laramie Treaty; and

d. The Oglala Sioux Tribe and its territories are not possessions of the United States.

Section 7. **Procedures.** All consultation between the Oglala Sioux Tribe and the Federal Government, and State or other tribal governments, must:

WHEN CONSULTATION IS REQEUSTED BY THE FEDERAL GOVERNMENT OR OTHER GOVERNMENTS

a. Occur through a formal meeting with the Oglala Sioux Tribal Council. Neither the Executive Committee nor any Executive Committee member or staff member of the Tribe shall be authorized to engage in government-to-government consultations with any government or governmental agency;

b. Accomplish the goals and objectives described in Section 8.

c. Be initiated by serving a formal written request for government-to-government consultation with the Secretary of the Oglala Sioux Tribe. The request for consultation should describe the impending, proposed project or activity that may or may not affect the Oglala Sioux Tribe's interests in its aboriginal or treaty territory and/or rights or interests therein. This include the Tribes aboriginal and treaty territory both within and outside the exterior boundaries of the Pine Ridge Indian Reservation;

d. It shall be the duty of the Tribal Secretary to immediately notify all members of the Executive Committee and Tribal Council of each request for consultation;

e. Upon receipt of a request for consultation, the Tribal President, or council members under established procedures, shall call a special council meeting for the purpose of responding to the request for consultation. The Tribal Council shall:

(i) Request by resolution a policy-level meeting, initiating government-to-government consultations;

(ii) Authorize the Tribe's technical staff (and when appropriate the Tribe's attorneys) to meet with the responding government's technical staff to discern and define the issues that are subject to the request for consultation including how the proposed governmental undertaking or activity affects the tribe's aboriginal, treaty, statutory or other interests;

(iii) Schedule a special council meeting in which the Tribe's technical staff (and when appropriate the Tribe's attorneys) can fully brief the Tribal council on the issues that are subject to consultation, with recommendations and opinions;

(iv) Schedule a follow-up special council meeting in which the Tribe through the Tribal council shall engage in formal government-to-government consultation based on the recommendations and opinions of its staff (and attorneys); and

(v) Pass a resolution fully articulating the Tribe's formal decision, which decision shall be consistent with the provisions of this ordinance.

WHEN CONSULTATION IS REQEUSTED BY THE OGLALA SIOUX TRIBE

a. Be initiated by passing a tribal council resolution requesting government -to-government consultation, which resolution shall be executed and sent by the Tribal President to appropriate official of the Federal Government or tribal or state government with which consultation is desired;

b. Follow the procedure described in Subsections 7.e. (i) through (v) above; and

c. Accomplish the same objectives described in Section 8.

Section 8. Objectives. All government-to-government consultations should ensure the following results:

a. Tribal officers and officials proceed in a dignified, orderly manner, keeping in mind that the Oglala Sioux Tribe is engaging in the consultations as a sovereign government that maintains government-to-government relations with the United States Government and other governments. Tribal officials engaging in consultation should dress in appropriate attire during the consultation proceedings, and conduct themselves in a professional, dignified, and diplomatic manner;

b. Tribal officers and officials fully understand the issues to be discussed prior to engaging in and consultation proceeding; this includes an understanding of tribal history, federal treaties and federal statutes, regulations and rules, that will be discussed at each consultation;

c. Ensure that the Tribe's interest are fully protected, including interests in all tracts of land located within the Tribe's aboriginal and treaty territories, and interests therein, as well as tribal cultural resources, human remains, and any other tribal patrimony;

d. Ensure compliance with federal treaties, statutes, regulations and rules and tribal policies (e.g., policy that the Black Hills Are Not For Sale and tribal land claims must include restoration of federally held lands to the Tribe);

Section 9. Documentation. Following any governmental-to-government consultation between the Oglala Sioux Tribe and the Federal government, or other governments, the Tribal Council shall:

a. Achieve a bi-lateral decision between the Tribe and the United States, or other government;

b. Adopt a resolution documenting the nature and results of the consultation and bilateral decision;

c. Direct the Tribal Secretary to file a copy of the resolution and all backup documentation with the Tribal Records Department.

Section 10. Representations. Neither the Federal Government nor any agency thereof, nor any other government, shall legitimately represent to any other government or governmental entity, nor to any third party, that they have consulted with the Oglala Sioux Tribe unless they fully comply with the terms and conditions of this ordinance.

Section 11. Effective Date. This ordinance shall become effective immediately.

Section 12. Repeal of inconsistent ordinances. All previously enacted ordinances are hereby repealed to the extent that they are inconsistent with this ordinance.

C-E-R-T-I-F-I-C-A-T-I-O-N

I, as undersigned Secretary of the Oglala Sioux Tribal Council of the Oglala Sioux Tribe, hereby certify that this Ordinance was adopted by a vote of: 13 For; 1 Against; 0 Abstain; and 0 Not Voting, during a SPECIAL SESSION held on the 7th day of JUNE, 2011.

Rhonda Two Eagle

RHONDA J. TWO EAGLE
Secretary
Oglala Sioux Tribe

A-T-T-E-S-T:

John Yellow Bird Steele

JOHN W. YELLOW BIRD-STEELE
President
Oglala Sioux Tribe

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

COMMISSIONERS:

Stephen G. Burns, Chairman
Kristine L. Svinicki
Jeff Baran

In the Matter of POWERTECH (USA), INC. (Dewey-Burdock *In Situ* Uranium Recovery Facility)	Docket No. 40-9075-MLA

CLI-16-20

MEMORANDUM AND ORDER

This decision addresses four petitions for review relating to a materials license application for an *in situ* uranium recovery facility filed by Powertech (USA), Inc.[1] All parties to the proceeding—the Oglala Sioux Tribe, Consolidated Intervenors, Powertech, and the NRC Staff—have filed petitions for review of the Atomic Safety and Licensing Board's Partial Initial Decision and in the case of the Oglala Sioux Tribe and Consolidated Intervenors, earlier Board decisions finding several of their proffered contentions inadmissible.[2]

[1] Powertech (USA) Inc.'s Submission of an Application for a Nuclear Regulatory Commission Uranium Recovery License for Its Proposed Dewey-Burdock In Situ Leach Uranium Recovery Facility in the State of South Dakota (Feb. 25, 2009) (ADAMS accession no. ML091030707).

[2] LBP-15-16, 81 NRC 618 (2015); *see Oglala Sioux Tribe's Petition for Review of LBP-15-16 and Decisions Finding Tribal Contentions Inadmissible* (May 26, 2015) (Tribe's Petition); *Consolidated Intervenors' Petition for Review of LBP-15-16* (May 26, 2015) (Consolidated Intervenors' Petition); *Brief of Powertech (USA), Inc. Petition for Review of LBP-15-16* (May 26,

As discussed below, we take review of these petitions in part. We grant each party's petition with respect to the finality of the Board's ruling on Contentions 1A and 1B, find that these contentions should be considered "final" for the purposes of the petitions for review at issue here, and, pursuant to our inherent supervisory authority over agency adjudications, direct that the proceeding remain open for the narrow issue of resolving the deficiencies identified in Contentions 1A and 1B. We deny the remainder of Consolidated Intervenors' petition for review. With respect to Powertech's and the Staff's petitions for review, we also take review of the Board's direction to the Staff to address the deficiencies identified in Contentions 1A and 1B and we affirm the Board's direction to the Staff to submit monthly status reports and to file an agreement between the parties or a motion for summary disposition to resolve the deficiencies identified by the Board. We deny the remainder of Powertech's and the Staff's petitions for review. With respect to the Tribe's petition for review, we take review of the Board's rejection of Contention 8 as inadmissible. We find that the Board erred in its reasoning for dismissing Contention 8, but we affirm the Board's decision. We deny the remainder of the Tribe's petition for review.

I. BACKGROUND

In situ uranium recovery involves injecting a solution, called lixiviant, into an ore body through an injection well. As it flows through the ore body, the lixiviant dissolves the underground uranium. A separate production well extracts the uranium-containing solution from the ground. The uranium is then extracted from the solution though a process called ion

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2015) (Powertech's Petition); *NRC Staff's Petition for Review of LBP-15-16* (May 26, 2015) (Staff's Petition).

The Board has referred to Susan Henderson, Dayton Hyde, and Aligning for Responsible Mining as Consolidated Intervenors, although it originally called them Consolidated Petitioners. *See* LBP-14-5, 79 NRC 377, 379 n.3 (2014); LBP-13-9, 78 NRC 37, 42 n.2 (2013).

exchange. After extraction, the lixiviant is recycled and reinjected into the ore body to dissolve more uranium.[3] The *in situ* uranium recovery process is used widely throughout Wyoming, South Dakota, Nebraska, and New Mexico to recover subterranean uranium for enrichment and later use in nuclear power plants.

In order to comply with its National Environmental Policy Act (NEPA) obligations and recognizing the widespread use of this technology in this region of the country, the Staff prepared a generic environmental impact statement (GEIS) to address certain aspects of the environmental analysis for these facilities that tend to be similar across sites.[4] The GEIS also identifies resource areas that require site-specific information to fully analyze the environmental impacts. It also notes that subsequent site-specific environmental review documents may summarize and incorporate by reference information from the GEIS.[5] Any subsequent site-specific environmental impact analysis must also include new and significant information necessary to evaluate the *in situ* recovery license application.[6]

This proceeding began in February 2009, when Powertech filed an application for an *in situ* uranium recovery facility in Custer and Fall River Counties, South Dakota. In response, the Oglala Sioux Tribe and Consolidated Intervenors challenged the license application.[7] The

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[3] Ex. APP-021-A, "Powertech (USA), Inc., Dewey-Burdock Project Application for NRC Uranium Recovery License Fall River and Custer Counties, South Dakota Technical Report," (Feb. 2009), at 1-6 (ML14247A342).

[4] Exs. NRC-010-A-1 to NRC-010-B-2, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities" (Final Report), NUREG-1910, vols. 1-2 (May 2009) (ML14246A328, ML14247A345, ML14246A333, ML14246A332, ML14246A351) (GEIS).

[5] Ex. NRC-010-A-1, GEIS, at xxxvii.

[6] *Id.*

[7] *Petition to Intervene and Request for Hearing of the Oglala Sioux Tribe* (Apr. 6, 2010) (Tribe's Petition to Intervene); *Consolidated Request for Hearing and Petition for Leave to Intervene* (Mar. 8, 2010) (Consolidated Intervenors' Petition to Intervene).

Board granted their hearing requests in August 2010.[8] On November 26, 2012, the Staff issued the Draft Supplemental Environmental Impact Statement (DSEIS) for public comment.[9] The NRC Staff issued a Safety Evaluation Report (SER) in March 2013.[10] On January 29, 2014, the Staff issued the FSEIS.[11] The Staff issued the license to Powertech on April 8, 2014.[12] The

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[8] LBP-10-16, 72 NRC 361, 443-44 (2010).

[9] Exs. NRC-009-A-1 to NRC-009-B-2, "Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota, Supplement to the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities" (Draft Report for Comment), NUREG-1910, Supplement 4, vols. 1-2 (Nov. 2012) (ML14247A350, ML14246A329, ML14246A330, ML14246A331) (DSEIS).

Both the Tribe and individual members of Consolidated Intervenors (Susan Henderson and Dayton Hyde) commented on the DSEIS and later filed proposed contentions relating to the DSEIS. Exs. NRC-008-A-1 to NRC-008-B-2, "Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota, Supplement to the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities" (Final Report), NUREG-1910, Supplement 4, vols. 1-2 (Jan. 2014), app. E, at E-5 to E-6 (ML14246A350, ML14246A326, ML14246A327, ML14247A334) (FSEIS); *see Consolidated Intervenors' New Contentions Based on DSEIS* (Jan. 25, 2013) (Consolidated Intervenors' DSEIS Contentions); *List of Contentions of the Oglala Sioux Tribe Based on the Draft Supplemental Environmental Impact Statement* (Jan. 25, 2013) (Tribe's DSEIS Contentions). On July 22, 2013, the Board admitted three of the new contentions and migrated seven of the originally admitted contentions. LBP-13-9, 78 NRC at 113-15.

[10] Ex. NRC-135, "Safety Evaluation Report for the Dewey-Burdock Project Fall River and Custer Counties, South Dakota" (Mar. 2013) (ML13052A182). The Staff issued a revised SER in April 2014 to correct certain technical references. Ex. NRC-134, "Safety Evaluation Report (Revised) for the Dewey-Burdock Project Fall River and Custer Counties, South Dakota" (Apr. 2014) (ML14245A347).

[11] Exs. NRC-008-A-1 to NRC-008-B-2, FSEIS. On March 17, 2014, the Tribe and Consolidated Intervenors filed additional contentions related to the FSEIS. *Consolidated Intervenors' Statement of Contentions* (Mar. 17, 2014) (Consolidated Intervenors' FSEIS Contentions); *Statement of Contentions of the Oglala Sioux Tribe Following Issuance of Final Supplemental Environmental Impact Statement* (Mar. 17, 2014) (Tribe's FSEIS Contentions). The Board ruled that the contentions previously admitted in reference to the DSEIS migrated to the FSEIS and held inadmissible the remaining proposed contentions. LBP-14-5, 79 NRC at 401.

[12] Ex. NRC-012, License Number SUA-1600, Materials License for Powertech (USA) Inc. (Apr. 8, 2014) (ML14246A408) (License).

Board held an evidentiary hearing on all nine admitted contentions in August 2014. In November 2014, the Tribe moved to file two new environmental contentions.[13]

The Board decision, LBP-15-16, resolved seven contentions in favor of Powertech and the Staff but found deficiencies in the Staff's NEPA analysis and NHPA consultation.[14] The Board upheld the license with an additional license condition, ruled inadmissible the two post-hearing contentions proffered by the Tribe, and directed the Staff to submit monthly reports regarding its progress in resolving the identified deficiencies.[15]

Our decision today involves four petitions for review that were filed by the parties to this proceeding. We summarize each petition below, along with the relevant procedural history for each set of issues. A full procedural history can be found in the Board's various decisions on this matter.[16]

A. The Oglala Sioux Tribe's and Consolidated Intervenors' Petitions for Review

The Oglala Sioux Tribe appeals the Board's resolution of several of its admitted contentions in favor of Powertech and the Staff.[17] The Tribe also seeks review of the Board's ruling on two of its admitted contentions that left the license in place and required the Staff to conduct additional consultation.[18] Consolidated Intervenors petition for review of the Board's decision resolving their admitted contentions in favor of Powertech and the Staff.[19] They further

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[13] *Motion for Leave to File New or Amended Contention on Behalf of the Oglala Sioux Tribe* (Nov. 7, 2014) (Tribe's Motion for New Contentions).

[14] LBP-15-16, 81 NRC at 657-58, 708-10.

[15] *Id.* at 708-10.

[16] *See id.* at 626-35; *see also* LBP-14-5, 79 NRC at 379-81; LBP-13-9, 78 NRC at 43-45; LBP-10-16, 72 NRC at 376-78.

[17] Tribe's Petition at 19-25.

[18] *Id.* at 18-19.

[19] Consolidated Intervenors' Petition at 2 & n.3, 4-7.

challenge the Board's ruling that left the license in place despite ruling in Consolidated Intervenors' favor on two of their admitted contentions.[20]

In Contentions 1A and 1B, the Tribe and Consolidated Intervenors challenged the NEPA analysis of cultural resources in the FSEIS and the Staff's compliance with the National Historic Preservation Act (NHPA).[21] The Board concluded that the Staff had fulfilled its NHPA obligations with respect to identification of historic properties. It nonetheless held that the Staff's analysis in the FSEIS did not satisfy NEPA's hard look requirement regarding cultural resources and that the Staff's consultation with the Tribe had been insufficient to comply with the Staff's additional obligations under the NHPA.[22] The Board retained jurisdiction over these contentions and required the Staff to "promptly initiat[e] a government-to-government consultation with the Oglala Sioux Tribe" to address the deficiencies identified in the Board's decision.[23] The Tribe and Consolidated Intervenors seek review of the Board's decision to leave the license in place pending resolution of Contentions 1A and 1B.[24]

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[20] *Id.* at 3, 6-7.

Consolidated Intervenors have requested that we set a briefing schedule for any issues that we accept for review. *Id.* at 8-9. In accordance with 10 C.F.R. § 2.341(c)(2), we have decided these matters on the basis of the petitions for review, and therefore deny Consolidated Intervenors' request to establish a briefing schedule.

Consolidated Intervenors also challenge the Board's ruling in LBP-10-16 that "certain petitioners" lacked standing to intervene. *Id.* at 2. In their petition, Consolidated Intervenors do not identify which petitioners they are referencing. We therefore deny review of that portion of their petition.

[21] *Oglala Sioux Tribe's Post-Hearing Initial Brief with Findings of Fact and Conclusions of Law* (Jan. 9, 2015), at 12, 27 (Tribe's Post-Hearing Brief); *Consolidated Intervenors' Proposed Findings of Fact and Conclusions of Law and Response to Post-Hearing Order* (Jan. 9, 2015), at 1-2, 14 (Consolidated Intervenors' Post-Hearing Brief).

[22] LBP-15-16, 81 NRC at 653-57.

[23] *Id.* at 657-58, 708, 710.

[24] Tribe's Petition at 18-19; Consolidated Intervenors' Petition at 6-7.

In Contention 2, the Tribe and Consolidated Intervenors argued that the FSEIS did not contain sufficient background groundwater characterization.[25] The Board resolved this contention in favor of Powertech and the Staff, and the Tribe seeks review of the Board's decision.[26]

In Contention 3, the Tribe and Consolidated Intervenors argued that the FSEIS insufficiently analyzed certain geological and manmade features that may permit groundwater migration.[27] The Board resolved this contention in favor of Powertech and the Staff but added a license condition regarding the proper treatment of unplugged boreholes.[28] Both the Tribe and Consolidated Intervenors seek review of the Board's decision.[29]

In Contention 6, the Tribe and Consolidated Intervenors challenged the FSEIS's analysis of mitigation measures and argued that it impermissibly deferred the development of additional mitigation measures.[30] The Board resolved this contention in favor of Powertech and the Staff, and the Tribe seeks review of the Board's decision.[31]

Additionally, the Tribe challenges the Board's decision in LBP-15-16 to reject as inadmissible new contentions submitted after the hearing regarding borehole data and an Environmental Protection Agency (EPA) Preliminary Assessment regarding potential Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

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[25] Tribe's Post-Hearing Brief at 38; Consolidated Intervenors' Post-Hearing Brief at 21.

[26] LBP-15-16, 81 NRC at 666, 708-09; *see* Tribe's Petition at 19-21.

[27] Tribe's Post-Hearing Brief at 43; Consolidated Intervenors' Post-Hearing Brief at 28, 47.

[28] LBP-15-16, 81 NRC at 681, 709.

[29] Tribe's Petition at 22-23; Consolidated Intervenors' Petition at 2 n.3, 4-7.

[30] Tribe's Post-Hearing Brief at 61-62; Consolidated Intervenors' Post-Hearing Brief at 53-56.

[31] LBP-15-16, 81 NRC at 697, 709; Tribe's Petition for Review at 23-25.

cleanup.[32] Further, it seeks review of earlier Board decisions that found two of its contentions (Contentions 7 and 8) inadmissible.[33] In proposed Contention 7, the Tribe argued that the application was deficient because it did not include a reviewable plan for disposal of byproduct material or discuss the environmental effects of such disposal.[34] The Tribe resubmitted this contention on both the DSEIS and the FSEIS, and the Board dismissed it as inadmissible each time.[35] In proposed Contention 8, the Tribe argued that the DSEIS had been issued without the requisite scoping process.[36] The Board held this contention inadmissible, finding that it did not articulate a material dispute, as required by the contention admissibility standards.[37]

Finally, Consolidated Intervenors challenge the Board's decision at the outset of the proceeding finding one of their contentions inadmissible.[38] In proposed Contention D, Consolidated Intervenors argued that Powertech's application was so disorganized that it violated 10 C.F.R. § 40.9, and the Board rejected this portion of the contention as inadmissible.[39]

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[32] Tribe's Petition at 8-11; *see* LBP-15-16, 81 NRC at 704-06, 709.

[33] Tribe's Petition at 3-8.

[34] Tribe's Petition to Intervene at 31-34.

[35] Tribe's FSEIS Contentions at 33-39; Tribe's DSEIS Contentions at 27-30, *see* LBP-14-5, 79 NRC at 396-97; LBP-13-9, 78 NRC at 71-72.

[36] Tribe's DSEIS Contentions at 30-33.

[37] LBP-13-9, 78 NRC at 74-75.

[38] Consolidated Intervenors' Petition at 2 n.3, 3-4, 7.

[39] Consolidated Intervenors' Petition to Intervene at 36; *see* LBP-10-16, 72 NRC at 402.

B. Powertech's and the NRC Staff's Petitions for Review

On appeal, the Staff and Powertech challenge the Board's resolution of Contentions 1A and 1B in favor of the Tribe and Consolidated Intervenors.[40] Additionally, both parties seek review of the Board's retention of jurisdiction over these contentions.[41] Finally, Powertech challenges the Board's imposition of an additional license condition in resolving Contention 3 that requires Powertech to locate and properly abandon unplugged boreholes within each wellfield prior to operations.[42]

II. DISCUSSION

A. Standard of Review

We will grant a petition for review at our discretion, upon a showing that the petitioner has raised a substantial question as to whether

> (i) A finding of material fact is clearly erroneous or in conflict with a finding as to the same fact in a different proceeding;
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> (ii) A necessary legal conclusion is without governing precedent or is a departure from or contrary to established law;
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> (iii) A substantial and important question of law, policy, or discretion has been raised;
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> (iv) The conduct of the proceeding involved a prejudicial procedural error; or
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> (v) Any other consideration that we may deem to be in the public interest.[43]

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[40] Powertech's Petition at 6-22; Staff's Petition at 17, 23. The Tribe filed a response to both petitions on June 22, 2015. *Oglala Sioux Tribe's Consolidated Response to Petitions for Review of LBP-15-16* (June 22, 2015) (Tribe's Response).

[41] Powertech's Petition at 5-6, 6 n.9; Staff's Petition at 13-16, 16 n.73.

[42] Powertech's Petition at 22-25; *see* LBP-15-16, 81 NRC at 709.

[43] 10 C.F.R. § 2.341(b)(4).

We review questions of law *de novo,* but we defer to the Board's findings with respect to the underlying facts unless they are "clearly erroneous."[44] The standard for showing "clear error" is a difficult one to meet: petitioners must demonstrate that the Board's determination is "not even plausible" in light of the record as a whole.[45] For this reason, where a petition for review relies primarily on claims that the Board erred in weighing the evidence in a merits decision, we seldom grant review.[46] In addition, we give substantial deference to the Board on issues of contention admissibility and will affirm admissibility determinations absent a showing of an error of law or abuse of discretion.[47] In *Pa`ina Hawaii, LLC* (Materials License Application) we said the following about our standard of review:

> We refrain from exercising our authority to make *de novo* findings of fact in situations where a Licensing Board has issued a plausible decision that rests on carefully rendered findings of fact. As we have stated many times, while we have discretion to review all underlying factual issues *de novo*, we are disinclined to do so where a Board has weighed arguments presented by experts and rendered reasonable, record-based factual findings. Our standard of "clear error" for overturning a Board's factual findings is quite high. We defer to a board's factual findings, correcting only clearly erroneous findings—that is, findings not even plausible in light of the record viewed in its entirety—where we have strong

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[44] *Honeywell International, Inc*. (Metropolis Works Uranium Conversion Facility), CLI-13-1, 77 NRC 1, 18-19 (2013); *David Geisen*, CLI-10-23, 72 NRC 210, 224-25, 242 (2010).

[45] *Honeywell,* CLI-13-1, 77 NRC at 18 n.102; *Geisen,* CLI-10-23, 72 NRC at 224-25.

[46] *See, e.g.*, *DTE Electric Co*. (Fermi Nuclear Power Plant, Unit 3), CLI-14-10, 80 NRC 157, 162-63 (2014); *Entergy Nuclear Generation Co*. *and Entergy Nuclear Operations, Inc*. (Pilgrim Nuclear Power Station), CLI-12-1, 75 NRC 39, 46 (2012) (stating "where a Board's decision rests on a weighing of extensive fact-specific evidence presented by technical experts, we generally will defer"); *Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc.* (Vermont Yankee Nuclear Power Station), CLI-10-17, 72 NRC 1, 30 (2010) (noting that the Commission is "generally disinclined to upset *fact*-driven Licensing Board determinations") (internal quotations omitted).

[47] *Entergy Nuclear Operations, Inc*. (Indian Point, Units 2 and 3), CLI-15-6, 81 NRC 340, 354-55 (2015); *Calvert Cliffs 3 Nuclear Project, LLC, and UniStar Nuclear Operating Services, LLC* (Calvert Cliffs Nuclear Power Plant, Unit 3), CLI-09-20, 70 NRC 911, 914 (2009); *Southern Nuclear Operating Co*. (Vogtle Electric Generating Plant, Units 3 and 4), CLI-09-16, 70 NRC 33, 35 (2009).

> reason to believe that a board has overlooked or misunderstood important evidence.[48]

B. Contentions Rejected Prior to Hearing

The Tribe and Consolidated Intervenors seek review of three Board decisions that found several of their proposed contentions inadmissible.

1. The Tribe's Proposed Contention 7

In proposed Contention 7, the Tribe challenged the lack of a reviewable plan for disposal of byproduct material as defined in Section 11e.(2) of the Atomic Energy Act of 1954, as amended (byproduct material).[49] The Tribe submitted this contention three times: with respect to the environmental report, the DSEIS, and the FSEIS.[50] In each case, the Tribe provided a different basis for the contention, and the Board dismissed each iteration as inadmissible.[51] In its petition for review, the Tribe argues that the Board "erred at law and abused its discretion" each time it found Contention 7 inadmissible.[52] We do not find that the Tribe raises a substantial question regarding the admissibility of this contention. With respect to each Board decision, the Tribe provides a separate basis to support its petition.

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[48] *Pa`ina Hawaii, LLC* (Materials License Application), CLI-10-18, 72 NRC 56, 72-73 (2010) (internal quotations and citations omitted).

[49] Tribe's Petition to Intervene at 31-34. Section 11e.(2) of the Atomic Energy Act of 1954, as amended, defines "byproduct material" as "the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content." 42 U.S.C. § 2014(e)(2).

[50] Tribe's FSEIS Contentions at 33-39; Tribe's DSEIS Contentions at 27-30; Tribe's Petition to Intervene at 31-34.

[51] *See* Tribe's FSEIS Contentions at 33-39; Tribe's DSEIS Contentions at 27-30; Tribe's Petition to Intervene at 31-34; *see also* LBP-14-5, 79 NRC at 397; LBP-13-9, 78 NRC at 71-72; LBP-10-16, 72 NRC at 434-35.

[52] Tribe's Petition at 3.

a. *Proposed Contention and Board Orders LBP-10-16, LBP-13-9, and LBP-14-5*

The Board rejected Contention 7 in LBP-10-16, finding that the Tribe did not show that Powertech had failed to comply with any NRC or other federal regulation.[53] The Tribe argued that 10 C.F.R. § 40.31(h) and Criterion 1 in Appendix A to 10 C.F.R. Part 40 require Powertech to provide a specific plan for disposal of byproduct material in its application. The Board rejected this argument and explained that—per our case law—these provisions apply to uranium mills, not *in situ* recovery sites.[54] Additionally, the Tribe argued that NEPA required that the application contain a specific disposal plan. The Board disagreed, holding that the Staff, not the applicant, is bound by NEPA.[55] But the Board noted that the Tribe would have the opportunity, if it were not satisfied with the treatment of this issue in the Staff's environmental documents, to renew this contention after issuance of those documents.[56]

The Tribe did just that when it filed a similar contention with respect to the analysis in the DSEIS, which the Board ruled inadmissible in LBP-13-9.[57] The Board determined that the Staff had addressed impacts related to byproduct material in both the DSEIS and the GEIS.[58] The Board observed that, insofar as the Tribe claimed that the contention was one of "omission," the

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[53] LBP-10-16, 72 NRC at 434. The Tribe called this Contention 7 in its initial petition and its DSEIS Contentions. It refers to the same contention as FSEIS Contention 2 in its FSEIS Contentions. To minimize confusion, we will refer to this contention as Contention 7 throughout this decision.

[54] *Id.* (citing *Hydro Resources, Inc.* (2929 Coors Road, Suite 101, Albuquerque, NM 87120), CLI-99-22, 50 NRC 3, 8 (1999) ("We agree with the Presiding Officer's general conclusion that section 40.31(h) and Part 40, Appendix A, 'were designed to address the problems related to mill tailings and not problems related to [*in situ*] mining.'")).

[55] *Id.* at 435.

[56] *Id.*

[57] Tribe's DSEIS Contentions at 27-30; *see* LBP-13-9, 78 NRC at 71-72.

[58] LBP-13-9, 78 NRC at 71.

contention was moot because the DSEIS contained the information the Tribe claimed was missing.[59] The Board stated that

> because the Oglala Sioux Tribe neither substantively disputes the analysis of impacts related to disposal of byproduct material in relevant sections of the DSEIS and the GEIS, nor addresses the license condition related to disposal of byproduct material, the Board rejects this contention as failing to comply with the admissibility dictates of 10 C.F.R. § 2.309(f)(1)(vi).[60]

Upon issuance of the FSEIS, the Tribe refiled an identical contention alleging inadequate analysis of direct, indirect, and cumulative impacts of disposal of byproduct material.[61] The Board found the contention inadmissible and explained that the section of the FSEIS the Tribe cited did not differ materially from the parallel section in the DSEIS. Accordingly, the Board held that the Tribe failed to meet the requirements of 10 C.F.R. § 2.309(c)(1)(ii) for the filing of a new contention.[62]

b. The Tribe's Petition for Review

On appeal, the Tribe challenges the Board's ruling, supported by both the plain language of the regulation and our precedent, that 10 C.F.R. § 40.31(h) and Part 40 Appendix A, Criterion 1, are inapplicable to *in situ* recovery facilities. We disagree—this point is well settled and we see no reason to revisit it here.[63]

Further, the Tribe argues that Part 40 Appendix A, Criterion 2, which is applicable to *in situ* uranium recovery facilities, requires a plan for waste disposal in the application. Based on

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[59] *Id.*

[60] *Id.* at 71-72.

[61] Tribe's FSEIS Contentions at 33-39.

[62] LBP-14-5, 79 NRC at 397. Additionally, the Board noted that Powertech's draft license contained license conditions requiring that "Powertech [have a] byproduct material disposal contract in place prior to the commencement of operations." *Id.*

[63] *Hydro Resources, Inc.*, CLI-99-22, 50 NRC at 8.

the plain language of Criterion 2, we disagree. Criterion 2 states that "byproduct material from [*in situ*] extraction operations … must be disposed of at existing large mill tailings disposal sites …."[64] This provision mandates that disposal of byproduct material take place at an existing disposal site—it does not require that the application include a waste disposal plan or designate which waste disposal site will be used.

Next, the Tribe argues that the Standard Review Plan "specifically discusses the need for a … waste disposal plan."[65] But the Tribe's argument regarding the Standard Review Plan does not demonstrate Board error. The Standard Review Plan is not a regulation; it is guidance for the Staff in reviewing an application, and it provides one way to comply with our regulations.[66] Additionally, as the Board explained in LBP-10-16, the Staff's standard practice allows applicants *either* to identify a waste disposal site in their applications *or* to implement a license condition regarding waste disposal.[67] As discussed below, Powertech's license includes two conditions related to waste disposal.[68] The Tribe has not identified any regulation to the contrary.

Additionally, the Tribe takes issue with the Board's statement that an applicant is not bound by NEPA.[69] The Board had stated that although "[t]he Tribe also argue[d] that a specific disposal plan must be included in Powertech's Application in order to comply with NEPA. … It is

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[64] 10 C.F.R. pt. 40, app. A, Criterion 2.

[65] Tribe's Petition at 4.

[66] *Crow Butte Resources, Inc.* (Marsland Expansion Area), CLI-14-2, 79 NRC 11, 23 n.70 (2014) (citing *Curators of the University of Missouri*, CLI-95-1, 41 NRC 71, 98 (1995)).

[67] LBP-10-16, 72 NRC at 435.

[68] *See* Ex. NRC-012, License, at 6, 12.

[69] Tribe's Petition at 4.

settled law that an applicant is not bound by NEPA, but by NRC regulations in Part 51."[70] Insofar as it could be interpreted as implying that the Tribe was premature in filing its environmental contentions on the application, the Board's decision was incorrect. Although it is true that "the ultimate burden with respect to NEPA lies with the NRC Staff," our regulations require that intervenors file environmental contentions on the applicant's environmental report.[71] In any case, any Board error here was harmless because it also stated that the Tribe would have the opportunity to formulate a contention regarding disposal of byproduct material on the DSEIS, and indeed, the Tribe did so.[72]

The Tribe asserts that the Board's recognition that planning for waste disposal is an important aspect of our regulations necessarily raises a substantial question for our review.[73] In support of this argument, the Tribe refers to concerns the Board expressed regarding whether waste disposal would be addressed in Powertech's license.[74] In LBP-10-16, the Board noted that "if a condition dealing with … byproduct material is not included in the license, the Tribe has no recourse because it cannot challenge the license at that time."[75] However, Powertech's

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[70] LBP-10-16, 72 NRC at 435.

[71] *Progress Energy Florida, Inc.* (Levy County Nuclear Power Plant, Units 1 and 2), CLI-10-2, 71 NRC 27, 34 (2010); *see* 10 C.F.R. § 2.309(f)(2).

[72] LBP-10-16, 72 NRC at 435. *See* Tribe's DSEIS Contentions at 27-30; *see also Geisen*, CLI-10-23, 72 NRC at 245 ("[T]o prevail on appeal, [a party] must show not only that the majority erred but also that the error had a prejudicial effect on the [party's] case." (citations omitted)).

[73] The Tribe argues that "[a]lthough the [Board] excluded Contention 7, the Board recommended 'that this issue be considered by the Commission (or Board) when it conducts the mandatory review and hearing that must be held in this case.'" Tribe's Petition at 4 (quoting LBP-10-16, 72 NRC at 435). The Board cited 10 C.F.R. § 51.107(a), which refers to issuance of a combined license for a nuclear power reactor; it has no applicability to *in situ* leach facilities. Mandatory hearings are not held in materials licensing proceedings like this one.

[74] Tribe's Petition at 4.

[75] LBP-10-16, 72 NRC at 435.

license contains multiple conditions regarding disposal of byproduct material. License Condition 12.6 requires Powertech to submit to the NRC a disposal agreement with a licensed disposal site before beginning operations.[76] License Condition 9.9 requires Powertech to maintain such a disposal agreement; if the agreement expires or otherwise terminates, Powertech must halt operations.[77]

Although the Board held that Contention 7 was rendered moot by the analysis of the impacts of the disposal of byproduct material in the DSEIS, the Tribe argues that the DSEIS only identified a possible site for the disposal of byproduct material; the Tribe reiterates its argument that the DSEIS's analysis of the impacts of byproduct material disposal was lacking.[78] On appeal, the Tribe argues that the Board erred in rejecting Contention 7 as a contention of omission.[79] But, as explained above, the Board found that the DSEIS and the GEIS analyzed the impacts of the disposal of byproduct material, and it pointed to specific sections of both documents.[80] The Board's ruling did not rest on the distinction between a contention of omission and one of inaccuracy—it found that the Tribe's proposed contention failed to challenge or address the information in the DSEIS and the draft license condition related to waste disposal.[81] On appeal, the Tribe argues that the discussion of waste disposal in the GEIS was insufficient to fulfill the Staff's responsibilities, but the Tribe fails to consider that, as the

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[76] Ex. NRC-012, License, at 12.

[77] *Id.* at 6.

[78] Tribe's Petition at 5; *see* LBP-13-9, 78 NRC at 71.

[79] Tribe's Petition at 5. As the Board noted, the Tribe itself characterized this contention as one of omission. *See* Tribe's DSEIS Contentions at 28; *see also* LBP-13-9, 78 NRC at 71.

[80] LBP-13-9, 78 NRC at 71.

[81] *Id.* at 71-72.

Board noted, both the DSEIS and the draft license condition also addressed waste disposal.[82] The Tribe does not identify any error regarding the Board's ruling on this point; therefore it does not raise a substantial question for our review.

Next, the Tribe argues that the Board dismissed Contention 7 as inadmissible "simply because the draft license contained a provision requiring the applicant to establish a disposal plan at some point in the future."[83] But the Tribe misstates the Board's basis for its ruling. The Board based its ruling on the Staff's analysis in the GEIS, the DSEIS, and expectation that the license would include conditions regarding waste disposal.[84] Given the Board's reliance on the Staff's analysis and the expected license conditions—which, are indeed present in Powertech's license—we see no substantial question for review here.

The Tribe's final argument in its petition for review with respect to Contention 7 invokes the United States Court of Appeals for the District of Columbia Circuit's decision vacating the waste confidence rule, now called the continued storage rule (10 C.F.R. § 51.23).[85] The Tribe argues that the court's vacatur of the former waste confidence rule confirms that the Tribe has raised a substantial question regarding the Board's dismissal of its proposed Contention 7 in LBP-14-5 and is analogous to this proceeding.[86]

But the court's decision regarding continued storage has no bearing on this issue. Neither the waste confidence rule nor the continued storage rule applies to 11e.(2) byproduct

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[82] Tribe's Petition at 5; *see* LBP-13-9, 78 NRC at 71-72.

[83] Tribe's Petition at 5.

[84] LBP-13-9, 78 NRC at 71-72.

[85] Tribe's Petition at 5-6; *see New York v. NRC*, 681 F.3d 471 (D.C. Cir. 2012).

[86] In a decision issued on June 3, 2016, the U.S. Court of Appeals for the District of Columbia Circuit denied the petitions for review challenging the NRC's updated continued storage rule. *New York v. NRC*, 824 F.3d 1012 (D.C. Cir. 2016), *reh'g denied* 2016 U.S. App. LEXIS 14584 (D.C. Cir. Aug. 8, 2016).

material. These rules only apply to environmental impacts of spent fuel storage at power reactors and spent fuel storage facilities after the end of a reactor's license term and before disposal in a deep geologic repository.[87] Moreover, License Condition 12.6 expressly prevents Powertech from beginning operations—and therefore producing byproduct material—before it has in place an agreement with a licensed waste disposal site. And License Condition 9.9 prevents Powertech from continuing to operate if the waste disposal agreement expires or is otherwise terminated. In sum, the continued storage rule is inapplicable to Powertech's facility and Powertech's license is conditioned to ensure that it will not produce byproduct material without a plan for disposal. Accordingly, the Tribe does not raise a substantial question for review.

2.   The Tribe's Proposed Contention 8

The Tribe petitions for review of the Board's rejection of its proposed Contention 8, in which it argued that the DSEIS had been issued without the requisite scoping process.[88] The Board rejected the contention for failing to demonstrate that a "genuine dispute exists with the applicant/licensee on a material issue of law or fact."[89] The Board held that 10 C.F.R. §§ 51.26(d) and 51.92(d) both exempt the Staff from conducting a scoping process for a

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[87] *See* 10 C.F.R. § 51.23.

[88] Tribe's Petition at 7; *see* Tribe's DSEIS Contentions at 30-33; LBP-13-9, 78 NRC at 74-75. In Contention 8, which the Tribe submitted on both the application and the DSEIS, the Tribe also challenged the requirement to submit environmental contentions before the Staff's completion of its NEPA analysis. The Board rejected—in both LBP-10-16 and LBP-13-9—the Tribe's argument that this requirement violates NEPA. LBP-13-9, 78 NRC at 74; LBP-10-16, 72 NRC at 437-38. The Board explained that the challenge "could be properly characterized as 'an impermissible attack on NRC regulations, in contravention of 10 C.F.R § 2.335.'" LBP-13-9, 78 NRC at 74 (quoting LBP-10-16, 72 NRC at 436). The Tribe has not challenged the Board's reasoning on this portion of Contention 8.

[89] LBP-13-9, 78 NRC at 74-75 (quoting 10 C.F.R. § 2.309(f)(1)(vi)).

"supplemental" EIS based on a plain language reading of the regulation.[90] Further, the Board found that the Staff had engaged in a scoping process when it developed the GEIS and had conducted additional outreach during development of the SEIS, thereby satisfying the scoping requirement.[91] Therefore, the Board concluded that the Tribe's contention was inadmissible.[92]

In its petition for review, the Tribe argues that the exceptions to the scoping requirements in 10 C.F.R. §§ 51.26(d) and 51.92(d) do not apply to site-specific EISs that tier off of a GEIS merely because the Staff may describe them as supplements.[93] In support of this argument, the Tribe refers to an Office of Inspector General (OIG) Audit Report from August 2013.[94] With respect to scoping, the Audit Report concluded that

> NRC did not fully comply with the scoping regulations because of incorrect understanding of the regulations related to scoping for EISs that tier off of a generic EIS. Specifically, NRC staff refer to the tiered site-specific EIS as a "supplement" to the generic EIS, leading to the belief that the exception in 10 [C.F.R.] § 51.26(d) applies to tiered EISs. Some NRC managers assert that the public scoping process for the generic EIS for [*in situ*] uranium recovery suffices for subsequent, site-specific uranium recovery applications.
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> However, during that generic EIS scoping process in 2007, NRC staff emphasized in response to public comments that all applications would receive a site-specific review. Staff also emphasized that there would be a request for public input on scoping through a "scoping meeting" on site-specific issues if an EIS were prepared for a future application.[95]

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[90] *Id.* at 75.

[91] *Id.*

[92] *Id.*

[93] Tribe's Petition at 7.

[94] "Audit of NRC's Compliance with 10 CFR Part 51 Relative to Environmental Impact Statements," OIG-13-A-20 (Aug. 20, 2013) (ML13232A192) (Audit Report). The OIG published the Audit Report after the Board's dismissal of the scoping portion of the Tribe's proposed Contention 8 in LBP-13-9.

[95] *Id.* at 24.

The Audit Report specifically identified the DSEIS for this project as deficient because it lacked a formal scoping process.[96]

We take review of the Board's denial of the Tribe's proposed Contention 8 with respect to scoping pursuant to 10 C.F.R. § 2.341(b)(4)(ii).[97] The Tribe's contention identifies an issue of law with respect to our NEPA scoping process. We find that the Board's reasoning was flawed because it relied on a section of our NEPA regulations (10 C.F.R. § 51.92) that is not applicable here. Despite this error on the part of the Board, we affirm the Board's ruling and find that, even without a separate scoping process on the SEIS, the Staff provided the Tribe with ample opportunities at an early stage in the process to participate in the development of the site-specific, supplemental EIS. The Tribe had the opportunity to participate in the NEPA process from the beginning, and it has not demonstrated harm or prejudice resulting from the lack of a separate, formal scoping process on the site-specific SEIS; thus, the Board's error was harmless.

We agree with the Staff's observation that tiering and supplementing are not mutually exclusive concepts.[98] However, we agree with the petitioners that the exception in 10 C.F.R. § 51.92(d) does not apply to a supplemental, site-specific EIS that tiers off a GEIS. Section 51.92(d) states: "[t]he supplement to a *final environmental impact statement* will be prepared in the same manner as the *final environmental impact statement* except that a scoping process need not be used."[99] This provision provides an exception from the scoping process for supplements to *final* EISs. The GEIS is not a final EIS for the purpose of the specific federal

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[96] *Id.* at 22; *see* Tribe's Petition at 7.

[97] We review questions of law *de novo. See Geisen*, CLI-10-23, 72 NRC at 242.

[98] *NRC Staff's Response to Oglala Sioux Tribe's Petition for Review of LBP-15-16* (June 22, 2015), at 8 (Staff's Response to Tribe).

[99] 10 C.F.R. § 51.92(d) (emphasis added).

action here—the proposed licensing of Powertech's *in situ* uranium recovery facility. The Powertech site-specific SEIS is not a supplement in the sense meant by 10 C.F.R. § 51.92(d). The Staff's reference to the SEIS for this project as a supplement does not change the applicability of the exception in 10 C.F.R. § 51.92(d)—it applies to supplements to final EISs, not site-specific supplements to a GEIS.

Because we determine that the Tribe is correct that 10 C.F.R. § 51.92 does not apply here, we now turn to the effect of the Board's error. After considering the Staff's involvement with the Tribe and other interested stakeholders throughout the NEPA process, we find that the Tribe has not shown that the lack of scoping resulted in harm or prejudice. Despite the fact that the Staff did not engage in a separate, formal scoping process in preparing the DSEIS, the Staff provided the Tribe with ample opportunities at an early stage in the process to participate in the development of the site-specific EIS.[100] For example, the Staff states that in 2009 it proposed a meeting with the Tribe to discuss the project, but that the Tribe was unable to attend.[101] Further, "[i]n early 2010, the Staff placed advertisements in six newspapers with circulation in the Dewey-Burdock area, including the Lakota Country Times and the Native Sun, inviting the public to comment on the Dewey-Burdock Project."[102] This public outreach demonstrates that the Tribe and the public had sufficient opportunity to provide input to the Staff regarding the scope of the Staff's environmental analysis. Moreover, the Staff conducted full scoping for the GEIS, which considered specific features of the Black Hills and identified Dewey-Burdock on

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[100] *See, e.g.*, Staff's Response to Tribe at 8-9 (listing opportunities for the Tribe's participation).

[101] *Id.* at 8-9; *see* Tr. at 771.

[102] Staff's Response to Tribe at 9; *see* Ex. NRC-008-A-1, FSEIS § 1.4.2.

maps and figures. The GEIS also specified that it would serve as part of Dewey-Burdock's environmental analysis.[103]

It is well settled that parties challenging an agency's NEPA process are not entitled to relief unless they demonstrate harm or prejudice—and the Tribe has not done so here.[104] Federal case law makes clear that procedural violations of NEPA do not automatically void an agency's ultimate decision.[105] For example, in *Northwest Coalition for Alternatives to Pesticides v. Lyng*, although the Bureau of Land Management had not properly notified the plaintiff during the scoping process, the Ninth Circuit upheld the District Court's determination that the plaintiff was unable to demonstrate prejudice after having participated in the development of the EIS.[106] Also in *Lyng*, the court, discussing the high bar for overturning a federal administrative decision, referred to a Fourth Circuit case holding that individuals not given notice of public hearings on a proposed wastewater treatment plant did not suffer prejudice, even though they were not provided the opportunity to participate until "the eleventh hour" of the NEPA process.[107] Here, by contrast, the Tribe was involved from the beginning of the process, despite the acknowledged lack of formality in the scoping for this EIS.

Further, the scoping process is intended to provide notice to individuals potentially affected by the proposed federal action.[108] Here, although the Staff did not conduct a formal

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[103] *See* Staff's Response to Tribe at 9.

[104] *Nw. Coal. for Alts. to Pesticides v. Lyng*, 844 F.2d 588, 594-95 (9th Cir. 1988); *Cty. of Del Norte v. United States*, 732 F.2d 1462, 1467 (9th Cir. 1984); *Cent. Delta Water Agency v. U.S. Fish & Wildlife Serv*., 653 F. Supp. 2d 1066, 1086-87 (E.D. Cal. 2009); *Muhly v. Espy*, 877 F. Supp. 294, 300-01 (W.D. Va. 1995).

[105] *Lyng*, 844 F.2d at 595.

[106] *Id.* at 594-95.

[107] *Id.* at 595 (citing *Providence Rd. Cmty. Ass'n v. EPA,* 683 F.2d 80, 82 (4th Cir. 1982)).

[108] *Kootenai Tribe of Idaho v. Veneman,* 313 F.3d 1094, 1116 (9th Cir. 2002) ("The primary purpose of the scoping period is to notify those who may be affected by a proposed government

scoping process for the DSEIS for the Dewey-Burdock project, the Tribe had ample notice of the project and numerous opportunities throughout the process to participate in the development of the DSEIS. The Tribe argues that it was "deprived … of the opportunity to present its concerns at the proper time," but it has not argued that any particular section of the site-specific EIS is deficient because of the lack of a formal scoping process.[109]

We are satisfied that the Tribe had the opportunity to provide input on the development of the DSEIS in this case; therefore, the Tribe has not demonstrated harm or prejudice resulting from the lack of a formal scoping process. We find that any error by the Board was harmless and decline to order a hearing on the merits of this contention.[110]

3. Consolidated Intervenors' Proposed Contention D

a. Proposed Contention and Board Order

Consolidated Intervenors challenge the Board's partial denial of their proposed Contention D in LBP-10-16.[111] In the dismissed part of Contention D, Consolidated Intervenors argued that Powertech's application violated 10 C.F.R. § 40.9 "by being disorganized …."[112] In

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action which is governed by NEPA that the relevant entity is beginning the EIS process; this notice requirement ensures that interested parties are aware of and therefore are able to participate meaningfully in the entire EIS process, from start to finish." (citing *Lyng*, 844 F.2d at 594–95)), *abrogated on other grounds by Wilderness Soc'y v. U.S. Forest Serv.*, 630 F.3d 1173 (9th Cir. 2011).

[109] Tribe's Petition at 8.

[110] Notably, the Tribe has not articulated a request for any specific relief regarding the Board's dismissal of this portion of Contention 8 on the DSEIS. Because the Staff has revised its guidance to provide for scoping for future supplemental EISs that tier off of a generic EIS, we decline to delve into the underlying legal issue. Memorandum from Catherine Haney, NMSS, to Stephen D. Dingbaum, OIG (June 30, 2015), at 2 (ML15166A406).

[111] Consolidated Intervenors' Petition at 2 n.3, 3-4, 7. In their petition for review, Consolidated Intervenors cite LBP-15-16 as the Board order that dismissed portions of their proposed Contention D. *Id.* at 2 n.3. To clarify, the Board actually held inadmissible the relevant portions of Contention D in LBP-10-16. *See* LBP-10-16, 72 NRC at 402-03.

[112] Consolidated Intervenors' Petition to Intervene at 36; *see* LBP-10-16, 72 NRC at 400-01. The Board only denied Consolidated Intervenors' Contention D with respect to the

denying this portion of Contention D, the Board found that the application was not "so incomprehensible as to be useless to the public" and stated that "issues of disorganization in an application cannot be said to be germane to the licensing process."[113]

b. Consolidated Intervenors' Petition for Review

On appeal, Consolidated Intervenors argue that the Board created "new standards for accuracy and completeness under [10 C.F.R. § 40.9]" and held "that [a]pplications must be 'incomprehensible' and 'useless to the public' to be deficient under [10 C.F.R. § 40.9]."[114] They claim that the Board's decision "undermines the entire purpose of having an [a]pplication if the standard is so low that it will pass muster if it is barely comprehensible and a hair better than 'useless.'"[115] Finally, Consolidated Intervenors argue that "[t]he public has a strong interest in the standard for accuracy and completeness of source material license applications being higher than that set by the Board ('incomprehensible'[;] 'useless to the public')."[116]

We find that Consolidated Intervenors have not identified a substantial question for our review here. They have not demonstrated that the Board erred at law or abused its discretion in dismissing this portion of Contention D. Consolidated Intervenors have misconstrued the Board's holding; the Board did not adopt or create a new standard for an application to be deemed deficient under 10 C.F.R. § 40.9. Rather, the Board determined that Powertech's application was sufficiently comprehensible for compliance with our regulations. That is, the

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comprehensibility of the application. LBP-10-16, 72 NRC at 402-03. The Board admitted portions of the contention that related to the technical adequacy of baseline water quality and adequate confinement of the host aquifer. *Id.* at 403.

[113] *Id.* at 402-03 (quoting *Hydro Resources, Inc.* (2929 Coors Road, Suite 101, Albuquerque, NM 87120), LBP-98-9, 47 NRC 261, 280 (1998)).

[114] Consolidated Intervenors' Petition at 2 n.3, 7.

[115] *Id.* at 3-4.

[116] *Id.* at 7.

Board simply disagreed with Consolidated Intervenors' argument that the application was incomprehensible and useless. Pursuant to 10 C.F.R. § 2.341(b)(4)(i), we will take review of a Board's factual findings when those findings are clearly erroneous or in conflict with a finding regarding the same fact in a different proceeding.[117] Consolidated Intervenors have not raised a substantial question with respect to the Board's factual conclusions here. Therefore, we deny Consolidated Intervenors' petition for review.

C. New Contentions Held Inadmissible

The Tribe has petitioned for review of the Board's ruling in LBP-15-16 finding its two newly proposed contentions inadmissible.[118] The Tribe filed these two contentions after the conclusion of the evidentiary hearing in August 2014 in response to the Board's post-hearing order directing Powertech to disclose to all parties additional information regarding borehole log data concerning the project site.[119] The Staff reviewed the data and determined that it did not contradict the findings in the FSEIS.[120] Thereafter, the Tribe proposed two new contentions: the first related to the Staff's October 2014 submissions regarding the data and the second related to EPA documents regarding potential CERCLA cleanup at the Powertech site.[121]

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[117] *See Honeywell*, CLI-13-1, 77 NRC at 18-19; *Geisen*, CLI-10-23, 72 NRC at 224-25.

[118] Tribe's Petition at 8-11; *see* LBP-15-16, 81 NRC at 704-06.

[119] Post Hearing Order (Sept. 8, 2014), at 19 (unpublished) (Post-Hearing Order); *see* Ex. OST-19, Press Release, Powertech Uranium Corp., Powertech Uranium (Azarga Uranium) Enters into Data Purchase Agreement for Dewey-Burdock Project (July 16, 2014) (ML14247A415).

[120] *NRC Staff's Motion to Admit Testimony and Exhibits Addressing Powertech's September 14, 2014 Disclosures* (Oct. 14, 2014), at 1; Ex. NRC-158, Supplemental Testimony Regarding NRC Staff Analysis of TVA Well Log Data (Oct. 14, 2014), at 12 (ML14344A931) (Staff's Supplemental Testimony).

[121] Tribe's Motion for New Contentions at 2-3.

1. The Tribe's New Contention 1

a. Proposed Contention and Board Order

In its first new contention, the Tribe argued that the Staff was required to evaluate the well log data as part of the NEPA process, and that the methodology the Staff used to evaluate the well logs (by conducting a "spot check") was unacceptable.[122]

The Board found that the contention did not meet the requirements of 10 C.F.R. § 2.309(c)(1)(ii) because the information in the well logs was not materially different from information already in the record.[123] The Board also noted that the Tribe failed to meet the requirements of 10 C.F.R. § 2.309(f)(1)(vi) because it had not raised a genuine dispute on a material issue of law or fact—the Staff's method for evaluating borehole data by reviewing representative borehole logs had not changed throughout the proceeding.[124] Further, the Board noted that the Tribe had not met the requirements in 10 C.F.R. § 51.92 for demonstrating the need to supplement a FSEIS—in particular that the information in question was "new and significant."[125]

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[122] *Id.* at 6-9.

[123] LBP-15-16, 81 NRC at 704-05. *See* 10 C.F.R. § 2.309(c)(1)(i)-(iii); *see also* Amendments to Adjudicatory Process Rules and Related Requirements, 77 Fed. Reg. 46,562, 46,571 (Aug. 3, 2012) (clarifying the requirements governing hearing requests, intervention petitions, and motions for leave to file new or amended contentions). Although this proceeding began in 2009, the Board ruled on the Tribe's proposed new contentions in 2015 and had previously adopted the 2012 amendments to 10 C.F.R. Part 2 for this proceeding. Order (Concerning Changes to 10 C.F.R. Part 2) (Aug. 21, 2012) (unpublished).

[124] LBP-15-16, 81 NRC at 705.

[125] *Id.* The Tribe objects to the Board's discussion of this point in its petition for review. The Tribe argues that the Board "conflate[d] the contention admissibility standard with the substantive standard of whether the new information would require a supplement to the NEPA documents." Tribe's Petition at 9. Regardless, the Tribe's challenge does not raise a substantial question for review, because the Tribe's New Contention 1 did not meet the requirements of 10 C.F.R. §§ 2.309(c)(1)(ii) and 2.309(f)(1)(vi). If the information is not materially different from previously available information, it stands to reason that it does not "paint a seriously different picture of the environmental landscape" for this proceeding. *Hydro*

b. The Tribe's Petition for Review

On appeal, the Tribe argues that the Board's denial of the Tribe's request to develop and present its contention presents a substantial question for review.[126] It challenges the Board's factual determinations that new well log data did not present materially different information and that the NRC's "spot check" methodology has been used throughout the Staff's review and issuance of the Powertech's license.[127] But this challenge does not show how the Board's determination here is in error. The Board determined that the Tribe did not present any information that was materially different than what was previously available.[128] The Tribe raised this contention after the hearing was complete and the Board had the benefit of hearing from all of the parties on the borehole information and the Staff's review methodology. On appeal, the Tribe does not give us a reason to find that the Board, which was familiar with the information available throughout the pendency of the proceeding, committed an error or abuse of discretion. Therefore, we decline to take review of the Board's dismissal of this contention as inadmissible.

2. The Tribe's New Contention 2

a. Proposed Contention and Board Order

In its second new contention, the Tribe argued that the Staff had not considered in its NEPA analysis information in a newly released EPA assessment regarding a historic hardrock

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Resources, Inc., CLI-99-22, 50 NRC at 14 (quoting *Sierra Club v. Froehike*, 816 F.2d 205, 210 (5th Cir. 1987)).

[126] The Tribe argues that the Board's post-hearing order provides support for its argument that rejection of this contention presents a substantial question for review. Tribe's Petition at 10. There, the Board ordered disclosure of various documents. Post-Hearing Order at 10-12, 19. The Board denied the Tribe's request for sanctions, and denied Powertech's motion for reconsideration. *Id.* at 12, 16. While the Tribe's description of the Board's post-hearing order is accurate, those rulings do not support its petition for review.

[127] Tribe's Petition at 8-10.

[128] *See* LBP-15-16, 81 NRC at 704-05; *see also* Ex. NRC-158, Staff's Supplemental Testimony, at 9-13.

uranium mine site within the Dewey-Burdock project area.[129] The Tribe argued that "the EPA states that it has determined that a CERCLA removal action is recommended for the site and will proceed."[130] In its contention, the Tribe asserted that the CERCLA removal action was therefore reasonably foreseeable, and that the Staff should have considered the action in the cumulative impacts analysis in the EIS.[131]

The Board held this contention inadmissible because the Tribe "fail[ed] to present sufficient information to show a genuine dispute exists on a material issue of law or fact, as required by 10 C.F.R. § 2.309(f)(1)(vi)."[132] Moreover, the Board found that the Tribe disregarded the analysis in the FSEIS of the environmental concerns raised in the EPA Preliminary Assessment, as well as the EPA Preliminary Assessment's repeated references to the FSEIS.[133] Given that the EPA documents themselves referred to the Staff's analysis in both the DSEIS and FSEIS, the Board concluded that the Tribe had not met the contention admissibility requirements, specifically 10 C.F.R. § 2.309(f)(1)(vi).[134]

b. The Tribe's Petition for Review

In its petition for review, the Tribe argues that the Board erred because it "glossed over" the fact that "[t]he EPA identified a new contamination pathway with implications for pollution containment at the site that is not addressed in the application, any NRC materials, or the

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[129] Tribe's Motion for New Contentions at 11; *see also* Ex. OST-026, Letter from Ryan M. Lunt, Task Order Project Manager, Seagull Envtl. Techs., Inc., to Victor Ketellapper, Site Assessment Team Leader, U.S. Envtl. Prot. Agency, Region 8 (Sept. 24, 2014), attach. "Preliminary Assessment Report Regarding the Darrow/Freezeout/Triangle Uranium Mine Site Near Edgemont, South Dakota" (ML14344A926).

[130] Tribe's Motion for New Contentions at 11.

[131] *Id.*

[132] LBP-15-16, 81 NRC at 706.

[133] *Id.*

[134] *Id.*

FSEIS."[135] The Tribe asserts that the FSEIS discusses the unreclaimed mines but does not address "the contamination pathway from the unreclaimed mines to the groundwater" and argues that this presents a substantial question for our review.[136]

Contrary to the Tribe's argument on appeal, the Board did not overlook the Tribe's arguments regarding environmental concerns related to the abandoned mines. In finding New Contention 2 inadmissible, the Board determined that the Tribe had "fail[ed] to show that the Preliminary Assessment is or contains significant new information" and therefore did not demonstrate a genuine dispute on a material issue of law or fact.[137] The Board's ruling was based on its determination that the information in the Preliminary Assessment, including information regarding groundwater contamination, did not differ significantly from that in the FSEIS so as to demonstrate that a genuine dispute existed on a material issue of law or fact.[138] The Tribe's petition does not raise a substantial question regarding the Board's finding that the information in the Preliminary Assessment about unreclaimed mines was insufficient to meet the requirements of 10 C.F.R. § 2.309(f)(1)(vi). Therefore, we deny review of the Board's dismissal of New Contention 2.

We now turn to the parties' claims with respect to the Board's merits decision.

D. Contentions Decided on the Merits

1. Contentions 1A and 1B

As we discuss in detail below, we find that the Board's ruling on Contentions 1A and 1B is final, and consideration of the petitions for review under 10 C.F.R. § 2.341(b)(4) is appropriate at this time. We deny each party's petition for review with respect to Contentions 1A and 1B—

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[135] Tribe's Petition at 11.

[136] *Id.*

[137] LBP-15-16, 81 NRC at 706.

[138] *Id.*

thus leaving in place the Board's ruling in favor of the Tribe and Consolidated Intervenors. Further, under our inherent supervisory authority over agency adjudications, we leave the proceeding open for the narrow issue of resolving the deficiencies identified by the Board.

a. Partial Initial Decision

First, we must clarify the appropriate standard of review of the Board's decision on these contentions. By its terms, the Board presented LBP-15-16 as a "partial initial decision" that left the ultimate resolution of Contentions 1A and 1B for a future decision.[139] Under this approach, the Board retained jurisdiction pending the Staff's remedy of the deficiencies the Board identified in the Board's ruling on Contentions 1A and 1B.[140] Each party, in turn, questioned the Board's decision to retain jurisdiction.[141]

The Board received full briefing and held oral argument and a merits hearing on the issues raised in Contentions 1A and 1B. The Board found in favor of the Tribe and Consolidated Intervenors and identified deficiencies in the Staff's efforts to comply with NEPA and the NHPA.[142] With briefing on these issues completed and the Board's having found in favor of the Tribe and Consolidated Intervenors, we find that the Board's resolution of Contentions 1A and 1B is final and consideration of the petitions for review of these contentions is appropriate at this time.[143]

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[139] *Id.* at 658, 710.

[140] *Id*.

[141] Consolidated Intervenors' Petition at 2 & n.3, 3, 6-7; Powertech's Petition at 5-6, 6 n.9; Staff's Petition at 13-16; *see also* Tribe's Petition at 18-19 (arguing that the "proper remedy" is to "vacate the [licensing] decision and remand back to the agency for further proceedings").

[142] *See* LBP-15-16, 81 NRC at 708.

[143] *See* 10 C.F.R. § 2.341(b)(4); *Pa`ina*, CLI-10-18, 72 NRC at 69-74 (fully reviewing appeals from a licensing board order on an issue where the board ruled in favor of the intervenor on the merits but directed further corrective action); *Vermont Yankee*, CLI-10-17, 72 NRC at 4-9 (same).

b. Contentions and Board Order

In Contention 1A, the Tribe and Consolidated Intervenors challenged the FSEIS's treatment of historic and cultural resources under the NHPA and NEPA.[144] In Contention 1B, the Tribe and Consolidated Intervenors challenged the adequacy of the Staff's NHPA consultation process.[145]

With respect to Contention 1A, the Board held that the Staff had complied with the NHPA requirement to "make a good faith and reasonable effort to identify properties … eligible for inclusion in the National Register of Historical Places within the Dewey-Burdock [*in situ* leach] project area."[146] The Board found that the Staff had largely complied with Advisory Council on Historic Preservation (ACHP) guidance on identification of historic properties.[147] However, with respect to the Staff's NEPA responsibilities, the Board found insufficient the Staff's analysis of the environmental effects of the Dewey-Burdock project on Native American cultural, historic, and religious resources.[148] Accordingly, it held that the Record of Decision was incomplete because the Staff "did not give this issue its required hard look in the FSEIS."[149] Regarding Contention 1B, section 106 consultation, the Board acknowledged that it could not

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[144] Tribe's FSEIS Contentions at 5-9; Consolidated Intervenors' FSEIS Contentions at 6-14. The Tribe and Consolidated Intervenors previously filed similar contentions on the application and the DSEIS. *See* Tribe's DSEIS Contentions at 4-10; Consolidated Intervenors' DSEIS Contentions at 2-7; *Petitioners' Request for Leave to File a New Contention Based on SUNSI Material* (April 30, 2010), at 1-6; Tribe's Petition to Intervene at 12-17.

[145] Tribe's FSEIS Contentions at 9-14; Consolidated Intervenors' FSEIS Contentions at 14-20. The Tribe previously filed similar contentions on the application and the DSEIS. Tribe's DSEIS Contentions at 4-10; Tribe's Petition to Intervene at 12-17.

[146] LBP-15-16, 81 NRC at 654.

[147] *Id.*

[148] *Id.* at 655. More specifically, the Board found a deficiency in the analysis of sites that might be significant to the Oglala Sioux Tribe.

[149] *Id.*

definitively determine whether the Staff or the Tribe bore responsibility for what the Board considered a breakdown in consultation. But the Board found that the NHPA consultation process between the Staff and the Tribe was inadequate because it did not provide sufficient opportunity for the Tribe to articulate its views on the Dewey-Burdock project's effects on historic properties and participate in the resolution of adverse effects.[150]

The Board directed the Staff to conduct additional consultation with the Tribe "to satisfy the hard look at impacts required by NEPA … [and] to satisfy the consultation requirements of the NHPA."[151] By the terms of its order, the Board issued a partial initial decision with respect to these contentions and, therefore, retained jurisdiction over the proceeding pending the Staff's curing of the deficiencies in the FSEIS and consultation with the Tribe.[152] On appeal, each party challenged the Board's issuance of a partial initial decision and retention of jurisdiction.[153]

c. Petitions for Review

(1) THE TRIBE'S AND CONSOLIDATED INTERVENORS' PETITIONS FOR REVIEW

Although the Board found in favor of the Tribe and Consolidated Intervenors, both parties have appealed the relief the Board granted with respect to these contentions.

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[150] *Id.* at 656-57.

[151] *Id.* at 657. The Board noted that it could have suspended Powertech's license, and it attributed its decision to leave the license in place to the Tribe's incomplete participation in the consultation process. *Id.* at 658.

[152] *Id.* at 710.

[153] Consolidated Intervenors' Petition at 2 & n.3, 3, 6-7; Powertech's Petition at 5-6, 6 n.9; Staff's Petition at 13-16; *see also* Tribe's Petition at 18-19 (arguing that the "proper remedy" is to "vacate the [licensing] decision and remand back to the agency for further proceedings").

(a) The Tribe's Petition for Review

The Tribe challenges the Board's decision to leave the license in place, despite finding that the NRC Staff's analysis did not comply with NEPA or the NHPA.[154] Given the Board's decision, the Tribe argues that NEPA and the NHPA prohibit the Board from leaving the license in place and asserts that "the proper remedy is that employed by federal courts up[on] a finding of a violation of NEPA: to vacate the decision and remand back to the agency for further proceedings necessary to achieve compliance."[155]

We disagree. It is well settled that a failure to comply with every aspect of procedural statutes like those at issue here does not necessarily void agency action; federal courts have required that parties demonstrate harm or prejudice to disturb an agency's decision.[156] Here, the Tribe has not articulated any harm or prejudice; in fact, it did not request a stay of the effectiveness of the license, despite the Board's invitation for it to do so.[157] Nor has the Tribe raised a substantial question that would merit granting its petition for review with respect to this issue.[158] Therefore, we deny this portion of the Tribe's petition for review and its request that we vacate Powertech's license.

(b) Consolidated Intervenors' Petition for Review

Consolidated Intervenors argue that "the Board improperly withheld an initial decision and refused to rule on Contentions 1A [and] 1B thereby depriving the Tribe and tribal

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[154] Tribe's Petition at 19.

[155] *Id.* (citing *New York*, 681 F.3d at 471).

[156] *Lyng*, 844 F.2d at 594-95; *Cty. of Del Norte*, 732 F.2d at 1467; *Cent. Delta Water Agency*, 653 F. Supp. 2d at 1086-87; *Muhly*, 877 F. Supp. at 300-01.

[157] *See* LBP-15-16, 81 NRC at 658.

[158] *See Pa`ina*, CLI-10-18, 72 NRC at 69-74 (noting that the board ruled in favor of the intervenor after a merits hearing but directed the parties to undertake additional action to cure identified deficiencies); *Vermont Yankee*, CLI-10-17, 72 NRC at 4-9 (same).

members … an opportunity to appeal the Board's decision."[159] Despite their argument that the Board's decision deprived them of an opportunity to appeal the decision, Consolidated Intervenors challenge the Board's decision to leave the license in place—tying their objection to the NRC's federal trust responsibility.[160] But they do not articulate why the federal trust responsibility precludes the Board from finding as it did; nor do Consolidated Intervenors attempt to demonstrate the existence of a substantial question that would merit granting their petition for review. Instead, they argue that the Board misconstrued the trust responsibility federal agencies owe to the Tribe by "presuming that the Tribe will act '[u]nreasonably.'"[161] This argument misconstrues the Board's decision and does not raise a legal question or demonstrate factual error on the part of the Board. In ruling on Contentions 1A and 1B, the Board did not presume that the Tribe would act unreasonably. Rather, the Board stated that "[e]ven after a thorough review of the record … [it was] not able to decide definitively which party or specific actions led to the impasse preventing an adequate tribal cultural survey."[162] Therefore, the Board directed the Staff to resume consultation with the Tribe, but it reminded the Tribe of its obligation to engage in a meaningful manner with the Staff.[163] We do not see how this statement presumes any unreasonable action or misconstrues the NRC's trust responsibility, nor does it satisfy our standards for granting a petition for review. Therefore, we deny Consolidated Intervenors' petition for review with respect to these contentions.

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[159] Consolidated Intervenors' Petition at 2.

[160] *Id.* at 3.

[161] *Id.*; *see also id.* at 6.

[162] LBP-15-16, 81 NRC at 656.

[163] *Id.* at 657-58, 658 n.236.

(2) POWERTECH AND THE STAFF'S PETITIONS FOR REVIEW

Powertech and the Staff appeal the Board's rulings on Contentions 1A and 1B as well as the Board's retention of jurisdiction.[164]

(a) Powertech's Petition for Review

On appeal, Powertech argues, at length, that the Board's ruling on Contentions 1A and 1B was inconsistent, legally flawed, and factually incorrect. Specifically, Powertech claims that the Board erred in finding the Staff's NHPA analysis deficient by committing clear error of law, ignoring the ACHP's determinations regarding the propriety of the Staff's analysis, providing "special treatment" to the Tribe as a litigant and consulting party, and ignoring critical facts regarding the nature of the government-to-government consultation between the NRC Staff and the Tribe.[165] With respect to the Board's NEPA determination, Powertech argues that the Board erred in finding that the Staff's analysis does not comply with NEPA. In Powertech's view, the NRC Staff has satisfied its NEPA obligation to assess the impacts to historic and cultural resources by considering and evaluating all the available information or information that could reasonably be obtained.[166] Powertech asserts that in requiring more from the Staff, the Board has committed a clear error of law.[167] We disagree. At bottom, Powertech's dispute with the Board's decision is factual, not legal. When assessing a petition for review on factual issues, we typically defer to a Board's findings, absent a showing of clear error.[168] Here, Powertech challenges the Board's weighing of the evidence to find that the Staff's NEPA and NHPA

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[164] Powertech's Petition at 6-22; Staff's Petition at 14-25.

[165] Powertech's Petition at 7, 9-11, 16.

[166] *Id.* at 20-22.

[167] *Id.* at 17.

[168] 10 C.F.R. § 2.341(b)(4)(i).

analyses do not satisfy the NRC's statutory obligations. For example, with respect to the Staff's NEPA analysis, Powertech claims that the Staff considered and evaluated "all available information or information that reasonably could be obtained …."[169] Yet none of Powertech's claims show clear error on the part of the Board, absent which we will not reconsider the Board's resolution of factual issues.[170] We therefore deny Powertech's petition for review with respect to the Board's findings in Contentions 1A and 1B.

(b) The Staff's Petition for Review

On appeal, the Staff argues that the Board misapplied NEPA's hard look standard as a matter of law, under which the Board should assess whether the Staff "made reasonable efforts" to obtain complete information on the cultural resources at issue here.[171] In its brief, the Staff describes the efforts it undertook and argues that these efforts were sufficient to meet the hard-look standard.[172] The Staff asks us to view the Board's application of the hard-look standard as a legal issue under 10 C.F.R. § 2.341(b)(4)(ii).[173] But the fundamental issue here—whether Staff complied with NEPA—is inherently factual.

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[169] Powertech's Petition at 21-22.

[170] We recognize that, as Powertech notes, the ACHP participated in the section 106 process and concluded that the NRC Staff's process complies with the "content and spirit" of the section 106 process. Ex. NRC-031, Letter from John Fowler, ACHP, to Waste Win Young, Standing Rock Sioux Tribe, at 3 (Apr. 7, 2014) (ML14241A473); *see* Powertech's Petition at 3, 9, 11, 15-16. The Staff likewise asks us to treat the ACHP's and North Dakota SHPO's views as dispositive of the fact that it complied with the NHPA. Staff's Petition at 24. Here, where the Board has weighed the relevant facts, including the cited exhibits, and determined that the Staff has not satisfied its obligations under the NHPA and NEPA, we will not disturb the Board's findings absent clear error.

[171] Staff's Petition at 17-18.

[172] *Id.* at 19-20.

[173] *Id.* at 17.

As a general matter, we defer to the Board's findings with respect to the underlying facts unless they are "clearly erroneous."[174] Here, the Board weighed the evidence and determined that the analysis of the environmental effects on cultural resources in the FSEIS was insufficient.[175] The Staff challenges this determination, describing the efforts it made to gather information on cultural resources, but the Staff has not demonstrated that the Board's findings are clearly erroneous.[176] Given the complexity of this proceeding, which involved hundreds of exhibits and over five years of litigation, we are not inclined to second guess the Board's fact-finding.

The Staff next challenges the Board's determination that, on the one hand, the Staff complied with the NHPA regarding identification of historic properties, but the Staff's analysis of cultural, religious, and historic resources under NEPA was insufficient. It argues that the Board's finding that it had complied with the NHPA in identifying historic properties compels the Board to conclude that the Staff also complied with NEPA with respect to cultural resources.[177] The Staff acknowledges that the Board relied on precedent in stating that NEPA compliance does not necessarily follow from NHPA compliance.[178] But it challenges the Board's application of that legal principle to the facts in this case, stating that it had taken a hard look at cultural resources in the FSEIS and arguing that "[t]he Board did not cite any authority supporting its divergent findings on whether the Staff complied with a common requirement of both

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[174] *Honeywell*, CLI-13-1, 77 NRC at 18-19; *Geisen*, CLI-10-23, 72 NRC at 224-25.

[175] LBP-15-16, 81 NRC at 644-55.

[176] Staff's Petition at 19-20.

[177] *Id.* at 21-22.

[178] *Id.*; *see* LBP-15-16, 81 NRC 654-55 (citing *Te-Moak Tribe of W. Shoshone of Nev. v. U.S. Dep't of Interior*, 608 F.3d 592, 606, 610 (9th Cir. 2010); *Hydro Resources, Inc.* (P.O. Box 777 Crownpoint, New Mexico 87313), LBP-05-26, 62 NRC 442, 472 (2005)).

statutes ….”[179] The Staff’s challenge to the Board’s alleged failure to cite authority for its findings is misplaced. Federal case law supports the legal principle that NHPA and NEPA compliance do not necessarily mirror one another.[180] The Board found that NEPA requires an analysis of the effects on all of the cultural resources present at the site, not only those properties eligible for listing on the National Register of Historic Places, which is the standard for further analysis under the NHPA.[181] The Staff does not demonstrate that the Board’s factual finding was implausible. Therefore, we decline to disturb the Board’s finding here.

Next, the Staff seeks review of the Board’s ruling on Contention 1B that the Staff failed to adequately consult with the Tribe under the NHPA.[182] The Staff argues that the Board’s holdings on Contentions 1A and 1B are contradictory because in Contention 1A the Board held “that the Staff complied with the NHPA when identifying cultural resources” while in Contention 1B, the Board held that the NHPA consultation process was inadequate.[183] But the Board’s rulings on compliance with the NHPA are not contradictory; its rulings on NHPA compliance in Contentions 1A and 1B relate to different obligations.

The NHPA imposes several obligations on federal agencies, which proceed in a step-by-step manner.[184] The consultation requirement continues throughout the steps. The first step is identifying any historic properties that might be affected by the federal undertaking (here

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[179] Staff’s Petition at 22.

[180] *See Te-Moak*, 608 F.3d at 606-07, 610.

[181] *See* 36 C.F.R. § 800.4 (requiring agencies to identify “historic properties”); *id.* § 800.16 (defining historic properties as “districts, sites, buildings, structures, or objects included in or eligible for inclusion in, the National Register of Historic Places”); *see generally id*. § 60.4 (providing the criteria for inclusion in the National Register of Historic Places).

[182] Staff’s Petition at 23.

[183] *Id. Compare* LBP-15-16, 81 NRC at 654, *with id.* at 657.

[184] *Id.* at 638-41.

licensing), and in doing so, making a reasonable and good faith effort to seek information from consulting parties, including Native American Tribes, to aid in that identification.[185] In ruling on Contention 1A, the Board determined that the Staff had satisfied the NHPA's consultation requirements with respect to identifying historic properties.[186] In other words, the Board determined that the Staff had satisfactorily completed the first step in the process.

But, as discussed by the Board, the identification of historic properties is not the end of the NHPA consultation process. After it identifies eligible sites that might be affected by the project, an agency must assess[187] and resolve[188] potential adverse effects in consultation with tribes that attach religious and cultural significance to those sites.[189] In its ruling on Contention 1B, the Board found that the Staff had not adequately consulted with the Tribe on the second and third steps; that is, despite its good faith effort to consult in order to identify historic properties, the Staff had not demonstrated that it provided the Tribe with the opportunity to identify concerns about those properties and participate in the resolution of any adverse effects.[190] The Board, after a merits hearing, reasonably concluded that the Staff's consultation with the Tribe was insufficient to meet these requirements. Thus, the Staff has not raised a substantial question for review. For the reasons stated above, we deny review of the Staff's petition with respect to Contentions 1A and 1B.

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[185] 36 C.F.R. § 800.4.

[186] LBP-15-16, 81 NRC at 654.

[187] 36 C.F.R. § 800.5.

[188] *Id.* § 800.6.

[189] *Id.* § 800.2(c)(2)(ii)(A).

[190] LBP-15-16, 81 NRC at 656-57. *See also* 36 C.F.R. § 800.2(c)(2)(ii)(A).

(3) RETENTION OF JURISDICTION

Both the Staff and Powertech appeal the Board's retention of jurisdiction pending resolution of the deficiencies identified in Contentions 1A and 1B.[191] In retaining jurisdiction, the Board directed the Staff to: (1) initiate government-to-government consultation with the Tribe; (2) file monthly status reports; and (3) submit "an agreement reflecting the parties' settlement … or a motion for summary disposition of Contentions 1A and 1B."[192] Both the Staff and Powertech argue that in each instance the Board "exceeded its authority" by retaining jurisdiction over the proceeding and prescribing "a process for the Staff to resolve" the deficiencies identified in Contentions 1A and 1B.[193] Consolidated Intervenors also questioned the Board's retention of jurisdiction over these contentions. Consolidated Intervenors argue that doing so constitutes prejudicial procedural error.[194]

With respect to the Board's specific direction to the Staff to initiate "government-to-government" consultation, we agree in principle with the Staff and Powertech. To the extent that the Board's ruling can be viewed as providing specific direction to the Staff, the Board overstepped its authority.[195] But, based upon our review of the Board's decision, the Board has not stated that it will direct or oversee the Staff's review of cultural resources; instead, it leaves it to the Staff—either by agreement among the parties or by motion for summary disposition—to

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[191] Staff's Petition at 15-16; Powertech's Petition at 6.

[192] LBP-15-16, 81 NRC at 708, 710.

[193] Staff's Petition at 15-16; *see also* Powertech's Petition at 5-6, 6 n.9.

[194] Consolidated Intervenors' Petition at 6-7.

[195] *See, e.g.*, *Duke Energy Corp.* (Catawba Nuclear Station, Units 1 and 2), CLI-04-6, 59 NRC 62, 74 (2004) ("NRC Staff Reviews, which frequently proceed in parallel to adjudicatory proceedings, fall under the direction of Staff management and the Commission itself, not the licensing boards.").

determine when it has addressed the deficiencies identified by the Board.[196] All the Board has required is that the Staff provide reports regarding its consultation efforts in a manner similar to that in which it reports on the progress of its review and the Board's directions to the parties in this respect do not exceed the bounds of its authority. Our regulations provide the Board with the authority to "take appropriate action to control the … hearing process," "[r]egulate the course of the hearing and the conduct of the participants," and "[i]ssue orders necessary to carry out the presiding officer's duties and responsibilities under [10 C.F.R. Part 2]."[197] In circumstances like these, we have made it clear that a Board has relative latitude to fashion appropriate remedies regarding issues properly before it.[198] The Staff is free to select whatever course of action it deems appropriate to address the deficiencies identified in the Board's order, including, but not limited to further government-to-government consultation.[199] For these reasons, we decline to disturb the Board's approach—the Staff must still file monthly reports, along with an agreement or a motion for summary disposition—depending on the outcome of its efforts to

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[196] LBP-15-16, 81 NRC at 710.

[197] 10 C.F.R. § 2.319.

[198] *Pa`ina*, CLI-10-18, 72 NRC at 96 (affirming the Board's decision to require an additional period for written public comment on a supplemental EA); *see also Offshore Power Systems* (Floating Nuclear Power Plants), ALAB-489, 8 NRC 194, 206 (1978) ("[T]he boards have broad and strong discretionary authority to conduct their functions with efficiency and economy. However, they must exercise it with fairness to all the parties …." (citation omitted)); *Wisconsin Electric Power Co., et al.* (Point Beach, Unit 2), ALAB-82, 5 AEC 350, 351 (1972) ("Administrative agencies and courts have long been accepted as 'collaborative instrumentalities of justice.'" (quoting *United States* v. *Morgan*, 313 U.S. 409, 422 (1941))); *Duke Power Co., et al.* (Catawba Nuclear Station, Units 1 and 2), LBP-83-24A, 17 NRC 674, 680 (1983).

[199] We note, however, that in licensing reviews such as this one, where Native American Tribes could be affected by the NRC's licensing action, we expect the Staff's actions to be guided by the principles outlined in the NRC's Tribal Protocol Manual. "Tribal Protocol Manual," NUREG-2173 (2014) (ML14274A014).

address the deficiencies. Therefore, we deny Powertech's, the Staff's, and Consolidated Intervenors' petitions for review of the Board's retention of jurisdiction over these contentions.

2. Contention 2

a. Contention and Board Order

The Tribe seeks review of the Board's resolution of Contention 2 in favor of Powertech and the Staff. In Contention 2, the Tribe argued that

> the FSEIS violates 10 C.F.R. Part 40, Appendix A, Criterion 7, 10 C.F.R. §§ 51.10, 51.70 and 51.71, and the National Environmental Policy Act, and implementing regulations … in that it fails to provide an adequate baseline groundwater characterization or demonstrate that ground water samples were collected in a scientifically defensible manner, using proper sample methodologies.[200]

The Tribe also challenged the fact that "while the FSEIS contains data from 2007-2009, the background water quality for use in the actual regulatory process for the facility will be established [at] a future date, outside of the NEPA process, and outside of the public's review."[201] The Tribe objected to the collection of additional background groundwater quality data after issuance of the license, but before the facility begins operating, and argued that the practice violates NEPA.[202]

In ruling on Contention 2, the Board noted that NRC case law supports the industry practice of definitively establishing groundwater quality baselines after licensing but before operation.[203] Additionally, the Board noted that it found the testimony offered by the Staff's and Powertech's witnesses more detailed and persuasive than the testimony offered by the Tribe's

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200 Tribe's Post-Hearing Brief at 38.

201 *Id.* at 39.

202 *Id.* at 38-39.

203 LBP-15-16, 81 NRC at 665 (quoting *Hydro Resources, Inc.* (P.O. Box 777, Crownpoint, New Mexico 87313), CLI-06-1, 63 NRC 1, 6 (2006)).

witness.[204] In reaching its decision, the Board examined the Tribe's exhibits regarding the EPA's Preliminary Assessment to determine that document's relevance to this contention.[205] The Board found unavailing the Tribe's argument that the conclusions in the Preliminary Assessment translated to an insufficient discussion of historic mining operations in the FSEIS.[206]

b. The Tribe's Petition for Review

On appeal, the Tribe challenges the Board's ruling, claiming that the Board erred as a matter of law when it permitted Powertech to defer collection of groundwater data to after licensing but before operation.[207] Based on our review of the record, we find that the Tribe has not raised a substantial question of law with respect to the applicable standards for site characterization. The Tribe mischaracterizes the Board's ruling when it claims that the Board allowed the Staff and Powertech to defer gathering groundwater data until after licensing.[208] The Board did not rule that "meaningful" baseline characterization may be deferred until the post-licensing period. Rather, it held that the pre-licensing groundwater monitoring used to describe the site for NEPA purposes need not conform to the post-licensing, pre-operation groundwater monitoring requirements applicable to a licensed facility because the monitoring

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[204] *Id.* at 666.

[205] *Id.*

[206] *Id.* The Board reasoned that the conclusion in the Preliminary Assessment that lack of groundwater sampling data limited the availability of background concentrations did not force a conclusion that the FSEIS's discussion of background water quality data was insufficient. It explained that the Preliminary Assessment was focused on CERCLA and the FSEIS was focused on our environmental regulations and the CEQ regulations. CERLCA's objectives are different from NEPA's objectives. With respect to CERCLA, it is important to determine the background levels to assess the impact of *past* mining activities on the site. By contrast, for NEPA purposes, the site's current baseline is important to determine the potential future impacts of the proposed project on the site.

[207] Tribe's Petition at 19-20.

[208] *Id.* at 20.

activities at these two stages serve different purposes.[209] We see no substantial question of law relating to NEPA's site characterization requirements.

The Tribe further asserts that the Board "committed … error and abused its discretion" by not requiring the Staff to account for past mining activity in its baseline water quality data.[210] In support of this argument, the Tribe argues that "[t]he Board even ignored evidence from the EPA Preliminary Assessment … confirming the lack of meaningful data as to the impacts associated with historic mining at the site and how that impacts current water quality and future impacts from the Dewey-Burdock site."[211] Contrary to the Tribe's assertions, the Board did not disregard the Preliminary Assessment; it specifically addressed the Tribe's argument regarding the Preliminary Assessment in its decision.[212] The Board found that due to the different objectives of NEPA and CERCLA, the Preliminary Assessment's finding regarding background data did not impact the adequacy of the analysis in the FSEIS.[213] The Tribe does not explain how the Board's determination on this point constitutes clear error or abuse of discretion.[214] The

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[209] LBP-15-16, 81 NRC at 665 (quoting *Strata Energy, Inc.* (Ross *In Situ* Uranium Recovery Project), LBP-15-3, 81 NRC 65, 91-92 (2015)). In the *Strata* proceeding, we recently denied review of the Board's decision on a contention that was substantially similar to the Tribe's Contention 2, on the same grounds. *Strata Energy, Inc.* (Ross *In Situ* Uranium Recovery Project), CLI-16-13, 83 NRC 566, 583-84 (2016) ("[T]he groundwater monitoring used to describe the environmental conditions at the site for NEPA purposes need not conform to the groundwater monitoring requirements applicable to an operating facility. The two standards serve different purposes.") (citations omitted).

[210] Tribe's Petition at 20.

[211] *Id.*

[212] LBP-15-16, 81 NRC at 666.

[213] *Id.*

[214] *See* Tribe's Petition at 20.

Tribe does not present a substantial question for review with respect to the Board's ruling on Contention 2; therefore, we decline to take review.[215]

3. Contention 3

a. Contention and Board Order

In Contention 3, the Tribe and Consolidated Intervenors argued that the Dewey-Burdock site contains numerous geological and man-made features that will permit groundwater migration.[216] Overall, the Board resolved this contention in favor of Powertech and the Staff.[217] The Board carefully and extensively considered evidence presented by all four parties, and it concluded that the Staff had taken the required hard look at the confinement of the overall ore zone.[218] Because of the numerous issues covered by this contention, the Board explained its ruling on each specific technical issue related to fluid containment separately.[219]

In its ruling on Contention 3, the Board conditioned Powertech's license as follows:

> Prior to conducting tests for a wellfield data package, the licensee will attempt to locate and properly abandon all historic drill holes located within the perimeter well ring for the wellfield. The licensee will document, and provide to the NRC, such efforts to identify and properly abandon all drill holes in the wellfield data package.[220]

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[215] The Tribe also argues that the Board abused its discretion in disregarding the Tribe's argument that Regulatory Guide 4.14 is outdated. *Id.* at 20-21. The Tribe's dissatisfaction with Regulatory Guide 4.14 does not demonstrate Board error presenting a substantial question for our review, particularly since, as the Staff points out, the Regulatory Guide did not form a basis for the Board's decision. *See* LBP-15-16, 81 NRC at 665-66; *see also* Staff's Response to Tribe at 17-18.

[216] *See* Tribe's Post-Hearing Brief at 43-56.

[217] LBP-15-16, 81 NRC at 681.

[218] *Id.* at 676.

[219] *See id.* at 676-81.

[220] *Id.* at 679, 709.

The Board explained that it conditioned the license because “despite the NRC Staff’s claim that ‘because there are a number of improperly plugged or abandoned boreholes at the Dewey-Burdock site, as a condition of its license Powertech must address these boreholes before beginning operations,’ [the Board] did not find any such explicit condition in the license.”[221] It concluded that with the additional license condition, the FSEIS and the record contain “adequate hydrogeological information to demonstrate the ability to contain fluid migration and assess potential impacts to groundwater.”[222]

b. Petitions for Review

Both the Tribe and Consolidated Intervenors have petitioned for review of the Board’s ruling on this contention.[223] Additionally, Powertech has petitioned for review of the license condition the Board imposed as part of its ruling.[224] As explained below, none of the petitions for review regarding this contention raise a substantial question.

(1) THE TRIBE’S PETITION FOR REVIEW

Although the Tribe characterizes its challenges to the Board’s ruling on Contention 3 as legal arguments, the arguments generally relate to how the Board weighed the evidence.[225] With respect to those challenges, based upon our review of the record, we find that none of the Tribe’s arguments demonstrate a substantial question for review regarding the Board’s factual findings.

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[221] *Id.* at 679 (quoting *NRC Staff’s Reply Brief* (Jan. 29, 2015), at 26).

[222] *Id.* at 681.

[223] Tribe’s Petition at 22-23; Consolidated Intervenors’ Petition at 2 & n.3, 4-7.

[224] Powertech’s Petition at 22-25.

[225] *See* Tribe’s Petition at 22.

The Tribe argues that the Board committed legal error in holding that, while "small faults and joints may be present in the project area, their presence does not support Intervenors' assertions [regarding the impacts of the faults and joints.]"[226] The Tribe asserts that the Board "appl[ied] an inappropriate legal standard when it effectively placed the burden on the Tribe to demonstrate the impacts associated with these faults and fractures."[227] We disagree—the Board has neither shifted the burden of proof nor applied an inappropriate legal standard. In its ruling, the Board made clear that "[t]his is not simply a question of whether faults and joints are present, but rather whether they are large and open enough to produce a substantial breach in the confining layers …."[228] The Board carefully weighed the evidence and made a factual finding that the faults and joints would not provide pathways for groundwater migration.[229] We defer to the Board's findings with respect to the underlying facts unless they are "clearly erroneous."[230] Here, the Tribe has not raised a substantial question of clear error on the part of the Board.

Next, the Tribe objects to the Board's imposition of a license condition requiring Powertech to attempt to locate and abandon boreholes.[231] The Tribe characterizes the license condition imposed by the Board as the sole means of achieving compliance and preventing leakage.[232] We disagree. In addition to the license condition imposed by the Board, License Condition 11.5 requires Powertech to monitor for excursions and take corrective action—

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[226] LBP-15-16, 81 NRC at 678.

[227] Tribe's Petition at 23.

[228] LBP-15-16, 81 NRC at 677.

[229] *Id.* at 671-73; 677-78.

[230] *Honeywell*, CLI-13-1, 77 NRC at 18-19; *Geisen*, CLI-10-23, 72 NRC at 224-25.

[231] Tribe's Petition at 22-23.

[232] *Id.* at 22.

including potentially terminating injection of lixiviant within the wellfield until the excursion is corrected. [233] This requirement provides incentive for Powertech to locate and abandon the boreholes. Moreover, the Board's additional license condition requires Powertech to "document its efforts" to find and fill the boreholes, enabling the Staff to assess whether Powertech's efforts are undertaken in good faith.[234] Additionally, absent evidence to the contrary, we assume at the licensing stage that a licensee will comply with its obligations.[235]

The Tribe argues that the Board "relie[d] entirely" on a license condition outside the NEPA process.[236] But the Tribe's assertion is inaccurate. As explained above, the Board relied on much more than one license condition; it weighed all parties' evidence and testimony on this contention, along with the information in the FSEIS and the record.[237] We see no clear error in the Board's reasonable conclusion that the additional license condition will ensure Powertech's compliance with the requirement to attempt to find and plug historic boreholes. Accordingly, we deny the Tribe's petition for review with respect to Contention 3.

(2) CONSOLIDATED INTERVENORS' PETITION FOR REVIEW

Like the Tribe, Consolidated Intervenors challenge the Board's weighing of the evidence in its ruling on Contention 3. Consolidated Intervenors argue that the Board shifted the burden of proof and instituted "a new 'compelling' standard"; they refer to the Board's findings with

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[233] Ex. NRC-012, License, at 10-11.

[234] LBP-15-16, 81 NRC at 679, 709.

[235] *See Curators of the University of Missouri*, CLI-95-8, 41 NRC 386, 400 (1995); *cf. Pacific Gas and Electric Co.* (Diablo Canyon Power Plant, Units 1 and 2), CLI-03-2, 57 NRC 19, 29 (2003).

[236] Tribe's Petition at 22.

[237] LBP-15-16, 81 NRC at 676-81; Ex. NRC-008-A-2, FSEIS § 4.5.2.1.1.2.2.

respect to whether leakage was caused by unplugged boreholes or by naturally occurring fissures and joints.[238]

Contrary to Consolidated Intervenors' argument, the Board's decision contains careful consideration of the parties' evidence regarding several subjects in dispute.[239] The Board neither shifted the burden of proof nor created a new standard of proof. It appropriately weighed the evidence presented by the parties and made factual determinations based on that evidence.[240]

Additionally, Consolidated Intervenors argue that the Board erred when it accepted a witness's "unsubstantiated opinion," and they argue generally that the Board committed factual error regarding leakage at the site.[241] Consolidated Intervenors argue that the Board should not have credited an expert witness proffered by Powertech because that witness was "speaking from the perspective of the mining industry" rather than in the interest of public health and safety.[242] The witness the Board cited is an experienced engineer and hydrologist.[243] Consolidated Intervenors have raised no objection to his qualifications aside from the fact that he testified for the applicant. Our deference to the Board is particularly great when it comes to weighing the credibility of witnesses.[244] Our review of the record demonstrates that the Board examined the exhibits, questioned witnesses, and considered the parties' pleadings and

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[238] Consolidated Intervenors' Petition at 2 & n.3, 4, 6-7; *see* LBP-15-16, 81 NRC at 677.

[239] LBP-15-16, 81 NRC at 676-81.

[240] *Id.*

[241] Consolidated Intervenors' Petition at 2 & n.3, 4-6.

[242] *Id.* at 5.

[243] *See* Ex. APP-014, Curriculum Vitae of Hal. P. Demuth, M.S., Petrotek Engineering Corporation (ML14240A422).

[244] *See, e.g.*, *Private Fuel Storage, L.L.C.* (Independent Spent Fuel Storage Installation), CLI-03-8, 58 NRC 11, 26 (2003) (citations omitted).

statements of position in making its decision.[245] Because Consolidated Intervenors have not raised a substantial question regarding the Board's findings of fact, we deny their petition with respect to this contention.

(3) POWERTECH'S PETITION FOR REVIEW

Powertech seeks review of the Board's imposition of an additional license condition regarding location and abandonment of historic boreholes. It argues that the Board's addition of this license condition constituted clear error of fact because Powertech had already committed to plugging historic boreholes.[246] We find that any factual error in the Board's determination that the license did not contain an explicit condition regarding historic boreholes was harmless. While Powertech is bound by License Condition 9.2 to its commitment to plug boreholes, we do not see the inherent conflict between that commitment and the Board's additional license condition that Powertech and the Staff assert exists. The Board's general license condition can be implemented through the more specific procedures contained in Powertech's commitment. We also see little in the way of additional burden here, particularly if, as Powertech asserts, the Dewey-Burdock site's artesian conditions make it easier to identify improperly plugged boreholes, and it has documentation that historical boreholes were plugged according to State regulations.[247]

Next, Powertech asserts that the Board committed factual and legal error in imposing the license condition *sua sponte*.[248] Powertech argues that because "[n]one of the argument or testimony pertained to plugging and abandoning *all* boreholes prior to the commencement of

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[245] *See, e.g.*, LBP-15-16, 81 NRC at 667-81.

[246] Powertech's Petition at 22-23.

[247] *Id.* at 25 n.57.

[248] *Id.* at 23-25.

licensed operations in a given wellfield," the Board imposed the license condition *sua sponte*.[249] But as the record reflects, historical boreholes were one of the issues raised in Contention 3; the Board imposed this license condition in ruling on that contention, which was the subject of a full evidentiary hearing.[250] Moreover, as the Staff points out in its response to Powertech's petition, "[the Tribe's and Consolidated Intervenors'] arguments could reasonably be construed as claiming that, in order to ensure adequate containment, Powertech must properly abandon all boreholes within the perimeter of each wellfield."[251] The Board ruled on a matter properly before it in imposing an additional license condition on Powertech. Powertech's argument that the license condition was imposed *sua sponte* does not raise a substantial question for review. We deny review of Powertech's petition regarding Contention 3.

4. Contention 6

In Contention 6, the Tribe argued that discussion of mitigation measures in the FSEIS was inadequate for two reasons. First, the Tribe asserted that the FSEIS's discussion and evaluation of mitigation measures was insufficiently detailed.[252] Second, it argued that the Staff erroneously deferred development of further mitigation measures until after the issuance of the FSEIS and the Record of Decision.[253] In its petition, the Tribe challenges the Board's ruling by asserting that the Board failed to address several of its arguments and that the Board's ruling on Contention 6 is inconsistent with its ruling on Contention 1A.

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[249] *Id.* at 24.

[250] *See* LBP-15-16, 81 NRC at 674-75, 679.

[251] *NRC Staff's Response to Powertech's Petition for Review of LBP-15-16* (June 22, 2015), at 7 n.16.

[252] *Oglala Sioux Tribe's Statement of Position on Contentions* (June 20, 2014), at 27-28 (Tribe's Statement of Position). Consolidated Intervenors adopted the Tribe's arguments with respect to Contention 6. *Consolidated Intervenors' Opening Statement* (July 7, 2014), at 9.

[253] Tribe's Statement of Position at 28.

a. Contention and Board Order

With respect to the portion of its contention that challenged the discussion of mitigation measures in the FSEIS, the Tribe argued before the Board that NEPA requires an EIS to "detail[] with [a] specific description, supporting data, and analysis of process and effectiveness" each mitigation measure.[254] The Tribe asserted that the Dewey-Burdock project FSEIS merely listed potential mitigation measures and lacked scientific evidence or analysis regarding the effectiveness of each measure.[255]

The Board, after a merits hearing and review of the record, determined that the Staff's discussion and evaluation of mitigation measures was sufficient.[256] The Board agreed with the Tribe's arguments regarding NEPA's requirements for analysis of mitigation measures, but it found that the Staff had met those requirements.[257] In its holding, the Board determined that the Tribe completely overlooked Chapter 4 of the FSEIS, which contained extensive analysis of mitigation measures.[258] Further, the Board stated that the FSEIS "fully evaluated the impacts and mitigation strategies detailed under other [expert agency] permits."[259] Finally, the Board concluded that Powertech's license requires compliance with mitigation and monitoring measures described in the FSEIS, the Record of Decision, and the license.[260] Accordingly, the

[254] *Id.* at 38.

[255] *Id.* at 30-32.

[256] LBP-15-16, 81 NRC at 690-91.

[257] *Id.* at 690.

[258] *Id.* at 690-91.

[259] *Id.* at 692.

[260] *Id.* at 691.

Board found that Powertech would be required to comply with mitigation strategies analyzed in the FSEIS from initial, pre-licensing activities through decommissioning.[261]

In the second portion of Contention 6, the Tribe argued that the Staff violated NEPA by deferring development of certain mitigation measures—particularly mitigation of adverse effects on cultural resources—until after issuance of the FSEIS.[262] The Tribe also challenged the Staff's analysis of the proposed monitoring well network, historical well hole plugging, and wildlife protections and monitoring.[263]

Regarding the development of mitigation measures after FSEIS completion, the Board ruled that "[t]he release of an FSEIS does not mark the completion of the NEPA review process."[264] The Board noted that the FSEIS referenced the yet-to-be-issued Programmatic Agreement and explained that mitigation measures adopted in the Programmatic Agreement could mitigate impacts on historic or cultural resources.[265] Further, the Board determined that the FSEIS included analysis of certain mitigation measures to be implemented post-licensing.

In finding the FSEIS's analysis adequate, the Board relied upon the generally accepted presumption that Powertech will comply with its obligations as listed in the license, the FSEIS, and associated documents.[266] The Board noted that monitoring programs are "a principal aid" to the Staff and the licensee in determining whether mitigation measures are effective.[267] Moreover, it stated that several of Powertech's license conditions require Powertech to

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[261] *Id.*

[262] Tribe's Statement of Position at 28.

[263] *Id.* at 33-34.

[264] LBP-15-16, 81 NRC at 694.

[265] *Id.*

[266] *Id.* at 695.

[267] *Id.*

document, maintain, and submit to NRC its monitoring results.[268] In sum, the Board held that the mitigation and monitoring plans in the FSEIS, while not final, complied with NEPA.[269] Accordingly, the Board resolved Contention 6 in favor of Powertech and the Staff.

b. The Tribe's Petition for Review

On appeal, the Tribe argues that it had identified significant analytical gaps in the agency's review of mitigation measures, and that the Board failed to address all of its arguments when ruling on Contention 6.[270] We disagree. The Board, after a careful examination of the record, determined that the FSEIS contained sufficient analysis of mitigation measures.[271] Absent clear error, which the Tribe has not demonstrated, we decline to disturb the Board's determination that the FSEIS's analysis of mitigation measures was sufficient for NEPA compliance. Therefore, we deny the Tribe's petition with respect to this point.

The Tribe also seeks review of the Board's decision regarding deferral of development of mitigation measures and argues that the Board erred at law and abused its discretion.[272] For the reasons stated below, we deny the Tribe's petition for review with respect to this issue.

First, the Tribe argues that future development of mitigation measures through the Programmatic Agreement violated NEPA.[273] The Tribe asserts that the Board's ruling disregarded the Tribe's claim that the Programmatic Agreement failed to include "any actual

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[268] *Id.* at 695-97.

[269] *Id.* at 694 (quoting *Hydro Resources, Inc.* (P.O. Box 777, Crownpoint, NM 87313), CLI-06-29, 64 NRC 417, 426-27 (2006)).

[270] Tribe's Petition at 24 (citing LBP-15-16, 81 NRC at 689).

[271] LBP-15-16, 81 NRC at 690-92.

[272] Tribe's Petition at 24.

[273] *Id.*

mitigation [measures]," in violation of NEPA.[274] We disagree with the Tribe's argument regarding lack of analysis in the Programmatic Agreement. Our examination of the record reveals that the Programmatic Agreement and the FSEIS contain discussion of mitigation measures for cultural resources, and the Board did not find deficiencies in those discussions.[275] Because the Tribe fails to address these discussions, it does not raise a substantial question for review of the Board's finding that they are adequate for NEPA compliance.

Next, the Tribe challenges the Board's ruling regarding the FSEIS's discussion of mitigation measures in numerous areas, including wildlife protection, wellfield testing, air impacts, and historical well hole plugging and abandonment.[276] It argues that "the [Board's] ruling also substantially ignore[d] the Tribe's arguments regarding other mitigation issues," which, in the Tribe's view, the Staff did not sufficiently describe or analyze in the FSEIS.[277]

We disagree. In ruling on these points, the Board did not disregard the Tribe's arguments; it determined—based on precedent and its review of the record—that the mitigation and monitoring plans discussed in the FSEIS and Programmatic Agreement contained the level

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[274] *Id.*

[275] *See, e.g.*, Ex. NRC-018-A, "Programmatic Agreement Among U.S. Nuclear Regulatory Commission, U.S. Bureau of Land Management, South Dakota State Historic Preservation Office, Powertech (USA), Inc., and Advisory Council on Historic Preservation Regarding the Dewey-Burdock [*In Situ*] Recovery Project Located in Custer and Fall River Counties, South Dakota" (Mar. 3, 2014), at 5 (requiring Powertech to protect all unevaluated properties until National Register-eligibility determinations are completed), at 10 (requiring Powertech to halt ground-disturbing activities within a 150-foot area and take numerous additional steps if a previously unknown cultural resource is discovered during the implementation of the Dewey-Burdock Project) (ML14246A401) (Programmatic Agreement); Ex. NRC-008-A-2, FSEIS § 4.9.1.1.1. The Staff's mitigation recommendations appear in the far-right columns of Tables 4.9-1 through 4.9-6.

[276] Tribe's Petition at 25.

[277] *Id.*

of detail required by NEPA.[278] The Tribe's petition does not articulate a substantial question for review with respect to this portion of the Board's decision.

Finally, the Tribe asserts that the Board's ruling with respect to Contention 6 is "internally inconsistent" because it conflicts with the Board's ruling on Contention 1A where it found, in part, that the Staff's analysis of mitigation measures for cultural resources did not satisfy NEPA.[279] The Board found generally that the Staff's analysis of mitigation was sufficient. Specifically regarding mitigation of cultural resources, the Board ruled that

> [t]he FSEIS … explains that mitigation measures adopted in the Programmatic Agreement "could reduce an adverse impact to a historic or cultural resource." … Therefore, the Board finds that the NRC Staff completing the Programmatic Agreement after the FSEIS was released, but before the issuance of the Record of Decision or the license, adequately satisfied NEPA.[280]

Regarding Contention 6, the Board concluded that the Staff's analysis of mitigation measures for cultural resources fulfilled NEPA's requirements. We agree with the parties, however, that this statement is inconsistent with the Board's ruling on Contention 1A. Specifically, there the Board stated that "the FSEIS does not include mitigation measures sufficient to protect [the Tribe's] cultural, historical, and religious sites that may be affected by the Powertech project."[281] With this statement, the Board appears to be mixing the requirements of NEPA and the NHPA—NEPA does not require the adoption of mitigation measures, only a discussion of their potential effects. Regardless, by pointing out these inconsistent Board statements, the Tribe has demonstrated only harmless error because the mitigation measures for cultural resources are covered by Contentions 1A and 1B. Thus, a separate ruling on this specific issue under

[278] LBP-15-16, 81 NRC at 694-95.

[279] Tribe's Petition at 25; *see* LBP-15-16, 81 NRC at 655.

[280] LBP-15-16, 81 NRC at 694.

[281] *Id.* at 655.

Contention 6 is not necessary. Therefore, we find that the Tribe does not raise a substantial question for our review with respect to Contention 6.

III. CONCLUSION

For the foregoing reasons, we *deny* in part each party's petition for review. We *grant* each party's petition with respect to the finality of the Board's ruling on Contentions 1A and 1B and find that these contentions should be considered "final" for the purposes of the petitions for review at issue here. We *grant* the Staff's and Powertech's petitions for review with respect to the Board's direction to the Staff regarding the resolution of Contentions 1A and 1B. Pursuant to our inherent supervisory authority over agency adjudications, we *direct* that the proceeding remain open for the narrow purpose of resolving the deficiencies identified by the Board in Contentions 1A and 1B and *affirm* the Board's direction to the Staff to submit monthly status reports and the Board's direction to file an agreement between the parties or a motion for summary disposition to resolve the deficiencies identified by the Board. We *grant* the Tribe's petition for review with respect to proposed Contention 8 and dismiss that contention.

IT IS SO ORDERED.

For the Commission

NRC Seal

/RA/

Annette L. Vietti-Cook
Secretary of the Commission

Dated at Rockville, Maryland,
this 23rd day of December, 2016

Commissioner Svinicki, dissenting in part.

I fully join the majority's order today with one exception: the Staff's and Powertech's appeals of Contentions 1A and 1B. For the reasons expressed below, I would take review of these petitions because the Board applied the wrong legal standards to these contentions. Moreover, when considered under the correct legal standards, the evidentiary record supports resolving Contentions 1A and 1B in favor of the Staff. Therefore, I would enter judgment in favor of the Staff and direct the Board to terminate this proceeding.

A. Contention 1A

On appeal, the Staff argues that the Board's ruling on Contention 1A constitutes legal error because it misapplied NEPA's hard look standard, under which the Board should assess whether the Staff "made reasonable efforts" to obtain adequate information on the cultural resources at issue here.[1] In its brief, the Staff describes the efforts it undertook and argues that these efforts were sufficient to meet the hard look standard.[2] The Staff asks us to view the Board's application of the hard look standard as a legal issue under 10 C.F.R. § 2.341(b)(4)(ii).[3] I would take review of the Staff's petition for review of Contention 1A and reverse the Board's ruling that the Staff's environmental analysis did not adequately address the environmental effects of the Dewey-Burdock project on Native American cultural, religious, and historic resources.

We have previously acknowledged that for some NEPA reviews, necessary data may "prove to be unavailable, unreliable, inapplicable, or simply not adaptable."[4] In such cases, we

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[1] Staff's Petition at 17-18.

[2] *Id.* at 19-20.

[3] *Id.* at 17.

[4] *Entergy Nuclear Generation Company and Entergy Nuclear Operations, Inc.* (Pilgrim Nuclear Power Station), CLI-10-22, 72 NRC 202, 208 (2010).

have directed the Staff to provide a reasonable analysis of the available information with a "disclosure of incomplete or unavailable information."[5] Likewise, Federal courts have upheld agency determinations not to analyze impacts "for which there are not yet standard methods of measurement or analysis."[6] Moreover, the NRC looks for guidance to the Council on Environmental Quality's implementing regulations for NEPA, which specify that an agency need not include relevant information if "the overall costs of obtaining it are exorbitant."[7]

While the Board cited to these principles in its discussion of legal standards, it did not apply these rules to the FSEIS.[8] Instead of responding to the Staff's argument that "it complied with NEPA by making repeated attempts to obtain information on cultural resources,"[9] the Board examined whether the FSEIS "adequately catalogued" the "cultural, historical, and religious sites of the Oglala Sioux Tribe."[10] Because it found that the FSEIS did not contain this information, the Board concluded that the "NRC Staff did not give this issue its required hard look in the FSEIS."[11] Consequently, the Staff is correct that the Board's ruling on Contention 1A constitutes legal error. Instead of considering whether the Staff could reasonably obtain the information it acknowledged was missing, the Board invalidated the FSEIS simply because the

[5] *Id*.

[6] *Town of Winthrop v. F.A.A.*, 535 F.3d 1, 13 (1st Cir. 2008).

[7] 40 C.F.R. § 1502.22; *see also Pacific Gas and Electric Co.* (Diablo Canyon Nuclear Power Plant, Units 1 and 2), CLI-11-11, 74 NRC 427, 443-44 (2011) (observing that while the NRC is not bound by CEQ regulations, it looks to them for guidance).

[8] LBP-15-16, 81 NRC at 638 (noting that "an environmental impact statement is not intended to be a research document" (internal quotation marks omitted)).

[9] *Id*. at 652.

[10] *Id*. at 655.

[11] *Id*.

information was missing in the first place.[12] This approach is facially inconsistent with our precedent, Federal case law, and the CEQ regulations, which recognize that in some instances information relevant to an EIS will not be reasonably available and direct the agency to proceed in accord with NEPA's rule of reason in the face of such lacunae.[13] Therefore, the Board's ruling on Contention 1A rests on a legal error.[14]

While the Commission would normally hesitate to wade through such a detailed factual record ourselves, particularly when we have not had the advantage of observing testimony first hand,[15] in this case other findings from the Board indicate that the missing information was not reasonably available. Specifically, upon reviewing the record in its entirety, the Board concluded that the amount of "funds requested to collect tribal cultural information" by the Oglala Sioux was "patently unreasonable."[16] If information is only available at a patently unreasonable cost, here potentially four million dollars to conduct one part of the cultural survey (itself only one part of the larger NEPA review), it follows that such information is not reasonably available.[17] Moreover, because this information missing from the FSEIS was not reasonably available, its absence from the FSEIS analysis cannot be a basis upon which the FSEIS fails to meet NEPA's hard look standard.

In its Response, the Tribe argues that the precedents cited by Staff do not stand for the legal principle that when relevant information to an EIS is unavailable, the agency must only

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[12] *Id*.

[13] *Pilgrim*, CLI-10-22, 72 NRC at 208; *Town of Winthrop*, 535 F.3d at 13; 40 C.F.R. § 1502.22.

[14] 10 C.F.R. § 2.341(b)(4)(ii).

[15] *Northern Indiana Public Service Co.* (Bailly Generating Station, Nuclear 1), ALAB-303, 2 NRC 858, 867 (1975) (noting that "Licensing Boards are the Commission's primary fact finding tribunals").

[16] LBP-15-16, 81 NRC at 657 & n.229.

[17] Staff's Petition at 6 (citing Tr. at 804, 807).

make reasonable efforts to obtain the information.[18] Specifically, the Tribe argues that many of the cases relied on by the Staff only hold that agencies need not consider remote and speculative impacts in an EIS.[19] But, it appears that the Staff only cited to these precedents to establish NEPA's general rule of reason.[20] Moreover, several of the authorities relied on by the Staff appear to support the position that agencies need only undertake reasonable efforts to acquire missing information, such as 40 C.F.R. § 1502.22, *Town of Winthrop*, and *Pilgrim.*[21] For the most part, the Tribe did not discuss these authorities in its response.[22] While the Tribe asserts that *Pilgrim* "simply confirmed" that an EIS is "not intended to be a research document,"[23] these quotations from *Pilgrim* support the Staff's position because they indicate that an agency need not take extraordinary efforts to obtain or create missing information.

B. Contention 1B

Powertech advances a similar argument with respect to Contention 1B — that the Board did not apply the correct standard for tribal consultation under the NHPA implementing regulations.[24] I would take review of Powertech's petition with respect to Contention 1B and

[18] Tribe's Response at 15-17.

[19] *Id*. (citing *Ground Zero Ctr. for Non-Violent Action v. U.S. Dep't of the Navy*, 383 F.3d 1082 (9th Cir. 2004); *Warm Springs Dam Task Force v. Gribble*, 621 F.2d 1017 (9th Cir. 1980); *Entergy Nuclear Generation Co.* (Pilgrim Nuclear Power Station), CLI-10-11, 71 NRC 287 (2010)).

[20] Staff's Petition at 17-18.

[21] *Id*. (citing *Pilgrim*, CLI-10-22, 72 NRC at 208; *Town of Winthrop*, 535 F.3d at 13; 40 C.F.R. § 1502.22).

[22] Tribe's Response at 16.

[23] *Id*. (quotation marks omitted).

[24] *See* Powertech's Petition at 9-11 ("T]he Licensing Board's attempt to distinguish between the characterizations of consultation as 'reasonable' versus 'meaningful' is not part of the NHPA statutory framework or regulatory regime.").

reverse the Board's ruling that the consultation process between the Staff and the Tribe was inadequate.

Under the NHPA's implementing regulations, the NRC must provide every tribe "a reasonable opportunity to identify its concerns about historic properties, advise on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, articulate its view on the undertaking's effects on such properties, and participate in the resolution of such adverse effects."[25] While the "Tribe is entitled to 'identify its concerns,' to 'advise,' to 'articulate,' and to 'participate,'" courts have warned that "consultation is not the same thing as control over a project."[26] Even if a party's involvement is limited, if that limited involvement is by choice, the agency has provided the party with a reasonable opportunity to participate.[27]

With regard to Contention 1B, the Board initially stated the correct legal standard, whether the Staff provided a "reasonable opportunity" for consultation.[28] However, in evaluating Contention 1B, rather than apply that standard, the Board sought to determine "which party or specific action led to the impasse preventing an adequate tribal cultural survey."[29] Ultimately, the Board determined that the "NRC Staff is at least partly at fault for the failed consultation process" largely because it never "held a single consultation session, on a government-to-government basis, solely with members of the Oglala Sioux Tribe."[30] Likewise, the Board

[25] 36 C.F.R. § 800.2(c)(2)(ii)(A).

[26] *Narragansett Indian Tribe v. Warwick Sewer Authority*, 334 F.3d 161, 168 (1st Cir. 2003).

[27] *Montana Wilderness Ass'n v. Connell*, 725 F.3d 988, 1009 (9th Cir. 2013).

[28] LBP-15-16, 81 NRC at 639 (quoting 36 C.F.R. § 800.2(c)(2)(ii)(A)).

[29] *Id*. at 656.

[30] *Id*. And the Tribe's status as a litigant in this proceeding does not alter its role as a consulting party. To be sure, the ACHP's regulations list various consulting parties, including both Indian tribes and "[c]ertain individuals and organizations with a demonstrated interest in the

concluded that the "Oglala Sioux Tribe does share some responsibility for the ... lack of meaningful consultation."[31] Therefore, because the Board focused its attention on apportioning culpability for what became an impasse, instead of determining whether the opportunity for consultation itself was a reasonable one, the Board's decision constituted legal error.[32]

As noted above, the Commission generally hesitates to make factual findings in the first instance, but again the record developed by the Board is sufficient to answer the question posed: here, whether the Staff provided a reasonable opportunity for consultation. One of the most striking aspects of this record is that the ACHP, the agency expert in implementing the NHPA, signed the NRC's Programmatic Agreement for the Dewey-Burdock project, and in so doing, found that it set forth a phased process for compliance with section 106.[33] While the ACHP's agreement is not binding on the Commission, its findings are entitled to considerable

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undertaking … due to their legal or economic relation to the undertaking or affected properties." *See* 36 C.F.R. § 800.2(c)(2) and (5). But the Board's implication that the Tribe's status as an intervenor somehow elevates its status as a consulting party is incorrect. *See* LBP-15-16, 81 NRC at 656.

[31] LBP-15-16, 81 NRC at 656.

[32] 10 C.F.R. § 2.341(b)(4)(ii).

[33] Ex. NRC-018-D, Letter from Charlene Dwin Vaughn, Advisory Council on Historic Preservation, to Kevin Hsueh, NRC (Apr. 7, 2014) (ML14246A405); *see* Ex. NRC-18-E, Advisory Council on Historic Preservation Signature Page of Programmatic Agreement Among U.S. Nuclear Regulatory Commission, U.S. Bureau of Land Management, South Dakota State Historic Preservation Office, Powertech (USA), Inc., and Advisory Council on Historic Preservation Regarding the Dewey-Burdock [*In Situ*] Recovery Project Located in Custer and Fall River Counties South Dakota (Apr. 7, 2014) (ML14246A417); *see also* Ex. NRC-018-A, Programmatic Agreement, at 2; Ex. NRC-018-B, Appendices Related to the Programmatic Agreement Among U.S. Nuclear Regulatory Commission, U.S. Bureau of Land Management, South Dakota State Historic Preservation Office, Powertech (USA), Inc., and Advisory Council on Historic Preservation Regarding the Dewey-Burdock [*In Situ*] Recovery Project Located in Custer and Fall River Counties South Dakota, app. A, at 2-7 (ML14246A406); 36 C.F.R. § 800.4(b)(2).51-52.

weight.[34] On balance, the record demonstrates that the Staff has committed to phased compliance with section 106, as endorsed by the ACHP. I fully expect the Staff to satisfy its obligations under the Programmatic Agreement, which include consultation. Accordingly, I would conclude that the Staff has provided the Tribe with a reasonable opportunity to consult and will continue to take appropriate actions under the Programmatic Agreement.

In its Response, the Tribe argues that the factual record contains sufficient information to rebut the Staff's and Powertech's efforts to "blame the Tribe for the problems with NRC Staff's NHPA compliance."[35] But, as noted above, the correct standard is not whether there is sufficient evidence to apportion blame, but whether the opportunity to consult was reasonable. While the Tribe may well be disappointed with how the consultation unfolded, courts have consistently held that "a reasonable opportunity to consult" does not guarantee any specific results.[36] Consequently, this argument is not persuasive.

Next, the Tribe argues that Federal case law supports the reasonableness of the Board's holding.[37] But, it appears that these cases involve very different factual backgrounds.[38] Indeed,

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[34] *Public Service Co. of New Hampshire, et al.* (Seabrook Station, Units 1 and 2), CLI-77-8, 5 NRC 503, 527 (1977).

[35] Tribe's Response at 19.

[36] *Narragansett Indian Tribe*, 334 F.3d at 168. While some courts have determined that agency shortcomings, such as misrepresenting important facts or only relying on written communications, may render an opportunity to consult unreasonable, *Pueblo of Sandia v. United States*, 50 F.3d 856. 860-62 (10th Cir. 1995), on balance the record does not support such findings here.

[37] Tribe's Response at 19-21 (citing *Quechan Indian Tribe of Fort Yuma Indian Reservation v. Dep't of the Interior*, 755 F. Supp. 2d 1104 (D. Ariz. 2008); *Attakai v. United States*, 746 F. Supp. 1395 (D. Ariz. 1990); *Slockish v. U.S. Federal Highway Admin.*, 682 F. Supp. 2d 1178 (D. Or. 2010); *Pueblo of Sandia*, 50 F.3d at 856).

[38] *Quechan Tribe*, 755 F. Supp. 2d at 1119 (noting that the Tribe was not provided with adequate information or time); *Slockish*, 682 F. Supp. 2d at 1197 (stating that in deciding whether the NHPA claim was moot, the court "must begin by assuming ... that the defendants have violated the NHPA").

the Tribe concedes that many of the cases have distinguishing characteristics from the instant case.[39] Finally, some aspects of these cases appear to be unfavorable to the Tribe's position; for example one district court noted, "None of this analysis is meant to suggest federal agencies must acquiesce to every tribal request."[40] Consequently, I am not persuaded by the Tribe's efforts to rehabilitate the Board's legal analysis.

Therefore, because the Board applied the incorrect legal standards to Contentions 1A and 1B, I would overturn the Board's determinations with respect to those two contentions and find (1) that the Staff's NEPA analysis of the environmental effects of the Dewey-Burdock project on Native American cultural, religious, and historic resources was adequate and (2) the Staff has provided the Tribe with a reasonable opportunity to consult under the NHPA. Consequently, I would find in favor of the Staff on these two contentions and direct the Board to terminate this proceeding.

[39] Tribe's Response at 21-22 (observing that *Attakai* and *Pueblo of Sandia* involved cases in which the agency wholly failed to consult with an affected Tribe).

[40] *Quechan Tribe*, 755 F. Supp. 2d at 1119.

Commissioner Baran, dissenting in part.

I join in the Commission's decision except for the portion of the decision that denies review of the Tribe's claim that the Board erred by not vacating the license for failure to complete an adequate NEPA review. I respectfully dissent on this issue.

As I stated in my partial dissent in the *Strata* proceeding and my dissent in the *Turkey Point* proceeding, a core requirement of NEPA is that an agency decisionmaker must consider an adequate environmental review *before* making a decision on a licensing action.[1] If the Commission allows a Board to supplement and cure an inadequate NEPA document *after* the agency has already made a licensing decision, then this fundamental purpose of NEPA is frustrated.

In this case, the Board found that the Staff's FSEIS did not meet the requirements of NEPA because the FSEIS was deficient with respect to the effects of the licensing action on Native American cultural, religious, and historic resources.[2] Thus, the agency did not have an adequate environmental analysis at the time it decided whether to issue the license. In fact, the deficiencies in the NEPA analysis remain unaddressed today, and therefore the Staff still cannot make an adequately informed decision on whether to issue the license. The Staff's licensing decision was based on (and continues to rest on) an inadequate environmental review. As a result, the Staff has not complied with NEPA.

The Commission should suspend the license until the Staff has, in accordance with the Board's order, filed its final monthly status report demonstrating that the FSEIS complies with

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[1] *Strata*, CLI-16-13, 83 NRC at 604 (citing *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989)), *appeal docketed*, No. 16-1298 (D.C. Cir. Aug. 24, 2016); *Florida Power & Light Co.* (Turkey Point Nuclear Generating Units 3 and 4), CLI-16-18, 84 NRC __ (Dec. 15, 2016) (slip op.).

[2] LBP-15-16, 81 NRC at 708, 655-58. The Board also identified a NEPA deficiency with respect to hydrogeological information, the subject of Contention 3, and conditioned Powertech's license to cure this deficiency. *See id.* at 679, 681, 709.

NEPA and our regulations. Once the Staff had satisfied the Board's order and completed an adequate NEPA analysis on which to base its decision, the Staff would then be in a position to decide whether to modify, reinstate, condition, or revoke the license.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
POWERTECH (USA) INC.	)	Docket No. 40-9075-MLA
(Dewey-Burdock In Situ Recovery Facility)	)	
	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **COMMISSION MEMORANDUM AND ORDER (CLI-16-20)** have been served upon the following persons by Electronic Information Exchange, and by electronic mail as indicated by an asterisk.

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[Original signed by Clara Sola]
Office of the Secretary of the Commission

Dated at Rockville, Maryland
this 23RD day of December, 2016

088623

SOUTH DAKOTA DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES
PROTECTING SOUTH DAKOTA'S TOMORROW...TODAY!

ENHANCE

Menu

SubMenu

Underground Injection Control Classification Table

US EPA Classification	Injection Well Description
CLASS I (Class I Wells are banned in South Dakota)	• Wells used to inject hazardous wastes beneath the lowermost USDW*. • Wells used to inject industrial non-hazardous liquid wastes beneath the lowermost USDW. • Wells used to inject municipal waste waters beneath the lowermost USDW. • Click here for a link to ARSD** Chapter 74:55 Underground Injection Control (Class I, III, IV, and V)
CLASS II	• Wells used to dispose of fluids associated with the production of oil and natural gas. • Wells used to inject fluids for enhanced oil recovery. • Wells used for the storage of liquid hydrocarbons. • Click here for a link to ARSD Chapter 74:10 Underground Injection Control (Class II)
CLASS III	• Wells used to inject fluids for the extraction of minerals. • Click here for a link to ARSD Chapter 74:55 Underground Injection Control (Class I, III, IV, and V)
CLASS IV (Class IV Wells are banned in South Dakota)	• Wells used to dispose of hazardous or radioactive wastes into or above a USDW (EPA*** has banned the use of these wells.) • Click here for a link to ARSD Chapter 74:55 Underground Injection Control (Class I, III, IV, and V)

CLASS V	• Wells not included in the other classes used to generally inject non-hazardous fluid into or above a USDW. • Click here for a link to ARSD Chapter 74:55 Underground Injection Control (Class I, III, IV, and V)
	*USDW = Underground Source of Drinking Water **ARSD = Administrative Rules of South Dakota *** EPA = Environmental Protection Agency

For more information on the Underground Injection Control Program, please contact Brian Walsh at (605) 773-3296.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
1600 E. LAMAR BLVD
ARLINGTON TX 76011-4511

April 3, 2017

EA-16-262
EA-16-156

Mr. Brent Berg, President
Cameco Resources
Power Resources, Inc.,
550 N Poplar St.
Casper, WY 82601

SUBJECT: NRC INSPECTION REPORT 040-08964/2016-003

Dear Mr. Berg:

This letter refers to the U.S. Nuclear Regulatory Commission (NRC) routine inspection conducted from November 15-17, 2016, at the Smith Ranch uranium recovery facility, in Converse County, Wyoming. The inspection also included review of information provided by your staff subsequent to the on-site portion of the inspection. The purpose of the inspection was to review your transportation program and your response to the transportation incident associated with a leaking intermodal container from an exclusive use barium sulfate sludge shipment to the Energy Fuel Resources' White Mesa Mill in Blanding, Utah, on March 28, 2016. Energy Fuel Resources reported the leaking container to the State of Utah on March 29, 2016, and the state subsequently contacted the NRC. The NRC issued a Confirmatory Action Letter (CAL), EA-16-156 (Agencywide Documents Access and Management System (ADAMS) Accession ML16238A359), on August 30, 2016. The enclosed report presents the results for this inspection. The inspectors discussed the preliminary inspection findings with members of your staff on November 17, 2016, at the conclusion of the onsite portion of the inspection. A final exit meeting was conducted telephonically on March 2, 2017, with you and members of your staff to discuss the results of the inspection. An additional discussion was held with members of your staff on March 13, 2017, to clarify an apparent violation characterization.

The announced inspection included an examination of activities conducted under your license as they relate to public health and safety, and to confirm compliance with the Commission's rules and regulations and the conditions of your license. Within these areas, the inspection consisted of an examination of selected procedures and representative records, observations of activities, and interviews with personnel.

Based on the results of this inspection, nine apparent violations were identified and are being considered for escalated enforcement action in accordance with the NRC Enforcement Policy. The current Enforcement Policy is included on the NRC Web site at http://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html. The apparent violations involved: (1) the failure to accurately assess the activity of pond sediment and barium sulfate sludge waste shipments; (2) the failure to adequately report the total activity for waste and resin shipments on the associated shipping documents; (3) the failure to accurately label waste shipment packages;

(4) the failure to classify and ship the waste packages as Low Specific Activity level two (LSA-II) material; (5) the failure to ship LSA-II waste material in appropriate containers; (6) the failure to ensure by examination or appropriate tests that packages were proper for the contents to be shipped and closure devices were properly secured; (7) the failure to perform evaluations or perform tests that ensured the transportation package would be capable of withstanding the effects of any acceleration and vibration normally incident to transportation; (8) the failure to provide the name of each radionuclide listed and an accurate chemical description of contents; and (9) the failure to provide function specific training to a hazmat employee concerning the requirements that are specifically applicable to the functions the employee performed.

The circumstances surrounding the apparent violations, the significance of the issues, and the need for lasting and effective corrective actions were discussed with your staff at the conclusion of the onsite portion of the inspection and with you and members of your staff during a telephonic conference conducted March 2, 2017.

Additionally, based on the results of this inspection, the NRC will not be closing CAL EA-16-156 at this time. The commitments documented in your CAL response (ML16357A774) were partially completed and the following items remain to be completed: (1) revision of facility procedures, (2) completion of employee training, and (3) obtain a complete IP-2 certification package containing the testing specifications. The NRC plans to review the remaining CAL commitments during the next inspection or review the status of the remaining open items if you choose to send a supplemental response to the CAL.

In addition, since your facility has not been the subject of escalated enforcement actions within the last 2 years, and based on our understanding of your corrective actions, a civil penalty may not be warranted in accordance with Section 2.3.4 of the Enforcement Policy. The final decision will be based on you confirming on the license docket that the corrective actions previously described to the NRC staff have been, or are being taken.

Before the NRC makes its enforcement decision we are providing you with the opportunity to (1) respond, in writing, to the apparent violations addressed in this inspection report within 30 days of the date of this letter; or, (2) request a Predecisional Enforcement Conference (PEC). If a PEC is held, it will be open for public observation. If you decide to participate in a PEC, please contact Mr. Ray Kellar, Chief, Fuel Cycle and Decommissioning Branch, at (817) 200-1191 within 10 days of receipt of this letter to notify us of your intentions. A PEC should be held within 30 days of the date of this letter.

If you choose to provide a written response, it should be clearly marked as a “Response to an Apparent Violation in NRC Inspection Report 040-08964/2016-003; EA-16-262,” and should include for each apparent violation: (1) the reason for the apparent problem or violation, or if contested, the basis for disputing the apparent violation; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken; and (4) the date when full compliance will be achieved. Your response may reference or include previously documented correspondence, if the correspondence adequately addresses the required response. Additionally, your response should be sent to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Center, Washington, DC 20555-0001, with a copy to Mark Shaffer, Director, Division of Nuclear Materials Safety, U.S. Nuclear Regulatory Commission, Region IV, 1600 East Lamar Blvd., Arlington, TX 76011-4511, within 30 days of the date of this letter. If an adequate response is not received within the time specified or an extension of time has not been granted by the NRC, the NRC will proceed with its enforcement decision or schedule a PEC.

If you choose to request a PEC, the conference will afford you the opportunity to provide your perspective on these matters and any other information that you believe the NRC should take into consideration before making an enforcement decision. The decision to hold a PEC does not mean that the NRC has determined that a violation has occurred or that enforcement action will be taken. This conference would be conducted to obtain information to assist the NRC in making an enforcement decision. The topics discussed during the conference may include information to determine whether a violation occurred, information to determine the significance of a violation, information related to the identification of a violation, and information related to any corrective actions taken or planned. In presenting your corrective actions, you should be aware that the promptness and comprehensiveness of your actions will be considered in assessing any civil penalty for the apparent violations. The guidance in NRC Information Notice 96-28, "Suggested Guidance Relating to Development and Implementation of Corrective Action," may be helpful. You can find an updated excerpt from NRC Information Notice 96-28 on the NRC Web site at http://www.nrc.gov/docs/ML061240509.pdf.

In addition, please be advised that the number and characterization of apparent violations described in the enclosed inspection report may change as a result of further NRC review. You will be advised by separate correspondence of the results of our deliberations on this matter.

In accordance with 10 CFR 2.390 of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter, its enclosure, and your response, will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's ADAMS, accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. To the extent possible, your response should not include any personal privacy or proprietary, information so that it can be made available to the Public without redaction.

Should you have any questions concerning this matter, please contact Mr. Ray Kellar, Chief, Fuel Cycle and Decommissioning Branch, of my staff at (817) 200-1191.

Sincerely,

/RA by LLHowell Acting For/

Mark R. Shaffer, Director
Division of Nuclear Materials Safety

Docket: 040-08964
License: SUA-1548

Enclosure:
NRC Inspection Report 040-08964/2016-003
w/Attachment: Supplemental Information

cc: D. Pavlick, Cameco Resources, Power Resources, Inc.
S. Ramsay, Wyoming Radiation Control Program
R. Schierman, Wyoming Depart. of Environmental Quality (WDEQ)
D. Anderson, WDEQ
R. Solid, WDEQ
K. Wendtland, WDEQ

U.S. NUCLEAR REGULATORY COMMISSION

REGION IV

Docket:	040-08964
License:	SUA-1548
Report:	040-08964/2016-003
EA No.:	EA-16-262
Licensee:	Power Resources Inc, dba Cameco Resources
Location:	Smith Ranch Converse County, Wyoming
Dates:	November 15, 2016 through March 13, 2017
Lead Inspector:	Bernadette Baca, Health Physicist Fuel Cycle and Decommissioning Branch Division of Nuclear Materials Safety
Inspectors:	David Brown, Sr. Health Physicist Uranium Recovery Licensing Branch Division of Decommissioning, Uranium Recovery, and Waste Office of Nuclear Materials Safety and Safeguards Martha Poston-Brown, Health Physicist Nuclear Materials Safety Branch - A Division of Nuclear Materials Safety
Accompanied by:	Thomas Lynch, Investigator Field Operations – Southwest Region Office of Hazardous Material Safety Pipeline and Hazardous Material Safety Administration U. S. Department of Transportation Ryan Schierman, Manager Uranium Recovery Program Department of Environmental Quality Land Quality Division State of Wyoming
Approved by:	Ray Kellar, Chief Fuel Cycle and Decommissioning Branch Division of Nuclear Materials Safety

Enclosure

088629

EXECUTIVE SUMMARY

Power Resources, Inc.
NRC Inspection Report 040-08964/2016-003

This U.S. Nuclear Regulatory Commission (NRC) announced inspection included a review of the licensee's transportation program to ensure compliance with NRC regulations and conditions of the license. The inspection included an evaluation of the circumstances related to two transportation incidents that occurred on August 20, 2015, and on March 28, 2016. Additionally, inspectors reviewed the changes made within the transportation program in response to the Confirmatory Action Letter (CAL), EA-16-156 (ML16238A359), issued on August 30, 2016.

Transportation Activities and Radioactive Waste Processing, Handling, and Storage

The licensee was conducting resin and 11e.(2) waste shipments in accordance with U.S. Department of Transportation (DOT) and NRC requirements with the following exceptions:

- An apparent violation was identified related to the use of an inappropriate analytical method to determine radioactive material concentrations for all pond sediment and barium sulfate sludge waste shipments. This resulted in four additional apparent violations related to DOT transportation requirements for: (1) the failure to adequately report the total activity for waste and resin shipments on the associated shipping documents; (2) the failure to label waste shipment packages; (3) the failure to classify and ship waste packages as Low Specific Activity level two (LSA-II) material; and (4) the failure to ship LSA-II waste material in appropriate containers. (Section 1.2 b.)

- Two apparent violations for failure to perform evaluations or perform tests that ensured a transportation package would be capable of withstanding the effects of any acceleration and vibration and the failure to ensure by examination or appropriate tests that the package was proper for the contents to be shipped and closure devices were properly secured. (Section 1.2 c.)

- An apparent violation was identified associated with inaccurate chemical name and radionuclide information on shipping papers for barium sulfate sludge shipments. (Section 1.2 d.)

Management Organization and Controls

The licensee's transportation training program components met applicable requirements and the licensee's staff had received appropriate training for their job assignments with one exception. An apparent violation was identified associated with the licensee's failure to provide task specific hazardous material transportation training for an individual who performed surveys and prepared and signed shipping papers. (Section 2.2)

Follow-up of Confirmatory Action Letters

The licensee had partially completed the CAL commitments and the following items remain to be completed: (1) revision of facility procedures, (2) perform employee training, and (3) obtain a complete IP-2 certification package containing the testing specifications. Therefore, the CAL remains open at this time. (Section 3.3)

Report Details

Site Status

At the time of the inspection Power Resources, Inc. (PRI) was extracting uranium using the in-situ recovery process. Uranium processing and drying operations were in progress at the Smith Ranch Central Processing Plant (CPP). Additionally, four satellite facilities (Sat-2, Sat-3, SR-1, and SR-2) and one remote satellite facility (North Butte) were in service. The Sat-2 facility was only supporting mine unit restoration activities.

Uranium recovery operations were on standby at the Highland CPP. The Reynolds Ranch Satellite had received Wyoming Department of Environmental Quality (WDEQ) approval. At this time, the licensee had not started activities at the Reynolds Ranch Satellite. The Gas Hills and Ruth Satellites were not in operation at the time of the inspection, although the licensee inspected these facilities once per quarter.

1 Inspection of Transportation Activities (86740) and Radioactive Waste Processing, Handling, Storage and Transportation (88035)

1.1 Inspection Scope

The inspection was conducted to determine whether the licensee had established and was maintaining an effective program to ensure radiological safety in the packaging and transportation of licensed radioactive material. The review included determining whether transportation activities were in compliance with the requirements of the applicable NRC and DOT transportation regulations. Particular areas of focus included: (1) the licensee's methodology for sampling and determining the activity of radioactive material shipped from the facility; (2) a review of the shipping containers currently in use or planned for use by the licensee, their selection process/criteria, and the procedures governing the packaging of shipments; and (3) a review of the licensee's shipping documentation process and the documents generated for 11.e(2) byproduct, resin, waste pond sediment, and barium sulfate sludge against the requirements of the DOT.

1.2 Observations and Findings

a. Background

On March 28, 2016, the licensee sent 13 cubic yards of barium sulfate sludge for disposal to White Mesa Uranium Mill, operated by Energy Fuel Resources, Inc. While en route to White Mesa Uranium Mill, the driver braked hard to avoid hitting a deer on the road. The driver did not stop between the braking event and reaching White Mesa Uranium Mill. When the shipment arrived at White Mesa, there was observable evidence the package was leaking. An interview with the driver, following his arrival at White Mesa, indicated he did not observe any leakage from the package during transportation.

On March 29, 2016, the State of Utah emailed a notice to the NRC that White Mesa Uranium Mill had notified PRI of a leaking 11.e(2) shipment (the barium sulfate sludge) received at their facility. In addition, the notification indicated this was the second incident of leakage associated with shipment of 11.e(2) waste sent to White Mesa Uranium Mill by PRI. The first incident occurred on August 20, 2015. The contamination levels reported for the August 2015 incident were below DOT Title 49 of the *Code of Federal Regulation* (CFR) 173.443 limits for an exclusive use shipment. The contamination levels for the March 2016 shipment, as reported by the State of Utah, for radiological material along the roadway at the White Mesa site ranged between 9,360 disintegrations per minute per 100 centimeter square (dpm/100 cm^2) to 5,850 dpm/100 cm^2 for total direct alpha surveys and 0.04 to 0.08 millirem per hour (mrem/hr) beta/gamma surveys. Removable alpha contamination for the asphalt roadways used by the carrier for the March 2016 shipment was reported as 383 to 493 dpm/100 cm^2. Direct surveys of the conveyance were reported as 35,100 to 58,500 dpm/100 cm^2 total alpha (i.e. fixed and removable) and 5.0 mrem/hr beta/gamma. Removable alpha contamination on the conveyance ranged between 439 to 2,551 dpm/100 cm^2. The contamination levels for the March 2016 shipment also did not exceed DOT contamination limits for an exclusive use shipment.

On April 1-2, 2016, Cameco-Smith Ranch health physics technicians (HPTs) conducted more extensive surveys along the transportation route used for the March 28, 2016, shipment and did not identify any areas along the route where contamination was present other than the roadway on-site as mentioned above.

In response to the notification from the State of Utah, the NRC conducted an inspection of transportation operations at the Cameco-Smith Ranch facility on June 20-23, 2016. During the June inspection several deficiencies were identified in the Cameo-Smith Ranch transportation program. As a result of the June 2016 inspection, the NRC issued CAL EA-16-156 dated August 30, 2016, to Cameco-Smith Ranch. On November 15-17, 2016, the NRC conducted an on-site inspection to review the licensee's response to the CAL (ML16357A774) and complete a more thorough assessment of the licensee's transportation program.

b. Shipment Activities

The licensee used analyzed samples to establish an annual baseline concentration of radionuclides for each shipment type. The licensee used the annual concentration number to calculate the activity of each shipment based on the volume of the shipment. The inspectors noted that the available sample analysis results for the radionuclide concentrations in barium sulfate sludge shipments appeared to be anomalously low. The inspectors compared the barium sulfate radionuclide concentrations from previous sample analysis to the radiation exposure rates measured by the Cameco-Smith Ranch HPTs for the August 20, 2015, and March 28, 2016, shipments to White Mesa. Using MicroShield version 10.0 software, the inspectors estimated the external dose rates based on the sample analysis should have been around 150 microRoentgen per hour (µR/hr) rather than the 5 miliRoentgen per hour (mR/hr) measured by the licensee for the packages.

The inspectors reviewed the analytical method used for the barium sulfate sludge shipments. The licensee's off-site analytical laboratory used Environmental Protection Agency (EPA) Method 903.0 "Alpha-Emitting Radium Isotopes in Drinking Water." EPA Method 903.0 is an appropriate method for screening samples for radium content. However, EPA Method 903.0, Section 1.2 states the method does not always give an accurate assessment of the radium-226 content of the samples when other radium alpha emitters are present. When the total radium alpha activity of a water sample is greater than 5 pico-Curies per litter (pCi/L), then radium-226 analysis is required.

The radium-226 analytical result reported to the licensee by the off-site analytical laboratory was 134 pCi/L; therefore, another analytical method to determine the radium-226 content was required. EPA allows for radium-226 analysis to include (1) Lucas cell counting after chemical treatment following EPA Method 903.1 or EPA EMSL-19, and (2) gamma spectroscopy following either EPA Method 901.1 (Gamma measurement of a sealed sample with a 21 day ingrowth period and calculating radium-226 content from Bi-214 content), or the Georgia Tech Method (chemical treatment to capture the radium in a precipitate and counting the precipitate). All 10 barium sludge shipments shipped off-site by the licensee between June 20, 2013, and March 28, 2016, contained radium-226 concentrations well above 5 pCi/L and the licensee should have followed the EPA 903.0 guidance to perform an additional radium-226 analysis. In addition to the barium sulfate sludge, the licensee informed the inspectors that the incorrect analytical method was also applied to 42 pond sediment shipments sent for disposal between June 17, 2014, and March 9, 2016. All 42 pond sediment shipments also had radium-226 concentrations above 5pCi/L and the licensee should have followed the EPA 903.0 guidance which indicated that additional radium-226 analysis was required. Use of an inappropriate analytical method resulted in under-reporting the activity of the radionuclides present in the pond sediment and barium sulfate sludge shipments.

The licensee used an excel spreadsheet provided by an independent contractor to perform calculations in determining if the material being prepared for shipment was Low Specific Activity level one (LSA-I) or level two (LSA-II). The NRC inspectors observed licensee staff use the contractor spreadsheet and analytical results from barium sulfate sludge samples (used to represent the concentrations in the August 20, 2015, and March 28, 2016, shipments) to determine the classification of the waste. The inspectors observed the material was identified as LSA-I regardless of what concentration of natural uranium was entered. The inspectors determined the spreadsheet was designed to exclude sample concentrations of natural uranium from the calculations. The calculations affected by this error also included the determination if an A_2 value (the maximum activity of normal form radioactive material permitted in a Type A package) or a reportable quantity (RQ) value of radioactive material was present. The inspectors independently performed calculations and determined the barium sulfate sludge material as LSA-II. In addition, during the June 2016 inspection, the licensee identified an additional error in the contractor spreadsheet related to the conversion factor from pCi to Ci. This error also lead to the misidentification of the material as LSA-I when the material was in fact LSA-II. These errors, in conjunction with the misanalysed waste stream samples, resulted in the misidentification of 42 shipments of pond sediment and the 10 barium sulfate sludge shipments as LSA-I when they were actually LSA-II. It was identified that 37 of the pond sediment shipments actually contained A_2 quantities of material and none of the shipments represented an RQ. Failure to correctly identify the quantity of material present in the each shipment and classify it correctly led to the selection of an inappropriate container and inappropriate labeling of the containers.

Under DOT rules, requirements for shipping containers and labeling vary based on the hazardous material and the classification of the hazardous material. For Class 7 (radioactive) materials, one of the criteria for determining the type of container required to safely transport the material is the total activity of the materials shipped. The requirements for shipping LSA-I material require the use of at least a level 1 industrial package (IP-1) and are exempt from various labeling requirements. The requirements for shipping LSA-II material require the use of at least a level 2 industrial package (IP-2) and the shipments are not exempt from various labeling requirements.

PRI's Materials License SUA-1548, Amendment 21, Administrative Condition 9.3, requires the licensee to comply with the statements and commitments made in the initial application and its amendments. The amendment dated March 20, 2008, Chapter 9, Section 9.4.4 requires, in part, that licensee workers adhere to all operating procedures. The licensee's operating procedure WYO-RPP-008, Revision 23, "Health Physics Manual - Transportation of Radioactive Materials," Section 1.7.2.4, states, in part, the licensee is responsible for having the waste samples analyzed for radionuclides, hazardous Resource Conservation and Recovery Act (RCRA) contaminations, and other characteristics.

The licensee failed to appropriately analyze waste samples for radionuclides, hazardous RCRA contaminations, and other characteristics for the 42 pond sediment and 10 barium sulfate sludge shipments from June 20, 2013, to March 28, 2016. The licensee did not ensure the analytical laboratory used an adequate method for determining radionuclides in waste samples. The analytical laboratory used standard EPA Method 903.0 to characterize the radionuclides, and contaminates. EPA Method 903.0, Section 1.2 clearly stated that when the total radium alpha activity of a water sample is greater than 5 pCi/L, then radium-226 analysis is required. Despite obtaining analytical results greater than 5 pCi/L radium for all pond sediment and barium sulfate sludge shipments, the licensee failed to ensure the use of an alternative analytical method to complete a radium-226 analysis. Failure to use an appropriate analytical method to determine radium-226 concentrations was identified as an apparent violation of Administrative Condition 9.3 of the license and Procedure WYO-RPP-008 (AV-040-08964/2016-003-01).

The inspectors determined that the under-reporting of the total activity in the 42 pond sediment and 10 barium sulfate sludge shipments led to four additional apparent violations associated with DOT regulations as described below.

NRC licensees are required to follow the DOT regulations in accordance with 10 CFR 71.5(a) which requires that each licensee who transports licensed material outside the site of usage, as specified in the NRC license or on public highways, or delivers licensed material to a carrier, shall comply with the applicable requirements of the DOT regulations in 49 CFR Parts 107, 171 through 180, and 390 through 397, appropriate to the mode of transport.

DOT regulation 49 CFR 172.202(a)(5) requires, in part, that the total quantity of hazardous materials covered by the (shipping papers) description must be indicated by mass or volume or by activity for Class 7 (radioactive) materials and must include an indication of the applicable unit of measurement. Since the licensee used an inappropriate analytical method which resulted in the establishment of incorrect concentrations, the licensee's shipping papers incorrectly listed the total quantity of hazardous material (by activity) for 42 pond sediment and 10 barium sulfate sludge packages shipped between June 20, 2013, and March 28, 2016. This was identified as an apparent violation of 49 CFR 172.202(a)(5) (AV-040-08964/2016-003-02). (Section 1.2 d. of this report documents another example of this apparent violation.)

DOT regulation 49 CFR 172.403(a) and (g) require, in part, that unless exempted from labeling by 49 CFR 173.421 through 49 CFR 173.427, each package of radioactive material must be labeled as provided in this section. The following applicable items of information must be entered in the blank spaces on the RADIOACTIVE label:

(1) Contents, (2) Activity, and (3) Transport index. Since the licensee failed to accurately assess the total activity in pond sediment and barium sulfate sludge shipments, the licensee failed to label each package for 42 pond sediment and 10 barium sulfate sludge packages shipped between June 20, 2013 and March 28, 2016. The licensee failed to recognize the material was LSA-II and had classified the packages as LSA-I which is exempt from these labeling requirements. This was identified as an apparent violation of 49 CFR172.403(a) and (g) (AV-040-08964/2016-003-03).

DOT regulation 49 CFR 173.403 states, in part, LSA material means Class 7 (radioactive) material with limited specific activity which is not fissile material or is excepted under 49 CFR 173.453, and which satisfies the descriptions and limits set forth below. (1) LSA-I; other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the values for activities specified in 49 CFR 173.436 or calculated in accordance with 49 CFR 173.433 or 30 times the default values listed in Table 8 of 49 CFR 173.433. As a result of failing to accurately assess the total activity of 42 pond sediment and 10 barium sulfate sludge shipments from June 20, 2013 to March 28, 2016, the licensee classified the shipments as LSA-1. A subsequent review performed by the licensee determined that all shipments exceeded 30 times the values specified in 49 CFR 173.436 and should have been classified and shipped as LSA-II material. This was identified as apparent violation of 49 CFR 173.403 (AV-040-08964/2016-003-04).

DOT regulation 49 CFR 173.427(b)(1) requires, in part, that LSA material must be packaged in an industrial package (Type IP-1, Type IP-2, or Type IP-3) subject to the limitations of Table 6. Table 6 requires the use of an IP-1 package for an exclusive use shipment of LSA-I solid or liquid contents and the use of an IP-2 package for the exclusive use shipment of LSA-II solid or liquid contents. As a result of failing to accurately assess the total activity of 42 pond sediment and 10 barium sulfate sludge shipments from June 20, 2013 to March 28, 2016, the packages were classified by the licensee as LSA-1 material and shipped in an IP-1 container. The licensee failed to recognize that the contents of shipments met LSA-II requirements and were required to be shipped in an IP-2 container. This was identified as an apparent violation of 49 CFR 173.427(b)(1) (AV-040-08964/2016-003-05).

c. <u>Shipping Containers</u>

The loss of material, which occurred during both the August 2015 barium sulfate shipment and the March 2016 shipment, was determined to be the result of selection of an inappropriate container coupled with failure by the licensee to conduct tests or checks to verify the package would be able to retain its contents under conditions incident to transportation, such as acceleration, rapid deceleration, and vibration. The licensee also did not have a process in place to perform checks to ensure all openings were appropriately secured prior to the August 2015 event. A corrective action after the August 2015 shipment was to revise the shipping procedure to require a check of the container's door seal to ensure it was closed and sealed. However, this corrective action did not prevent the loss of the package contents in the March 2016 shipment.

DOT regulation 49 CFR 173.475 requires, in part, that before each shipment of Class 7 (radioactive) material, the licensee must ensure by examination or appropriate tests that: (a) the package is proper for the contents to be shipped; (c) each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects; and (f) each closure, valve or other opening of the containment system through which the radioactive content might escape is properly closed and sealed.

On August 20, 2015, and March 28, 2016, the licensee failed to ensure by examination or appropriate tests that the packages were appropriate for transportation of material saturated with liquid. For the August 20, 2015 shipment, the licensee's procedure did not contain a step to require that the container's door seal be physically inspected to ensure the container was properly closed and sealed so radioactive content would not escape. After implementing corrective actions, the licensee's new procedure step to ensure the gasket was properly installed, secured, free of defects, and properly closed was found to be insufficient since the container leaked again during the March 28, 2016, shipment. This was identified by inspectors as an apparent violation of 49 CFR 173.475(a), (c), and (f) (AV-040-08964/2016-003-06).

Prior to use of the transportation container for each incident, the licensee failed to perform adequate evaluations to identify vibration as a potential mechanism that could separate the liquid and solid components of the sludge. In an evaluation after the August 2015 shipment, the licensee identified that seepage due to vibration increased with distance travelled and considered shipping to a closer location, but did not implement the idea due to cost considerations. The licensee also considered the use of an alternate container but the licensee was not able to readily identify one and thus the idea was not implemented. The corrective actions associated with the first incident focused on changing the absorbent material (from plug gel to bentonite chips) and adding inspection of the door seals to the procedure to prevent a reoccurrence. After the second incident, the licensee reconsidered changing containers as a corrective action.

DOT regulation 49 CFR 173.410(f) requires, in part, that the package (used for shipment) will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal conditions of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole. On August 20, 2015, and March 28, 2016, the licensee failed to perform evaluations or perform tests that ensured the package would be capable of withstanding the effects of any acceleration and vibration normally incident to transportation in the selection of packaging and package configuration for shipments of barium sulfate sludge from the Cameco-Smith Ranch facility to the White Mesa Mill. The vibration and acceleration during transportation allowed for separation of water from the sludge and caused a loss of radioactive contents from the package during transport for the two shipments of barium sulfate sludge from Cameco-Smith Ranch to White Mesa facility. This was identified by the inspectors as an apparent violation of 49 CFR 173.410(f) (AV-040-08964/2016-003-07).

d. <u>Shipping Paperwork</u>

During a routine inspection conducted April 14-16, 2015, the NRC identified a Severity Level IV violation involving the licensee's failure to include the total quantity of hazardous material on shipping papers (NOV-040-08964/2015-001-01) (ML15191A335). As part of its corrective actions, documented in a letter dated August 17, 2015, (ML15231A011), the licensee committed to: (1) all shipping paperwork would be reviewed for accuracy by a second party with the preparer and reviewer signing the bill of lading; (2) all bills of lading would be originals with no copies being made or stored for use on future shipments; and (3) employees responsible for surveying shipments and those responsible for preparing and reviewing bills of lading would renew their DOT training. During a routine inspection on June 20-23, 2016, the inspectors observed that from April 14, 2015, to June 23, 2016, there were 39 shipments of 11.e(2) byproduct material waste to offsite disposal facilities. The inspectors reviewed copies of the shipping papers. For 10 out of the 25 shipments made in 2015 and all of the shipments made in 2016, none of the shipping papers included the signatures of the preparer or reviewer on the bill of lading. When questioned, licensee staff indicated a new bill of lading form with two signature lines (one for preparer, one for reviewer) would be effective on June 23, 2016. The inspectors also confirmed the use of original paperwork as committed to by the licensee. The inspectors confirmed the training for the two primary individuals responsible for shipping. The previous violation could not be closed as training for other individuals had not yet been performed. Cameco had not consistently ensured shipment paperwork was being reviewed for accuracy or that the preparer and reviewer were both signing the bill of lading, and additional examples of inaccurate activities on shipping paperwork were identified by the licensee when performing an extended review of their records.

During this inspection, the inspectors reviewed the shipping documentation process and the shipping documentation generated by the licensee since the previous inspection with a focus on shipments of the 11.e(2) byproduct material, resins, pond sediment and barium sulfate sludge. As part of this review, the inspectors also reviewed four licensee identified violations related to shipping documentation. Three of these involved (1) the use of the wrong UN number on paperwork prepared to facilitate return of shipping containers to Smith Ranch; (2) a failure to accurately identify a shipping container for a single shipment of an empty container, the container was identified as a cargo trailer rather than a roll-off bin; and (3) a failure to perform a survey or prepare and provide shipping documents for a single shipment of dewatering contents to the SR-2 facility. The NRC inspectors reviewed the licensee's corrective actions for each of the self-identified violations and determined the licensee was taking appropriate corrective actions that would prevent reoccurrence.

In a fourth licensee identified violation, the licensee identified that shipping paperwork generated for the resin shipments from the North Butte facility to the CPP contained the wrong activity due to a change in the shipping trailer the licensee had used. The trailer's volume decreased from 1000 cubic yards to 500 cubic yards. The first set of paperwork generated after the change in trailer volume correctly modified the volume, but failed to reduce the total activity. This error, coupled with licensee's practice of using the previous paperwork to generate paperwork for the next shipment, resulted in perpetuation of the error. The licensee's documentation reviewed by the inspectors did not provide the total number of shipments or dates for which this issue applied. At the inspector's request, the licensee reviewed the shipments and identified that this error occurred for 308 shipments of resin between May 2013 and April 2016. The inspectors identified that the resin shipment documentation error was a recurrence of a prior violation involving the licensee's failure to include the total quantity of hazardous material on the shipping papers (NOV-040-08964/2015-001-01).

DOT regulation 49 CFR 172.202(a)(5) requires, in part, that the total quantity of hazardous materials covered by the (shipping papers) description must be indicated by mass or volume or by activity for Class 7 (radioactive) materials and must include an indication of the applicable unit of measurement. The licensee self-identified that its staff failed to provide the maximum activity for the radioactive contents contained in each package during transport. From May 2013 to April 2016, Cameco-Smith Ranch listed the activity for 308 resin shipments made from the North Butte facility to the CPP at a value twice as high as was physically present. This error occurred based on the licensee's practice of using previous shipping paperwork as a template for generating new shipping paperwork, and the licensee failing to recognize a reduction in shipping container volume by half (from 1000 cubic yards to 500 cubic yards) would result in a reduction of activity per shipment by half. The licensee's corrective action in response to a prior NRC violation, NOV-040-08964/2015-001-01, failed to prevent recurrence. This repeat failure to comply with 49 CFR 172.202(a)(5) was identified as another example of apparent violation (AV-040-08964/2016-003-02), which was previously discussed in Section 1.2 b. of this report.

When the NRC inspectors reviewed the shipping paperwork for barium sulfate sludge shipments, the inspectors observed the paperwork described the barium sulfate sludge as "natural uranium oxide" or "yellowcake" rather than barium sulfate containing natural uranium, throrium-230 and radium-226.

DOT regulation 49 CFR 172.203(d) requires that the description in each shipping paper for a shipment of Class 7 (radioactive) material must include the following additional entries as appropriate: (1) the name of each radionuclide that is listed in 49 CFR 173.435 of this subchapter. (For mixtures of radionuclides, the radionuclides required to be shown must be determined in accordance with 49 CFR 173.433(g) of this subchapter); and (2) a description of the physical and chemical form of the material. For the barium sulfate sludge packages that were shipped from June 20, 2013, and March 28, 2016, the licensee failed to provide the name of each radionuclide listed in 49 CFR 173.435 and the accurate chemical description of contents for all the shipments. The licensee identified the barium sulfate sludge shipments as natural uranium oxide or yellowcake rather than barium sulfate containing natural uranium, throrium-230 and radium-226. This was identified as an apparent violation of 49 CFR 172.203(d) (AV-040-08964/2016-003-08).

1.3 Conclusions

The licensee was conducting resin and 11e.(2) waste shipments in accordance with U.S. DOT and NRC requirements with the following exceptions: (1) failure to accurately assess the activity of pond sediment and barium sulfate sludge waste shipments; (2) failure to adequately report the total activity for waste shipments and resin shipments on the associated shipping documents; (3) failure to accurately label waste shipment packages; (4) failure to classify and ship the waste packages as Low Specific Activity level two (LSA-II) material; (5) failure to ship LSA-II waste material in appropriate containers; (6) failure to ensure by examination or appropriate tests that the packages were proper for the contents to be shipped and closure devices were properly secured; (7) failure to perform evaluations or perform tests that ensured the transportation package would be capable of withstanding the effects of any acceleration and vibration normally incident to transportation; and (8) failure to provide the name of each radionuclide listed and an accurate chemical description of contents for barium sulfate sludge shipments.

2 Management Organization & Controls (88005)

2.1 Inspection Scope

The focus of this portion of the inspection was to ensure the licensee's employee training program and retraining program adequately addressed licensed activities. The inspectors reviewed licensee-provided training to ensure that responsibilities applicable to each employee's specific job functions were covered in the training provided by the licensee.

2.2 Observation and Findings

The licensee is required to conduct initial training in accordance with License Condition 9.7, RG 8.31 and Section 9 of the Technical Report, as committed to in the initial license application and supplements for its contractors and new employees. The licensee was also required to provide annual refresher training to current employees and contractors specific to their job duties and responsibilities. The inspectors reviewed the employee training records regarding health physics technical assignments, transportation and HAZMAT handling, respiratory protection, and operator training.

Training was found to adequately cover the required topics and was conducted in a timely manner for both initial and refresher training. The majority of staff had completed and were current for hazmat training required for their specific jobs. However, one individual at North Butte was found to have initiated shipments of resins from that facility to the CPP without being current on the required Hazmat training. This individual signed paperwork for 12 shipments between June 23, 2016, and September 29, 2016, without current Hazmat training.

DOT regulation 49 CFR 172.704 (a)(2)(i) requires, in part, that each hazmat employee must be provided function specific training concerning the requirements of this subchapter, or exemptions or special permits issued under subchapter A of Chapter 1, that are specifically applicable to the functions the employee performs.

The inspectors identified the licensee failed to provide function specific training to a hazmat employee concerning the requirements that were specifically applicable to the functions the employee performed. From June 23 to September 29, 2016, a facility operator employed at the North Butte facility performed surveys and generated paperwork associated with 12 shipments of resins from the North Butte facility to the CPP without completing task specific hazardous material training associated with the performance of surveys or completing shipping paperwork. The licensee was only able to provide documentation that supported this individual's completion of general awareness hazardous material training. This was identified as an apparent violation of 49 CFR 172.704 (a)(2)(i) (AV-040-08964/2016-003-09).

2.3 Conclusion

Training program components were in place and the majority of the licensee's staff had received the appropriate training for their job assignments. An apparent violation was identified associated with failure to provide task specific hazardous material transportation training for an individual who performed surveys and prepared and signed shipping papers.

3 Follow-up of Confirmatory Action Letters (92703)

3.1 Inspection Scope

The inspectors reviewed the licensee's progress with commitments provided in a letter dated October 24, 2016 in response to the CAL issued on August 30, 2016.

3.2 Observations and Findings

On August 30, 2016, the NRC issued a CAL to PRI (EA-16-156, ML16238A359) as a result of the two transportation incidents that took place in August 2015 and March 2016. On October 24, 2016, PRI submitted its response to the CAL to the NRC (ML16357A774). The inspectors reviewed the licensee's progress in implementing with the corrective actions listed in the licensee's response to the CAL. The inspectors toured the facility, observed licensee transportation activities, reviewed documentation, and interviewed the licensee's staff.

At the time of the inspection, the licensee had revised procedures to use EPA Method 901.1 to ensure an adequate radium-226 analysis was performed on composite samples (such as pond sediment and barium sulfate sludge) to appropriately quantify radioactive material for shipment. However, the licensee was not ready to implement use of the new container the licensee proposed to use in the CAL response. The CAL response indicated the licensee secured a different style of IP-1 intermodal container (IMC) and an IP-2 container. The licensee was in possession of both of these alternate containers, but had not yet determined the level of fill for the IP-2 container, the number of IP-2 containers that would be used for each IP-1 IMC, the sequence for loading the IP-2 containers into the IP-1 IMC (before or after loading with sludge), or a final method to be used to incorporate the absorbent material (sodium polyacrylate) into the sludge (in parallel with sludge loading, layered, or after the sludge was already added). At the time of the inspection the licensee did not have the capability to load a full IP-2 container and then place it into an IP-1 IMC. The licensee indicated they were considering loading partially filled IP-2 containers but were not sure what controls will be implemented to prevent overloading the IP-2 container before lifting it into the IP-1 IMC. Additionally, at the time of the inspection, the licensee did not have a complete IP-2 certification package containing the associated testing specifications.

At the time of the inspection the licensee was continuing to develop facility procedures regarding the sampling and analysis techniques associated with the barium sulfate sludge and pond sediments, use of the new shipping containers, and labelling instructions. The licensee committed to train personnel once the new procedures have been completed.

The NRC will review the remaining CAL commitments during the next inspection or the NRC would review the status of the remaining open items if the licensee chooses to send a supplemental response to the CAL.

3.3 Conclusion

The NRC will not close the CAL at this time. The licensee had partially completed the CAL commitments and the following items remain to be completed: (1) revision of facility procedures, (2) perform employee training, and (3) obtain a complete IP-2 certification package containing the testing specifications.

4 Exit Meeting Summary

On November 17, 2016, the inspectors presented the initial inspection findings to the licensee's representatives at the conclusion of the onsite inspection. On March 2, 2017, after additional review and obtaining supplemental information, Region IV staff discussed the preliminary inspection findings with Mr. Brent Berg, President, and other members of the licensee staff. On March 13, 2017, an additional discussion was held with licensee staff to clarify an apparent violation characterization. The licensee confirmed that any proprietary information reviewed by the inspectors had been returned or destroyed.

SUPPLEMENTAL INSPECTION INFORMATION

PARTIAL LIST OF PERSONS CONTACTED

Licensee

T. Coleman, Radiation Safety Officer
K. Garoutte, Safety, Health, Environment Quality Manager
D. Laird, Central Processing Plant Foreman
M. Thomas, Safety, Health, Environment Quality Director
B. Frye, Health Physics Technician
M. Griffitts, Health Physics Technician
J. Eads, Health Physics Technician in training
C. Sexson, Health Physics Technician
C. Griffitts, Satellite Foreman

Items Opened, Closed and Discussed

Opened

040-08964/2016-003-01	AV	Failure to accurately assess the activity of pond sediment and barium sulfate sludge waste shipments.
040-08964/2016-003-02	AV	Failure to have appropriate shipping paperwork that documented total activity for pond sediment, barium sulfate sludge, and resin shipments.
040-08964/2016-003-03	AV	Failure to appropriately label packages used for pond sediment and barium sulfate sludge waste shipments.
040-08964/2016-003-04	AV	Failure to appropriately classify pond sediment and barium sulfate sludge waste shipments as LSA-II.
040-08964/2016-003-05	AV	Failure to ship pond sediment and barium sulfate sludge waste shipments in IP-II containers when the shipments contained LSA-II material.
040-08964/2016-003-06	AV	Failure to ensure by examination or appropriate tests that the packages were proper for the contents to be shipped and closure devices were properly secured.
040-08964/2016-003-07	AV	Failure to perform evaluations or perform tests that ensured the transportation package would be capable of withstanding the effects of any acceleration and vibration normally incident to transportation.
040-08964/2016-003-08	AV	Failure to provide the name of each radionuclide and an accurate chemical description of content in shipping papers for barium sulfate sludge shipments.

040-08964/2016-003-09	AV	Failure to provide function specific training to a hazmat employee concerning the requirements that were specifically applicable to the functions the employee performed.

Closed

None

Discussed

040-08964/2015-001-01	NOV	Failure to record the correct activity on 30 shipments of 11.e(2) byproduct waste shipments.

Inspection Procedures

IP88005	Management Organization and Controls
IP86740	Inspection of Transportation Activities
IP86730	Transportation of Radioactive Materials (49 CFR Parts 100-179 and 10 CFR 71)
IP88035	Radioactive Waste Processing, Handling, Storage and Transportation
IP92703	Follow-up of Confirmatory Action Letters or Orders

List of Acronyms

ADAMS	Agencywide Documents Access and Management System
AV	apparent violation
Bq	Becquerel
CAL	Confirmatory Action Letter
CPP	Central Processing Plant
CFR	Code of Federal Regulations
dpm/100 cm^2	disintegrations per minute per 100 centimeter square
DOT	U.S. Department of Transportation
EPA	Environmental Protection Agency
HPT	Health Physics Technician
IMC	intermodal container
IP	NRC Inspection Procedure
LSA	Low Specific Activity
mrem/hr	milliRoentgen equivalent man per hour
µR/hr	microroentgen per hour
mR/hr	milliroentgen per hour
mSv	milliSievert
NRC	U.S. Nuclear Regulatory Commission
NOV	Notice of Violation
pCi/L	pico-Curies per litter
PEC	Predecisional Enforcement Conference
PRI	Power Resources Inc.
RCRA	Resource Conservation and Recovery Act
RG	NRC Regulatory Guide
RQ	reportable quantity
WDEQ	Wyoming Department of Environmental Quality

NRC INSPECTION REPORT 040-08964/2016-003; DATED APRIL 3rd, 2017.

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ADAMS ACCESSION NUMBER: ML17079A564

■ SUNSI Review By: **BDB**	ADAMS ■ Yes ☐ No	■ Non-Sensitive ☐ Sensitive	■ Publicly Available ☐ Non-Publicly Available	Keyword: NRC-002
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NEW PUBLICATIONS AND RESOURCES

- [Urenco 1970-2020: From Treaty of Almelo to Atom Ausstieg](#), by D. Bannink, LAKA Foundation, Amsterdam, Oct. 2020
- [Operating Experience from Events Reported to the IAEA/NEA Fuel Incident Notification and Analysis System (FINAS)](#), IAEA-TECDOC-1932, Nov. 2020 (1.9MB PDF)
- [Rosatom: Annual Report 2020](#) (4.9MB PDF)
- [Geochemical and Mineralogical Characterization of Uranium and Thorium Deposits](#), IAEA TECDOC-1929, Nov. 2020 (8.7MB PDF)
- [Domestic Uranium Production Report Third-Quarter 2020](#), U.S. DOE EIA, Nov. 2020 (328kB PDF)

ISL SPILL OF THE DAY

Latest major spills and excursions reported from mines exploited by the in situ leach process

[Crow Butte, Nebraska](#):
Sep. 22, 2020: Injection well fails 5-year mechanical integrity test
May 29, 2020: Monitor well excursion
May 21, 2020: Monitor well excursion
Mar. 3, 2020: Production well fails 5-year mechanical integrity test
Jan. 31, 2020: Production well fails 5-year mechanical integrity test
Jan. 2, 2020: Evaporation Pond 1 liner leak
Aug. 22, 2019: Monitor well excursion
July 11, 2019: Production well fails 5-year mechanical integrity test
June 24, 2019: Production well fails 5-year mechanical integrity test
June 5, 2019: Monitor well excursion
May 29, 2019: Evaporation Pond 1 liner leak
May 2, 2019: Monitor well excursion
Apr. 18, 2019: Monitor well excursion
Apr. 9, 2019: Monitor well excursion
Mar. 27, 2019: Monitor well excursion
Mar. 25, 2019: Monitor well excursion
Nov. 28, 2018: Monitor well excursion
June 1, 2018: Monitor well excursion
Sep. 12, 2017: 27,287 gallon spill of injection solution
Aug. 29, 2017: Monitor well excursion

[The third quarter production data is withheld - because it is too low to meter?]

- **[Regulatory Oversight Report for Uranium Mines and Mills in Canada: 2019](#)**, CNSC, Oct. 2, 2020 (1.3MB PDF)
- **[Regulatory Oversight Report for Uranium and Nuclear Substance Processing Facilities in Canada: 2019](#)**, CNSC, Oct. 2, 2020 (1.8MB PDF)
- **[Cameco Corp.: 2020 Sustainability Reporting](#)**
- **[BHP: Annual Report 2020](#)** (7.2MB PDF)
[now includes Sustainability Reporting (p.51-74)]
- **[Supervising Scientist: Annual Technical Report 2019–20](#)**, Australian Government Department of Agriculture, Water and the Environment, Oct. 15, 2020 (4.8MB PDF)
[covers the environmental situation at the uranium mines in the Alligator River Region, in particular the Ranger mine]
- **[La radioprotection des travailleurs - Exposition professionnelle aux rayonnements ionisants en France: bilan 2019](#)**, IRSN, Oct. 2020 (2.5MB PDF - in French)
[annual report on radiation exposure of workers in France]
- **[Second Update on the Chemical Thermodynamics of Uranium, Neptunium, Plutonium, Americium and Technetium](#)**, OECD NEA, Oct. 2020
- **[Orano: 2019 Annual Sustainability Review](#)** (3.3MB PDF)
- **[Rössing Uranium Limited: Annual Environmental Management Report 2019](#)** (975kB PDF)
- **[World Nuclear Industry Status Report 2020](#)**
- **[CNSC: Radionuclide Release Datasets 2019](#)**
[includes releases from Nuclear Processing Facilities and from Uranium Mines and Mills in Canada]
- **[Euratom: Annual Report 2019](#)** (2.3MB PDF)
- **[External Exposure to Radionuclides in Air, Water and Soil](#)**, Federal Guidance Report No. 15, U.S. EPA, August 2019 (8.4MB PDF)
[This report updates and expands Federal

July 27, 2017: Production well fails 5-year mechanical integrity test
Mar. 14, 2017: Injection well fails 5-year mechanical integrity test

[Ross, Wyoming](#):
post Sep. 30, 2018: withheld *)
Aug. 9, 2017: 4,316 gallon spill of injection fluid
July 27, 2017: 10,008 gallon spill of injection fluid
May 25, 2017: 800 gallon spill of injection fluid
Feb. 28, 2017: Samples taken from Pond 1 Monitor Well in exceedance of limits

[Nichols Ranch, Wyoming](#):
post Sep. 30, 2018: withheld *)
Jun. 12, 2017: 4,500 gallon spill of injection fluid (< 1 mg/L U)

[Lost Creek, Wyoming](#):
post Sep. 30, 2018: withheld *)
Aug. 16, 2018: monitor well on excursion
Jul. 28, 2018: 1,625 gallon spill of production fluid (84 mg/L U_3O_8)
Jun. 21, 2018: monitor well on excursion
Apr. 5-7, 2018: bleed rate lower than 0.5% requirement
Oct. 9, 2017: monitor well on excursion
Sep. 5, 2017: 10,000 gallon spill of injection fluid (1.1 ppm U)
Aug. 19, 2017: 188,000 gallon [712 m^3] spill of injection fluid (1.2 mg/L U)
May 22, 2017: 1,100 gallon spill of injection fluid (1.5 mg/L U)
Feb. 6, 2017: 3,360 gallon spill of injection fluid (0.5 ppm U)
Jan. 9, 2017: 3,654 gallon spill of injection fluid (1.3 ppm U)

[Smith Ranch, Wyoming](#):
post Sep. 30, 2018: withheld *)
Oct. 19, 2017: 533 gallon spill of restoration recovery fluid (4.2 ppm U)

[PRI Highland, Wyoming](#):
post Sep. 30, 2018: withheld *)
Mar. 16, 2014: 8,916 gallon spill of injection fluid (1 ppm U)

[North Butte, Wyoming](#):
post Sep. 30, 2018: withheld *)
May 7, 2018: monitor well on excursion
Nov. 17, 2017: two monitor wells on excursion

[Willow Creek (ex Christensen Ranch/Irigaray), Wyoming](#):
post Sep. 30, 2018: withheld *)
Aug. 6, 2018: 4,130 gallon spill of recovery fluid (9.6 ppm U_3O_8)
June 29, 2018: Monitor well placed on excursion status
Aug. 9, 2017: 7,400 gallon spill of production fluid (8.9 ppm U)
Jul. 25, 2017: 5,000 gallon spill of injection fluid (1.1 ppm U) and production fluid (9.7 ppm U)
May 24, 2017: 3,600 gallon spill of injection fluid (0.41 - 0.81 ppm U)

[Muyunkum (Moinkum), Kazakhstan](#):
Nov. 25, 2011: spill of 240 cubic metres of production solution, after pipeline was severed by truck

[Beverley, South Australia](#):
Feb. 28, 2012: spill of 30 - 34 cubic metres

[Beverley North, South Australia](#):
Feb. 20, 2016: 8980 L barren injection solution spill

Guidance Report No. 12, External Exposure to Radionuclides in Air, Water, and Soil (EPA, 1993).]

QUOTE OF THE DAY

"It is a misunderstanding that uranium mining can cause radioactivity. It is not true because uranium gets radioactive only when it is enriched. Otherwise, uranium is just like any other soil as it has got no radiation"
(TP Sreenivasan, former Governor for India of the International Atomic Energy Agency (IAEA), in The Shillong Times, Sep. 25, 2017)

"We extract ... uranium from the formation and send it to atomic reactors, so we are actually purifying the subsoil from heavy metals."
(Kazatomprom senior manager Kalilallo Baytasov on groundwater impacts of uranium in situ leaching in Kazakhstan, in: Christian Science Monitor, Aug. 28, 2013)

"Two thirds of the earth's surface is water... the rest we can process"
(Motto of MDM Engineering Group Limited, contractor to gold/uranium miners Gold One International Ltd and Gold Fields Ltd)

"Interviewed, URANEX Public Relation Officer Nyero Godwin denied the allegations, contending that the type of uranium that would be extracted was in “salt form”, insisting that no person would be affected."
(referring to health problems, in particular from dust, attributed to uranium exploration performed by Uranex NL in Bahi and Manyoni districts, in: The Guardian, Tanzania, Oct. 8, 2011)

"the deputy minister for Energy and Minerals, Mr Adam Malima, said the mining activities would not have any impact on the people since the minerals would only be produced in their raw form"
(referring to uranium mining projects in Bahi and Manyoni districts in Tanzania, in: The Citizen, August 15, 2011)

"With regard to tailings, tailings are in fact a potential future resource so I think there's a considerable incentive to manage the tailings in a very good way with that in mind."
(Michael Angwin of the Australian Uranium Association referring to the uranium mill tailings from a proposed

Honeymoon, South Australia:
July 10, 2012: fumes observed emanating from the dry hopper in the Drying and Packaging controlled area
Jan. 6, 2012: 30 cubic metre spill of injection solution (2 mg/L U_3O_8)

*) On September 30, 2018, Wyoming became an agreement state with the NRC, assuming regulatory authority over uranium in situ leach mining, uranium milling and mill tailings on its territory. Spill reports from Wyoming ISL sites, therefore, no longer appear in NRC's ADAMS document system, while the state has not set up a comparable document system of its own.

expansion of the Olympic Dam uranium mine, ABC Aug. 5, 2011)

"Another woman said Arizona Mine Inspector Joe Hart of Kingman told her the mining process would make the environment cleaner."
(Mohave Daily News, July 7, 2011, reporting on meeting of Mohave County Board of Supervisors, before it voted to *support* rather than ban uranium mining near the Grand Canyon)

"No, that's not radioactive, you can't say that. This is water that indeed contains radium, a certain number of products [...]"
(François Sublime, technical director of Areva's subsidiary COMUF responsible for reclamation of the Mounana uranium mine site, Gabon, referring to the water covering the uranium mill tailings dam; RFI May 28, 2011)

"Mining is a 24 hour operation and cannot be stopped as a result of a shortage of available dust masks"
(Johan De Bruin, geology superintendent of Paladin's Kayelekera uranium mine in Malawi, Nyasa Times Sep. 25, 2010)

"at the mine we focus on production matters"
(Mr. Werner Duvenhage, Managing Director Langer Heinrich, Paladin Energy Africa, September 2010, in an email communication with WISE Amsterdam, denying request for information and site visit)

"This is like a water clean up project, and we are going to sell the by-product on"
(Powertech project manager Mark Hollenbeck on the Dewey-Burdock in situ leach uranium mining project, South Dakota Public Broadcasting Apr. 5, 2010)

"We're taking the uranium out of the ground, we're exporting it to be used for productive purposes, so we should be getting a medal for cleaning up the environment."
(Neville Huxham, Malawi country director for Paladin Energy Africa, operator of the Kayelekera uranium mine, IPS Aug. 24, 2009)

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From:	Jeffery C. Parsons
To:	Shea, Valois
Cc:	"Roger Flynn"
Subject:	Oglala Sioux Tribe Comment Attachments #1
Date:	Monday, June 19, 2017 3:37:47 PM
Attachments:	August 19 transcript.pdf August 20 transcript.pdf Ex 2 Abitz Report on baseline characterization.pdf January 31 2017 OST-NRC meeeting summary ML17060A260.pdf LaGarry Supplemental Testimony FINAL.pdf May 19 2016 OST-NRC meeting summary ML16182A069.pdf May 31 2017 OST THPO letter to NRC Staff.pdf Powertech initial position statementandtestimonytext(final).pdf USGS In situ recover in the US Abstract Otton 2009.pdf

Ms. Shea – in support of the comments submitted this day (June 19, 2017) by the Oglala Sioux Tribe, attached are supplemental documents. As there are several such documents, there are likely to be a series of emails to follow. Thank you.

****
Jeffrey C. Parsons
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****

Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title:	Powertech USA, Inc.: Dewey-Burdock in Situ Uranium Recovery Facility
Docket Number:	40-9075-ML
ASLBP Number:	10-898-02-MLA-BD01
Location:	Rapid City, South Dakota
Date:	Tuesday, August 19, 2014

Work Order No.: NRC-1008 Pages 692-920

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ATOMIC SAFETY AND LICENSING BOARD PANEL

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HEARING

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In the Matter of:       : Docket No.
POWERTECH USA, INC.     : 40-9075-ML
                        : ASLBP No.
(Dewey-Burdock In Situ  : 10-898-02-MLA-BD01
Uranium Recovery        :
Facility)               :
------------------------x
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Tuesday, August 19, 2014

Hotel Alex Johnson

Ballroom

523 6th Street

Rapid City, South Dakota

BEFORE:

WILLIAM J. FROEHLICH, Chairman

DR. RICHARD F. COLE, Administrative Judge

DR. MARK O. BARNETT, Administrative Judge

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P-R-O-C-E-E-D-I-N-G-S

(8:59 a.m.)

CHAIRMAN FROEHLICH: Good morning. We'll come to order.

My name is William Froehlich, Chairman of this Atomic Safety and Licensing Board, which has been designated to hear this matter and to decide the issues related to the application of Powertech for a license application and an NRC combined source and byproduct materials license to construct and operate a proposed in situ uranium recovery operation called the Dewey-Burdock In Situ Leach Recovery, or ISR project, in South Dakota. The proposed site is approximately 13 miles north-northwest of Edgemont, South Dakota.

We are here today to conduct the evidentiary hearing in this proceeding. The matter has been docketed by the Nuclear Regulatory Commission as Docket Number 40-9075-MLA. The MLA stands for Materials License Application. This ASLBP Number is 10-898-02-MLA.

Today's proceeding was publicly noticed by order issue of the Board on July 16th, and also published in the Federal Register.

For the record, today is Tuesday,

August 19th, 9:00 a.m., Mountain Daylight Time. And we are present in the Hotel Alex Johnson in Rapid City, South Dakota.

This hearing is scheduled to continue through Thursday of this week.

First, let me introduce the Atomic Safety and Licensing Board. To my right is Judge Richard Cole. Judge Cole is a full-time technical judge and has been a member of the panel since 1973. He holds a Bachelor's of Science degree from Drexel, a Master's from MIT, and his Ph.D. is from the University of North Carolina. He is a diplomat in the American Academy of Environmental Engineers.

To my left is judge Mark Barnett. Judge Barnett holds a Bachelor of Science and a Master of Science from the University of Tennessee, and his Ph.D. is from the University of North Carolina. He is currently the Malcolm Pirnie Professor of Civil Engineering at Auburn University, and he is a part-time technical judge with the panel.

As I mentioned earlier, my name is William Froehlich. I have been designated Chairman of this ASLB Panel, ASLBP panel. I am a lawyer by training, and I have had about 40 years of federal administrative and regulatory law experience. Because

I'm a lawyer and one of the judges on the panel, I serve as Chairman for this Board for all procedural matters.

I would also like to introduce a few other people to you at this point. To my far right is the Board's Law Clerk, an attorney, Nicholas Sciretta. The parties have been receiving emails from him for the past few weeks as we prepare for this hearing.

Also joining us in the room is our administrative and logistical support member, Ms. Twana Ellis. Thank you. And our Clerk of record and the master of everything electronic, Mr. Andrew Welkie. He will make sure that the screens, the computers, the microphones, and all of these things are working properly for our hearing.

We also have with us in the audience the Director of NRC's Office of Public Affairs, Eliot Brenner. Feel free to contact Mr. Brenner if there's questions about the proceeding, i.e. background or anything relating to procedures at the NRC. He is also the contact for the press and anyone from the public who has questions about our proceeding.

I would also like to note just for the record that one of -- another ASLBP Judge, a Judge from the Strata case, is in our audience, Dr. Craig

White. Judge White, okay, is in the back.

Okay. Our Court Reporter today is Matt Miller. There will be an electronic transcript made of this proceeding. Copies of that transcript will be available in about a week. It will also be posted on the NRC website at that time.

I would like now to ask the parties to introduce themselves. For each party I'd like lead counsel to introduce him or herself, stating your name, the name of your client, the name of any counsel who might be with you today to participate in the evidentiary hearing.

Let's start with the Applicant, for Powertech?

MR. PUGSLEY: Good morning, Your Honor. Christopher Pugsley for Powertech USA, Incorporated. I'm joined at counsel's table by my co-counsel, Anthony J. Thompson, also counsel for Powertech.

CHAIRMAN FROEHLICH: Thank you.

And for the Oglala Sioux Tribe?

MR. PARSONS: Thank you, Your Honor. Jeff Parsons representing the Oglala Sioux Tribe. With me at counsel table is Travis Stills.

CHAIRMAN FROEHLICH: Thank you.

For the NRC Staff?

MR. CLARK: Good morning. For the NRC Staff, my name is Michael Clark. My co-counsel is Patricia Jehle, and also with us is Sabrina Allen, a paralegal in our division.

CHAIRMAN FROEHLICH: Thank you.

And for the Consolidated Intervenors?

MR. ELLISON: Bruce Ellison on behalf of Consolidated Intervenors. Co-counsel, Mr. Tom Ballanco and Mr. David Frankel.

CHAIRMAN FROEHLICH: Thank you.

I should note that, as you may have discovered, the microphones are always live. So if you are conferring among your co-counsel or other parties, you have to hold the pause button, which is directly in front of the microphone, to block it out from the sound system in the room.

All right. At this point, I'd ask everyone to please turn off their cell phones and turn them to vibrate. Also, if you need to have a conversation, or whatever, unrelated, please take it out in the hall.

Members of the public are free and welcome to observe our proceedings today, as well as all NRC proceedings. But only counsel for the parties and the witnesses who will be testifying will be heard by the

Board today. Questioning will be primarily by the Board, with a limited amount of followup questions that the parties' counsel will submit to us at the conclusion of our inquiry.

Let's give a little background on this case, and we'll get started with a few preliminary matters before we hear from our witnesses.

On February 25th, 2009, Powertech submitted a license application for a combined source 11(e)2 byproduct materials license to construct and operate the proposed Dewey-Burdock ISR project in South Dakota. After completing the 90-day acceptance review, the NRC determined that the application required additional data. The application was refiled on August 10th, 2009.

After completion of that second 90-day acceptance review period, the Staff determined that the license application, as supplemented, was acceptable for detailed technical and environmental review, and it was docketed by the agency.

On January 5th, 2010, the NRC issued a Federal Register notice providing interested parties and stakeholders, interested members of the public, with an opportunity to request a hearing on the application. A number of groups and individuals petitioned to intervene, to participate in the process, among them the Consolidated Intervenors and the Oglala Sioux Tribe.

This Board was created to hear the case, and after an oral argument in Custer, South Dakota, in June of 2010, the Board granted the hearing request of Consolidated Intervenors and the Oglala Sioux Tribe and admitted them as parties to the proceeding.

Three of the Consolidated Intervenors’ 10 proposed contentions were accepted by the Board at that time, and four of the Oglala Sioux Tribe’s 10 proposed contentions were accepted.

In November -- on November 15th, 2012, the Staff notified the Board of the public availability of its Draft Supplemental Environmental Impact Statement, the DEIS, prepared pursuant to the Environmental Policy Act and the agency’s implementing regulations.

The environmental review contains analysis that considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures to either reduce or avoid adverse effects.

The Oglala Sioux Tribe and Consolidated Intervenors both filed -- both filed additional proposed contentions related to the DEIS, which

Powertech and the NRC Staff opposed. In addition to the original seven contentions, three additional new contentions were admitted at that stage.

On January 29th, 2014, the NRC Staff issued its Final Supplemental Environmental Impact Statement, the FSEIS. This final statement memorialized the Staff's environmental impact review and contained a recommendation that the license be issued to Powertech.

After another round of proposed contentions by the Intervenors, the existing contentions were found to apply to the FSEIS, and no new contentions were added at this stage.

April 8th, 2014, the NRC Staff issued NRC source materials license SUA-1600 to Powertech. This license allows Powertech to possess and use source and byproduct material in connection with the Dewey-Burdock Project. Both the Oglala Sioux Tribe and Consolidated Intervenors moved for a stay of that license pending outcome of the evidentiary hearing.

The Board granted a temporary stay on April 30th, which was lifted on May 20th, finding that the continued stay would have a very limited, incomplete effect on preventing any of the specific injuries which the Intervenors' contentions claimed the ISR mining might cause.

The Board can still invalidate or put conditions on the license, though its decision -- though its decision, which will be considered and released after -- this decision will be considered and released after the evidentiary hearing.

Most recently, the parties have continued to build the record in this case by submitting all of their position statements, witness testimony and exhibits to the Board. Contentions 14A and 14B, which had previously been admitted by the Board, were withdrawn by the Intervenors. Those contentions concerned whether an appropriate Endangered Species Act consultation was conducted and whether the FSEIS impact analysis on the greater sage grouse, the whooping crane, and the black-footed ferret were sufficient.

Today, seven contentions are active before the Board. We will question witnesses on these contentions in three separate panels. The first panel of witnesses will cover Contentions 1A and 1B, which discuss the claim that there has been a failure to meet applicable legal requirements regarding the protection of historical and cultural resources, and a failure to consult all interested tribes as required by law.

The second panel will be questioned on Contentions 2, 3, and 4. These contentions allege that the FSEIS prepared by the NRC Staff fails to include information regarding an adequate determination of baseline groundwater quality, fluid migration, and impacts to groundwater and groundwater quantity impacts.

The third panel of witnesses will address Contentions 6 and 9, and claims that the FSEIS fails to adequately describe or analyze proposed mitigation measures and connected actions.

We will begin with Panel 1. And depending on the timing, and so on, we will move to Panel 2, and then Panel 3.

MR. ELLISON: Judge Froehlich, if I may --

CHAIRMAN FROEHLICH: Yes.

MR. ELLISON: -- just for purposes of the record. The Court stated that the Contention 14 was withdrawn by Intervenors, and I just wanted the record to reflect it was withdrawn by the Oglala Sioux Tribe over the objection of Consolidated Intervenors.

CHAIRMAN FROEHLICH: Thank you. So noted for the record.

Among the preliminary matters we have

pending is the matter of the electric logs or the additional quality data. At this point, it is uncertain as to the relevance and whether they will be helpful one way or the other. The existence of this additional data will not delay the evidentiary hearing or our proceedings today.

Before the Board is able to decide on these additional quality data, and I believe some other data that have been requested in a motion that was filed by the Intervenors on Saturday, we are going to wait until we have Panel 2 seated -- Panel 2 who will be addressing Contentions 2, 3, and 4 -- and before we begin the questioning of those witnesses, we will take up and have argument on the -- what to do with that additional quality data.

But the Board believes it will need an opportunity to hear from both the lawyers on that issue, as well as the experts and the expert witnesses who will be testifying on Contentions 2, 3, and 4, in order to decide what we are going to do with that data.

Second procedural matter. There has been an exhibit list which was circulated by the Board's Law Clerk up to and including a compilation that was sent by email to all parties on August 11th, 2014.

It's a document entitled Powertech USA Dewey-Burdock In Situ -- In Situ Project. It is 34 pages long -- 34 pages long.

And this list that was circulated had a number of questions that were outstanding as to -- as to the identification and ultimate admission of certain of the exhibits that had been proposed. I would like to poll each of the parties and hear from them whether the 34-page list that was circulated on the 11th of August contains -- is accurate and contains all of the exhibits that they wish to be included in the record of this proceeding.

I will begin with Powertech. Have you had an opportunity to review that 34-page document and the exhibits that are listed thereon?

MR. PUGSLEY: Yes, Your Honor. We have reviewed it. We submitted a response to your inquiry on August 12th in our pleading regarding the electric logs.

To answer the question here for the record, the exhibits highlighted in yellow on the document we have -- we would like Powertech Exhibit APP-053, which is the testimony of Gwyn McKee, and APP-054, her CV, admitted into the record, because while the document stated this was applicable to

Contentions 14A and 14B, the table of contents of that testimony shows that her testimony is also applicable to Contention 6.

Other than that, the other items highlighted in yellow do not need to be part of the record.

CHAIRMAN FROEHLICH: Okay. So with the addition of APP-053 and APP-054, the list of exhibits that Powertech has sponsored and proposed is correct.

MR. PUGSLEY: Yes, sir.

CHAIRMAN FROEHLICH: Okay. The same question now to Staff. Has the NRC Staff had an opportunity to review the list of exhibits that was circulated on August 11th, and do you have any changes or corrections?

MR. CLARK: We have, Your Honor. It is complete and accurate with one exception. We submitted a revised exhibit last week. It is a minor revision to Exhibit NRC-2, so it would be NRC-002-R. We filed it by motion, and we received no opposition to that motion.

CHAIRMAN FROEHLICH: That was Exhibit NRC?

MR. CLARK: Dash 002. The revised exhibit would be NRC-002-R.

CHAIRMAN FROEHLICH: Okay.

MR. CLARK: It’s the revised resume for Dr. Kevin Hsueh.

CHAIRMAN FROEHLICH: Okay.

MR. CLARK: Other than that, the list is complete and accurate.

CHAIRMAN FROEHLICH: Okay. So we will add to the list of admitted exhibits NRC-002-R.

Moving now to the Intervenors, the prepared exhibits from the Oglala Sioux Tribe?

MR. PARSONS: Thank you, Your Honor. Jeff Parsons for the Oglala Sioux Tribe. The list is accurate for what is contained in it. In my response to the question about completeness, I indicated that Exhibit OST-020 had not been included. That is -- was attached to our response to the August 8th order filed on August 12th. That is an email motion from Powertech dated August 7th that was never, as far as I can tell, included on the electronic information exchange. And so we attached that to that filing.

In addition, Exhibit OST-021, which is a Powertech quarterly management discussion and analysis dated August 11th, that was attached to the motion to enforce the disclosure requirements that you referenced a moment ago filed this preceding Saturday.

So with those two exceptions, the Tribe

sees the list as complete.

CHAIRMAN FROEHLICH: Okay. Is there any objection to the admission of OST-020 or OST-021?

MR. PUGSLEY: No objection from Powertech, Your Honor.

MR. CLARK: The Staff has no objection.

CHAIRMAN FROEHLICH: Okay. Moving now to the Consolidated Intervenors.

MR. ELLISON: We believe that the list is accurate as far as what it contains. I would renew offering Exhibits Intervenors 010 and 010A through Q by way of a proffer with regard to Contention 14. And we would submit that that evidence should be admitted and that contention should be heard.

CHAIRMAN FROEHLICH: It’ll be admitted as a proffer, but not as one of the exhibits that is admitted into the record of the proceedings, since Contentions 14A and 14B are no longer before us.

I would like to take up one additional matter with you, counsel, and that deals with the testimony and affidavit of Dr. Kelley. That is INT-008A and INT-008.

Inasmuch as Dr. Kelley participated in the limited appearance statement sessions held yesterday in Hot Springs, he cannot appear again as a witness in the evidentiary portion of the hearing. So I will not admit Exhibits INT-008 or 008A.

I also would note that the affidavit supporting the testimony of Linsey McLean, INT-014B, will be included in the record and will be admitted as part of the list of exhibits admitted in this proceeding.

MR. ELLISON: Thank you, Judge Froehlich.

CHAIRMAN FROEHLICH: Okay. All right. Does any party at this point have any objection to the admission of the exhibits we have just described, the exhibits that were included in the 34-page document circulated by the Law Clerk and the corrections or additions that were stated this morning on the record? Is there any objection from Powertech?

MR. PUGSLEY: No objection, Your Honor.

CHAIRMAN FROEHLICH: From the Commission Staff?

MR. CLARK: None for the Staff.

CHAIRMAN FROEHLICH: From the Consolidated Intervenors?

(Pause)

MR. ELLISON: I'm sorry. I was visiting counsel. Excuse me, sir.

CHAIRMAN FROEHLICH: Is there any

objection to the admission of the exhibits that are contained in the 34-page document listing the exhibits, with the corrections and additions that were stated this morning on the record?

MR. ELLISON: Other than previously raised, no, Your Honor.

CHAIRMAN FROEHLICH: Okay. And, finally, for the Oglala Sioux Tribe?

MR. PARSONS: No objection, Your Honor.

CHAIRMAN FROEHLICH: The exhibits on the list are now admitted into evidence, and the Court Reporter is instructed to bind this exhibit list into the transcript of these proceedings.

(Whereupon, the above-referred to exhibits were received into evidence.)

Okay. At this point, I'd ask counsel if all of their witnesses who are scheduled to appear in our evidentiary hearing are present in the hearing room this morning.

MR. PUGSLEY: Your Honor, all of our witnesses are present in the hearing room this morning.

CHAIRMAN FROEHLICH: Okay. And for the Commission Staff?

MR. CLARK: For the Staff, Your Honor, I

would need to call out to one witness, if I may.

CHAIRMAN FROEHLICH: I mean, is --

MR. CLARK: This witness isn't testifying on Contention 1, so --

CHAIRMAN FROEHLICH: All right. Whether we're going to swear in all the witnesses at once in the beginning or we'll do it panel by panel.

MR. PUGSLEY: If I could --

CHAIRMAN FROEHLICH: Sure. Chris?

MR. PUGSLEY: Your Honor, I apologize. One of our witnesses, Ms. Gwyn McKee, is not currently here at this time but will be available for the panel, Panel 3.

CHAIRMAN FROEHLICH: Panel 3.

MR. PUGSLEY: Yes. Yes, sir.

MR. CLARK: Judge Froehlich, an update, all of the Staff's witnesses are here.

CHAIRMAN FROEHLICH: Okay. And for the Consolidated Intervenors?

MR. ELLISON: We are still waiting for the arrival of Wilmer Mesteth, and I'm just addressing this particular panel in terms of witnesses. But Dr. Redmond is here.

CHAIRMAN FROEHLICH: Okay. For the Oglala Sioux Tribe?

MR. PARSONS: Thank you, Your Honor. Same -- same answer. Mr. CatchesEnemy is here. Mr. Mesteth is en route.

CHAIRMAN FROEHLICH: Okay. At this point, I would I guess -- Mr. Mesteth is the only witness missing from the first panel, is that correct?

MR. PARSONS: That is correct, Your Honor. We are in process of reaching him by telephone to determine his location.

CHAIRMAN FROEHLICH: Okay. That being the case, I think the more prudent approach to take is to swear in our witnesses panel by panel. At this point, I would ask that the witnesses for all of the parties who are scheduled to testify on Panel 1 please stand and raise your right hand. Do you solemnly swear or affirm that the statements you are making in this hearing before the ASLBP will be true and correct to the best of your knowledge and belief?

(Responses in the affirmative.)

Please stay standing. The record will reflect that each witness responded in the affirmative.

Do you adopt your prefiled testimony in this -- your prefiled testimony as your sworn testimony in this proceeding?

(Responses in the affirmative.)

The record will reflect that each witness responded in the affirmative.

Thank you. You may be seated.

At this point, I would ask if there is any procedural matters, any matters that counsel wishes to raise before we move to opening statements? Do you want to --

MR. FRANKEL: Your Honor?

CHAIRMAN FROEHLICH: Yes.

MR. FRANKEL: David Frankel for Consolidated Intervenors. We had filed a motion concerning a motion to strike what we felt were legal opinions offered by non-lawyers, and that that was irrelevant and confusing and a waste of time, Your Honor. You held that open in abeyance pending this moment. So if you could respond to that motion, we would appreciate it.

Thank you.

CHAIRMAN FROEHLICH: At this point, the Board will not strike any of the witnesses which have been alleged to be opinion of counsel or rendering a legal opinion. As we move through the cross-examination of the witnesses, you are free to renew your objection as to legal conclusion. However, the

Board will take the statements as the understanding of the expert witness of how the law applies, and the Board is aware that many of the people who your pleading alleges are making legal statements are not lawyers.

Are there any other procedural matters or concerns that anyone cares to raise before we go to opening statements?

MR. PUGSLEY: None from Powertech, Your Honor.

CHAIRMAN FROEHLICH: From the Commission Staff?

MR. CLARK: None for the Staff.

CHAIRMAN FROEHLICH: From the Consolidated Intervenors?

MR. ELLISON: None, Your Honor.

CHAIRMAN FROEHLICH: Okay. And from the Oglala Sioux Tribe?

MR. PARSONS: None at this time. Thank you.

CHAIRMAN FROEHLICH: Okay. Counsel for each party will be allowed five minutes to make a brief opening statement before we hear from each panel. These opening statements should introduce the issue or issues to be addressed by the witnesses and provide an overview of the controversy.

The panel has already been seated, with the exception of Wilmer Mesteth, and we will begin with opening statements.

Let us hear first from the NRC Staff.

MR. CLARK: For the Staff, Ms. Jehle will be giving the opening statement.

CHAIRMAN FROEHLICH: Please proceed, Ms. Jehle.

MS. JEHLE: Good morning. First, I would like to say that the Staff looks forward to answering the Board's questions during this oral portion of the evidentiary hearing. The Staff is confident that it can provide the Board and the public attending the hearing with information showing how the Staff carefully considered the environmental issues raised by the admitted contentions.

Turning, first, to Contention 1A, as the Staff has explained in its written testimony, it thoroughly reviewed how the Dewey-Burdock Project may affect cultural resources. The Staff's witnesses are Dr. Kevin Hsueh, Haimanot Yilma, Kellee Jamerson, and Dr. Hope Luhman.

I will sum up the key evidence that supports the Staff's protection of cultural resources, and this evidence has already been admitted as Staff exhibits in this hearing.

The Augustana Class 3 archaeological survey of the Dewey-Burdock site was important in the Staff's review. Also, the Augustana College report on the evaluative testing of sites within the Dewey-Burdock site area.

The Staff also relied upon the ethnohistorical study of the SRI Foundation, and, importantly, the Staff conducted tribal field surveys of the Dewey-Burdock site with the participation of seven American Indian tribes.

The Staff also prepared and conducted auditory and visual impact assessments, and, most importantly, the Staff prepared and executed a programmatic agreement for the protection of -- specifically for the protection of cultural resources that had not yet been identified or have not yet been evaluated at the Dewey-Burdock site.

The programmatic agreement was executed on April 7th, 2014, with the signatures of the Advisory Council on Historic Preservation, and the South Dakota Historic Preservation Office. In answering the question of whether the NRC Staff has adequately protected the cultural resources at issue, the answer is yes.

In turning to Contention 1B, the Staff's prefiled testimony, written testimony, indicates that the Staff consulted extensively with American Indian tribes when considering impacts to cultural resources. Again, the Staff presented extensive written testimony, which demonstrates the consideration of these resources.

The extensive exhibits will be discussed as part of the tribal consultation on the tribal consultation issues. The key evidence on which the Staff has -- relies is its tribal outreach summary. This 17-page document lists the important tribal consultation activities the Staff undertook beginning in October of 2009 through April of 2014, with the execution of the programmatic agreement.

The programmatic agreement was signed, as I stated earlier, by the Advisory Council and the South Dakota Historic Preservation Office.

We also look to an exhibit, NRC-031, and that exhibit is a letter from the Advisory Council to the Standing Rock Sioux Tribe. In this letter, the Advisory Council concluded that the Staff's consultation efforts met both the content and the spirit of Section 106.

And, finally, in NRC-018D, the Advisory Council stated to the NRC that the Advisory Council's signature on the programmatic agreement completes the NRC's Section 106 requirements.

Staff is prepared to answer the Board's questions.

Thank you.

CHAIRMAN FROEHLICH: Ms. Jehle, one question, please. The tribal outreach summary, is that a separate exhibit? Or where is that found, just so we --

MS. JEHLE: Yes. That's Exhibit 015.

CHAIRMAN FROEHLICH: Thank you.

MS. JEHLE: And the --

JUDGE COLE: You should probably preface that with "NRC Exhibit."

MS. JEHLE: NRC Exhibit-015.

CHAIRMAN FROEHLICH: Could I hear next from Powertech? Mr. Pugsley?

MR. PUGSLEY: Yes. Good morning, Your Honor, members of the Board. May it please the Court, my name is Christopher Pugsley, and I am here representing the licensee, Powertech USA, Incorporated.

I would like, first, to thank the Board

and the city of Rapid City for hosting this hearing. And for purposes of Panel 1, dealing with Contentions 1A, dealing with allegations regarding failure to meet legal requirements for the protection of -- assessment and protection of historical and cultural resources, and Contention 1B, alleged failure to consult all interested tribes as required by law.

I would like to say, as a general matter, Powertech's approach to the assessment of historic and cultural resources is typical of the development of in situ recovery sites and reflects Commission legal precedent, common sense, accepted science, and regulatory compliance.

For purposes of Contention 1A, Powertech's license application included what is called a Level 3 pedestrian archaeological survey that was conducted pursuant to the State of South Dakota's standards and guidelines using competent personnel from the archaeology laboratory of Augustana College, all of whom have significant experience in this field.

The Level 3 survey is properly characterized here as a 100 percent survey that included appropriate subsurface testing and other commonly accepted investigative techniques to properly identify historical and cultural resources at the

Dewey-Burdock Project site.

It is important in the context of Contention 1A to know that a Level 3 survey, archaeological survey, is different from what you would call a traditional cultural property survey, in that the former is considered to be a full report with appropriate confidentiality and protective measures for identified sites conducted pursuant to state-mandated standards, whereas the latter is based solely on confidential and protected tribal traditional knowledge, drawing from a tribe-specific approach to site or resource identification.

The witnesses currently representing Powertech on the panel before you are Dr. Adrian Hannus of Augustana College, Dr. Lynne Sebastian, and Mr. Mike Fosha, who currently serves as the Assistant State Archaeologist for the State of South Dakota.

For purposes of Contention 1B, after the submission of the survey and its license application, Powertech actively participated in NRC Staff’s National Historic Preservation Act Section 106 tribal consultation process.

Powertech participated in a number of 106 meetings, assisted in the development of the scope of work for field surveys, and the programmatic agreement previously referenced by NRC Staff counsel, and agreed to be subject to the provisions of the programmatic agreement, including the continued involvement of tribes in the phased development of the Dewey-Burdock Project.

During this process, the Oglala Sioux Tribe was asked to participate as a consulting party for multiple avenues by NRC and was invited to participate in the NRC- and Powertech-sponsored meetings and site field surveys. However, while initially agreeing to participate in the field surveys, they subsequently withdrew.

Participating tribes in the field surveys, however, were permitted to survey the entire 10,000-plus-acre Dewey-Burdock site using their specific traditional approaches to identifying cultural or historical sites rather than what has been argued by counsel as a scientifically defensible standard methodology.

Powertech’s contribution to the Section 106 process primarily was active participation in the development of a 36 CFR Section 800.14(b) programmatic agreement, which was agreed to by all parties required to execute such a document, including Powertech, NRC Staff, the United States Bureau of Land

Management, who served as a cooperating agency on the finalization of the Supplemental Environmental Impact Statement, and the State of South Dakota Historic Preservation Officer, who concurred on the eligibility determinations offered by NRC Staff after completion of the identification phase of the Section 106 process.

In addition, NRC determined in a letter dated April 24, 2013, that they formally requested consultation with the Advisory Council on Historic Preservation, the expert federal agency on promulgation and implementation of National Historic Preservation Act-based regulations at 36 CFR Part 800, et sequens, and their interpretation, which was accepted in October of 2013.

As a result, the Advisory Council also participated in the development of, and executed, the aforementioned programmatic agreement, which demonstrates that NRC Staff had completed its responsibilities for the Section 106 process which requires that the lead agency exercise a reasonable and good faith effort to complete the process and consult.

Opposing counsel have argued that NRC Staff impermissibly severed the National Environmental

Policy Act process, i.e. the development of the Final Supplemental Environmental Impact Statement from the Section 106 process. By regulation, conduct of the NEPA process, with -- in conjunction with the Section 106 process, is not mandatory. Thus, severance of that process from the NEPA process is indeed legally permissible.

Lastly, Powertech and NRC Staff’s conduct of the review of historic and cultural resources is consistent with current Commission legal precedent for what is termed in 36 CFR Section 800.4(b)(2) as “phased identification.”

Commission precedent in the Hydro Resources, Incorporated Subpart L proceeding, denoted by LBP-05-26 and CLI-06-11, hearing expressly approves the use of phased identification for ISR processes, ISR projects, due to the inherently phased nature of the development of these project sites.

Provisions for identification and eligibility determinations, as well as consultation with tribes of potential sites, as the Dewey-Burdock Project is developed are explicitly addressed in the aforementioned programmatic agreement, as well as an NRC license condition, which is typically termed as an unanticipated discovery condition of previously unidentified sites, in addition to a current standing memorandum of agreement with the State of South Dakota.

Issues associated with this contention will be addressed by Dr. Sebastian during your cross-examination period.

In conclusion, members of the Board, I would say Powertech's position is that the evaluation -- the comprehensive evaluation of historic and cultural resources in the entire Record of Decision adequately satisfies NRC requirements at 10 CFR Part 51 and Advisory Council Regulations at 36 CFR Part 800, and respectfully ask that the Board find that neither Contention 1A nor Contention 1B should result in any modification of any aspect of the Record of Decision for NRC's issuance of NRC License Number SUA-1600 to Powertech.

Thank you.

CHAIRMAN FROEHLICH: Thank you, Mr. Pugsley.

From the Oglala Sioux Tribe, please?

MR. PARSONS: Thank you, Your Honor. Jeff Parsons on behalf of the Oglala Sioux Tribe.

Contention 1A deals primarily with the NEPA requirement that cultural resources at the site be surveyed, their impacts analyzed, and mitigation measures developed and also analyzed and measured for effectiveness in that document.

We contend that that has not happened in this case. The controversy surrounds and the testimony you'll hear today is that the Final Environmental Impact Analysis does not include any survey data collected or analyzed with participation by any Sioux Tribe or representatives.

This is despite the Tribe's attempts to engage in a very meaningful way throughout this process, consistent with accepted methodology, and alongside other Sioux tribes, as is their cultural practice. But these proposals were rejected by NRC, despite these efforts. Powertech and NRC Staff rejected the Tribe's survey proposals, as the record shows, primarily due to cost.

We heard from representatives of NRC and Powertech about the thoroughly reviewed site, the Augustana study primarily being the source of that review, but the record shows that that study failed to identify sites, cultural sites relevant to the Sioux tribes, particularly the Oglala Sioux Tribe.

In fact, the testimony and the evidence presented in this hearing show that Powertech's witnesses admit that they were not equipped to identify cultural resources with priority to the Sioux tribes. And so to say that that survey included a full, thorough review is belied by that record.

Powertech says that they used a typical approach of ISL sites. I think what the record also shows, and what --the testimony you will hear, is that this site is not a typical site. Even the Augustana study indicates the unusually high number of cultural resources in this area. And so given that unique status of this site, it deserved better attention to detail than may be in a typical ISL, particularly with the Tribe attempting to engage submitting their own statements of work and methodologies that were subsequently rejected by the NRC Staff.

With regard to Contention 1B, 106 consultation under the National Historic Preservation Act requires a reasonable good faith effort. The 106 process in this matter was not conducted in a meaningful way, so as to result in a competent cultural resources review. As mentioned, the NRC Staff and Powertech rejected the Tribe’s survey proposals.

NRC Staff and Powertech rely heavily on the programmatic agreement to solve the inadequacies of the 106 process. But what the record shows is when the tribes submitted extensive comments on the programmatic agreement, those comments were not incorporated; they were rejected.

And I think it speaks volumes that the information that NRC Staff and Powertech state as far as the signatures on the programmatic agreement, I think it's notable that none of the Native American tribes involved in this process signed that programmatic agreement.

I think that undercuts an assertion that this process was conducted in a meaningful and good faith manner.

NRC Staff cites to their Exhibit 015, which is the list of contacts with the Tribe. What that appears to be is a preference of quantity over quality. You can have a lot of discussions with -- involved in the 106 process, but if they aren't of the quality necessary to ensure meaningful participation, then the number of discussions and contacts is not the determinative factor.

The PA does not -- programmatic agreement does not specify how any future identification or mitigation will occur, leaving all of these details to the future, despite the failures of these attempts in the past. And so essentially the PA perpetuates a system that had failed previously and now relies on that same system to solve all the problems in the future.

We submit that that's not meaningful and not in good faith. The result is the public and the decisionmakers were denied the benefit of a competent cultural resources analysis before the NRC made decisions.

Thank you.

CHAIRMAN FROEHLICH: Thank you, Mr. Parsons.

And now for the Consolidated Intervenors?

MR. ELLISON: Thank you, Judge Froehlich.

CHAIRMAN FROEHLICH: Mr. Ellison, it probably would be best if you sat, although I appreciate your standing, so that the microphone will pick up what you have to say.

MR. ELLISON: Courtroom style experience.

It is the position of the Consolidated Intervenors under Contention 1A that what has been done so far has failed to meet applicable legal requirements regarding the protection of historical and cultural resources. The National Historic Preservation Act is not a meaningless piece of paper.

It is designed to protect cultural resources, historical, ancestral resources.

It is not meant to simply show, well, we have done this step and this step, and so it must be okay. It is not designed to pretend to go through certain procedures, which we submit were totally inadequate up to this date. We also feel that it is an impermissible separation of the Section 106 studies from the FSEIS, which we feel was in error.

We have two witnesses who are prepared to answer the Board’s questions in these regards, Dr. Lou Redmond and Wilmer Mesteth.

The Clean Water Alliance and the Consolidated Intervenors include members of the Oglala Sioux Tribe as well as other local tribes. These tribes have historical and ancestral connections to the Dewey-Burdock area.

There was a survey that was conducted by the State Historic Preservation Officer from Augustana. The supervisor is here. However, in their report, there were many sites that were identified that were not even examined. So the report itself, we would submit respectfully, is essentially inadequate on its face.

The tribes which did do field surveys we would submit are those least connected historically and geographically from the area. The tribes most affected, the Oglala Sioux Tribe, the Rosebud Sioux Tribe, Cheyenne River Sioux Tribe, Standing Rock Sioux Tribe, raised serious questions as to methodology and raised serious questions as to what needed to be done.

The Tribal Historic Preservation Officers stated that there was a lack of meaningful consultation and input. We submit that the evidence will show that sending letters is not the same thing as listening, that it is an example of form over substance, and that the people, the professionally trained Tribal Historic Preservation Officers who know best how to conduct a survey of their own people’s historical artifacts, if you will, was simply ignored. This is not a good faith effort.

This is an area that is full of cultural resources -- burial grounds, medicine gathering areas, ceremonial sites, tool-making area, food-gathering area. People go there to collect tinsala, roots, game area. Dayton Hyde, who is -- as you know, is the owner of the Wild Horse Sanctuary some 15 miles from the site, has found thousands of artifacts dating back from the earliest times of Lakota history back to the hunting of mammoths. So we said before, there are insufficient resources done to do a proper survey.

As Mr. Parsons pointed out, the tribes did not sign the programmatic agreement. This is basically one side saying, “Well, we agree to do the right thing,” and the other side saying, “You haven’t even started to, and we’re not going to sign this agreement.”

The fact that none of the tribes who are potentially affected and recognized as being potentially affected by the letters that were sent out signed this agreement, that should say something about its insufficiency of not only that agreement, to protect cultural resources and the process.

We would submit that this shows a clear lack of understanding, if not lack of respect, for traditional Indian indigenous culture in this area which will be dramatically affected by any aspect of this project. And we would submit that it is all too typical of an approach that has been taken by the United States, by the dominant culture, with disregard for the original inhabitants.

The idea of a phased survey would require that you have competent people available on the site to identify cultural sites before they are destroyed. There is nothing in the programmatic agreement, there is nothing as a license condition, that requires Tribal Historic Preservation Officers from the Oglala Sioux Tribe, from the Rosebud Sioux Tribe, from the Cheyenne River Sioux Tribe, from the Standing Rock Sioux Tribe, to all have Tribal Historic Preservation Officers present to make such an identification.

So not only is the surveys that have been done to date been inadequate, because these folks who have said, “We need to do this in a certain way for it to be done right,” and the response by Powertech and NRC Staff has been, “Well, we want to do it our way. We don’t care what you think is the right way to do it. We know best.” How could that possibly be?

The idea of a first phased survey with this programmatic agreement does nothing more than guarantee further destruction of cultural resources in that area.

We would submit that what has been done so far, what is proposed in the programmatic agreement, does not offer real protection as required under the Historic Preservation Act of cultural resources. We would ask that this matter be remanded back to the prehearing stage for a proper survey to be conducted.

Thank you.

CHAIRMAN FROEHLICH: Thank you, Mr.

Ellison.

Contention 1A in particular involves legal requirements. So before we begin with the questioning of our witnesses, and also the swearing in of our late-arriving witness, I would like to ask counsel for the parties to explain the differences, if any, of responsibilities towards protection of historical and cultural resources between the National Historic Preservation Act and NEPA. Is it the same? Is it one study that satisfies both statutes, or are there different requirements between the two generic statutes that deal with or seek to have cultural and historic protections?

Could I begin with Staff?

MR. CLARK: Your Honor, the overall answer is there are slightly different requirements. NEPA requires the Staff to assess the impacts to the affected environment, and by “impacts” they mean the reasonably foreseeable impacts, not impacts that are speculative.

The National Historic Preservation Act describes a process by which agencies consult with other parties and attempt to identify, assess impacts to, and, if appropriate, mitigate impacts to resources. The main difference is that while NEPA requires the Staff to directly assess impacts, the NHPA describes a process under which impacts are assessed as a result of consultation with interested American Indian tribes, if appropriate, and other agencies, including, in addition to agencies, the Applicant.

The processes can be -- they can be joined together, as Mr. Pugsley stated previously, and they can also be separated, so they can be -- an agency can use its NEPA process, including the comment process, to invite comments under the National Historic Preservation Act. However, it can also use separate processes.

I'm not sure if you want more information on any specific area?

CHAIRMAN FROEHLICH: Let me ask you, then. The programmatic agreement is the Staff's response to the requirements of the National Historic Preservation Act. Is that correct?

MR. CLARK: It's the culmination of the Staff's response to the requirements of the process.

CHAIRMAN FROEHLICH: And Section 3.9, et seq., is -- in the FSEIS is the Staff's response to their responsibilities under the National Historic Preservation Act. Is that correct?

MR. CLARK: That is a partial response --

CHAIRMAN FROEHLICH: I'm sorry. Okay.

MR. CLARK: -- to the National Historic Preservation Act.

CHAIRMAN FROEHLICH: I'm sorry. I meant the National Environmental Policy Act. Excuse me. Section 3.9 of the FSEIS is the Staff's response to their obligations under NEPA.

MR. CLARK: No.

CHAIRMAN FROEHLICH: No. Okay. Please --

MR. CLARK: And my answer is, the Record of Decision is the answer to the Staff's requirements under NEPA. The Record of Decision includes the Final Supplemental Environmental Impact Statement. It also incorporates the programmatic agreement. So the Record of Decision and all the documents referred to in the Record of Decision is the Staff's answer to its NEPA requirements.

JUDGE COLE: So, in that situation, the programmatic agreement works towards satisfying the NEPA requirement --

MR. CLARK: Correct.

JUDGE COLE: -- in the Record of Decision.

MR. CLARK: Correct, Your Honor. And this is consistent with the NRC's Commission precedent in

Hydro Resources. I don’t want to miscite the case. I can find it. It’s one of the Commission decisions where the Staff obtained additional information on cultural resources after it completed its NEPA document, the environmental impact statement in that case or the environmental assessment. I forget what document they used.

The Commission found there was no fault in the Staff’s review, because although it received information after it issued its NEPA document, it considered the information before it reached a licensing decision. As the Board knows, the Staff cannot reach a licensing decision until it issues the Record of Decision.

So this approach is consistent with Commission precedent, and not just Commission precedent but precedent -- the guidance -- one of the Staff’s exhibits -- I believe it’s Exhibit NRC-35, but I’d have to verify -- is joint guidance published by the Advisory Council on Historic Preservation and the Council on Environmental Quality. ACHP issues the regulations under the NHPA. CEQ issues the regulations under NEPA. In that joint document, they prescribe how agencies can comply with both statutes. The Staff followed that guidance in this case.

CHAIRMAN FROEHLICH: Mr. Pugsley?

MR. PUGSLEY: Your Honor, Powertech would agree with NRC Staff's assessment of the situation with the following additions. That for purposes of the National Historic Preservation Act regulations as implemented by the Advisory Council, there are prescriptive requirements there for process, including a four-step process, which I'm going to paraphrase here.

Basically, step one, identification and contacting/consulting parties; two, identification -- resource identification, site identification; three, identification of potential adverse effects; and then the fourth is resolution of adverse effects. That is a prescriptive process that must be followed and has been in this case.

Once again, let me be specific that those regulations at 36 CFR Part 800 specifically allow for phased identification. Now, while we have said -- both the Staff and the licensee have said it is consistent with Commission precedent, the Commission precedent is consistent with the regulations. So, thus, the use of phased identification for this is appropriate.

In addition, there are prescriptive

requirements for agreement documents, such as a programmatic agreement, which has been used here. So that -- as well as consistent with those regs, but the difference between that and NEPA is exactly what Mr. Clark said, that the NHPA prescribes a certain process that needs to be followed.

For NEPA, under Part 10 CFR Part 51, the triggering requirement is what type of NEPA document needs to be produced pursuant to NUREG-1748 guidance for environmental -- for NEPA documents. In this case, according to 10 CFR 51.20(b)(8), an initial operating license for a source material milling facility requires an EIS level document -- in this case, the combination of a programmatic, or in NRC's case a generic environmental impact statement at NUREG-1910, coupled with a tiered Final Supplemental Environmental Impact Statement, NUREG-1910 Supplement 4.

With those additions, we concur with the Staff's position.

MR. CLARK: Judge Froehlich, could I correct that reference? The joint guidance from the ACHP and CEQ is Exhibit NRC-048.

CHAIRMAN FROEHLICH: Thank you, counsel.

MR. PUGSLEY: Oh. And, Your Honor, if --

I apologize. May I just add one more thing? That when Mr. Clark refers to the Record of Decision, I'd like to add that it doesn't just include the Final Environmental Impact Statement or Supplemental EIS, there also is an extensive response to comments from the public in the back of that document. Those are also the Staff's opinions and findings with respect to the site-specific assessment of the Dewey-Burdock Project. That is also a part of the Record of Decision and part of the NEPA process.

CHAIRMAN FROEHLICH: And that set of response to comments are comments made to the environmental document or the National Historic Preservation concerns, the I guess edits or suggestions that were requested by the Intervenors to the programmatic agreement.

MR. PUGSLEY: Well, as a matter of process, response to comments are done to the Part 51 NEPA document, which is the Draft Supplemental Environmental Impact Statement, which was put out for 45 days' public comment.

However, that does not preclude an interested stakeholder from offering comments on National Historic Preservation Act related issues. It is impossible to separate the analyses offered in the

FSEIS from what is conducted in the National Historic Preservation Act process. It is prudent to do so, but it doesn't preclude stakeholders from commenting on it.

CHAIRMAN FROEHLICH: I think I heard you say, Mr. Pugsley, that those comments that were a part of the Record of Decision were comments that were submitted to the FSEIS, although they could include, at that stage, comments responsive to the programmatic agreement or documents drafted to comply with the National Historic Preservation Act. They would have the ability to do it, but that isn't the purpose of that set of comments. And, indeed, that set of comments were responsive to NEPA concerns. Am I correct?

MR. PUGSLEY: It's their response to the Draft Supplemental Environmental Impact Statement and included in the FSEIS.

CHAIRMAN FROEHLICH: Okay. All right. Back to the original question for Intervenors. Mr. Parsons?

MR. PARSONS: Thank you, Your Honor. This issue was briefed rather extensively in the opening and rebuttal statements. We have a pretty serious issue I think with what we see as NRC Staff and

Powertech conflating the requirements in the National Historic Preservation Act and the National Environmental Policy Act.

Federal case law makes it very clear -- I believe I cited this case to you on a conference -- oral argument on the motion for a stay of the permit, but the case law clearly states that compliance with the National Historic Preservation Act does not relieve a federal agency of the duty of complying with the environmental -- with the National Environmental Policy Act, and the language in the case laws say “to the fullest extent possible.”

And so -- and that cite is Lemon v. McHugh. It’s a District of D.C. case from 2009, 668 F. Supp. 2d 133 at 144. And I think that gets to the heart of this issue, that from our perspective NRC Staff had published a Final Environmental -- a Supplemental Environmental Impact Statement, and then subsequently attempted to shore up the lack of a competent cultural resources analysis, and relying in large part on the programmatic agreement.

Contrary to what you just heard, a Record of Decision is not a NEPA document. The purpose of NEPA is to provide information to the public and allow them to digest the information and participate in the process, as well as the decisionmaker. And so by attempting to provide any analysis at the Record of Decision stage explicitly denies the public the ability to review and comment and participate in that analysis.

You have CEQ regulations that specify that environmental analysis, including a cultural resource analysis, must be contained in an environmental document. An environmental document is defined in the CEQ regulations as being an environmental assessment, an environmental impact statement, or a finding of no significant impact.

Those do not include a Record of Decision, and that's, again, for that very good reason that NEPA requires involvement of the public and interested parties to inform the decision and allow them to participate.

The requirements of the National Historic Preservation Act are not quite so prescriptive. The overriding standard is a reasonable and good faith effort. That is distinct from the NEPA requirements that are, I would argue, more prescriptive. That is, that they require the agency to include in an environmental document their full analysis of cultural resources.

And what we've got in this case is essentially the agency saying, "We know there's more resources out there we haven't looked at, but what we've done is good enough." I think that's sort of a theme running through this entire hearing and a basis of many of our contentions is NRC Staff saying, "Well, what we have is good enough. We'll do the rest at some point later without the involvement of the public, without disclosure of this information as required under the National Environmental Policy Act."

I think the programmatic agreement is an NHPA document. It is not a NEPA document. And I think that's evidenced by the programmatic agreement itself. In the programmatic agreement, which is NRC-018A, at page 6 it talks about the programmatic agreement.

It states, "If the NRC, BLM, and South Dakota SHPO, in consultation with the tribes" -- now, we have already discussed it, and you'll hear more about how the consultation has not exactly been what we would consider meaningful and good faith -- in consultation with the tribes, if they make the determination that identified cultural resources are not NRHP eligible -- that is, the National Register of Historic Places -- no further review or consideration of the properties will be required under this PA.

And so what that means is the PA applies only to resources that rise to the level, in NRC, BLM, and the South Dakota State Historic Preservation Office's opinion, as being eligible for listing on the National Register, NEPA requires a full review of the cultural resources, not just those that rise to the level, according to these agencies, of the National Registry of Historic Places.

And so there is a big difference between what is required under NEPA, which requires a more comprehensive review of the resources, and not just those, which is essentially the substantive focus on the National Historic Preservation Act, is to -- is on those that are eligible for the National Registry of Historic Places.

And so in our brief we go through a whole section in our opening statement on the requirement -- the NEPA requirements, which require all this information to be up front and involved with the public to say that the NRC Staff can comply with NEPA in a relatively narrowed hearing procedure, without involvement of the public, no opportunity for the public to comment, to review, to critique those studies and that analysis, is contrary to NEPA.

Now, the NHPA, as was pointed out, allows for a more phased approach, but NEPA does not. To the extent that you have information out there that was not gathered and not included in the NEPA document, you can't just push that out to later as they are trying to do in the programmatic agreement.

So I think we see it as very much distinct in terms of those legal standards between the National Environmental Policy Act and the National Historic Preservation Act, neither of which we would say were complied with in this case.

CHAIRMAN FROEHLICH: Okay. Finally, from the Consolidated Intervenors?

MR. ELLISON: We would defer to Mr. Parsons' analysis of the law. I would just note the case that was discussed by NRC Staff about how information was received after NEPA analysis was completed and before the license was issued. Here we have known information which is out there which was not included in NEPA.

So it wasn't that some additional information that was unavailable or could not be obtained was not included in the original NEPA document that was then supplemented, here we have known information which was not included in NEPA and the license has already been issued. So that case is clearly distinguishable.

We have a fairly unique situation here by the way this has been approached. You know, and I would submit that, you know, there was a decision that was made to try and do something more than perhaps has previously been done in terms of examining what cultural resources are there. But, again, the people who know best what they are and can find where they are were left out of the process. So no good faith effort.

CHAIRMAN FROEHLICH: Thank you, Mr. Ellison.

Go ahead.

JUDGE COLE: I thought the Record of Decision included all of the environmental documents that the Staff had produced, and you could not issue the license until the -- all of the environmental documents were completed. Is that your understanding, or is it not true?

MR. ELLISON: Who is that addressed to? Judge Cole, are you addressing that to me or to --

JUDGE COLE: Well, no, I was going to ask you, but we can also ask the Staff.

MR. ELLISON: Yes. I would think the

Staff should have to explain first, please.

JUDGE COLE: Okay. We'll let the Staff do that.

MR. CLARK: The Staff answer is yes, the Record of Decision incorporates all of the environmental documents that the Staff developed and relied on in its review.

JUDGE COLE: All the documents that are necessary for license issuance.

MR. CLARK: Correct. That includes the Safety Evaluation Report as well.

JUDGE COLE: And the FSEIS and --

MR. CLARK: Correct. And it --

JUDGE COLE: Okay.

MR. CLARK: Under Exhibit NRC-048, which I previously referred to, it explains at page 28 that an EIS is not a NEPA decision document. A Record of Decision is a decision document. They are both NEPA documents. One is analysis and one is the actual decision. The decision, as Judge Cole said, incorporates all of the environmental and safety documents needed for the Staff to complete its review.

JUDGE COLE: So the Staff review, as far as the NRC Staff is concerned, were complete before the Record of Decision was issued.

MR. CLARK: Correct. Not much before the Staff finalized the programmatic agreement on April 7th, and the Staff issued the Record of Decision on April 8th, 2014. But the Staff waited precisely so that it could include a programmatic agreement and all of the findings in that agreement as part of its Record of Decision.

JUDGE COLE: Thank you.

MR. PARSONS: Your Honor, if I might just address that briefly. Thank you. What we just heard was that the environmental analysis document was completed, and it referenced a PA that would at some point be developed. And I think that’s where we’re getting at the crux. The decision document, yes, comes later sometimes. Oftentimes, they issue a Final Environmental Impact Statement and a decision document at the same time, or some agencies do.

But the key fact here is that the analysis -- that the FSEIS is a stand-alone document in terms of requiring the complete analysis under the National Environmental Policy Act. And that is when I say that that’s -- that the ROD is not an environmental document because, as we just heard, there is no analysis to be done, additional analysis of the impacts on the environment or cultural resources in this case to be done at the Record of Decision stage.

NEPA requires that that entire analysis be stand-alone and be complete as of the publication of the Final -- in this case Supplemental Environmental Impact Statement. And so I just wanted to make sure that that distinction was presented.

MR. CLARK: If I could make a brief point to the Board in response to that. Under that theory, an agency can never use a programmatic agreement because they would have to do all of the analysis specified in the agreement before finalizing an EIS. However, again, Exhibit NRC-048, the joint guidance of the ACHP and CEQ, clearly envisions the agencies will use programmatic agreements that comply not with just the NHPA but NEPA.

MR. PARSONS: And I disagree with that analysis. NEPA requires that competent -- all information be included in the NEPA process. I understand that the NHPA allows for a tiered system.

Now, if evidence comes to light as they are disturbing ground, and they find new resources, I can understand how that could result in the agency going back and reviewing that information for whether it is significant or not. But in this case, what we have is an admittedly -- well, we argue that it's admitted; we certainly think it is -- an insufficient cultural resources analysis that was included in the Final Environmental Impact Statement, in an attempt to repair that analysis using the programmatic agreement.

I think that's a distinct -- distinct from the situation that Mr. Clark is referring to. Here we have a cultural resources analysis that was not completed, not sufficient, in the final -- admittedly not done in the Final Supplemental Impact Statement. And so that's a distinction that I think carries significant legal weight.

JUDGE COLE: But hasn't the programmatic agreement been designed or allegedly designed to eliminate those kind of problems as they follow through with completing the programmatic agreement, with all of the special conditions contained therein?

MR. PARSONS: I think it's -- a programmatic agreement, for it to work properly, presumes that a complete cultural resources analysis had preceded in the Final Supplemental Environmental Impact Statement. Here what we have essentially is an attempt to use the programmatic agreement to shore up known flaws in the Final Supplemental Environmental Impact Statement.

So where you have a complete study being done, and you don't -- and there is no evidence that things were missed or not analyzed in the NEPA document, then the programmatic agreement in terms of the phased approach that is allowed under the National Historic Preservation Act carries that forward. And to the extent they discover new significant information that was not obtainable previously, it can sort of bring NEPA back to life, but it presumes that prior to that you have a complete analysis in the final.

JUDGE COLE: Yes. But isn't that covered in the programmatic agreement, that that would happen if they uncovered significant new information?

MR. PARSONS: If they uncover significant -- what I'm saying is that they have in their Final Supplemental Environmental Impact Statement not reviewed -- not finished their cultural resources survey. And, remember, the programmatic agreement, by its own terms, said if we find -- the agencies determine that the resources they find are not eligible for the National Registry of Historic Places, the programmatic agreement doesn't apply at all.

And so that is I think a clear indication that it's -- a programmatic agreement in itself, and those measures, are not a substitute for an inadequate

NEPA process preceding it.

JUDGE COLE: So under NEPA you might have to do something else, but under the other law you wouldn’t have to. You could stop at that point.

MR. PARSONS: I think that’s -- that’s accurate. But, again, the whole system is premised on a complete analysis in the National Historic -- in the National Environmental Policy Act document. And in this case, we I think have made a very strong case that the Final Supplemental Environmental Impact Statement did not include a complete or, we argue, competent cultural resources analysis.

JUDGE COLE: Thank you.

CHAIRMAN FROEHLICH: Okay. What I would propose we do at this point is I’d like to swear in our late-arriving witness, then we’ll take a very -- a 10-minute break, and then we will begin the cross-examination of the first panel.

Wilmer Mesteth, would you please stand? Raise your right hand. Do you solemnly swear or affirm that the statements you will make in this hearing before the ASLBP will be true and correct to the best of your knowledge and belief?

MR. MESTETH: Yes.

CHAIRMAN FROEHLICH: Do you adopt your

prefiled testimony as your sworn testimony in this proceeding?

MR. MESTETH: Yes.

CHAIRMAN FROEHLICH: The record will reflect that the witness answered in the affirmative on both counts. You may be seated.

All right. Let’s take a 10-minute break, and then we will begin with the cross-examination of Panel 1.

(Whereupon, the above-entitled matter went off the record at 10:19 a.m. and resumed at 10:37 a.m.)

CHAIRMAN FROEHLICH: Back on the record. I'd like to direct the questions now to our empaneled witnesses. Let me begin with a single question to the Ph.D. anthropologists on our panel. I'd like to have an explanation of the difference between a Level 3 survey, as it's used by the professionals in the field, and a TCP survey, a traditional cultural property survey, that's also mentioned in the testimony.

I guess my first question maybe is from the staff. Dr. Luhman?

DR. LUHMAN: If I understand your question correctly, you're asking me to identify the Level 3 survey and distinguish it with a TCP survey.

CHAIRMAN FROEHLICH: Exactly.

DR. LUHMAN: A Level 3 survey in accordance with the South Dakota SHPO guidelines is essentially a 100 percent survey of the area potential effects. It's a pedestrian survey. There are other guidances that are provided in their documentation with regard to background research that needs to be conducted, the kind of field reconnaissance and how you might go about that, and then reporting.

A TCP survey is a traditional cultural property survey. A traditional cultural property survey essentially would look at those resources that are of traditional importance to particular groups. It may not necessarily be Native Americans. It could be other groups that attach some degree of significance to a particular location.

CHAIRMAN FROEHLICH: Dr. Sebastian, anything to add?

DR. SEBASTIAN: Yes. When archaeologists talk about a Class 3 survey, they're talking about archeology. They're talking about a scientific archaeology. They're talking about looking for places on the landscape that have evidence of past human life that might have information to yield about --

scientific information about life in the past. So it's a narrower focus on the places where people have lived. It really is about whether we can secure scientific information or not.

Traditional cultural properties are identified in many different ways. And in many parts of the United States they're done strictly through ethnographic studies by interviewing the elders, by interviewing the knowledgeable practitioners, by gathering that information because the information about traditional cultural properties is held in the traditional knowledge of the community. And as Dr. Luhman says, it can be other than Native Americans or Native Hawaiians. It can be ethnic groups. It can be any kind of a community.

The process of identifying those is not specified in the same way that archaeological surveys are pretty much done the same way everywhere in the country. Identifying traditional properties depends on the views of the community about how that should happen. As it happens here in the Northern Plains, we've learned that people want to go out and actually walk the ground and identify things that way. That's not necessarily the way it's done in other places. Does that help?

CHAIRMAN FROEHLICH: It helps. Dr. Redmond?

DR. REDMOND: It can also be defined as very specific intervals in your surveying across the landscape, whereas an inventory may be a survey of intervals dealing with a hundred meters between your survey intervals. A Level 3 inventory is primarily, in most areas, 15 meters between survey personnel. It's a very intense survey and it deals with looking very intensely and it also deals with once materials are located, a more intense analysis and in many cases, it also combines subsurface testing with the surface analysis. It may also involve offsite analysis to include analysis by other scientific means which can include things like C-14 or other processes, if that helps.

CHAIRMAN FROEHLICH: Dr. Hannus, the Augustana College conducted a Level 3 survey, as I understand it.

DR. HANNUS: Correct. And that survey was to respond to the requirements of the National Historic Preservation Act. Is that what a Level 3 survey is geared to satisfy?

DR. HANNUS: Correct. I guess, you know, to distinguish the two, the Level 3 survey is absolutely a structured set of procedures that we are required to go through, both from the nature of it being initially a pedestrian survey. In this case, we did a 100 percent, defined by the regulations, pedestrian survey. That would mean that the maximum distance between people would be 30 meters. But in conducting this, I think it would be important to call to everyone's attention to the fact that as you begin to go across, and these are linear transects, so you're lining up across the landscape. But within that framework, you then as you identify sites, you then begin to close this interval.

And so within this particular project, there are instances in which we were probably within fingertip-to-fingertip relationship to each other because as you identify a zone where you're looking at a site, you then bring everyone together to clearly try to establish the horizontal extent of that site.

Now as far as subsurface testing goes, within a Level 3 process, you're doing subsurface testing depending on a number of factors, but largely how clearly you can see the landscape surface. During the process of our Class 3 work at the Dewey-Burdock project, the conditions had been under a fairly lengthy drought circumstance. So you had a surface visibility that was really quite conducive to seeing the sites without having to go across the landscape doing intermediate shovel tests.

In any case, what we were conducting then was a process by which -- and the other thing I should note, too, is that when you look at particular features on the landscape that would either be elevated areas and/or either fossil or active water sources, you would certainly intensify the closeness of proximity of people conducting the survey because there are indicators that we, as archaeologists, are trained to look for. There are indicators telling us about the logical areas on a landscape that people either would have settled on or would not have settled on.

So as part of this scientific process, it's incumbent on whatever archeological group is conducting the work to be aware of those set of parameters. In other words, you're looking at the climatic parameters that are either present currently and/or are known from the past as well as -- so this and it should be separated though clearly from a traditional cultural property survey because there is not a set of specific type guidelines. And those are outside the parameters of what we, as archaeologists, would be privy to that information. That information is held in the deep knowledge of the tribal elders and so on. And that's something that the way in which those surveys would be conducted I say is different and it doesn't have the same set of strictures drawn in a legal sense that those that we are working under have drawn.

CHAIRMAN FROEHLICH: Dr. Luhman, is that because the National Historic Preservation Act is focused on properties' eligibility to be added to the National Register of Historic Places? Is that the reason why the Level 3 surveys are used?

DR. LUHMAN: Level 3 surveys are used in particular circumstances when they're appropriate to the project. But yes, it's all part and parcel of the process by which evaluating whether or not any identified resources would, in fact, be eligible to the National Register of Historic Places.

CHAIRMAN FROEHLICH: Now from that answer, are Native American cultural and religious places the types of things that a Level 3 survey picks up and are those the type of things that are looked for in a traditional Level 3 survey?

DR. LUHMAN: A traditional Level 3 survey may, in fact, encounter some resources that would be associated with Native American Groups or which they would identify. But they wouldn't necessarily identify all of the resources primarily because some of the knowledge is not available to those conducting a Level 3 survey. That would be provided by the Native American groups themselves.

CHAIRMAN FROEHLICH: Do any of the other expert archaeologists care to respond or add to Dr. Luhman's answer?

Dr. Sebastian?

DR. SEBASTIAN: There's an overlap because many archeological sites are of importance to native people. It's their ancestors who lived there. So there's an overlap, but it's not exact.

Archaeologists can identify archeological sites that are likely to yield information about the past and some of those would also be traditional cultural places that would be important. But there are lots of other kinds of traditional cultural places, Mountain Top Springs, lots of things that have that importance and that would be eligible to the National Register that archaeologists don't have the skills or the knowledge to identify.

CHAIRMAN FROEHLICH: Okay, Mr. CatchesEnemy or Mr. Mesteth, can you tell me some of the things that would be picked up or recognized in the traditional cultural TCP survey that would not show up in a Level 3 survey that was just described by the previous witnesses?

MR. MESTETH: Well, before I talk, I'd like to greet everybody in my Lakota language.

(Native language spoken)

What I am saying is I'm from the Ogala Lakota Nation. And when I was growing up, you know, I grew up in my language. That's my first language is Lakota language. And I want that clearly understood here today in these proceedings here.

We are the ones that had rejection and we're the ones that are the experts, not the archaeologists. They make assumptions and hypotheses about our cultural ways and it's not accurate. Some of the information is not accurate. And that's why we object in certain situations. But I'm a Lakota spiritual leader all my life. I grew up in my traditional ways and the history of my people. I am well versed in the history of my people. And Khe Sapa, the Black Hills, I was born here in the Khe Sapa. I was born at (Native language spoken). That's "Where the Thunder Beings Perch." It's Harney Peak. That's where I was born. In 1957, I was born there at the man-made lake of Sylvan Lake. That's where I was born and I'm proud of my place of birth because it's my ancestral land that I was born in. And I grew up with the history of our people in and around the sacred Black Hills.

We are one of the largest indigenous nations in this country on this continent, the Lakota, Dakota, and Nakota people. And our land base, aboriginal land base was vast. You have to clearly understand that this land base is a vast territory, where our people roamed and ventured and coexisted with other tribes before it became the United States of America.

This Turtle Island, and we have respect among each other, our tribes and our cultural ways and our burial grounds, ar well understood between tribes and we have effigies, stone features. We have sacred places here in this country and we are the only ones that can determine those things. And sometimes we are reluctant to share this information with archaeologists because the nature of the information, sacred places. Your understanding of a sacred place is different from mine. And I want those things clearly understood here today in these proceedings.

We are the ones, and the only ones, that are qualified. When we're talking about tribes in and around the Black Hills, the Lakota Nation, the Kiowa Nation, the Crow Nation, Arapaho, Northern Arapaho, Northern Cheyenne Nations, Hidatsa, Mandan and Arikara, the Ponca and Pawnee. These tribes are historical tribes. When we're looking at features and artifacts and you're talking about history of this Black Hills, then we are the experts. I want that clearly understood.

And as far as this Level 3 survey, the way I understand it, these have to be included in that and it should be included. And it should be stated to that effect. And include the Native American tribes that are in question here. That's my understanding of that. And the cultural TCP surveys, cultural TCP surveys, that's where we are the ones that determine what is clearly Lakota, a stone feature, a plinth artifact, arrowpoint. Those things, because we still practice our culture and we can trace it back. And what kind of stones are used on this land?. What kind of medicines that we utilize? We still use -- I'm a medicine man. I use in my practice with these medicines on this country and I go into the Black Hills and I harvest these medicines yet today.

The knowledge of our people, you know,

their existence here, you know, in the Black Hills area, some experts in the archeologist's field say that we're newcomers here. But no, in my ohunka, it states in there that we came forth upon creation here, not where Adam and Eve came in the Garden of Eden, wherever that is, you know. But here in (native language spoken) we call it, that's where our tradition states that we came forth upon this island here, the sacred Black Hills and we crossed over this land towards the east and then made our journey back here. That's our story and it's just as valid as this Holy Bible, you know. That's my understanding.

CHAIRMAN FROEHLICH: Thank you. I would ask that at the next break you write out the Lakota language that you spoke early on for the court reporter, so he can insert it properly and it will be there clearly.

Ms. Yilma, to address the EIS, you're required to have a section that includes places of religious and cultural significance. And I guess to do that, you're going to need to have input from people to whom the area has religious and cultural significance.

Can you tell me how you began the process to address the requirement that places of religious and cultural significance were included in the Draft Environmental Impact Statement initially?

MS. YILMA: When we first initially got the application, we reviewed it. We accepted it. We noticed -- we included a Notice of Intent to prepare a statement -- to prepare an Environmental Impact Statement. And as part of that process, we also sent out invitation letters to all the consulted tribes. Initially, we got a list of tribes that we believe had ancestral ties to that area from the State Historic Preservation Officer and for those tribes we --

CHAIRMAN FROEHLICH: Let me interrupt you there. You received that initial list from a State Preservation Historic Officer?

MS. YILMA: Yes.

CHAIRMAN FROEHLICH: Is that Mr. Fosha?

MS. YILMA: No.

CHAIRMAN FROEHLICH: No? Explain.

MS. YILMA: Although Mike Fosha is associated with the State --

MR. FOSHA: Historical Society.

MS. YILMA: Society. That's correct. It was Paige Olson at the SHPO's office in Pierre, his colleague.

CHAIRMAN FROEHLICH: His colleague.

MS. YILMA: Yes.

CHAIRMAN FROEHLICH: Okay. Can I ask Mr. Fosha at this point and interrupt your chronology? We'll come back to that.

MS. YILMA: Okay.

CHAIRMAN FROEHLICH: Evidently, the office sent a list of potentially affected tribes and native peoples who would be potentially interested in development in this area. Is that correct?

MR. FOSHA: That's standardly what we do, yes.

CHAIRMAN FROEHLICH: And that list contained --

MS. YILMA: It initially contained 17 tribes based on historical ties that could have used that area in the past.

CHAIRMAN FROEHLICH: And was that list -- I remember the list and it included the names of the tribes followed by a state. South Dakota for some, North Dakota -- that's the list we're talking about?

MS. YILMA: That's correct.

CHAIRMAN FROEHLICH: Was that list in order of most connected with the area to least or possibly traversed the area at some in the past thousand years? What was the nature of that list?

MR. FOSHA: I believe it's based upon maps that were generated by the U.S. Government at a certain point in time when they started establishing ancestral lands for each tribe.

MS. YILMA: The list, Your Honor, didn't have any priorities. If I recollect, I can reference the SEIS and confirm. It was just alphabetically listed.

CHAIRMAN FROEHLICH: Alphabetically.

MS. YILMA: So it was not areas of importance. But like Mr. Fosha has stated, the list was developed based on the maps that was generated by the State Historic Preservation Officer.

CHAIRMAN FROEHLICH: Back to your chronology, but ask after having received the list of potentially interested parties, any attempt was made to prioritize from most impacted to least impacted on that list?

MS. YILMA: It is my understanding that if a tribe has historical ties to that area, they are entitled to be a consulting party. And so therefore, we did not prioritize who has the most concern versus not because they all should have a similar type of concern. That was my understanding. Just to preface that though, Your Honor, when we went out, we had a site visit in December 2009 and when we went out there, recognizing that the Ogala Sioux Tribe is the closest proximity-wise, we did try to meet with the Ogala Sioux Tribe at which time we weren't able to because they didn't have the availabilities while we were out there to meet with them.

JUDGE COLE: But you did not attempt to prioritize at all?

MS. YILMA: Because our understanding is any tribe that had historical ties has the same importance, if you know what I mean.

CHAIRMAN FROEHLICH: From an archeological? Is that correct? Is that how you understand it, Dr. Hannus?

DR. HANNUS: My understanding would be that you are not prioritizing this at all. You're saying that there's evidence both in the ethnographic data and so on to suggest presence of certain groups who are in a region and we're not really talking about a time dimension to this. We're talking about the fact that there are various ways of defining those presences, but that you're not trying to give one group a greater role or a lesser role. What you're really trying to understand is there's a vast continent here across which people were using resources, interacting with each other and so the attempt of these lists of identification is really to try to be as broad as possible, a net which you throw out, to bring in those groups who would legitimately have some concern.

A good example, I suppose, would be the Southern Cheyenne, for instance, aren't physically located in the Dakota today, but Bear Butte is a crucial traditional, cultural site for the Southern Cheyenne because it's where they would have their arrow renewal ceremony. So it doesn't have anything to do with contemporary proximity. And again, my understanding it's not supposed to have anything to do with ranking the level of importance. It would be that those who feel a connection either immediately or in the distant past would have the correct input to a process like this. And it becomes very complicated because you're not trying to exclude anyone.

CHAIRMAN FROEHLICH: Dr. Sebastian?

DR. SEBASTIAN: Yes. Under the requirement that's placed on the federal agency in terms of how they comply with Section 106 is any tribe that expresses a wish to be consulted about places of religious and cultural significance is consulted.

I was working on a project in Ohio and we thought we had contacted all of the potentially interested tribes, but the Seneca from New York heard about the project, contacted us and said they would like to do that. We said certainly, that you can do that.

CHAIRMAN FROEHLICH: Okay. Dr. Luhman, does the perspective change when you're attempting to comply with NEPA and the sections there that require analysis of discussion of the religious and cultural resources? Does that change where you have to look to those tribes or those peoples who have had more contact with the area than such like other tribes who may have had at some point had contact? Is there an effort in the NEPA compliance?

I understood the answers from Dr. Hannus and Dr. Sebastian, but as you focus on the Historic Preservation Act, it doesn't matter as much. But when you're complying with NEPA, and assessing the impacts, is there a difference? Is there a change in focus, at least on the staff to address those tribes, those peoples who have greater connection, greater links to a particular area?

DR. LUHMAN: I would have to say no. It is self-identified by the tribes. And so therefore any group that expresses an interest or has a concern is considered equally.

CHAIRMAN FROEHLICH: Okay, Dr. Sebastian.

DR. SEBASTIAN: I could be wrong, but as far as I'm aware there isn't a specific requirement in NEPA for tribal consultation.

CHAIRMAN FROEHLICH: No, there's not.

DR. SEBASTIAN: Okay.

CHAIRMAN FROEHLICH: There is a requirement, however, that I guess that's what I was going with with Dr. Luhman, there is the necessity to take a hard look.

DR. SEBASTIAN: Oh, yes.

CHAIRMAN FROEHLICH: And I'm wondering as part of that hard look, the focus changes on those peoples or those tribes that may have been there longer, in there more, or more of them, whatever the criteria are. How does that hard look requirement change when you're doing your NEPA analysis?

Ms. Yilma, you can continue.

MS. YILMA: Yes, I guess I should have just started off chronologically. Because of the hard look requirement for NEPA, we recognize Ogala Sioux being the closest to the project. And initially, our efforts were geared towards the Ogala Sioux and consulting with the Ogala Sioux Tribe, until we met with the South Dakota State Historic Presentation Office and was informed of the broader view that we needed to take into consideration and consult with all the rest of the tribes that wish to be consulting parties because at one time they had inhabited that area as their historical ties.

For that reason, as I mentioned earlier, when we went out for our initial site visit in November 2009, we did try to contact the Ogala Sioux Tribe to get any information we could gather of anything of importance to them for us to consider in our NEPA review at which time, like I mentioned, they weren't able to meet with us because of scheduling conflicts.

So when we came back to the office, our communication continued with the Ogala Sioux Tribe in addition to sending the letters, the invitation letters officially to get interest from all the tribes. We also communicated with them when we issued the notice for a hearing, for instance. And so I guess as part of the hard look, we did consider Ogala being the closest tribes.

CHAIRMAN FROEHLICH: So then, does it follow that since the Ogala were the closest that that would be the focus of the hard look for the FEIS? Now separate your mind for a moment, the consultation requirements and the National Historic Preservation requirements, but for the purpose of preparing the EIS?

MS. YILMA: Your Honor, I do want to say one more thing before we continue down that road. What I want to say is that initially when we started doing the NEPA document, we did coordinate the NEPA and NHPA together. Because of that, we needed to take a broader look than just focus our efforts on to the Ogala Sioux Tribe. And for that reason, all of our consultation effort has always included the other consulting tribe, not just the Ogala Sioux.

CHAIRMAN FROEHLICH: Okay. Continue with your efforts and your work.

MS. YILMA: Okay, so we contacted them initially with letters and followed up with phone calls and contacted them again with letters and followed up with the phone calls until we had our initial face-to-face meeting in 2011.

In 2011, when we had our initial face-to-face meeting, there were a number of tribes including the Ogala Sioux present there and during that effort we were told that in order for us to -- in order for the tribes to identify properties, they would need to conduct a tribal field survey which we refer to as TCP surveys.

CHAIRMAN FROEHLICH: Let me interrupt you again.

MS. YILMA: Sure.

CHAIRMAN FROEHLICH: My apologies, but now this meeting, this was a face-to-face meeting you referred to?

MS. YILMA: That's correct.

CHAIRMAN FROEHLICH: Is that the same or different as a government-to-government meeting? Is there any difference?

MS. YILMA: Your Honor, the way we look at it is we are -- we consider all contacts we have with the tribes, government to government, in a sense that we are speaking with elected representative or representatives of each respective tribe, so therefore by that virtue we consider it a government-to-government consultation.

CHAIRMAN FROEHLICH: So all the meetings, all the emails, all the correspondence, those are all government-to-government communications in your perspective?

MS. YILMA: In my perspective, yes, that's correct. And again, it's because we are communicating with those representatives that the tribes deemed appropriate for us to contact for cultural resources type information.

CHAIRMAN FROEHLICH: Okay. I ask because I notice as I went through the chronology at some point the tribes in their responses wanted to, at least I think from their perspective, escalate it from these face-to-face meetings to a government-to-government meeting and I just wondered if there was any difference?

MS. YILMA: In my perspective, again, we considered all contacts government to government. I believe some of the tribes did request for us to meet with the tribal leaders and considered a meeting with the tribal leaders as a government to government.

With that respect, any communications we had with the representatives, if we, for instance, followed up with a letter or an email, we tried to copy the leaders to keep them informed of all the decisions that was being conducted through the consultations that we were having with the Tribal Historic Preservation officers.

Additionally, I'm going to fast forward to almost the future and say that we did try to attempt the government to government as defined by the tribes, I believe it's March or May of 2013 where we invited over 30 tribal leaders to meet with us so we could discuss all sorts of matters under the NHPA at which point there was only one representative that showed up stating that they were representing the tribal elders, but the others that showed up said they were just representing the tribes, but not the elders.

JUDGE COLE: Representing the what?

MS. YILMA: The tribes, but not the leaders.

JUDGE COLE: Thank you.

CHAIRMAN FROEHLICH: Interrupt you again.

MR. SHEEHAN: Yes.

CHAIRMAN FROEHLICH: Mr. CatchesEnemy, can you tell me from your perspective the difference, if any, between the face-to-face meetings that are in that chronology and the requests, I guess, from the tribes for government-to-government consultation?

MR. CATCHESENEMY: Indulge me a little bit to allow me to introduce myself as well.

(Native language spoken)

I say greetings to all my relatives, to all of you here. I greet you with a good heart and good handshake, your time and diligence in having this hearing.

My Lakota name is Sacred Thunder Buffalo, given to me by my elders. I am Lakota and I am the land. That's what I said in Lakota. There's a lot of things that are running through my mind as we're listening to the different testimony and this is one of the items that is of concern for the tribes.

The distinction between NHPA, Section 106 Consultation, which normally involves staff people and attorneys of federal agencies, in this case, the NRC staff and the Tribal Historic Preservation officers. Typically, you're not going to find elected tribal leadership at these Section 106 consultation meetings because typically we're talking about strictly archeological and cultural resource-related items.

When it gets elevated to a government-to-government status, that is when you have folks that are both elected officials on the federal government side and the tribal government side sitting at the table. So I would disagree with the point being made that these were considered government-to-government consultations because I do not represent as an elected official. I am not a government-elected person. I am an employee of the tribe to do a job related to historic preservation and cultural resource issues.

But when our councilmen and council women, our executive officers such as our tribal chairman, tribal president are at the table, we then view that as a government to government only if the federal government is sending their decision makers to the table to discuss certain matters. So I would at this point disagree with the government to government versus Section 106 consultation.

CHAIRMAN FROEHLICH: As I understood your answer, sir, that when you hear government to government, you think of the elected leaders of the tribe speaking with someone other than the staff members you've been working before. Who is it that you would have expected at the other end of the table from the NRC?

MR. CATCHESENEMY: Well, maybe it may sound, you know, profound or unrealistic, but if we have a sovereign nation such as we carry ourselves, regardless of our status in most Americans' minds, we still see ourselves as a sovereign nation with treaty rights that were signed between the tribal president, forgive me, the treaty signers and the president of the United States or Congress. And so when we talk about government to government, if our tribal president is at the table, then so should President

Obama.

That's why I'm saying it's probably profound for most people to consider that that level of leadership, but for our folks, I just see myself as a staff person. And if I'm going to be sitting in a consultation, I want to be sitting with a staff person and that's the Section 106 consultation.

CHAIRMAN FROEHLICH: In the staff testimony, the staff states it conducted its own independent analysis to determine eligibility determinations of archeological and tribal sites and uses this analysis when making its cultural resources impact determination. That's in NRC Exhibit 151 at page 6.

Can you tell me, please, the extent of the nature of the independent analysis that staff conducted?

MS. YILMA: Sure. Of course, we started off with the cultural resource survey that the applicant provided as our initial starting point. We reviewed the Level 3 class survey.

CHAIRMAN FROEHLICH: That original survey was the Augustana College survey?

MS. YILMA: Augustana College, as part of the application, yes.

CHAIRMAN FROEHLICH: Okay.

MS. YILMA: Yes, and so we reviewed the survey and determined there was additional testing that needed to be done on some of the unevaluated sites that could potentially be disturbed by the ground disturbing activities of proposed Powertech's license. And because of that, we asked for additional information from Powertech to be provided on those sites we deemed might potentially be impacted and were not included extensively in the Augustana initial survey.

Powertech then went ahead and did additional survey on those sites and provided additional information on those sites for us to consider during our eligibility determination. So archeological survey, the initial survey, plus the additional survey we took into consideration when we were making our eligibility determination. In addition to that, we looked at the tribal survey that was provided to us. In addition to that, we looked at the noise and auditory impact assessment that we had done. In addition to that, we took into consideration all information we were provided through the various consultations that we had with the tribes, the SHPO, BLM, and so forth.

We also did background research information just to identify the type of properties that could be found in that area and we -- for that, we looked at the SRIF, SRI's report that was provided on historical background on what type of information that could be found in the Great Plains. And went into the South Dakota Archeological Research Center to validate all the lists of eligible sites that are currently in existence and that could also be potentially available on that project's property when coming up with our eligibility determination.

CHAIRMAN FROEHLICH: Okay, and in your answer, you made reference to the SRI Foundation and that's Dr. Sebastian's organization. At what point did SRI or you become involved in the analysis for this project?

DR. SEBASTIAN: Are you asking me?

CHAIRMAN FROEHLICH: Yes, please, Dr. Sebastian.

DR. SEBASTIAN: In the summer of 2011, I believe the NRC asked Powertech to provide information about potential properties of religious and cultural significance. And they hired us to assist them in providing the NRC with the information that they asked for.

CHAIRMAN FROEHLICH: And again, in your mind, or I guess in your work order instructions or requests from the staff, was that to satisfy National Historic Preservation Act issues or to what extent did it include NEPA type questions?

DR. SEBASTIAN: Because they asked for information on properties of religious and cultural significance which is the Section 106 term of art, I made the assumption that that's what they wanted, yes.

CHAIRMAN FROEHLICH: Okay.

MS. YILMA: Your Honor, may I preface that?

CHAIRMAN FROEHLICH: Absolutely.

MS. YILMA: Under NEPA, we're supposed to be looking at cultural resources. Historical property is a subset of cultural resources and so therefore any information that are provided under the NHPA historical properties are a subset of NEPA review. So we have to consider them under the NEPA review.

CHAIRMAN FROEHLICH: Okay. Point taken. Thank you.

Dr. Redmond, did you want to respond?

DR. REDMOND: Yes, one of the problems that I had had with the way the inventory was conducted was not with any of the qualifications of any of the people that Dr. Hannus had or the way that Dr. Hannus did anything or his qualifications, was that I had done several surveys in an area about 20 miles south of the Dewey-Burdock site. And it was in an area that looked very similar. It was as desiccated as the Dewey-Burdock area was, the same thing. And had I simply done a Level 3 survey by looking at the surface, I would have missed a lot of archeology. But instead, I did subsurface testing and what I found was in a 300-acre parcel, I found 22 intact hearths on 22 sites. That is significant.

And part of what I said in my letter was that in surveys that I had done in South Dakota up to 2005, it had been my experience that had I found sites similar to what Dr. Hannus had found, had I not done subsurface testing on materials that were found there and described them as he had found them, my reports would have been turned back to me, both as a federal employee for the National Forest when I worked as an archeologist for them or as a private contractor when I ran my own company doing private contracts. My reports would have been turned back to me for not doing subsurface investigations when I found material such as he found. And that was my contention in the letter that I put forth earlier.

CHAIRMAN FROEHLICH: Dr. Redmond, could I interrupt you and just ask when you speak to subsurface tests, is that more than shovel tests or soil cores?

DR. REDMOND: Yes. What I was told to do was to put into -- put down 50 by 50 centimeter or 1 by 1 meter test pits, in 10 centimeter levels, down to sterile levels from surface down to a sterile level to make sure that I was not missing anything. Totally immaterial of what I found on the surface. And that was what I was told to do by the South Dakota Archeological Research Center every time that I did some type of a survey in South Dakota.

CHAIRMAN FROEHLICH: To what extent were subsurface tests conducted after you had received the Augustana College study and the other items that you listed in your last answer, Ms. Yilma?

MS. YILMA: The Augustana College did have some subsurface testing in the original results. And then as I mentioned, after we did our review and requested for additional information they did go back out and do some more testing.

CHAIRMAN FROEHLICH: And I guess, Dr. Luhman, can you tell me what the additional testing was, especially as it might relate to subsurface testing?

DR. LUHMAN: Well, if I am correct, the request regarding the additional subsurface testing would have been at those sites where there was the potential for impact as a result of the proposed project activities. From an archeological standpoint, if an identified site is not going to be impacted, in the interest of preservation and protection, further studies are not warranted.

However, if it is believed that an area is, in fact, going to be impacted by the proposed project, there would need to be additional investigation subsurface, for example, to determine whether or not those properties possess the aspects that one would see in a site that would be determined eligible for the National Register of Historic Places.

JUDGE COLE: The area of concern, are we restricting this to roughly 16 square miles of the Dewey-Burdock project? Or are we outside of that area?

DR. LUHMAN: Well, here, I believe we're referring to what I would consider to be the archeological APE which would be that portion of the project which would be impacted by ground-disturbing activities. So if there is going to be no impact to an area, it would not be of an archeological concern.

JUDGE COLE: Is that occasioned by the project?

DR. LUHMAN: Yes.

JUDGE COLE: Okay. So it could be outside the Dewey-Burdock 16 square miles? Or is it entirely within?

DR. LUHMAN: It's determined by the project, where the project will impact, where there will be ground disturbance as a result of the project.

JUDGE COLE: But you're talking about within the 10,000 acres, the 16 square miles.

DR. LUHMAN: Yes, that is correct.

JUDGE COLE: Would there be any occasion when you're conducting a study like this where you go outside that range?

DR. LUHMAN: No, not unless warranted by the project being expanded in some way, no.

JUDGE COLE: Thank you.

CHAIRMAN FROEHLICH: I think we're going to get back to your chronology and I guess at some point in time, the staff endeavored to meet with the tribes' listing and address the necessity for further surveys or a survey of the area. Take me through that chronology if you would.

MS. YILMA: Okay, so in 2011, during the first face-to-face meeting, the tribes requested to have a tribal survey done at which point we asked Powertech to provide us with that information, communicated that the tribes requested for a tribal survey.

CHAIRMAN FROEHLICH: And when you refer to the tribes, you're referring to one tribe, two tribes, all tribes?

MS. YILMA: The invitation went out to all the consulting tribes. There were -- I'm going to have to check my records, but there were I want to say six or seven tribes in attendance at that face-to-face meeting. Ogala Sioux was one. Yankton was another. Standing Rock was another. Cheyenne River, I believe, was another. I'd have to check my records and let you know.

CHAIRMAN FROEHLICH: Staff counsel, if you want to give her the chronology that's an exhibit, that may help.

MS. YILMA: The timeline is Exhibit NRC 15.

CHAIRMAN FROEHLICH: Yes.

MR. CLARK: Judge Froehlich, I don't believe that chronology will provide the information, the specific tribes that were at that meeting. We'd be happy to get that information and provide it later.

MS. YILMA: I can definitely check my notes and provide the number of tribes and who were there.

CHAIRMAN FROEHLICH: But your testimony was that they were all invited.

MS. YILMA: They were all invited.

CHAIRMAN FROEHLICH: And you ended up having six or seven tribes and that included members of the Ogala Sioux Tribe.

MS. YILMA: That is correct. And so after that we requested Powertech to provide us with additional information and communicated that the tribes had an interest in the tribal survey to be done, at which point Powertech then went out and hired SRI to be their consulting party and assist them in identifying and satisfying the tribes' request.

And as part of the continued consultation with the various tribes, it was determined that a statement of work was necessary to document the requirements and by which the tribes would go out and do the tribal survey. And we started working on the statement of work development.

CHAIRMAN FROEHLICH: Okay.

MS. YILMA: So then we had a draft statement of work from the applicant and then another draft statement of work from the tribes. And we reviewed those two statements of work to see whether they were appropriate and they satisfied our requirements to meet the NHPA and also NEPA. And --

CHAIRMAN FROEHLICH: I'm going to just stop at that point and that statement of work went out and Powertech came back with a proposal for the additional work. Was that response, or whatever, that SRI would conduct further studies? Can you tell me whether that's part of it?

DR. SEBASTIAN: Once we came on board in the fall of 2011, we began with the NRC introducing us to the tribes and asking the tribes to work with us. We began contacting all the tribes. We added additional tribes at that time. Some of the existing consulting tribes had pointed out other tribes that might want to be part. We had consulted the National -- one of those awful acronyms, the NAGPRA, N-A-G-P-R-A, which is the Native American Graves Protection and Repatriation Act, database. It's a big database of tribes that might have an interest in a particular physical area.

So we contacted additional tribes beyond the ones that they had started with. They asked for a big face-to-face meeting which we organized here in Rapid City. It was in February of 2012. The company brought in all the tribes who wanted to come.

We had a two-day meeting and it was out of that that initially the tribes said they would provide a scope of work, but NRC was anxious to sort to move the process along because the scope of work didn't come after several months, so they asked us to come up with a draft scope. We did the best we could and said okay, here's the draft document. Clearly, we're not the experts on how to do this. But here it is for the tribes to have something to work against or to have a structure to begin saying we don't like this, we do like that.

The tribes would not respond to that scope of work. They said it was completely inadequate, but we didn't really get much comment.

We tried again. One of the few things that -- we did get a few things that we learned. We tried with a second draft which they also said was completely not acceptable, but we didn't get comments on. I think Haimanot needs to pick up at that point.

CHAIRMAN FROEHLICH: Actually, before we get to that, I'd like to hear from the tribes and their response to the Powertech proposal or whatever, and what they submitted as a counter from their perspective.

Mr. CatchesEnemy.

MR. CATCHESENEMY: Well, based on what I can recall from what was submitted by -- I guess more the Lakota Sioux Tribes was a scope of work that was more or less culturally relevant. I think it was going to have some strong representation from each of the bands of the Lakota, Dakota, Nakota in order to provide some kind of culturally competent consensus. They weren't looking too much at a democracy of it, as long as a majority of us or a part of us were okay with it. A lot of our culture dictates that we do things in consensus. That way things can move along better and there's not any recourse to an action that's taken where maybe the minority is left out.

So we supported the scope of work that was submitted in hopes that NRC would continue to try to work out the kinks with that proposal and not this counter proposal.

CHAIRMAN FROEHLICH: Ms. Yilma, can you describe maybe in a little more detail the differences between the two proposals that you received?

MS. YILMA: In general terms, the proposal that we received, the initial proposal that we received from the tribes didn't actually have specifics in it. And so we had to go back out and ask for specifics to be included in the statement of work because we weren't able to determine how long the survey would take or what type of survey -- methodologies of the survey and also the cost and the duration. That was not included in the original, the tribes' statement of work.

CHAIRMAN FROEHLICH: It was included in the SRI and Powertech?

MS. YILMA: While in the SRIF, it had all those information in it and SRIF's -- Powertech's statement of work actually a phased approach. The initial statement of work had a phased approached where they initially would go out and do a reconnaissance of what's out there and based on what is found during the reconnaissance survey, they would then increase the level of effort. Those types of specifics was included Powertech's statement of work. But the tribes' statement of work was in general terms. But we did hear that the amount of compensation and the duration that was included in the Powertech statement of work was not appropriate.

An additional effort needed to be done and we also heard that the tribes wanted to do the entire 10,000 acres, survey of the 10,000 acres as opposed to what we defined as the areas of potential effect in accordance with the National Historic Preservation Act.

So there were differences in those two statements of work and we were trying to work through those differences and had many telephone calls, face-to-face meetings, trying to work out those differences. Over a month of negotiations between the two parties, we recognized that we weren't going to be able to come to consensus to what was deemed as appropriate using the statement of work approach.

JUDGE COLE: You mentioned the area of potential effect versus the 10,000 acres.

MS. YILMA: Yes.

JUDGE COLE: I assume that the area of potential effect is larger than the project area, is that correct?

MS. YILMA: That is -- yes and no. Yes and no. There are two areas of potential effect. The direct areas of potential effect is actually smaller than the 10,500 acres. The indirect areas of potential effect is a little bit larger than 10,500 acres.

JUDGE COLE: How much larger?

MS. YILMA: We go out three miles from the tallest building in this situation, would have been the Central Processing Unit and/or the satellite facility. So --

JUDGE COLE: Okay, thank you.

MS. YILMA: Not that much farther, but a little bit outside of the 10,000.

JUDGE COLE: Okay.

CHAIRMAN FROEHLICH: Let me go back to the Powertech proposal at that point in time. And could either you or Dr. Sebastian tell me a little bit more about the scope of that reconnaissance or whatever, compared to the earlier Augustana subsurface study, the one that you had started with. How did it differ?

MS. YILMA: It was not a subsurface study. The methodology was left up to the tribes to come up with how they would like to do the survey, recognizing that you heard this morning this is a difference between a TCP survey and an archeological survey, recognizing the special expertise of the tribes. We didn't actually specify a methodology. It was more general guidance that Powertech provided in the statement of work and asked feedback from the tribes.

CHAIRMAN FROEHLICH: What elements were in the SRI proposal, Dr. Sebastian, that relied on or drew upon the special expertise of the tribes?

DR. SEBASTIAN: One of the things that we heard in the February 2012 meetings where we really tried to get a sense from the tribes of what would be needed to identify these religious and cultural properties was that it needed to be a field identification process and that the archeological methods were not fine-grained enough, that what Dr. Hannus referred to as the survey intervals were too wide. So that was one kind of hint that we had. And then based on that and sort of our knowledge of the fact that this requires expertise and the knowledge of elders and things like that, we put together a proposal that basically assumed a survey interval half as big as the archeological survey interval and taking the number of acres and then the number of person days, it's a story problem that archaeologists do a lot because we have a sense of how much ground you can cover in a day. And so we put together a proposal that was for time. So this many -- we assumed they would need a bigger survey crew maybe because they would have to have representatives from different bands as Mr. CatchesEnemy said.

So we increased the size of the crew. We decreased the survey interval and then we figured out from that what it would take. We also put in money and time to bring elders out to the field because we thought maybe the actual people who are doing the survey might need the advice of their elders or special practitioners. So we brought in some money and time for that. And then it was just basically the way you would request a statement of work. We put in money for per diem, money for travel time and travel expenses, those kinds of things. So we started out with an archeological survey because we were talking field survey and then we tried to put in additional time and additional personnel.

CHAIRMAN FROEHLICH: Mr. CatchesEnemy, would you respond, please, to the intervals and the personnel that the SRI proposal had and why the tribes or at least your tribe and like tribes disagreed or felt that it would be inadequate?

MR. CATCHESENEMY: It's already been stated as far as the differences between the Level 3 and TCP survey, it was pretty evident based on cultural knowledge under the TCP. But the tribes are going to provide a statement of work that has that specific component, then if we're just going to go with an SRI proposal or statement of work, that basically follows almost like a secondary archeological review with just a little bit of changes. That's not to the liking of the tribes. But the intervals, you're getting into methodology there. And that's where the tribes are not wanting to follow exact intervals that are set typically by archeological studies.

CHAIRMAN FROEHLICH: As I understood it, Dr. Sebastian just explained that there were avenues for input from tribal elders and to be sensitive to the cultural aspects. What part of that proposal was unacceptable?

MR. CATCHESENEMY: It's not led by the tribes. It's still led by a consulting group with tribal participation. There's a difference there.

CHAIRMAN FROEHLICH: Tell me more about the difference if you could.

MR. CATCHESENEMY: It comes back to what I was explaining about the consensus portion, where you're bringing tribes together to come to a place that they've been displaced from for so long, maybe 100, 150 years. As Uncle Wilmer stated, him and other folks that from our tribe have openly and consistently revisited these places, but on the most part, we've been displaced from these.

So here we are being asked to come and produce evidence outside of what the archeological report already identified. But at the same time, we're having to bring tribes as different takes on it within set deadlines, set cost parameters. That's a pretty harsh timeline to follow to bring tribes back together to ask them to set all these methodologies within a very short timeline.

These methodologies may have a little bit of differences or intricacies when we get out into the field. We would rely, ourselves as Ogalas, on a lot of our elders, our traditional medicine people, spiritual leaders, historians, but all of them would be available to come up. And maybe another tribe historically tied with us may have a different take on it. So we'd have to try to work out all those intricacies of how we're going to conduct our methodology because this isn't something that is typical.

TCP surveys on the most part are fairly new or at least being willing to be looked at. I know part of the evidence doesn't really include National Park Service guidance, but that's where it's in the literature about Bulletin 38, the identification of traditional cultural properties.

I call the state of the TCPs, that can go with any ethno group. It's not specific to Lakotas. It could be towards Asian-Americans, Hispanic-Americans. It's open when you consider it a TCP. But I think the big difference is the culture and how it's conducted. That's the biggest difference.

CHAIRMAN FROEHLICH: Did the Sioux Tribe or Lakota come back with a counter proposal to say the SRI proposal doesn't capture our concerns. To do it properly, it would take tribal elders, X number, so many weeks, at such an interval, or a different approach? Did the tribes come back with a proposal saying here is what it would take to do it to our satisfaction and to be a meaningful TCP study?

MR. CATCHESENEMY: From what I recall during that time, and I want to make the record clear, that my employment with the tribe as a natural resource director at the time ended in March of 2012. So from that point until February of this year, 2014, I was not an employee. So I'm not privy to a lot of the intricacies that occurred probably via emails or teleconferences amongst the tribes on the specifics of the scope of works being resubmitted.

CHAIRMAN FROEHLICH: And just so I'm clear, Mr. Mesteth preceded you as the tribal officer and then someone who succeeded you after this point in time when the proposals were sought as an alternative or as an enhancement to what had already been done?

MR. CATCHESENEMY: We have always, since our establishment in September of 2009, that's when we got our Tribal Historic Preservation Office designation. So we're a fairly new office as far as NHPA functions that we assume from the state.

Mr. Mesteth has been the Tribal Historical Preservation officer, if I recall, since late 2010 until just recently and then I came in in February. However, he's not a full-time employee. But we did have one staff person in the office which is titled project review officer and that person is no longer employed there, but she had the ins on the email communications with the scopes of work.

CHAIRMAN FROEHLICH: Okay. To the extent you remember, the response to the solicitation for statements of work from the tribes was what? Would you describe that?

MS. YILMA: Yes, so they did come up with a proposal. The proposal was to have a contractor of their choice to do the survey and specified the number of days that it would take them to do it, how much it would cost, and how long it would take to develop the report afterwards.

CHAIRMAN FROEHLICH: Is that the Kadrmas Lee Jackson proposal?

MS. YILMA: No.

CHAIRMAN FROEHLICH: No, okay.

MS. YILMA: It was a proposal by the Sioux Tribe and they recommended Tim Mentz's company. I don't remember the name of the company, another tribal entity who does field survey to conduct a field survey for them. Makoche -- how do you say it?

MS. JAMERSON: Makoche Wowapi/Mentz-Wilson Consultants.

MS. YILMA: That was the consultant's name that they had provided for them to do the TCP survey on their behalf.

CHAIRMAN FROEHLICH: So the tribe did submit a proposal, whatever, to have a tribal company, entity, whatever, conduct the kind of survey that they believed would adequately address the cultural and historical issues in the area?

MS. YILMA: That is correct and I just want to again clarify that this is the Sioux Tribes that provided the statement of work. Remember, we had more than the Sioux Tribes that we were consulting with. And in the proposal, the proposal that came back, if I remember correctly, had a significant amount of time between when they conducted the field survey and provided us with the information that we needed for our NEPA and Section 106 compliance.

So looking through those statements of work, our schedule, because by this time we had already been consulting with the tribes for close to two years and we haven't agreed on an approach to do the TCP survey to gather the information we needed for us to comply with the cultural resources section of the NEPA and NHPA.

And so we looked through the proposal and compared this with other proposals that other federal agencies have done for similar type of activities and determined that the proposal that was submitted by the tribes' contractor was significantly larger in dollar amount and also duration than others that we have seen. And for that reason we -- and significantly varied from what Powertech provided. For that reason, we felt it was prudent for us to find another way of conducting the tribal survey that we needed in order to make impact assessment.

JUDGE COLE: Do you remember the time involved in their proposal?

MS. YILMA: It was over a couple of months to do the identification and I want to say close to six months to do the reporting afterwards. I can check that again and provide that information as well.

CHAIRMAN FROEHLICH: Okay, and what we're comparing here is the proposal from SRI on behalf of Powertech to the Makoche Wowapi studies. Is that correct, Ms. Jamerson?

MS. YILMA: That's correct.

MS. JAMERSON: Yes.

CHAIRMAN FROEHLICH: Okay, so that's what you were looking at. And just so I have the order of magnitude, the time interval to follow up on Judge Cole's question for the SRI proposal was how much -- what was the time interval from when the work would start until you had the reports that you needed for your NEPA and historic preservation. What was the time interval for --

MS. YILMA: Lynne, do you remember those specific dates? I don't remember, but it was significantly larger. It was about six months, if I recall. By the end of six months, we would have gotten a report, whereas, we were looking at magnitude of a month that we would identify historic properties and do our assessment.

CHAIRMAN FROEHLICH: All right, another

parameter, I guess, that goes into this is the cost of the two proposals.

MS. YILMA: That's correct.

CHAIRMAN FROEHLICH: Can you compare, please, for me the cost of the Makoche Wowapi proposal to the SRI proposal?

DR. SEBASTIAN: It was a factor of ten higher. It was ten times ours.

MS. YILMA: The tribes' proposal was close to $1 million.

CHAIRMAN FROEHLICH: Which one?

DR. SEBASTIAN: That was just for the small part.

MS. YILMA: The tribes' proposal was close to $1 million. And Powertech's proposal was close to $110,000 or $120,000.

CHAIRMAN FROEHLICH: Just to keep this in perspective for me, the Augustana report, what was cost and the duration of that study?

MS. YILMA: Can I just -- I don't know those answers. Powertech would have to answer to that because the Augustana College survey was done before the application was submitted. But before I go there, I want to clarify that the statement of work that we were developing between the tribes, ourselves and SRI and Powertech was only supposed to be for the areas of direct impact which is the 250,000 acres as opposed to the 10,000 acres.

CHAIRMAN FROEHLICH: At this stage, you were talking about the smaller area --

MS. YILMA: The smaller area.

CHAIRMAN FROEHLICH: And then subsequently, as I recall, the proposal was to expand the survey area.

MS. YILMA: That's correct. So for the Augustana College it was 100 percent full survey that was conducted. So the whole entire 10,000 acres. So that is also another variation between the two.

CHAIRMAN FROEHLICH: Okay. Dr. Hannus, do you have that information?

DR. HANNUS: I knew you were going to ask that question. I do not. In other words, what happens here is that we did the Level 3 and then there were two more years of work that was done. This exhibit behind me is the 13 volumes that we produced on the work that we did. So I can get those figures for you, but I just don't have them. I mean this is a mixed bag because we were doing subsurface testing in the intervening years.

DR. REDMOND: Judge?

CHAIRMAN FROEHLICH: Yes, Dr. Redmond?

DR. REDMOND: Can I clear up something on the TCP? It's an analogy.

CHAIRMAN FROEHLICH: Okay, sure.

DR. REDMOND: When I was doing TCPs for the Forest Service, I was working with some elders and one of them I had taken up to a site and his comment was very simple. He said, "Okay, fine. You've got a site. Where is the rest of it?" And his meaning was you've got where the people lived. Now where did they do their living? Where did they get -- where did the women collect their food? Where did the men collect their materials that they lived with? Where did they process their food? Where did they do their ceremonies? Where did they do these things? Those are the TCPs.

JUDGE COLE: Where did they bury them?

DR. REDMOND: Where did they bury them?

CHAIRMAN FROEHLICH: Dr. Redmond, you have conducted these TCP studies for other agencies?

DR. REDMOND: Yes.

CHAIRMAN FROEHLICH: You have.

DR. REDMOND: And that is a vast area around a simple site.

CHAIRMAN FROEHLICH: And your cost to

prepare such a study, would that be closer to the SRI proposal or to the --

DR. REDMOND: Closer to the tribes'.

CHAIRMAN FROEHLICH: To the tribes' proposal.

DR. REDMOND: Yes. And that's the problem. It's an order of magnitude over looking a simple site. And that's the problem. It balloons because you're not simply looking at a spot. You're looking at a living. You're looking at a living environment.

Like my brother Wilmer said, "This is a living environment. It's across the hills."

CHAIRMAN FROEHLICH: Thank you. Ms. Yilma, did you want --

MS. YILMA: Yes, I wanted to -- first of all, I wanted to clarify what we had said originally. There were six tribes at the initial face-to-face meeting and I do have the names of those tribes. It's Ogala Sioux, Standing Rock Sioux, Flandreau Santee Sioux, Sisseton Wahpeton, Cheyenne River Sioux and Rosebud Sioux.

CHAIRMAN FROEHLICH: And this was the meeting where the discussion was held about an expanded or subsequent survey that would take into consideration TCP type of issues?

MS. YILMA: That's correct. And then to follow up with the costs analogies, we do have NRC Exhibit NRC-071 which is a letter from State Department Keystone Pipeline Project and where they provided various tribal entities to come out and identify a TCP survey as an open site approach without specifically doing a restrictive methodology for about $100,000.

CHAIRMAN FROEHLICH: Thank you. I know it's slightly after noon. Dr. Cole also reminded me of the time. So I think this might be a convenient time for us to take a lunch, our luncheon break after which we will resume with Panel 1. May I suggest we take about an hour and 10 minutes and resume here at 1:15. We'll pick it up from there.

MR. PARSONS: Your Honor, if I may briefly, Jeff Parsons over here. Just so the parties can plan a little bit, would the Board have an idea of whether we're likely to get into the next panel today? I don't want to put you on the spot, but it might help for the parties to do some planning in that regard.

CHAIRMAN FROEHLICH: I think we'll have questions for most of the afternoon for Panel 1, I believe, if I factor in time for any follow up from counsel to the questions that were asked. It's very hard to gauge these things, especially with a large number of witnesses and I would think it's more likely than not that we'll have Panel 1 here for the balance of the day. And if things work out, we will probably start tomorrow with argument on the additional data and Panel 2.

MR. PARSONS: Thank you. I won't hold you to it, but I appreciate that.

CHAIRMAN FROEHLICH: All right, we'll stand in recess until 1:15.

(Whereupon, the above-entitled matter went off the record at 12:05 p.m. and resumed at 1:17 p.m.)

CHAIRMAN FROEHLICH: I think we'll resume. We'll be back on the record. Let me just remind you, please, to shut off your cell phones or turn them to silence. And for those people who wanted to take pictures, that's perfectly all right, however, please don't use the flash or a strobe since that will be distracting to the Board and to the witnesses.

Mr. CatchesEnemy, I'd like just to follow up with you on a few points. Are you currently the tribal historic preservation officer, or did I understand you that your term has ended and that someone has succeeded you?

MR. CATCHESENEMY: I am the current tribal historic preservation officer as of February of 2014.

CHAIRMAN FROEHLICH: How does one become the tribal historic preservation officer? What's the process or the requirements? How is that organized?

MR. CATCHESENEMY: To date since our first initial establishment it's been by the president of our Oglala Sioux Tribe that appoints the THPO officer.

CHAIRMAN FROEHLICH: And you succeeded Mr. Mesteth. Is that because there's a term associated with the position, or how does that --

MR. CATCHESENEMY: No, Mr. Mesteth is a full-time faculty at Oglala Lakota College.

CHAIRMAN FROEHLICH: Yes.

MR. CATCHESENEMY: And he could speak more to his own résumé. but he was initially -- we have a three-member advisory council for our office and Mr. Mesteth was one of three founding members of our office and took that role. Initially it was supposed to be a temporary appointment and just until we got more funding. The fact remains we didn't have any subsequent funding that came to the office of our National Park Service annual funding, so Mr. Mesteth was acting in a part-time capacity. And so the changeover came with some additional funding that we're just receiving. And I do more of the administrative responsibilities day-to-day in the office now --

CHAIRMAN FROEHLICH: Okay.

MR. CATCHESENEMY: -- as a full-time employee.

CHAIRMAN FROEHLICH: Thank you. And in the Programmatic Agreement it provides for the development ultimately of mitigation plans prior to construction or disturbance of sensitive areas. Is it your office or your position that would be dealing or advising under the terms of the Programmatic Agreement?

MR. CATCHESENEMY: Yes, that is part of our function as a tribal historic preservation office.

CHAIRMAN FROEHLICH: Okay. Let's see, Dr. Redmond has not rejoined us? All right. I'll proceed with you then in his absence.

In the FSEIS, page 81 of NRC-008-A, it stats that the tribes maintain that the only level of effort sufficient for identifying historic properties would be an on-the-ground 100-percent survey of the entire licensed boundary by tribal personnel from participating tribes. Is this an accurate recitation of the position of the Sioux Tribe?

MR. CATCHESENEMY: Yes.

CHAIRMAN FROEHLICH: In order to have an appropriate survey, would that be -- the tribal personnel that's referred there from participating tribes, would that mean that each Sioux Tribe or each tribe that was originally listed would have to participate?

MR. CATCHESENEMY: Culturally we have a relation; and Wilmer could probably speak to this a lot better, but at least amongst the Dakota and Nakota and Lakota -- and then everybody's calling us Sioux. We always usually refer to ourselves -- even though our tribe is called the Sioux Tribe, we usually identify as Lakota or Dakota or Nakota. We would probably have more cultural affiliation or similarities than we would with some of the other tribes that Wilmer had mentioned that have historical ties to the Black Hills.

CHAIRMAN FROEHLICH: Among the various Lakota tribes would representation by one tribe suffice to protect the cultural interests of the other Lakota tribes?

MR. MESTETH: No, I don't believe so.

CHAIRMAN FROEHLICH: So the participating tribes when we're referring to -- would require participation from each tribe --

MR. CATCHESENEMY: Yes.

CHAIRMAN FROEHLICH: -- to have a survey that would satisfy the criteria that you believe are necessary?

MR. CATCHESENEMY: Yes.

CHAIRMAN FROEHLICH: Okay.

MR. CATCHESENEMY: I wanted to, if I could, add another clarification for Mr. Mesteth here is he's currently reverted back to being an advisory council member for our office. So he's one of our three members, and that's why we still have a connection to the office.

CHAIRMAN FROEHLICH: Okay. Dr. Redmond, in your testimony, Exhibit INT-019, you refer to the guidelines for cultural resource surveys and survey reports in South Dakota. And in there you make reference to the document, and indeed you quote from it. I noticed that in your answer you highlighted in embolded portions of that answer where you referred to actions necessary upon encountering any type of archaeological or historic materials, what constitutes archaeological historic sites, proper recording procedures for archaeological and historical materials of sites, proper reporting procedures for archaeological historic matters of sites.

Okay. Is it your position that the staff violated any or the parts here that are highlighted? Is that the gist of what we're advocating in your testimony? Yes, the italics.

DR. REDMOND: Oh, okay. Can you move it? Okay. What I meant by this is that at times it's ambiguous, that for some entities, for instance, for mine, I had to do subsurface testing whenever I encountered materials that I identified as a site. If I identified it as a site, I had to do subsurface testing, period.

CHAIRMAN FROEHLICH: Okay. Did not the follow-up surveys or studies that the staff had called for subsequent to the Augustina study include subsurface testing, Dr. Redmond?

DR. REDMOND: Only on some. Only on some of the sites. Augustana.

CHAIRMAN FROEHLICH: Augustana.

DR. REDMOND: I'm sorry.

CHAIRMAN FROEHLICH: All right. Dr. Lyman?

MR. LUHMAN: Luhman.

CHAIRMAN FROEHLICH: Luhman. I'm sorry. I'm not doing very well the names today.

DR. LUHMAN: That's okay.

CHAIRMAN FROEHLICH: I apologize.

(Laughter)

CHAIRMAN FROEHLICH: Dr. Luhman, what was the extent of the subsurface testing in the follow-on survey that was called for and requested by the staff?

DR. LUHMAN: You're referring to the subsurface testing phase?

CHAIRMAN FROEHLICH: Yes.

DR. LUHMAN: It is my understanding that that survey work was done in response to the identification of those archaeological sites that had been identified and that were going to be impacted by the proposed project activities. Because of that, those would have been the only sites that would have been subjected to follow-on surveys. Because the remaining sites would be avoided, they would not be impacted by project activities.

CHAIRMAN FROEHLICH: And who conducted this survey for you, or this additional work?

DR. LUHMAN: Augustana.

CHAIRMAN FROEHLICH: Oh, Augustana? Ah.

DR. HANNUS: That's what these 13 volumes contain --

CHAIRMAN FROEHLICH: That was the follow-on to that.

DR. HANNUS: -- in its entirety is those additional two seasons of work.

CHAIRMAN FROEHLICH: Okay.

DR. HANNUS: And so, in the process of a level 3 survey, like I had indicated earlier today, you would do some shovel tests in areas where you did not have -- in other words, your ground cover would be too dense to give you clear vision of the sites, but you really during a class 3 survey would not be doing, you know, extensive subsurface testing. That would come in a later phase.

And it's also the case that in this particular environment; and of course this is our evaluation of it, but the -- as I had initially stated earlier this morning, this is an incredibly degraded, eroded, desiccated set of land surfaces. And many of the sites are literally on the bedrock, so you would not be excavating into the bedrock because it would take you to an era geologically that wouldn't have anything to do with human occupation. And also you would not be out testing sites before you knew that there was a chance that they would be impacted by the project, because our charge, at least within the strictures of the guidelines that we work under in the

106 process, would be that you're trying to protect the sites, not do further damage to the sites.

So you're trying to identify them for the idea that then you'll move to a phase hopefully of avoidance rather than any other type of activity. But if you're then -- and we were then provided with -- you know, as this project proceeded, then we were given the zones that were going to most likely impact sites. And so we were then asked to go forth and do further evaluation for potential National Register eligibility.

CHAIRMAN FROEHLICH: The staff published the supplemental cultural resource report. That's Exhibit 151. And that report, I take it, took into account or included the comments or reports that you received from various tribes?

MS. YILMA: That's correct, Your Honor.

CHAIRMAN FROEHLICH: And which tribes were it that provided additional comments or reports?

MS. YILMA: The Cheyenne and Arapaho, the Northern Cheyenne and -- there's one more. There are three out of the seven that -- there were seven tribes that participated in the field survey. Three out of the seven provided the field survey report, and those comments we received and eligibility recommendations we received we included in our eligibility determination.

CHAIRMAN FROEHLICH: And just to be clear, there weren't any comments or reports received from Lakota tribes?

MS. YILMA: No Sioux tribes, that's correct. We did have two Sioux tribes that participated in the field survey, but they didn't provide written recommendation on what they found.

CHAIRMAN FROEHLICH: Okay. All right. Also in the staff testimony NRC 151 at 9, they testified that staff incorporated comments received on the FSEIS and the cultural resources supplement in its revisions to the Programmatic Agreement. Did the staff make any changes to the Programmatic Agreement based on written comment letters submitted by the Oglala Sioux Tribe or the Standing Rock Sioux Tribe?

MS. YILMA: We did, Your Honor. The Standing Rock Sioux Tribe gave us comments and the Oglala Sioux Tribe concurred with the Standing Rock Sioux' comments. So we incorporated the concerns of the Standing Rock Sioux and the Oglala Sioux in that they wanted to be a participant member, active participant member for ongoing identification, evaluation, anything else that is going to occur in the future. And for those activities within the Programmatic Agreement we went in and made sure that the tribes are an active participant when we're evaluating and evaluated sites when we're doing development of mitigation measures and when we are partaking in future identification for power line that was proposed to occur in the future.

CHAIRMAN FROEHLICH: The staff -- in its bidding to the Board in March of 2013, staff answered to contentions on the Draft Supplement Impact Statement at page 13. Stated that they would supplement its analysis to the DSEIS and circulate any new analysis for public comment. If the interveners disagreed with the staff analysis, they would be able to submit comments or contentions based on that supplement.

At that point in time, or shortly thereafter, I suppose, the staff made a decision to proceed with a Programmatic Agreement approach instead. Am I sort of correlating the timeline properly at this point?

MS. YILMA: I'm sorry, Your Honor, can you repeat? I don't know if I understand the question.

CHAIRMAN FROEHLICH: Up until about March of 2013 the Board; and I presume the interveners, would have expected to be able to file comments to the DSEIS if they disagreed with the staff analysis or anything contained in the DSEIS. But instead of sort of proceeding along that route, at about that time or shortly thereafter I believe the staff decided to undertake the Programmatic Agreement approach. Is that the timing? The approach that the staff was planning to take with the documents required on the case changed I guess in the first quarter of 2013 or so?

MS. YILMA: The Programmatic Agreement discussion actually occurred prior to that, because we knew that there was going to be phase identification occurring. So we knew all along that there will be Programmatic Agreement development. So by March 2013 we knew there would be a Programmatic Agreement developed, but we hadn't started working on it.

CHAIRMAN FROEHLICH: All right. And if comments are submitted in response to a DSEIS, staff has an obligation to respond to those comments in the FSEIS. That's correct?

MS. YILMA: Yes, that's correct.

CHAIRMAN FROEHLICH: Now, in the Programmatic Agreement if you receive comments on the Programmatic Agreement, is there any obligation for the staff to make them, even to address them?

MS. YILMA: Well, the regulation says when you're doing a Programmatic Agreement you're actively consulting with all parties. And the understanding then is that if there are comments received during your consultation, you will address it appropriately before you finalize the Programmatic Agreement.

CHAIRMAN FROEHLICH: And I guess in the course of the preparation of the Programmatic Agreement, did you receive comments from the various Sioux Tribes as to the language and the direction the Programmatic Agreement was taking?

MS. YILMA: We received comments from Standing Rock Sioux Tribe, Oglala Sioux Tribe, Cheyenne River Sioux and Northern Cheyenne on the various aspects of the Programmatic Agreement.

What we did was we held a specific teleconference to discuss those comments and how we would go about addressing them in the Programmatic Agreement. Then we followed up with making those changes and sent it out again for review.

CHAIRMAN FROEHLICH: Your testimony is that you adjusted or adopted or changed the Programmatic Agreement in response to comments received --

MS. YILMA: That's correct.

CHAIRMAN FROEHLICH: -- from the Sioux Tribes?

MS. YILMA: That's correct.

CHAIRMAN FROEHLICH: Okay.

MS. YILMA: Sioux, and Northern Cheyenne as well.

CHAIRMAN FROEHLICH: Northern Cheyenne. All right.

Mr. CatchesEnemy, do you agree with the answer you just heard from Witness Yilma?

MR. CATCHESENEMY: No.

CHAIRMAN FROEHLICH: Explain the comments or suggestions that were conveyed from the tribe to the staff that in your view were not addressed.

MR. CATCHESENEMY: I think when you're talking about the simultaneous things occurring at the same time when this Programmatic Agreement was being initiated, a lot of the tribes were still trying to revamp the scope of work. That seemed like the PA was coming irregardless if we were happy about the proposal that we had submitted in the years before. So it was kind of hard to be trying to address something that the federal agency, the NRC was just going force through anyway. They were going to just promote this PA irregardless of our participation in identification of historic properties.

CHAIRMAN FROEHLICH: But as I understand it, the staff circulated the Programmatic Agreement and sought comments or input; consultation, if you would, I believe you used in your answer, from all the various tribes. And then Ms. Yilma just testified that those concerns that were received were addressed.

MR. CATCHESENEMY: I would say that there were probably -- it's still at the NRC's discretion to take what they felt was necessary to incorporate into that PA, but it still wasn't everything that we had provided.

CHAIRMAN FROEHLICH: It wasn't everything that you had requested. I understand that. Your definition then perhaps of "consultation" may differ from that of the staff. To you, what does "consultation" mean as in 106 procedures.

MR. CATCHESENEMY: Throughout the whole process I can say that the tribes, especially the Oglala Sioux Tribe, have always advocated for the face-to-face. A lot of things can happen or not happen behind a teleconference call. There's not the same interaction that you and I are having right now as if we were on the phone with each other, so we would always be advocating for the face-to-face.

CHAIRMAN FROEHLICH: You're referring to I guess a session where there was a video conference among staff and various tribes, is that correct?

MS. YILMA: It's actually a teleconference.

CHAIRMAN FROEHLICH: Teleconference.

MS. YILMA: Yes.

CHAIRMAN FROEHLICH: Excuse me.

MS. YILMA: Due to the limitation of our budgets we couldn't really travel to do the face-to-face interactions for every single meeting we had. We did have three face-to-face interactions with the tribes to come up with methodologies and survey approaches and consider inputs from the tribes in our cultural resources, but we started developing the Programmatic Agreement. We did use alternative means to come to consensus of what needs to be included in the Programmatic Agreement. And we used a teleconference for that where we had a Webinar set and displayed the Programmatic Agreement on a computer. And we also had a line set up where we can discuss each step of the Programmatic Agreement that we had displayed on the Webinar and made appropriate changes that we were hearing from the tribes, the SHPO, the state historic preservation officer, and also the ACHP, Advisory Council on Historic Preservation. They were all on the teleconferences when we were developing the Programmatic Agreement.

CHAIRMAN FROEHLICH: I guess a simple question would be does Webinar and teleconference constitute consultation under 106 in your experience, Dr. --

DR. LUHMAN: Luhman.

CHAIRMAN FROEHLICH: -- Luhman. Thank you.

DR. LUHMAN: That's okay.

CHAIRMAN FROEHLICH: I apologize again.

DR. LUHMAN: I believe so. I mean, it is an interaction among the parties discussing the issues at hand. The Webinars, I facilitated the Webinars for the development of the Programmatic Agreement. We went through every aspect of the document including all the comments that have been received. The Programmatic Agreement itself was distributed as a Word document so that everybody could insert their comments and track changes. So it was possible to go through and address everyone's comments.

Ms. Yilma is correct, the advisory council was on the calls. The BLM was on the calls. The

South Dakota SHPO was on the calls. The tribes that chose to participate were on the calls. Powertech was on the calls. They were very, very active and vibrant conversations relating to the issues that were at hand.

CHAIRMAN FROEHLICH: I would ask the same of Dr. Hannus.

DR. HANNUS: We were not involved in that set of interviews, so we were not part of the Programmatic Agreement.

CHAIRMAN FROEHLICH: And the definition that you would use for "consultation," does that include Webinars or teleconferences or whatever, or is that --

DR. HANNUS: Are you asking me?

CHAIRMAN FROEHLICH: Yes.

DR. HANNUS: Well, I mean in the current parlance of what seems to be happening in the world of technology, I guess that that is a very common practice. I guess whether everyone that was involved would fully agree and embrace that practice is a different question, but it is certainly a common practice.

CHAIRMAN FROEHLICH: Dr. Sebastian, in your experience?

DR. SEBASTIAN: In my experience "consultation" is defined as seeking, discussing and considering the views of others and, where possible, seeking agreement with them. And that's the definition that we're giving for what "consultation" is. And I also would add, if I may, that in a lot of cases these kinds of electronic media are the only way to deal with them. If you think about folks working in Pennsylvania who all their tribes are in Oklahoma and so there's really no way for them to be able to have very many face-to-face meetings -- so they routinely do all of their consultation in electronic media or the exchange of drafts and comments.

CHAIRMAN FROEHLICH: Dr. Redmond, in your testimony, INT-003, you make reference to certain heritage research studies. Can you explain to me what a heritage research study is?

DR. REDMOND: I'm not sure I understand what you're referring to there.

CHAIRMAN FROEHLICH: Okay. I believe in your testimony I saw a reference to heritage research studies listed in Exhibit INT-003.

Can you call that, Andy?

DR. REDMOND: That's part of my data.

CHAIRMAN FROEHLICH: Yes. Do a search,

Andy, for heritage research studies.

Oh, there is it. Heritage resource survey. You see it, in reference 2007?

DR. REDMOND: 2007. Heritage --

CHAIRMAN FROEHLICH: Heritage resource survey.

DR. REDMOND: -- source. Which one?

CHAIRMAN FROEHLICH: Okay. Well, my question actually comes down to what is a heritage resource survey and how does that differ, if it does differ, from a level 3 study?

DR. REDMOND: It doesn't. That was the way they wanted it listed. It was a matter of semantics.

JUDGE COLE: So it's the same thing as a level 3 study?

DR. REDMOND: It was the same thing.

CHAIRMAN FROEHLICH: And it's not a cultural survey, a TCP, like they talked about this morning?

DR. REDMOND: No, it's the same as a cultural resource study, but they wanted it listed as a heritage resource study.

CHAIRMAN FROEHLICH: Cultural resource.

DR. REDMOND: It was a semantic thing for the Custer National Forest.

CHAIRMAN FROEHLICH: And it was then a level 3 --

DR. REDMOND: Yes.

CHAIRMAN FROEHLICH: -- survey, the kind of surveys we've been talking about?

DR. REDMOND: Yes.

CHAIRMAN FROEHLICH: Okay. And did any of these heritage resource surveys include the kind of surveys or studies that the Oglala Sioux Tribe has advocated are necessary in this case?

DR. REDMOND: There were some that I did that were TCP studies, but I don't think any of these were those type of studies.

CHAIRMAN FROEHLICH: Are your TCP studies included in your vitae or in the materials you've pre-filed in this case?

DR. REDMOND: I'm sorry, I'm not hearing well.

CHAIRMAN FROEHLICH: The TCP studies --

DR. REDMOND: Yes.

CHAIRMAN FROEHLICH: -- that you have undertaken, are they included in your vitae or in the materials filed in this case?

DR. REDMOND: They -- I did put some of

them in there, but I would have listed them as TCPs. They're not listed there, no.

CHAIRMAN FROEHLICH: Okay. Then I'd like to ask among the other anthropologists, in what cases that you have worked on have the types of TCP studies advocated by the tribes been utilized and what is the outcome? Which types of cases or cases that you've worked in your profession have these type surveys been required or have been done in cases, especially if it involves a major federal action?

DR. REDMOND: In what cases?

CHAIRMAN FROEHLICH: Well, you may start off. Start with you, Dr. Redmond. In what cases?

DR. REDMOND: The one that comes to mind immediately was a logging permit on the southern Black Hills down near Deadwood.

CHAIRMAN FROEHLICH: Is that listed among your materials?

DR. REDMOND: It should be. Do you remember, Mike?

MR. FOSHA: Near Deadwood?

DR. REDMOND: Yes, it was down near Cheyenne Crossing.

MR. FOSHA: I'm not familiar with that one.

DR. REDMOND: It was about 2002 or 2003. Can you run it down a little bit? Oh, yes, sure, it's not there. Naturally. Oh, it may be. There's Elk Bug's power analysis. That was the one. Level 3 resource for the power analysis for the Spearfish District. We did some -- it was a combined level 3 and a TCP simply because we ran into a series of TCPs on the higher elevations. And we also ran into a Sundance ground. It's the last one that's listed there.

CHAIRMAN FROEHLICH: At the bottom of the screen, Andy, could you highlight 2001?

DR. REDMOND: It was 2001.

CHAIRMAN FROEHLICH: At the bottom of the screen.

DR. REDMOND: 2001 the power analysis area. Yes, that was the one. It was almost an accident that we ended up combining that one because of what we ran into. And it ended up a level 3 and a TCP analysis for the Spearfish simply because of what we ran into.

CHAIRMAN FROEHLICH: Okay. Mr. Fosha, among the I guess reports that are received which ones or how many include the type of studies both the traditional, I guess, level 3 and the TCP enhancement additions received by your office and what distinguishes where they -- which types of cases or when they are required?

MR. FOSHA: We don't get traditional cultural property reports submitted to our office. The state does not keep those. We don't receive them and we don't review them. Now that doesn't mean to say we haven't conducted traditional cultural property surveys in synchronization with our archaeological surveys, because we have done that in the past, especially when we're dealing with highway projects within the Black Hills, for instance.

CHAIRMAN FROEHLICH: Are there guidelines for when a TCP would be required?

MR. FOSHA: There are no guidelines. They're essentially project-dependent.

CHAIRMAN FROEHLICH: All right. I guess then explain to me what you mean by "project-dependent" and how we know whether a project depends on having one of these or not.

MR. FOSHA: Well, what I would call project-dependent, one, is it a major project within the Black Hills National Forest. That's federal land and quite often that would be the venue where the tribes would request a traditional cultural property survey in conjunction with an archaeological survey. If it's a project of the magnitude such as Powertech USA is trying to do, then during the consultation process the tribes may ask for or demand a traditional cultural survey as well. So typically if it's a much smaller project not related to lands such as the Black Hills, these don't occur.

CHAIRMAN FROEHLICH: Right. Dr. Luhman, can you help me to understand when these types of surveys are required or done routinely and when they're not required?

DR. LUHMAN: When you are dealing with a federal undertaking, consultation is a major part of the process, and it is through the process of consultation and interacting with the tribes and finding out their interests and concerns that participation in the survey processes usually comes out of that. And in those projects in which I have been involved it is typically that they are working alongside with the archaeological survey teams as they are going about doing the survey. It could be in the preliminary stages of doing the generalized recognizance of the project area. Oftentimes the federal agency and other parties will be along that process so that there can be discussions while out in the field, and these are for sometimes some very large projects. But in my experience it typically is at the same time when there is an ongoing consultative and survey process.

I will say that I am participating in a current project for the NRC at which there has been a tribal survey, field survey that has recently been concluded.

DR. HSUEH: Your Honor, if I may, I'd like to add something.

CHAIRMAN FROEHLICH: Oh, yes.

DR. HSUEH: Kevin Hsueh. I'd just like to maybe share with you how -- for the Dewey-Burdock how this tribal survey started. It was in 2011 during the meeting with the tribes that Ms. Yilma mentioned, and during that meeting there were requests from tribes to conduct the TCP surveys. And at that time the TCP surveys in 2011, that's relative new. It's an emerging issues. So and these surveys is not -- is emerging issues and many federal agencies that NRC also facing with this kind of request.

So one of the things that we have done is to consult with the advisory council because they are the -- agency they are charged with administering Section 106 and that work all the federal agencies.

And they have seen all that request. So since then we interact with the advisory council and to seek their feedback and also the input we had throughout the meetings with them and to seek feedback and advice as to how to address this TCP survey request.

And one thing that I would also like to add, staff mentioned about on the meetings and also emails, phone calls. One thing that is also very important to highlight is that we had many, many opportunities working with tribal officials, tribal members during the tribal consultation meetings or during the site visits or for Ms. Yilma and Ms. Jamerson. They participate in the field surveys working side-by-side with tribal members, and so they tell a lot of feedback information from the tribes.

But going back to these TCP surveys, it's very changing -- also emerging issues. So NRC staff, we recognize the importance of these TCP surveys for the tribes, because over the years we have working relationships with the tribes. We know the tribal officials, tribal members. So we recognize the importance of the TCP survey. So that's why we find ways to the extent we can. There are regulatory requirements. There are regulatory framework to accommodate these surveys.

And so I think in the end we -- as been mentioned, is that we have this open-side approach that seven tribes participate. And many, many tribal members participated these surveys. So I think that's a lot of effort put into these surveys. And in the end, there were so many interactions.

So one other thing that I would also like to mention is that any member of the public or many member of the tribes can contact the advisory council if they have any questions, any concern with the agencies or in Section 106. They can contact them. And sometimes the advisory council will contact the agency and ask for additional information. And in the past we have done that and we have provided information.

So I think it's very important to also point that out after almost more than four years I think in the end this letter that mention this morning, I think that's a letter from ACHP to me dated April 7. I think it's the NRC Exhibit 08018-D. The advisory council recognize that there were a range of issues over the course of this project that NRC need to address, and NRC need to address these issues balancing a range of the concerns and also the project scope.

And so I think in the end, ACHP concluded that NRC has completed the requirements of the Section 106 and also recognize that the Programmatic Agreement is the right approach for the next steps because they are all the processes to implement the additional Section 106 work. So I'd just like to add that point to kind of hopefully address one of your question as to how these TCP surveys started.

CHAIRMAN FROEHLICH: Thank you, Dr. Hsueh. You addressed a concern of mine, but also raised another question in my mind. Did the NRC I guess in its conversations with the ACHP tell them we have a request from a number of tribes that wish to have a TCP study as part of the 106 process, and indeed the TCP study requested is one that would be in great deal, one that would be very expensive, as I understand it from this morning's testimony, and would also be primarily conducted by members of those tribes who had requested that additional TCP study? Was that conveyed to the ACHP and what kind of a response did you receive from them?

DR. HSUEH: Yes, as I indicated, ACHP was fully informed of our interactions with tribes. And when there are issues and questions that we have, we always interact with the advisory council. And I think that the bottom line is this: The agency -- in this case the NRC is the agency for Section 106 consultation. They need to consider that request and then base on the scope of the project and then also the level of effort. And so the agencies made the final decision. However, the agency in the end -- if the advisory council -- after the agency made that decision, if the advisory council have questions, they can always send a letter to the agency to challenge that decision. But the agency is the one need to base a number of factors in to determine the level of efforts to proceed with these TCP survey.

CHAIRMAN FROEHLICH: The ACHP has no specific guidelines that tells you the level of detail or the level of effort, the types of surveys that would satisfy a TCP-type survey? Is that correct?

DR. HSUEH: I would say that they have a general guidance, but not specific. One of the things -- well, personally I would hope that there were step-by-step procedures that is available to the agencies as to how to address the TCP survey requests. And at this point my understanding is that there is no specific step-by-step procedures for the agency to follow, but each agencies need to address this specific issue base on the level effort and then the number of considerations and make its own decision. But I think in the end the agency need to be able to -- if the advisory council has issues or challenges, the agency's decision -- I mean, the agency should be able to defend why the agencies proceed with that approach.

CHAIRMAN FROEHLICH: Dr. Hannus, in your experience can you help me understand when a comprehensive TCP study, the type requested by the Oglala Sioux Tribe in this case, is or isn't required

DR. HANNUS: Oh, in the first place our office has not been involved in any other projects in which a TCP survey has been required, although we've worked on some huge projects, but there is a situation here that is evolving. So that is in part -- but the rules promulgated for the 106 process include Bulletin 38, which is the bulletin that refers specifically to the guidelines for TCP projects. And that's probably more familiar to Dr. Sebastian. He can probably quote it verse-by-verse.

(Laughter)

JUDGE BARNETT: I'm sorry, I can't hear the answers, at least of the last witness. I'm sorry, sir. I couldn't hear you, sir.

CHAIRMAN FROEHLICH: Dr. Hannus, could you repeat --

(Simultaneous speaking)

DR. HANNUS: Well, I mean, what I was saying basically is (A) that our office -- I mean, the question in part was have we ever been working with other projects that came in to requiring TCP things. And I just said our office has not. But I also said that the regulations that were promulgated for dealing with TCPs are contained in Bulletin 38, which I understand is under revision, but it is one of those moving targets, I think, at the present time.

JUDGE BARNETT: Thank you, sir.

CHAIRMAN FROEHLICH: Okay. Dr. Sebastian?

JUDGE COLE: Could you hear that?

JUDGE BARNETT: At that time I did hear it, yes, sir.

JUDGE COLE: Yes, he doesn't have a microphone in front of him. Maybe we could --

DR. HANNUS: Yes, I'm sorry.

JUDGE COLE: It hasn't been lighting up. That may be --

DR. HANNUS: Yes, okay. Sorry.

JUDGE BARNETT: Okay. Thank you.

CHAIRMAN FROEHLICH: All right. Dr. Sebastian, can you shed some light on this?

DR. SEBASTIAN: Well, I've kind of lost track of what this is, but let me try. One of the questions that you asked Dr. Hsueh was whether the advisory council has standards for identification efforts for TCPs. The advisory council doesn't have standards for the identification of any kind of historic properties. They say that agencies have to make a -- in their regulation they say that agencies have to make a reasonable and good faith effort, but the agencies set their own standards for archaeology, for historic buildings, for traditional cultural properties.

The only real published guidance, as Dr. Hannus said; and I never leave home without it --

(Laughter)

DR. SEBASTIAN: -- is National Register Bulletin 38. The National Register of Historic Places puts out bulletins about identifying and registering all kinds of historic properties. Landscapes. Mining districts. You know name it, they have a bulletin for it. And they do have this one for traditional cultural properties.

I think the other part of your question was about my experience --

CHAIRMAN FROEHLICH: Yes.

DR. SEBASTIAN: -- with projects and when --

CHAIRMAN FROEHLICH: When it's been required.

MR. HSUEH: -- things are required? I've been working with projects that identify traditional cultural properties since 1991, and the National Register Bulletin 38 came out in 1990. So it was the first time that people had begun to think about how to incorporate these kinds of places into a process that was originally created for historic buildings. It had been expanded over time to include things like archaeological sites, both pre-contact archaeological sites and Euro-American archaeological sites, other kind of properties.

And the agencies are supposed to consider all kinds of historic properties for every project, but sometimes the consideration is, you know, we're out in the middle of nowhere in the Great Plains. I don't think we have to make a big effort for building surveys, because there isn't a building for about 200 miles in any direction. And so the agency has to consider the effects on historic properties, but then they make a reasoned decision about how much effort to put into identifying different kinds of historic properties. So some places there's really a heavy focus on archaeology because there's a very high probability it's out there. Sometimes there isn't, You know, if we know that the landscape has been changed by cities or whatever. And so there's no identification effort, only a provision for discoveries. So it's an agency-based decision on when it's appropriate and how much it's appropriate.

In terms of the actual physical on-the-ground TCP survey-kind of thing that we're talking about, I have never been involved with one of those before. As I said, other parts of the country people identify traditional cultural properties usually mostly through ethnographic research. And then there are maybe field visits with the elders who want to go see a particular area, or they've looked at an archaeological report and they say this site right here, we want to go to see that site. So there's a field component, but I've never actually been involved in one that had this kind of extremely intensive effort proposed.

CHAIRMAN FROEHLICH: Okay. I'll go back to Ms. Yilma. Did the staff investigate or review ethnographic reports or suggest at any point in this process visits with tribal elders to try to collect the type of data necessary to respond to the cultural and historic resources?

MS. YILMA: We did not conduct an ethnographic study, but we did have a discussion about them during our face-to-face interactions with the tribes. And the ultimate decision was instead of an ethnographic study a field survey was necessary, so we focused our attention on the field survey approach.

CHAIRMAN FROEHLICH: Was there any thought given to utilizing the tribal elders in a field survey approach?

MS. YILMA: Yes. So after we decided the statement of work wasn't going to work, we did seek out for alternative approach. And one of the approach was the open-side approach that we ended up deciding on, and that open-side approach, the idea was that each tribal representative would select an elder or anyone that's knowledgeable of the tribe's culture to come out and identify sites within the Dewey-Burdock projects that are important to that tribe.

CHAIRMAN FROEHLICH: And of the tribes that took you up on that offer --

MS. YILMA: Yes.

CHAIRMAN FROEHLICH: -- how many people did they bring? I mean, how much of an undertaking was that?

MS. YILMA: There were three representatives. They were allowed to have three representatives from each site. Some had three. Others had a couple. And for some of them they did have tribal elders out with the tribal monitors doing a site survey and provided input on what was found and what was the interpretation of what was found.

CHAIRMAN FROEHLICH: Just trying to decide what's reasonable. They were allowed three? Why were they --

MS. YILMA: I should clarify. For purposes of reimbursements, because Powertech was covering the expenses, the expense allotment was for three representatives. But of course tribal entities could have brought more than three. But if they had brought more than three, the per diem and such were not going to be covered.

CHAIRMAN FROEHLICH: I see. Dr. Sebastian?

DR. SEBASTIAN: But in addition to covering travel and per diem, there was a $10,000 grant to each participating tribe, and they could use that money in any way they wanted to to further this. So some of them I believe used it to pay wages for the people who came. They used it to produce reports. However they wanted to. So they could have used some of that money to fund the travel and per diem for additional members if that's how they wanted to spend it.

MS. YILMA: And I also want to point out that there were -- Powertech had some flexibilities in that some of the tribal representative had three representatives on board doing the field survey and also invited their THPO to join afterwards to consult with what they have found. And that THPO representative that attended afterwards, that per diem was covered by Powertech, although as a gesture of -- to show flexibility, I guess.

CHAIRMAN FROEHLICH: Dr. Redmond, what's your opinion of this approach to attempt to capture the tribal perspective as to cultural resources?

DR. REDMOND: Let me clarify something first. It's something I didn't bring up earlier. I'm also an American Indian. I'm not a Lakota. I'm a Mohawk. But there are some things that are being bypassed here. Mr. CatchesEnemy brought up earlier that one of the things that's being bypassed here is this idea of government-to-government on a specific scale. And I believe that idea of the scale is being ignored. His position would be essentially the same as possibly a Senate staff or a Congressional staff, and he's being forced to meet with people that are way below his level, first of all.

Second of all, you're talking about having elders come out in this specific area to describe TCPs. Each family has different ideas of where TCPs occur within the geography of the Black Hills. Each family has different areas that they hold sacred. Each family. Each tiospaye. Each extended family. That's more than three per tribe.

Okay. That's a financial burden on Powertech. They stand to make money on this. This is a financial enterprise that they're embarking on. If it's worth it to them to continue this, then it must be worth it to invest in this thing. If they're not willing to invest in it, why are they involved in this thing? They're paying lip service to this thing of wanting to consult in a meaningful manner with the tribal people, but only with three per tribe. That doesn't sound meaningful. There's more than three tiospaye per tribe, more than three extended families per tribe. Okay. There's this amount of money that's been given to the tribe for this amount of people. Okay. Fine. It still doesn't add up. It's coming back to the amount of money, money, money, money.

Well, we're talking about money on one side and we're talking about spiritual concerns on the other. That's apples and oranges. You know, it doesn't really jive. You know, I know I'm supposed to be a scientist. I know I'm supposed to give some type of scientific answer here, but the Indian side of me says that all I'm hearing is a lot of money. And people are saying that they want to do meaningful consultation. And the consultation on the Native side is saying, hey, look, we're talking about our spirituality and you folks are talking about your money.

CHAIRMAN FROEHLICH: I understand your answer, and please appreciate my position. I'm trying to determine what's reasonable under the circumstances. As to consultation, in the government-to-government definition I understood you and Mr. CatchesEnemy to say that the tribes had desired either the president or, in your last answer, members of Senate staff to be conducting these discussions. Is that correct?

DR. REDMOND: Well, at least let's do it face-to-face.

CHAIRMAN FROEHLICH: Face to face? Here's another question: I understand face-to-face and the role it places, but you raised in your most recent answer the Senate staff.

DR. REDMOND: No, I understand that's not possible, but --

CHAIRMAN FROEHLICH: That wouldn't be reasonable, would it?

DR. REDMOND: -- at least with -- no, it's not reasonable.

CHAIRMAN FROEHLICH: But that wouldn't be reasonable.

DR. REDMOND: But at least let's do it with respect. And today's world everything seems to be through media. It's not face-to-face, eyeball-to-eyeball. And in our culture it's a handshake and face-to-face. I look in your eye and see if you're telling me the truth. Because if I can't see your face, I don't know what you're telling me.

CHAIRMAN FROEHLICH: I appreciate and understand your point on face-to-face. As to the number of people that would be reasonable, okay, you speak about extended families. What number of extended families would be inclusive or reasonable from the perspective of the Sioux Tribe or in your professional opinion?

DR. REDMOND: That I don't know. That would be -- Mr. CatchesEnemy and Mr. Mesteth could answer that better than me. Some families really have -- they don't really care anymore about the TCPs. Some care deeply. The families that I deal with; there's five of them, they would want to send a representative. They're on the eastern side of Pine Ridge. That's just the eastern side, and there's five of those. So I don't know. I know Mr. Mesteth is involved with several others and they would probably want to send at least one representative. I don't know.

CHAIRMAN FROEHLICH: I'd welcome an answer from either Mr. CatchesEnemy or Mr. Mesteth on what is the number of participants that would be reasonable to conduct a TCP-type study that would be satisfactory to the tribes.

MR. CATCHESENEMY: I don't believe there is a reasonable -- you know, and when we're correlating it with cost. It's just a dynamic to consider how many of our knowledgeable wise people back home that could have a interest, could have a stake in having some input into these types of discussions, these type of field surveys. Our tribal membership is 45,000. Half of those are under 18. So if you look at how many adults are there -- I don't know, that's what I'm saying. It's a pretty large number. But when they're using the word "reasonable" -- and I want to come back to the consultations.

CHAIRMAN FROEHLICH: Okay.

MR. CATCHESENEMY: If true consultation was to occur and the tribes asserted this, the NRC would have had to make separate visits to all 17 or more tribes individually to truly uphold that standard. But the tribes were reasonable in coming to one table one time with NRC. But if the tribes so choose to do so, they could have did so individually. And imagine what the cost would have been associated for NRC to conduct consultation with each tribe individually. So to me, I want to go back to that before we start moving forward and talking about how many would be reasonable on a survey.

Initially the consultation -- I think tribes have been taking the higher road all along. And while it doesn't seem like maybe the NRC staff is meeting us in a good ethical way and they're going to bypass a few things, it causes this to occur. We probably wouldn't even have to be here right now if it wasn't for maybe some of the things that happened or didn't happen and if there was more reasonable actions taken.

CHAIRMAN FROEHLICH: Okay. All right. I'm not certain which is the correct witness to respond to this for me, but the Powertech environmental report that I guess started us off, that would be perhaps the Augustana study that Dr. Hannus is responsible for. And that study found that the sheer volume of sites documented in the areas was noteworthy. The area proposed for mining was found to have a high density of cultural resources. Is that correct, Dr. Hannus?

DR. HANNUS: The density of sites was certainly -- it wasn't exceptional, but it would be what you would expect -- I mean, it was within the structure of what we have been seeing in that region through a number of other studies. We worked in the Badlands National Monument and conducted surveys for a five-year period. We also worked with GCC Dacotah. And actually some of that land is contiguous to the Powertech study. So we're finding about the same number of site density in those areas as we found in the specific Powertech project.

CHAIRMAN FROEHLICH: Okay. Can that high density and the statement you made be reconciled with the environmental report, page 2-9, table 2.11-1, that ultimately impacts to cultural resources will be none? Is this correct? Am I missing something in reading these two portions of the environmental report together?

DR. HANNUS: That's not our report.

CHAIRMAN FROEHLICH: Yes.

DR. HANNUS: And I'm not sure.

CHAIRMAN FROEHLICH: You're not sure? Perhaps, Mr. Pugsley -- I realize your not a witness, but I had trouble reconciling two portions of the environmental report that was submitted, one concluding that based on the Augustana study that there was a high density of cultural resources, but then in the environmental report I believe I read that the impacts to cultural resources -- and it was marked none. Am I missing something?

MR. PUGSLEY: One moment, Your Honor.

CHAIRMAN FROEHLICH: Thank you.

MR. PUGSLEY: I apologize, Your Honor. Thank you for the moment.

At the time the environmental report was finalized and accepted by NRC staff, Powertech had already executed the memorandum of agreement that I noted earlier in our opening statement with the State of South Dakota to mitigate and wherever possible avoid impacts to historic cultural resources.

That being said, the assessment performed by Powertech in its environmental report was as consistent as possible with Dr. Hannus' level 3 survey, but by no means should that be considered by the Board as the entirety of the assessment performed on historic and cultural resources. I would strongly encourage the Board to look to the entirety of the record of decision to see NRC staff's evaluation of it, including but not limited to any and all field surveys that were conducted, assessments of eligibility, concurrence by the state historic preservation officer, etcetera.

CHAIRMAN FROEHLICH: Thank you. Dr. Hannus, at page 16 of your testimony you state that the mitigation measures in the Programmatic Agreement seem acceptable for addressing adverse impacts to eligible archaeological sites. ALC doesn't know when it is applicable for addressing impacts to tribal sites that are not also archaeological sites. Can you explain this statement, please?

DR. HANNUS: Well, I guess in the first place it strikes me that there's a certain tone that is in all of our discussions today that isn't exactly clearly separating level 3 surveys and then the attached evaluations that follow those; in other words, what we conducted, with TCPs. The two really are, at least in my understanding of it at this point, on separate lines, because we're not in any way qualified to be conducting TCP surveys, and then under the same scientific framework, if you want to say that, that the 106 process is defining for the work that we did.

So I guess that there are arrangements, as I understand it, in the Programmatic Agreement to take into account that there will be consultation going on as this process goes on. And both when additional information is provided after -- I mean, if the license here is granted and as they proceed with the project, there will be sites that will need to be addressed archaeologically and there will be probably sites that need to be addressed as traditional cultural properties. But like I say, we're not really qualified in the work we do to address traditional cultural properties.

And the other thing that becomes important perhaps to note for the record is that the discipline of archaeology rarely has the good fortune to be able to connect actual tribal entities to archaeological sites. It is not part of the framework of our profession because you've got -- in other words, the things that we consider to be diagnostics of activities that were going on are not labeled in such a way as it were for us to recognize specific tribal entities. So at least in my long career, which is spanning more than 40 years now, I have not really seen more than about three sites that could be conclusively scientifically linked to a specific tribal entity.

So it's a complicated question for archaeology itself. This is not a complicated question for me. It's a complicated question for our discipline in that the data sets that we work with can answer numerous questions about time, space, climates, types of sites as far as what was going on at the site, but we can't really attach historically identified tribal entities to those levels of evaluation. And again, that really should clearly, I think, show us that for us to then be able to make some kind of in roads ourselves, being not of Native background, to identification of sites that are traditional cultural properties that have a tie to spirituality and so on, it is not in our purview to do that.

CHAIRMAN FROEHLICH: Then I take it you

would wholeheartedly agree with Dr. Sebastian and her testimony, APP-63, where she says identification of such places depends on the knowledge of traditional culture practitioners, not on the exercise of some scientific discipline or method?

DR. HANNUS: Yes, I mean, I absolutely would have to, because there isn't any other way the framework that I work within functions.

CHAIRMAN FROEHLICH: Okay.

JUDGE BARNETT: I have a question for Mr. Fosha. Are you testifying as a representative of the State of South Dakota or as a private consultant for Powertech?

MR. FOSHA: I guess I am here because I am an archaeologist that is employed by the State of South Dakota. Did that answer you question? I'm not here on behalf of Powertech.

JUDGE BARNETT: Okay. So the testimony that you're making today is in your role as an assistant state archaeologist, is that correct?

MR. FOSHA: And mining archaeologist for the state.

JUDGE BARNETT: Okay. Thank you.

JUDGE COLE: Just a couple of questions. This is for Mr. CatchesEnemy. Do you acknowledge that the Advisory Council on Historic Preservation is the principal agency charged with administering the National Historic Preservation Act and in making determinations on whether an agency has properly consulted under Section 106?

MR. CATCHESENEMY: I acknowledge that is their role.

JUDGE COLE: Do you acknowledge that the Advisory Council on Historic Preservation signed the Programmatic Agreement for the Dewey-Burdock project because it found that the staff has consulted as required under the National Historic Preservation Act? The reason why they signed it?

MR. CATCHESENEMY: I believe that there's statutes and regulations that hold them to comply with agreeing to such a Programmatic Agreement, however, by agreeing to it and signing off on it does not constitute like a true trust responsibility over tribes agreeing or not agreeing to that same PA.

JUDGE COLE: I understand your position, sir. In your pre-file testimony you state that you are concerned tribes will not be involved in future efforts to resolve adverse impacts on evaluated sites and identifying new sites. Do you acknowledge that the staff prepared the Programmatic Agreement just to resolve those kind of problems? Isn't that what they tried to do by developing the programmatic impact, to eliminate or minimize those kind of problems?

MR. CATCHESENEMY: As soon as -- the project, if allowed to proceed, will have irreparable harm to the cultural resources there no matter what the avoidance, minimizing or mitigation acts that are proposed. It will still have irreparable harm to those cultural resources no matter what. So a Programmatic Agreement and the stipulations that are provided in there does not safeguard/protect cultural resources, in my opinion.

JUDGE COLE: So you're saying it's not adequate?

MR. CATCHESENEMY: Inadequate, yes. I would like to add to that.

JUDGE COLE: Sure.

MR. CATCHESENEMY: A lot of what we're discussing right now between archaeology, the discipline of archaeology, the standards that are set for quite some time now and then the culmination of how TCPs came to be, there's a lot of things that occurred. Dr. Sebastian brought up Bulletin 38 in 1990. She brought up NAGPRA, which was also passed by Congress in 1990. And then two years after that

that's when the amendments to the National Historic Preservation Act came to be to allow THPOs to be created. So there's a lot of changes that have occurred since that to come up to where we're at now.

And as we're seeing now, there's not a lot of standards set or, as Mr. Kevin Hsueh has said, guidance for how these TCPs are created. A lot of guidance nationally is kind of a one-size-fits-all. And for tribes, I know we will always assert that there's not such a thing. That's why I bring up the fact that if consultation was going to be reasonable they would have been consulted with individuals. So guidance such as this, we won't be able to agree to a one-size-fits-all as tribes.

JUDGE COLE: Any of the other panel members want to comment on that?

DR. SEBASTIAN: Actually, I would, sir. On the question of whether the group tribal meeting that was held here in February of 2012 was a compromise rather than having individual meetings with the tribes, the SRI Foundation was in charge of setting it up and organizing everybody's travel and finding out what people wanted. And we were told consistently that the tribes did not want individual meetings, that they preferred to have a complete group meeting. And in fact one of the THPOs said to us that holding individual meetings would be an attempt to divide and conquer. So I want to make that clear in the record.

CHAIRMAN FROEHLICH: Is that your opinion also, Mr. CatchesEnemy?

MR. CATCHESENEMY: I don't share that same sentiment. I'm merely bring up a point that the tribes could assert that they be consulted individually. They could have. And I was trying to make a point in regards to being reasonable knowing that these meetings -- it would be unreasonable to ask them to do such a thing. But like Dr. Sebastian is saying, there is a benefit to having us together. A lot of times at some of these federal agency consultations that we have, we have tribal caucuses where we're able to get together and discuss a few items. So that's a benefit. My only point was being the reasonable portion. It wasn't reasonable to ask the NRC to consult with us individually.

JUDGE COLE: Thank you, sir.

CHAIRMAN FROEHLICH: I had one question that I forgot to ask of Mr. Fosha. Your testimony concludes that this office has no further reservations concerning the granting of a large-scale mine permit for the project. What were the initial reservations that that refers to?

MR. FOSHA: Okay. I was involved from the very start in the project, so the bulk of this material is a result of myself reviewing what Augustana College had been doing in the field. So can you repeat that, because I don't want to get in teacher mode and wander off the question.

CHAIRMAN FROEHLICH: Well, I notice in APP-010 your testimony concludes that this office, your office, has no further reservations concerning the granting of a large-scale mine permit for this project. My question was merely what were your initial concerns? What does that refer to?

MR. FOSHA: Okay. These mining projects start out with what's called a scenic, unique and critical review. That is, what do I know that I need to tell the applicant about what you can and can't do within certain areas of that property? In this case we knew nothing about the sites that were located here except for what I knew of adjacent areas. So I knew there would be sites there.

So I met with Powertech USA and we discussed methods of identification of archaeological sites and the methods and the steps we would take throughout this process. And again, this was all for a state permit. This had nothing to do with the NRC permit or anything like that. So up until the point where Augustana was nearly finished I was the only review agency on this project.

So as such, I worked very closely with Augustana College in the field. I met with their staff periodically to see if they were having any issues or problems that -- or things they couldn't recognize, let's say wrap their arms around archaeologically. And we did that because I had a lot more background in some of this than the people that were doing the survey in this region of the state at this point in time.

Also, I consider it my job to help agencies like Augustana College, or whoever is performing this work, to do the very best job they can. Therefore, I do a lot of site visits. I work closely with them. And throughout the course of this I think we identified once the initial was conducted; now we had met with Powertech, what areas are you going to directly impact? My questions then were I don't know the significance of these sites, so I still can't sign off on this until I understand what may or may not be disturbed. That's when Powertech initiated archaeological testing of these sites.

Once that was done; and at least to the point where we knew what was going to take place in the near future, at that point in time I could say, yes, this is not going to affect any historic properties based upon what we know right now. And it's also at that point in time that Powertech and my office had an MOA that would give me quarterly updates on events that are taking place, what they're planning to do so that I can keep abreast on we're ready to move into a new area. What do you think we should be taking into consideration? What steps would you recommend we do on these particular sites?

CHAIRMAN FROEHLICH: Those reservations then were all archaeologically-focused, not --

MR. FOSHA: Correct.

CHAIRMAN FROEHLICH: -- culturally or religiously as to the concerns of the tribes?

MR. FOSHA: No, it's just the field of archaeology and our science.

CHAIRMAN FROEHLICH: Okay. This concludes the questions that I had and prepared for Panel 1. What I would suggest we do is take a break. There may be some questions that the counsel would prepare that they would submit to us to ask as follow-on cross-examination for this panel. And then depending on how many questions there are, how many the Board elects to ask from the parties, since I would like to make the best use of our time, we'll move to argument on the additional data questions that is pending, if that meets with the approval of counsel.

MR. PARSONS: Your Honor, I have one clarifying question for you.

CHAIRMAN FROEHLICH: Sure.

MR. PARSONS: Are you anticipating there would be argument surrounding the issues identified in the subsequent motion filed, or are you just referring to the sort of August 6th order followed by the August 8th order data issues?

CHAIRMAN FROEHLICH: Because we were traveling, I haven't reviewed in great detail the motion that was filed Saturday. I did read it over electronically. And it would probably make sense for us to address those items which the intervenors have requested, that the tribe has requested, in addition to the data that was specified or related to the data in the Powertech press release.

Okay. How long would the counsel request or seek to prepare any follow-on cross of Panel 1?

MR. PUGSLEY: Your Honor, I would say at

least 20 minutes.

CHAIRMAN FROEHLICH: Staff, your perspective?

MR. CLARK: Twenty minutes is fine with the staff.

CHAIRMAN FROEHLICH: And from our intervenors?

MR. ELLISON: We would concur.

CHAIRMAN FROEHLICH: All right. Why don't we take 20 minutes so you can compile the questions that you would like asked of Panel 1 by the Board. I would ask that you do them on a sheet of paper. Write or print neatly.

(Laughter)

CHAIRMAN FROEHLICH: What will happen is questions that have been submitted, whether they're asked or not asked, are made part of the record afterwards. So your handwriting will be preserved. So I'd ask, one, that we can read it and, two, when it gets copied in the record at the end of the proceeding people will know what you wanted asked that wasn't asked.

Okay. Why don't we take 20 minutes to prepare those questions? We'll go through with any follow-on cross of Panel 1 and then we will hear argument on the additional data that's been requested by the Consolidated Intervenors. That will get us back here about 3:15.

(Whereupon, the above-entitled matter went off the record at 2:53 p.m. and resumed at 3:19 p.m.)

CHAIRMAN FROEHLICH: We'll be back on the record. I have received questions from each of the parties to the case, and since there is a modest amount of questions I'm going to go ahead and ask all of them. Begin with those.

Dr. Sebastian, what is the purpose of the execution statement in the Programmatic Agreement that's Exhibit NRC-018-A at 14.

DR. SEBASTIAN: Is that going to go up?

CHAIRMAN FROEHLICH: Could we display 18-A, please.

(Off the record comments)

JUDGE COLE: Your Honor, it's probably 1. 18-A1.

CHAIRMAN FROEHLICH: That's 8.

DR. SEBASTIAN: It's on page 14, if that helps. Right at the bottom here. Great, right at the bottom of the page.

Okay. At the end of Programmatic Agreements or Memoranda of Agreement, any kind of a

Section 106 agreement document, the last thing after all the stipulations is something like this that says that the execution of that document by the federal agencies and the other required signatories, and invited signatories, and the implementation of it is the evidence that a federal agency has done the two things that you have to do in the 106 process; take into account the effects of the undertaking on historic properties and give the Advisory Council an opportunity to comment. So, once all of the parties that are culled out in this execution or signing statement have executed the document, then that's the evidence that the federal agency has that it has met the requirements.

CHAIRMAN FROEHLICH: Dr. Sebastian, does the use of Section 106 Programmatic Agreement assume that identification of all historic properties has been completed?

DR. SEBASTIAN: No. Usually with a Memorandum of Agreement, which is the other kind of 106 document, pretty much all of the 106 activity is done at that point. Everything has been identified with minor exceptions, all the property have been evaluated, everybody knows what the effects are, and there's been the discussion about how to resolve the effects, so in an MOA all of those standard steps of the 106 process are done.

With a Programmatic Agreement, the idea is that it sets out a process for completing the 106 process, and it can pick up anywhere. Sometimes it picks up after all the properties have been identified and the effects are known, but the discussion about mitigation hasn't happened. Sometimes it picks up before any identification is done. I've written any number of large Programmatic Agreements and any amount of the 106 process can be provided for in the agreement including all of the identification in some cases.

CHAIRMAN FROEHLICH: What is the definition of the Area of Potential Effect, APE?

DR. SEBASTIAN: APE, as it says, the Area of Potential Effect is the area within which a federal undertaking could affect historic properties if there are any. It's phrased that way because you define the APE really early in the process. It's one of the first things that you do when you're doing 106. And people sometimes talk about the direct effects APE, and the indirect effects APE, so there are -- but there's really only one, the largest one. So, in the case of Dewey-Burdock, for example, the APE is nearly as large as the full project area. And, in fact, as Ms. Yilma testified earlier because of the visual effect efforts that were done to determine if there were going to be any visual effects, it actually goes a bit outside of the license area.

The direct effects area is a much smaller part of the greater APE, so the indirect effects happen in the larger area. The direct effects has been defined as a smaller area within which Powertech has indicated given the current level of planning; and, of course, things do change because ISR development is phased. But given what we currently know these are the direct effect areas, and we also designed a buffer around those to make sure that we understood which properties were going to be in or very close to the direct effects part of the APE. I think that answers it.

CHAIRMAN FROEHLICH: For Ms. Yilma, would you please elaborate on the specific way the field surveys were carried out to identify TCPs?

MS. YILMA: Sure. I'm guessing you're asking me how the tribes conducted the tribal survey?

CHAIRMAN FROEHLICH: How much time was actually spent in the field, and was the entire 10,000 plus acre site evaluated, or only the approximately

2,500 area of potential effect, which we just had defined?

MS. YILMA: The tribes were out there from –- for about a month in total. They did have access to 100 percent of the project boundary, the 10,500 acres. When they decided the identification efforts they came up with priorities to do the field survey, and those priorities ranged in importance to the tribes where they want to go first, look at burial sites, look at sites of importance to them, and also archeological sites that had also TCP contents to them, and they did a –- a survey was done in such a way that they were similar to archeological survey lined up, and walked the fields, basically. And they covered about 95 percent of the field.

They didn't do the entire 100 percent because they recognize that some of the sites within the project boundary were highly disturbed, and are places where they didn't necessarily think they had tribal sites to be found on those areas. Like the open pit mine areas that is highly disturbed, they didn't think they would find a tribal survey. So, in essence, they covered almost 100 percent of the property, although they had access to the entire project area.

CHAIRMAN FROEHLICH: Thank you. Mr. Fosha, did the Level 3 archeological survey meet or exceed the state standards for these types of surveys?

MR. FOSHA: It exceeded the state standards for these types of surveys.

CHAIRMAN FROEHLICH: I believe, Ms. Yilma. Did the FSEIS incorporate written reports or survey results from any Sioux tribe?

MS. YILMA: No. Although there were two Sioux tribes that attended that field survey, they did not provide a written identification.

CHAIRMAN FROEHLICH: Is it true that over 30 percent of the sites within the Area of Potential Effect are unevaluated?

MS. YILMA: There are a large number of unevaluated sites. However, Your Honor, we do have a Programmatic Agreement which captures how those unevaluated sites will be identified and evaluated in the future should the need arise before any ground disturbing activities occur.

CHAIRMAN FROEHLICH: The Programmatic Agreement defers additional consultation for the future. What makes the NRC Staff believe that future consultation efforts will be any more effective than past?

MS. YILMA: Well, Your Honor, we developed the Programmatic Agreement in consultation with those consulting parties, including the tribes I mentioned earlier. Considering we altered the Programmatic Agreement based on the Standing Rock Sioux, the Oglala Sioux, the Cheyenne River Sioux tribes interest to be part of future identification evaluation or development of mitigation measures, we believe it will be successful.

CHAIRMAN FROEHLICH: Thank you. Dr. Redmond, the ACHP has published a guidance document titled "Meeting the Reasonable and Good Faith Identification Standards in Section 106 Review." That's Exhibit NRC-047. Page 3 of this document states that, "A reasonable and good faith identification effort does not require; one, the approval of the THPO or other consulting party; two, identification of every property within the APE, Area of Potential Effects; three, investigations outside of or below a properly documented APE; four, ground verification of the entire APE.

Do you agree that an agency need not take these steps in order to comply with Section 106?

DR. REDMOND: Do I agree with this?

CHAIRMAN FROEHLICH: Do you agree that an agency need not take these steps in order to comply with Section 106?

DR. REDMOND: Section 106 simply says that they need to consider the effects, and they are not required to do these things. It's not up to me to agree or disagree with what 106 says.

CHAIRMAN FROEHLICH: But in your testimony today, aren't you arguing that the NRC Staff had to take some of these steps that the ACHP said are not required?

DR. REDMOND: I don't think I -- I wasn't saying that they -- I don't think I said that they did. I was -- I believe what I said was that the State of South Dakota in their guidelines said that they had to go by these things. And I think that's what I was stating, not this. Okay? I mean, is that clear with what I'm -- with what you're asking?

I've never agreed with this. No, I don't agree with this. Okay?

CHAIRMAN FROEHLICH: Okay.

DR. REDMOND: I never have agreed with it. When I saw this in the case law, I didn't agree with it initially when I was in graduate school. So, do I agree with it? No. Is that clear?

CHAIRMAN FROEHLICH: Well, you don't agree with, I guess, what the ACHP has published, but area you advocating in this case that the NRC Staff had to take some of these steps –- had to take these steps?

DR. REDMOND: What I was quoting was what the guidelines were that the –- I was following as far as the State of South Dakota guidelines were. Okay? And what my experience was as far as the State of South Dakota. Is that clear?

CHAIRMAN FROEHLICH: It'll have to do.

DR. REDMOND: No, I mean, I want to be absolutely clear in what I was stating. I wasn't going by the ACHP, I was going by what I had had to follow as far as the State of South Dakota and the guidelines that I followed according to the State of South Dakota up to their guidelines between 1992 and 2005. And they were changed what, about every two years. Right?

MR. FOSHA: The guidelines, essentially, have not been changed.

DR. REDMOND: No, they changed every two years. They would come out every two years.

MR. FOSHA: With a draft.

DR. REDMOND: Yes.

MR. FOSHA: That would never be accept –- never be implemented.

DR. REDMOND: Yes. Yes, but they came out every two years, and that's what we went by.

MR. FOSHA: It's now about every 10, but correct.

DR. REDMOND: From 1992 to 2005, those were the guidelines that we went by in the State of South Dakota. And that's what I was referring to when I found exception to the Augustana survey. And that was what –- in a letter that I gave to Mr. Frankel. Is that clear?

CHAIRMAN FROEHLICH: Yes, thank you.

DR. REDMOND: I know, I get verbose.

CHAIRMAN FROEHLICH: NRC Staff, the final question. The Intervenors' witnesses claim that the Staff did not include information from the April to May 2013 tribal field surveys in the FSEIS. Did you, indeed?

MS. YILMA: We did. It is in Chapter 4 of the Cultural Resources section, and also in our appendix.

CHAIRMAN FROEHLICH: Okay. At this point, I'd ask counsel if there's any other questions that they believe need to be asked of members of Panel 1?

MR. PUGSLEY: None from Powertech, Your Honor.

CHAIRMAN FROEHLICH: Staff?

MR. CLARK: Nothing for the Staff.

CHAIRMAN FROEHLICH: Consolidated Intervenors?

MR. ELLISON: Within the limited context within which this proceeding is proceeding, no.

CHAIRMAN FROEHLICH: Subpart L is Subpart L.

MR. PARSONS: Apart from maintaining our objections that we filed prior to this hearing, nothing further.

CHAIRMAN FROEHLICH: Okay. All right. Panel 1 is excused. You can stay there if you're comfortable, or you can retreat to the audience. The next portion will be your counsel at work.

MR. PUGSLEY: Your Honor, can I ask a question?

CHAIRMAN FROEHLICH: Yes.

MR. PUGSLEY: I just –- it's typical for us to ask whether our witnesses can be discharged at this time?

CHAIRMAN FROEHLICH: I don't believe we have any further questions for any of the witnesses on Panel 1.

MR. PUGSLEY: Thank you.

CHAIRMAN FROEHLICH: Mr. Parsons, could you just to start off the discussion restate the substance of your first motion having to do with the newly acquired data that was filed August 14th.

MR. PARSONS: If I may, Your Honor.

CHAIRMAN FROEHLICH: Yes, please.

MR. PARSONS: I think the sequence of events was along the lines that after the rebuttal statements were due in this case, we became aware of a press release issued by Powertech.

CHAIRMAN FROEHLICH: Okay.

MR. PARSONS: We asked to cross-examine on that issue. The Board had denied that motion for cross-examination, but during the April 5th pre-hearing conference the Board requested some argument on the relevance of that data. Based on that April 5th argument, on April 6th the Board issued an order finding that document, excuse me, that data relevant and posing a question to Powertech to respond as to when they would disclose that data.

On August 7th, Powertech submitted an email that essentially asked the Board to reconsider and for legal briefing on the matter. And then on August 8th the Board asked the parties to submit briefing. And then on August 12th all the parties submitted briefing. Certainly, if any of the other counsel thinks that that's not an accurate timeline, but I –- so, it wasn't necessarily that we raised a motion that gave rise to this particular dispute other than the motion for cross-examination. But, obviously, the question that was posed to me on August 5th in the hearing conference dealt with the relevance of this data, so just to kind of set the stage there.

CHAIRMAN FROEHLICH: Right. Then just take a moment to reassert your argument as to the relevance, and then we'll go to Powertech and the affidavit from Mr. Clement in response.

MR. PARSONS: Sure. So, you know, in our response on August 12th to the August 8th order, we were a bit concerned about the process that gave rise to the August 8th order, because the August 6th order had been in our mind very clear with a finding of relevancy, and an order for Powertech to disclose that data.

As I made clear in the August 12th filing, what we consider some pretty serious irregularities associated with an email to the Board, not filed as a motion, not certified, no conferral, in our mind because the Board –- because the NRC regulations require conferral and, in fact, say that a motion will be denied –- must be denied if conferral doesn't occur, we continue to assert those objections on the process. And we're not sure how the Board saw that as an appropriate form to go about making a motion, an email that, in fact, as we look at it didn't even serve all counsel. Mr. Ballanco here was not included on that email, so was kept out of that discussion. I think those are some serious issues.

I think the Board made a well-reasoned decision in their August 6th ruling. I think the Board looked at the testimony of Powertech's witnesses, NRC Staff, and Dr. Moran, and properly recognized that the issue of these TVA data has been live in this case for some time. It's presented, I think, pointedly in the testimony that's been submitted with respect -- especially with respect to the model that Powertech relies on that was incorporated and relied on in the Final Supplemental Environmental Impact Statement that assumes that there's no faults, no fractures, no gaps at all in the hydrogeology out there. And this data was one of the pieces of data that we had been claiming all along needed to be fully incorporated into this analysis, into this discussion, into the scientific review to look at that.

Now, the problem -- one of the problems we have in this situation is that we haven't seen this data. We're expected to argue relevancy based on a guess, essentially, as to what's in there. Powertech has testified or submitted an affidavit, anyway, that they're reviewed it, but we have not been given that opportunity, so it puts us, I think, at a distinct disadvantage. And I'm not sure that's an equitable way to approach this.

I will note that the relevancy standard is, as I recited in my brief on August 12th, a wide-reaching standard, so when you have data that comes to light that is the precise data that –- or at least in part some of the data that we have been arguing must be incorporated into the analysis in order to insure the hydrogeological integrity at the site, and that data comes to light, I think it's a fairly straightforward question that it is, indeed, relevant. That doesn't mean it's admissible, that's not the standard, but rather an even looser standard, so to speak, greater flexibility, I guess, is how the NRC presents it as we cited in our case law, than the Federal Rules of Evidence. So, we think that based on that standard it should be an extraordinarily high showing for Powertech to overcome to show that it's not relevant in any –- not even likely to lead to any discoverable evidence, as is the standard in the federal rules.

The NRC Staff has said that they haven't seen the data and, essentially, don't –- you know, their position where they don't necessarily have to make an argument or not because they haven't seen the data. And I think their response, essentially, went to that effect, we haven't seen it. We don't know what it is. But I think for what we do know, that it is what they refer to as –- and I want to make sure I get this correct, if you'll give me just a moment. I apologize.

"That the data being acquired consists of historical drill hole logs and maps prepared by the Tennessee Valley Authority in the '70s and '80s, as well as digitized data generated from this work. It's expected to assist Powertech's planning of wellfields for the property by providing additional quality data to supplement or complement, rather, their existing database."

I think what we've seen in the affidavit from Mr. Clement is that this is similar to data they've submitted and relied on in creating their hydrogeologic study, so that, I think, would be strong evidence of relevance. In addition, we understand again from the affidavit, and I think it's enough to overcome an objection on relevancy, is that it's to be used in preparation of the hydrogeologic wellfield packages.

I understand that Powertech sees the primary purpose of this data as bolstering their review of the economic reserves essentially at the project, but the fact that they intend to use it primarily for that purpose certainly does not mean that it's not useful in other ways. And I think the fact that they intend to include it in their hydrogeologic data goes to the point of relevance, as well as in the August 5th transcript at that hearing, you have NRC Staff asserting that this is the type of data that they would look at and review, and intend to review at some point in the future.

So, given that it's going to be submitted in the future, and it is currently in Powertech's possession, at least a portion of it as we understand, we think it falls squarely into the disclosure requirements in 10 CFR 2.336 which essentially says any relevant –- any data relevant to the contentions.

I'll note that Mr. Clement is not a hydrologist. I understand he's a geologist, and he has experience in the uranium industry, but what his affidavit does not do is talk about the hydrogeological and how this data could or could not be used. So, given the wide ranging relevance standard, I think that that's enough to get over this hurdle.

Mr. Clement says the electric logs by themselves do not demonstrate the ability to contain fluid migration. And that's sort of, it seems to me, a very well carefully crafted sentence that in and of itself do not demonstrate the ability to contain migration, but it certainly isn't evidence that in no way could this data be relevant to those determinations. Given the premium I think that this process ought to put on scientific integrity where you have data of the same kind and like that is already being used to perform the analysis, that additional data ought to be also disclosed.

There was some concern from Powertech about the cost of producing that data. I'm not sure that that's entirely relevant to this discussion. I don't see a test in the relevant standard that if the company thinks it will cost too much, then they don't have to produce it. It's a pretty encompassing standard in terms of producing relevant data.

I will note that it does say that at least the data that they have now includes digitized data. It's not clear to me how digitized data is not at least more easily transmitted than some of the other data for which the sort of practical concerns have been raised.

And to the extent that Powertech asserts that it should come in only under a protective order, we would like to assert an objection to that process to go forward under a protective order without the ability to –- potentially, even to brief that. The fact that they've paid for it does not automatically make it confidential business information, so to speak. If it's information that they're planning on at some point submitting to the NRC, and will be required to submit to the NRC, I think that that undermines their argument that it need be subject to a confidential or a protective order.

I think that their proffer has not gone far enough to establish that at this point, so I think further –- once we resolve the issue of relevance, I think we ought to take up the issue of a protective order.

I'm more than happy, also, at this point to go into the motion for the yet additional data and information that we've become aware of recently that was included in our motion to enforce the disclosure requirements, but that may be useful to bifurcate those, if the Board finds that useful.

CHAIRMAN FROEHLICH: Thank you. I think it would be useful to bifurcate it. I'd like to hear now from Mr. Pugsley in response as to the relevance and the nature of this data, and perhaps elaborate on the affidavit from Mr. Clement.

MR. PUGSLEY: Thank you, Your Honor. Just to keep our answer specific to your questions because we do have some issues with Mr. Parsons' claim that the Board should not have ordered legal argument on this due to an email, but we -- since you haven't asked about that, we won't get to that.

Essentially, what we have provided to the Board on August 12th of 2014 is a showing, we believe, that this data acquired from Energy Fuels, as noted in that press release referenced OST-19, I believe it is, that it does not meet the standard articulated for relevance. Essentially, we cite in our pleading filed on the 12th at page 3 that the Federal Rules of Evidence state that, "The standard for relevance is --- relevant evidence has the tendency -- any tendency to make a fact more or less probable than it would be without the evidence."

As far as Powertech is concerned, none of the information identified and discussed here today has any tendency to support or negate the issues associated with Contention 3 in this proceeding, which was the subject of the Board's order asking for legal argument.

I will note that despite the fact that the Board specifically directed the parties to address its relevancy to Contention 3, the other parties did attempt to link this to Contention 2. If I may address that briefly? There is no water quality data in terms of what is in the water in any of this information; so, thus, it cannot be relevant to Contention 2.

With respect to Contention 3, as detailed in Mr. Clement's affidavit at paragraph 6, he states, "I can see no reason why additional electric logs are relevant to the adequacy of the hydrogeologic information in the FSEIS regarding fluid migration."

Well, let me –- while we have provided you a pleading that provides you the information you ask in your question, Your Honor, let me summarize it for you very quickly.

These electric logs are used purposefully for economic reasons, and as is the case in any mineral recovery operation, the idea is to recover the ore as efficiently as possible. Because of the nature of NRC regulations, and it's detailed in Chapter 2 of the Standard Review Plan in NUREG-1569, we are required to engage in what's called site characterization. That is a limited study of where an operation would take place. However, logs like this are relevant to the following three questions, none of which can be completely answered until a full wellfield is put in. Where is the ore? What is the grade, and where do the wells go? That's it. No information in these electric logs can answer either in favor of Powertech's application, in support of NRC Staff's licensing determination, or in support of the Intervenors's claims. None of this information can act to address any of the issues associated with Contention 3, including but not limited to the location of previously unplugged boreholes, historic boreholes, the identification of subsurface features such as faults, fractures, or breccia pipes. None of the allegations offered by the parties in their initial position statements, rebuttal position statements, or the pleadings filed August 12th, nothing in there is relevant –– these logs are not relevant to any of those issues.

In fact, acquisition of this data is typical of ISR operations for economic purposes. And because Powertech is a publicly traded company, it has a responsibility to its shareholders to provide economic resource updates on a particular time table. And acquisition of this data is for that very purpose.

The fact that these things might be included in future hydrologic wellfield packages, as alleged by Mr. Parsons, is not relevant to the licensing decision before the Board at this time, which is whether or not the record of decision can be supported –- the decision to issue the license can be supported by the record of decision.

Lastly, I would note that, excuse me, I'm sorry. Pardon me. With respect to the issues regarding a protective order, Powertech –- in the event that this is necessary, Powertech can satisfy NRC regulations at 10 CFR 2.390(a)(4), demonstrating that this satisfies the requirements for confidential business information because it is of the information typically kept in confidence by a licensee or an applicant. If you'll give me one moment.

And as we said before, part of the reason Mr. Clement's affidavit talks about this being part of wellfield hydrologic packages post-license issuance is because it saves from having to conduct additional borehole drilling post-license issuance which minimizes impacts to a proposed project site because you know, again, where is the ore? What's the grade, and where do we put the wells? And that's really all this information is required for.

JUDGE BARNETT: If you had done what you just said, if you had not bought this data, you went out later and did this yourself, and you found something in the data that made you question whether or not you could contain the fluids, do you have any duty to disclose that data at all to anyone?

MR. PUGSLEY: Well, let me say one thing before I answer your question, sir. If we're talking about the type of data here that we're talking about today, that type of data even post-licensing when we develop the wellfield packages won't tell us anything about fluid migration.

JUDGE BARNETT: e-Logs are not relevant to fluid migration?

MR. PUGSLEY: What is relevant to fluid migration is things like pump testing, water quality differentiation analysis within the wellfield. It tells you where to put monitor wells, et cetera, but this e-Logs themselves are not relevant to fluid migration. It's the pump tests that need to be done when the full wellfield is in will actually give you information associated with some of these issues.

And do we have a duty to disclose that to anybody? To NRC, because according to the Commission's ISR regulatory program, and if you read the license conditions associated with the Dewey-Burdock project, there are license conditions that set requirements for wellfield packages to be at the very least reviewed by NRC Staff during its pre-operational inspection prior to commencement of operations. And, in fact, there is license conditions in there, as well, that require additional review by NRC Staff in language they use as review and approve, which means –- and there's certain identified areas of the site where that needs to be done. So, in terms of –- and I apologize for taking a long time to answer that, but the answer is yes, we have to disclose that to NRC, if we find an issue.

MR. ELLISON: Excuse me. May we also be heard, too?

CHAIRMAN FROEHLICH: Yes, at this point –-

MR. ELLISON: Thank you.

CHAIRMAN FROEHLICH: –- let me ask a few questions of Powertech at this point.

As I understand well logs, especially electric well logs, they are potentially useful to ascertain qualitative hydrogeological data and strata definition. As you pull the sensor up you learn as to the continuity or discontinuity nature of the confining layers, and the thickness of the shale layers as that probe is being pulled up. Is that correct? Do I have a correct understanding of how well logs are used?

MR. PUGSLEY: Yes, that's correct.

CHAIRMAN FROEHLICH: So, to the extent that well log data shows whether a particular layer is continuous or discontinuous, and the thickness of those layers, does that not affect fluid migration or potential fluid migration, and also where the wells might go?

MR. PUGSLEY: Basically, what we're saying here, Your Honor, is the log itself does not show continuity or discontinuity. And in the current case, they are –- what we're talking about here are surrounded by existing e-logs for the purposes of site characterization for the licensing action at hand and what is before the Board.

JUDGE BARNETT: Do you have easy access to Exhibit APP-017?

MR. PUGSLEY: Let's see.

CHAIRMAN FROEHLICH: Could you please display.

JUDGE BARNETT: The second page. There you go. Are those e-logs on there?

MR. PUGSLEY: Yes.

JUDGE BARNETT: This is a figure from your expert's testimony on Contention 3 that has e-logs in it, but now these additional e-logs have no relevance whatsoever to Contention 3?

MR. PUGSLEY: Basically, what we refer to these logs as are infill logs which are, essentially, as we said before, they're surrounded by existing e-logs, and it goes nothing –- to nothing more than –- it doesn't add any additional information to this.

JUDGE BARNETT: Well, so what you would have is, essentially, information from different wells along that cross section, potentially. Is that correct?

MR. PUGSLEY: I would say in a very small portion of the area.

(Off the record comments)

MR. PUGSLEY: And I would wrap that answer up, Your Honor, by saying that these e-logs are not going to give you any additional data that supersedes or is above and beyond what is currently available in the record of decision because of the fact that the way the sites are characterized pursuant to NRC guidance, they encompass a larger area that shows you where -- that deals with these issues. And these e-logs themselves don't provide any additional information.

JUDGE BARNETT: Have you all analyzed the e-logs?

MR. PUGSLEY: Yes.

JUDGE BARNETT: You've analyzed them all?

MR. PUGSLEY: I'm not sure if we've analyzed them all. The ones we've received --

(Off the record comments)

MR. ELLISON: Could we put Mr. Clement under oath, please, for these questions?

CHAIRMAN FROEHLICH: Indeed. Initially, what the Board had intended was to swear in the entirety of Panel 2, which includes all the hydrogeological experts on all sides. If they are present at this time, I would swear them in, and perhaps they can answer directly, as opposed to speaking through their counsel.

MR. ELLISON: But, Judge Froehlich, Mr. Clement is not a witness.

CHAIRMAN FROEHLICH: Not a witness.

MR. ELLISON: And, therefore, what I would like to suggest is that we're having answers through counsel that are going on the record --

CHAIRMAN FROEHLICH: Yes.

MR. ELLISON: –- that are not under oath, that are very important to these proceedings. And Mr. Clement should be under oath to not only answer the Board's questions, but to answer our questions about this data. So, I would request that, you know, Mr. Pugsley started out his argument by saying well, I want to supplement –-

MR. PUGSLEY: I didn't say supplement, I said summarize.

MR. ELLISON: Well, he gave a lot of additional information in the summary.

MR. PUGSLEY: Well, it's because I'm being asked questions. That's why.

MR. ELLISON: Okay. Let's put the man under oath and let's get the questions from him under oath.

CHAIRMAN FROEHLICH: We have Mr. Clement's affidavit which was supplied under oath, and to that extent that is acceptable and admissible for the exhibit. He will not be a witness in this case, but I believe the questions that you would like to ask, that Mr. Clement is answering as the President of the company would be probably enhanced if we heard it from the geologists and those people who use the data, or what use could be made of that data. I believe it would be more relevant to the kind of questions, at least, that the Board has to hear this from the geologists and the hydrologists who will be witnesses in the case.

MR. ELLISON: With one exception, if I might state, Judge Froehlich.

CHAIRMAN FROEHLICH: Sure.

MR. ELLISON: And that would be questions having to do with the timing and acquisition of this data, because if this Board were to determine that this data is relevant to these proceedings, it would be very important for this Board to know whether Powertech timed its acquisition of this data to have it follow NRC review, the FSEIS being released, the license being released, and so that basically they can then argue well, it has nothing to do with these proceedings.

CHAIRMAN FROEHLICH: Let us hold any argument along that line until after we determine the relevance or usefulness of well logs and enhanced data. We'll take that up after we've gotten to that --

MR. ELLISON: Very well, sir.

MR. PUGSLEY: Your Honor, may I note for the record that Mr. Ellison's statements here were part of Mr. Parsons' motions in limine and motion for cross-examination regarding the path forward for cross-examination on this issue, and it was ruled outside the scope of the contentions.

CHAIRMAN FROEHLICH: And my bifurcation at this point is consistent with the earlier approach of the Board.

Are the hydrogeological witnesses who would be testifying on Contentions 2, 3, and 4 present at this point in time? That would include Dr. Moran, Mr. Demuth, Mr. Lawrence, Mr. Lancaster, Mr. Pirko, and Ms. Henderson?

MR. PARSONS: Your Honor, for the tribe, Mr. Moran is present. I may suggest that it could be useful to allow Staff to respond. They're the only party that has not stated anything, and it may just for the purposes of the record be helpful to have Staff's take on this.

CHAIRMAN FROEHLICH: I believe the Consolidated Intervenors also wanted to be heard.

MR. PARSONS: Thank you.

CHAIRMAN FROEHLICH: All right. Before we swear any witness or see if they're present, I would like to hear from the Staff.

MR. CLARK: I'll be brief, Your Honor, and thank you to Mr. Parsons for bringing up this point. Mr. Parsons is correct, if the Staff received this information we would review it. However, the Staff's review obligations and disclosure obligations are broader than those of Powertech, in part because the Staff has to provide a hearing file, and the hearing file updates to the Board and the parties in which they need to disclose or log as privileged all documents between the Staff and the Applicant regarding the application. So, had the Staff received these data, the Staff would have identified the data and claimed the privilege of proprietary information privilege. The Staff would not have disclosed these data.

Regarding the relevance, I think I'll be brief, and I think the Board's approach is a sound one to ask questions of the witnesses who can provide more insight. Given the information I've heard, I don't want to misstate the position of the Staff's witnesses. I believe Mr. Ellison is correct, what you've been hearing is a little bit of what you might be hearing from the witnesses, so I won't delay any further. I don't have anything more.

CHAIRMAN FROEHLICH: All right. Mr. Ellison.

MR. ELLISON: I guess I'm a little confused about some of the proceedings that have happened here. As Mr. Parsons pointed out, this Board in its August 6th order found these logs to be relevant to these proceedings, and ordered them disclosed. And now we have a Powertech affidavit, obviously an interested party, who says well, without releasing this data we want to tell you that this has nothing to do with what you folks are involved with deciding.

I don't really understand that from a due process standpoint. I guess I would object to any, and I would move to strike Mr. Clement's affidavit because if he is not subject to confrontation, we have no way of knowing what he's talking about. He did acknowledge, as I understand it through Mr. Pugsley, that he hasn't even looked at all of this data, so he can't -- his affidavit is incomplete, therefore, because he's not looked at everything and, therefore, not able even from their perspective to give a full summary and evaluation of what this data consists of.

The whole purpose of a contested hearing is that the parties get to look at the evidence and get to from our respective positions make our arguments, cite appropriate law, regulations as to any of the issues that are involved. What Powertech proposes is that we accept their word that this is irrelevant, which the Board has already found to be relevant. And, Judge, I think you were asking some very pointed questions. And I apologize because I think that I cut you off, and I -- from further inquiry of Mr. Pugsley. And I would like to encourage that you continue.

But the central question here that has to be decided here, or one of the central questions is, does the hydrogeology consist -- is it such that with existing technology it is reasonable for Powertech, for the NRC Staff to allege that they can contain this -- the mine fluids?

The whole question has been do we evaluate this from the most general data that's available, or do we look at very site-specific data that's available? If this will contribute to site characteristics in a very detailed manner, how could that not be relevant to the issues that we're deciding here? So, I guess I am really confused, because one of the questions is, are these leaky aquifers, or are these isolated aquifers? And I think as some of the questions that the Board was asking, that is data -- the data that we're talking about may well include this.

But, you know, what we would like to do, and I guess what I'd like to suggest again is, I'd like to encourage the Board to put Mr. Clement on there so that we can get not only –- we can get the history of this. I would also like to suggest that this data may well provide information as to whether there are faults or fractures in there, and the details in between the existing e-logs that have been produced, because everybody says that there are faults and fractures in this area except Powertech. So, this is very, very important, and I feel totally handicapped at being able to argue relevancy without having our experts have a chance to look at this data and tell me what it says. I'm not a geologist, I'm not a hydrologist. I don't even try to pretend to be one, that's why I stumble with some questions. But my experts can answer those questions, and my experts tell me this is important data. Thank you.

CHAIRMAN FROEHLICH: Mr. Ellison, I think I as a lawyer suffer from the same disadvantage that many of the other lawyers in this room suffer from. For that reason, I'd like to ask questions regarding this data and its relevance to the case, to the issues in the case from the hydrologists, from the geologists, and from the witnesses that will be testifying as to the issues that may or may not be impacted by data from well logs.

MR. ELLISON: I understand, Your Honor. And what I'd like to orally move is that we hear from the experts then on just this question, and that we have any additional argument on the issue of relevance and discovery that may be appropriate. And that the Board then make a decision as to relevance and discoverability before we proceed any further with the evidence on Contentions 2 and 3. Because if the Board were to decide that it is relevant and discoverable, then we might just have to do this again if the Board orders disclosure, and six months or a year from now we come back and have to go through the whole thing again because we didn't have important data.

CHAIRMAN FROEHLICH: Let's not get ahead of ourselves.

MR. ELLISON: Yes, sir.

CHAIRMAN FROEHLICH: Let's at this point get a combined understanding of what this data does or doesn't show, and whether it's relevant or irrelevant to the issues that are before the Board, the issues that would be addressed by Panel 2.

MR. ELLISON: We do suffer from a slight disadvantage though, Judge, because our expert, Dr.

LegGarry is not here yet.

CHAIRMAN FROEHLICH: He's not here yet.

MR. ELLISON: No, sir. And, in addition, earlier the Board said that we'd probably not get to the --

CHAIRMAN FROEHLICH: Right.

MR. ELLISON: -- the other contentions today. So, I'm at an additional disadvantage by not having my expert here to ask questions.

CHAIRMAN FROEHLICH: At this point, I don't think there's much to be gained by hearing what the lawyers think these things are or aren't, and what they show or don't show. I think we're going to hold the balance of this argument in abeyance until tomorrow morning's session where at 9:00 we will have the witnesses for Contention 2. It's the Board's intention to swear them in and then to pick up this argument as to the relevance, irrelevance, admissibility, inadmissibility, discoverability, disclosure requirements that may follow from that. Once we all have a better understanding of exactly what we're talking about when we're discussing well logs, or digitized well logs, or the type of data this -- these type of logs present.

MR. ELLISON: I have a question for

clarification, Your Honor, if I may.

CHAIRMAN FROEHLICH: Yes?

MR. ELLISON: You just mentioned Contention 2, did you mean Contentions 2-4?

CHAIRMAN FROEHLICH: 2, 3, 4.

MR. ELLISON: Thank you.

CHAIRMAN FROEHLICH: Right. To the extent that this information that comes from people who are trained in geology and hydrology can learn from these type of tests, then we'll be able to assess the relevance, the importance, the disclosurability as opposed to discoverability in NRC parlance of the data that's at question.

MR. CLARK: Your Honor, can I make one point for the Staff? It's a legal point.

CHAIRMAN FROEHLICH: Legal points from lawyers are welcome.

MR. CLARK: That's for -- the Board has already framed the contention, and the contention includes within a claim that the Final EIS is insufficient because it lacks these data.

CHAIRMAN FROEHLICH: Right.

MR. CLARK: It's not the Board's role to amend the contention. That needs to come from the Intervenors. Regardless of whether the Board finds these data are discoverable or not, or privileged, the Board's role is not to rewrite the contention --

CHAIRMAN FROEHLICH: Right.

MR. CLARK: -- to incorporate the claim of missing data. It's for the Intervenors to seek leave to either amend their existing contention or file a new contention based on any new data that is available, or any information such as Mr. Clement's affidavit. And they have to meet the standards for amending or filing a new contention. Unless they meet those standards, these data may be relevant to a discovery violation which the Staff believes there's no firm evidence right now, but they're not relevant to the merits of any issue before the Board. That's to be decided, and it requires action by the Intervenors, not this Board.

CHAIRMAN FROEHLICH: Is not the merits determination among the contentions the ability for fluids to migrate among or between strata?

MR. CLARK: Correct.

CHAIRMAN FROEHLICH: And if that's an issue in this case, this data may or may not be relevant to fluid migration between strata.

MR. CLARK: But the contention is framed against the Final EIS. It's whether the analysis in the EIS which did not include these data was sufficient.

MR. PARSONS: I would like to chime in here, Your Honor. We raised this argument at the application stage. It has both safety and environmental components to this. In fact, Staff attempted to seek summary disposition on any safety component to this contention, and that was denied by the Board.

MR. CLARK: Your Honor, there's a long precedent of cases under 10 CFR 51.92, the standard that applies to the Staff, and when the Staff needs to supplement an Environmental Impact Statement based on new and significant information. And the Commission is quite clear that the –- when the Intervenors seek to amend their contention based on new information, they have to meet those standards.

Now, I recognize, as Mr. Parsons said, the existing contention includes a claim that the Staff should have considered these missing data. However, to the extent they seek to broaden the contention to include new challenges based on any new data that the Board orders disclosed, it's their obligation to seek leave to amend their contention and do that. It's not within the Board's role to rewrite the contention for them.

JUDGE BARNETT: So, if they see data that is relevant to this contention, that they would have to amend their contention, or could they use that data?

MR. CLARK: They can use -- they will need to amend their contention if they want to -- if the new data merely confirm some element of their existing contention, then possibly they don't need to amend it. But if they seek to add an additional basis for the contention, a new line or argument, then they would need to follow the rules for amending their contention.

JUDGE BARNETT: But not just new data. Right? I mean, data in and of itself would not mean that you had to amend the contention. Right? It would just be support for your existing contention. Is that correct?

MR. CLARK: It would depend what sort of challenges. The importance isn't the data, but the use they seek to make of the data. So, we don't know now it's -- it may be premature because we don't know yet whether the data is disclosable. And if so, what the nature of it is. The Board and the parties may learn tomorrow on that, but the Staff would just I guess caution the Board against rewriting the contention to include new arguments raised for the first time either during this hearing or after the hearing without the Intervenors following Commission precedent on amending contentions.

CHAIRMAN FROEHLICH: I believe you've accurately framed the Commission's regulations; however, to the extent that the data supports, attempts to support allegations that they made in the existing contentions, it would clearly be not only relevant, it would be admissible if it tended to prove or disprove, or to shed light on their contention as to let's say things like fluid migration, or connectivity between -- continuity between various strata.

MR. CLARK: Judge Froehlich, I think it would remain to be seen what use they seek to make of the data, so the --

CHAIRMAN FROEHLICH: Right.

MR. CLARK: But that could be one avenue, and you're correct, if that's the case.

CHAIRMAN FROEHLICH: If that's the case they wouldn't need to amend, or enlarge, or change their contention. Their contention has been that there is communication between these strata, and if this is evidence that either proves or disproves that, that wouldn't be an enlargement of their existing contention. Would it, Mr. Clark?

MR. CLARK: It could potentially be. I don't know. I wouldn't want to speculate right now. Just the Staff will be I guess on the alert to make sure the contention stays within the bounds admitted by this Board.

CHAIRMAN FROEHLICH: Okay. Are there any other issues or concerns that any of the parties wish to raise before we conclude for the day with the understanding that tomorrow when we reconvene at 9:00 a.m. we will swear in the panel, Panel 2, and we will follow-up with the argument on the data, the newly acquired data referenced in the Powertech OST-19.

MR. PARSONS: Your Honor, Jeff Parsons over here. At the risk of annoying the Board, the other issue that we had not quite got to was the premise or the basis for the motion that we had filed seeking additional discovery. I just wanted to flag that. I'm certainly happy to accede to the Board's intent to adjourn for the day, if that's your preference, but there is that issue.

CHAIRMAN FROEHLICH: Just so I have that clearly in mind, the additional data that you seek in the follow-on motion, one that was filed Saturday includes what materials or what data beyond the new acquired data that was referenced in the press release?

MR. PARSONS: Sure, Your Honor. So, in the Powertech email motion, for lack of a better description of it on August 7th, Powertech referenced additional drill logs that were used, apparently, by their characterization, used to create maps and other figures and information that supported –- purported to support their application. They made reference to the fact that somehow we shouldn't get this new data because we never asked for that old data, which raised –- certainly raised a flag in my mind that we're not required to ask for data that's relevant. And if they use that data for creating the maps, and isopach maps, and other sorts of figures and data to support their application, then that information should have also been disclosed so we could verify or make use of it, and determine whether it would be an exhibit, or other information that would be not just relevant for disclosure purposes, but relevant for admission as evidence. So, that is the first category of contents.

The second has to do with a non-purposeful take application that was submitted to the Fish and

Wildlife Service. In that –- as part of that application, they're required to submit essentially what amounts to an avian mitigation plan. One of our contentions in this case is that –- Contention 6, that the mitigation has not been properly vetted in this case. And, in fact, we specifically refer to the avian mitigation plan as a example of the lack of analysis, and the fact that this has been out there and not disclosed. We think it's also relevant to our contention because it is an avian mitigation plan that the FSEIS did not review, as we allege, and as was admitted.

The third piece of that motion was apparently a letter from the United States Bureau of Land Management to Powertech in early July asking them for additional information on their plan of operations to the BLM. Obviously, we haven't seen that letter, it has not been disclosed. We would note that the criteria that the BLM uses for reviewing plans of operations do overlap considerably with NRC regulations, and they include such things as mitigation plans. They also deal with state and other permits. And what we suspect is that at least portions of that BLM letter relate to, or at least potentially intercept with our contentions in this case. And what we understood from that letter is that Powertech is preparing a response to BLM due in August of this month. It appears from their filing, or at least I won't characterize, but through conferral we understand that they have not filed that. I certainly would let them speak to that.

But to the extent that that information comes up and it includes data or other information that's relevant to our contentions, we think that the disclosure requirements apply to that, as well. This information was disclosed in an August 11th, essentially a quarterly filing with the Canadian -- required by the Canadian Securities laws, and so it was brought to our attention through that sort of online filing database. And I think that is the extent of the additional material.

(Off record comment)

MR. PARSONS: Sorry. And that is it. I apologize.

CHAIRMAN FROEHLICH: Okay. Since your motion was filed Saturday, the other parties have not had an opportunity to respond to it. Although, it might be helpful if at this point just before we take up these issues, which will be after we take care of the additional quality data, if you have an initial response as to whether the documents that Mr. Parsons seeks are subject to the mandatory disclosure rules.

MR. PUGSLEY: Your Honor, we don't –- we have not had an opportunity to read this motion. We've been preparing for this hearing, and unfortunately we don't have an initial response at this time.

CHAIRMAN FROEHLICH: Okay. The type of documents that were described, Staff Counsel, are those the type of documents to be –- to the extent you understand what is being asked for, are these the type of documents that are normally required to be disclosed as part of the mandatory disclosure rules?

MR. CLARK: If the Staff –- again, if the Staff received the documents because our disclosure obligations are broader, we would have disclosed them. As to whether Powertech needs to disclose them, I guess I'd say two things. First, these are fairly recent documents from July. The argument was that they should have been disclosed in the August 1st updates. Typically, many NRC Boards close –- set a date for the final disclosure which is typically about a month before the hearing, so this is kind of unusual, just that there hasn't been any cutoff date.

CHAIRMAN FROEHLICH: Right.

MR. CLARK: But the argument –- I don't

understand the relevance of –- I understand there are additional mitigation measures and that Contention 6 refers to mitigation, but the claim in the Contention 6 is the EIS, the Final EIS didn't discuss mitigation sufficiently. The existence of some later mitigation measures which were actually referred to in the EIS, they were referred to as being in progress, the avian monitoring plan which is mentioned extensively in the EIS, the Staff understood that the plan would be developed. I do not see how the fact that an avian monitoring plan was finalized either tends to prove or disprove the completeness of the Staff's review.

Likewise with the plan of operations, so I would agree with Mr. Parsons that there's very limited information, so I won't want to take a position on that. The Staff simply doesn't know enough about that. But the claim in Contention 6 is the Staff didn't sufficiently discuss mitigation measures, and that it failed to evaluate the effectiveness of mitigation measures. I don't see how the Staff could have evaluated something that did not exist until after –- until seven months after it finalized the EIS. Thus, I don't see it as being, obviously, relevant to Contention 6, and I don't see any strong basis for saying that Powertech needed to disclose the information.

MR. PARSONS: Your Honor, point of clarification. The mitigation plan that we're talking about being submitted to the U.S. Fish and Wildlife Service was submitted in January of 2014. There's no specific date, whether it was before or after the FSEIS. Well, presumably, that would have been before the ROD. I'm not sure if it was before or after the FSEIS, so I think it's not quite accurate to say that it was seven months after. The July we understand that -- but that's the BLM document, and then this previous data apparently was available at the time of the application, so that would seem to be well before the Staff had conducted their NEPA review. Just to clarify that we're not talking about documents that had all been created in July of this year.

MR. CLARK: If I could respond briefly with the Board's permission.

CHAIRMAN FROEHLICH: Sure.

MR. CLARK: To the take permit, Contention 14 involved the claim the Staff failed to consult with the Fish and Wildlife Service. The Staff doesn't see how the take permit application is relevant to that contention, former Contention 14A. Former Contention 14B involved the Staff's assessment of impacts to the sage grouse, and whooping –- greater sage, grouse and whooping crane. Unless there's some information that the take permit covered those species, which seems unlikely, the Staff also doesn't see how the take permit application is relevant to former Contention 14B.

And I understand the claim that's relevant to mitigation measures but, again, the Staff referred to –- I'm confident referred to the take permit application in the Final EIS, and it wasn't information the Staff had available at the time. So, the existence of the document wouldn't call into question the scope of the Staff's analysis because the Staff didn't rely on that.

I'm just trying to recall exactly. The EIS is a large document, I can't –- I'm trying to mentally recall that section right now, and at quarter of 5, it's not coming to me, so I'll leave it at that. But the analysis in the EIS on mitigation measures stands for itself, and the existence of an application, I think the Board would need more to find that to take from an application which isn't obviously even –- doesn't obviously even go to mitigation is relevant to Contention 6.

CHAIRMAN FROEHLICH: Okay. I think we've

gone as far as we can for today. We will reconvene at 9:00 a.m. tomorrow. We'll proceed to swear in Panel 2. The Board will proceed first to sort through the newly acquired quality data referenced in the press release, and then address the other discovery or disclosure concerns that were raised by Mr. Parsons in his most recent filing. Although, I realize the other parties have not had an opportunity to file answers where they can do their research and address the issues in the motion that was filed Saturday.

MR. ELLISON: Judge Froehlich, if I may orally do so, the Consolidated Intervenors would join in the motion of the Oglala Sioux Tribe regarding those disclosures.

CHAIRMAN FROEHLICH: Okay.

MR. ELLISON: Thank you.

CHAIRMAN FROEHLICH: Thank you. We'll stand adjourned until 9:00 a.m. tomorrow morning. Thank you.

(Whereupon, the above-entitled matter went off the record at 4:38 p.m.)

Atomic Safety and Licensing Board Panel

In the Matter of:

Powertech (USA) Inc., (Dewey-Burdock In Situ Uranium Recovery Facility)

Docket No. 40-9075-MLA

ASLBP No. 10-898-02-MLA-BD01

Applicant's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
APP-001	Dr. Lynne Sebastian Initial Testimony.	Identified and Admitted
APP-002	Dr. Lynne Sebastian CV.	Identified and Admitted
APP-003	Dr. Adrien Hannus Initial Testimony.	Identified and Admitted
APP-004	Dr. Adrien Hannus CV.	Identified and Admitted
APP-005	Representative Sample of ALAC Projects.	Identified and Admitted
APP-006	ACHP Section 106 Regulations: Text of ACHP's Regulations, "Protection of Historic Properties: (36 CFR Part 800) (incorporates amendments effective Aug. 5, 2004)".	Identified and Admitted
APP-007	National Park Service, Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation, 1983	Identified and Admitted
APP-008	South Dakota State Historic Preservation Office, Guidelines for Cultural Resource Surveys and Survey Reports in South Dakota (For Review and Compliance), 2005.	Identified and Admitted
APP-009	Level III Cultural Resources Evaluation of Powertech (USA) Inc.'s Proposed Dewey-Burdock Uranium Project (Public Version), Vol. 3 Part 6; ML100670366.	Identified and Admitted
APP-010	Michael Fosha Initial Testimony.	Identified and Admitted
APP-011	Michael Fosha CV.	Identified and Admitted
APP-012	February 11, 2013 letter from Michael Fosha to SDDENR.	Identified and Admitted
APP-013	Hal Demuth Initial Testimony.	Identified and Admitted
APP-014	Hal Demuth CV.	Identified and Admitted
APP-015-A	Revised Technical Report (TR) for the Dewey-Burdock Project; Part 1 of 22; Transmittal Letter, Change Index and Revised TR RAI Responses; ML14035A052.	Identified and Admitted
APP-015-B	Revised TR for the Dewey-Burdock Project; Part 2 of 22; Text through Sec. 2.8.5.7; ML14035A029.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-015-C	Revised TR for the Dewey-Burdock Project; Part 3 of 22; Text Sec. 2.9 through 10.2; ML14035A030.	Identified and Admitted
APP-015-D	Revised TR for the Dewey-Burdock Project; Part 4 of 22; Plates 1.5-1 through 2.6-8; ML14035A031.	Identified and Admitted
APP-015-E	Revised TR for the Dewey-Burdock Project; Part 5 of 22; Plates 2.6-9 through 2.6-12; ML14035A032.	Identified and Admitted
APP-015-F	Revised TR for the Dewey-Burdock Project; Part 6 of 22; Plates 2.6-13 through 2.6-15; ML14035A033.	Identified and Admitted
APP-015-G	Revised TR for the Dewey-Burdock Project; Part 7 of 22; Plates 2.6-16 through 2.7-2; ML14035A034.	Identified and Admitted
APP-015-H	Revised TR for the Dewey-Burdock Project; Part 8 of 22; Plates 2.8-1 through 5.7-1; ML14035A035.	Identified and Admitted
APP-015-I	Revised TR for the Dewey-Burdock Project; Part 9 of 22; App. 2.2-A through 2.5-F; ML14035A036.	Identified and Admitted
APP-015-J	Revised TR for the Dewey-Burdock Project; Part 10 of 22; App. 2.6-A through 2.6-G; ML14035A037.	Identified and Admitted
APP-015-K	Revised TR for the Dewey-Burdock Project; Part 11 of 22; App. 2.6-H through 2.7-E; ML14035A038.	Identified and Admitted
APP-015-L	Revised TR for the Dewey-Burdock Project; Part 12 of 22; App 2.7-F through 2.7-G; ML14035A039.	Identified and Admitted
APP-015-M	Revised TR for the Dewey-Burdock Project; Part 13 of 22; App. 2.7-H 1 of 3; ML14035A040.	Identified and Admitted
APP-015-N	Revised TR for the Dewey-Burdock Project; Part 14 of 22; App. 2.7-H 2 of 3; ML14035A041.	Identified and Admitted
APP-015-O	Revised TR for the Dewey-Burdock Project; Part 15 of 22; App. 2.7-H 3 of 3; ML14035A042.	Identified and Admitted
APP-015-P	Revised TR for the Dewey-Burdock Project; Part 16 of 22; App. 2.7-J through 2.7-L 1 of 2; ML14035A043.	Identified and Admitted
APP-015-Q	Revised TR for the Dewey-Burdock Project; Part 17 of 22; App.2.7-L 2 of 2; ML14035A044	Identified and Admitted
APP-015-R	Revised TR for the Dewey-Burdock Project; Part 18 of 22; App. 2.7-M; ML14035A045.	Identified and Admitted
APP-015-S	Revised TR for the Dewey-Burdock Project; Part 19 of 22; App 2.7-N through 2.8-H; ML14035A046.	Identified and Admitted
APP-015-T	Revised TR for the Dewey-Burdock Project; Part 20 of 22; App. 2.8-I through 2.9-L; ML14035A047.	Identified and Admitted
APP-015-U	Revised TR for the Dewey-Burdock Project; Part 21 of 22; App. 2.9-M through 3.1-A; ML14035A048.	Identified and Admitted
APP-015-V	Revised TR for the Dewey-Burdock Project; Part 22 of 22; App. 3.1-B through 7.3-D; ML14035A049.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-016-A	Revised Response to the Request for Additional Information (RAI) for the Technical Report (TR) for the Dewey-Burdock Project; Cover Letter; ML11207A711.	Identified and Admitted
APP-016-B	Revised TR RAI Response; Text Part 1: ML11208B712.	Identified and Admitted
APP-016-C	Revised TR RAI response; Text Part 2; ML11208B719.	Identified and Admitted
APP-016-D	Revised TR RAI response; Text Part 3; ML11208B714.	Identified and Admitted
APP-016-E	Revised TR RAI Response; Exhibits Part 1; Exh. 2.6-1 through 2.6-4; ML11208B716.	Identified and Admitted
APP-016-F	Revised TR RAI response; Exhibits Part 2; Exh. 2.6-5; ML11208B763.	Identified and Admitted
APP-016-G	Revised TR RAI response; Exhibits Part 3; Exh. 2.6-6 through 3.1-1; ML11208B764.	Identified and Admitted
APP-016-H	Revised TR RAI Responses; Exhibits Part 4; Exh. 3.1-2 through 5.7-1; ML11208B767.	Identified and Admitted
APP-016-I	Revised TR RAI response; Appendices Part 1; App. 2.5-D through 2.6-G; ML11208B765.	Identified and Admitted
APP-016-J	Revised TR RAI response; Appendices Part 2; App. 2.6-H 1 of 3; ML11208B766.	Identified and Admitted
APP-016-K	Revised TR RAI response; Appendices Part 3; App. 2.6-H 2 of 3; ML11208B769.	Identified and Admitted
APP-016-L	Revised TR RAI response; Appendices Part 4; App. 2.6-H 3 of 3; ML11208B770.	Identified and Admitted
APP-016-M	Revised TR RAI response; Appendices Part 5; App. 2.7-B through 2.7-G; ML11208B771.	Identified and Admitted
APP-016-N	Revised TR RAI response; Appendices Part 6; App. 2.7-H 1 of 4; ML11208B777.	Identified and Admitted
APP-016-O	Revised TR RAI response; Appendices Part 7; App. 2.7-H 2 of 4; ML11208B778.	Identified and Admitted
APP-016-P	Revised TR RAI Response; Appendices Part 8; App. 2.7-H 3 of 4; ML11208B784.	Identified and Admitted
APP-016-Q	Revised TR RAI Response; Appendices Part 9; App 2.7-H 4 of 4; ML11208B827.	Identified and Admitted
APP-016-R	Revised TR RAI response; Appendices Part 10; App. 2.7-K; ML11208B832.	Identified and Admitted
APP-016-S	Revised TR RAI Response; Appendices Part 11; App. 2.7-L 1 of 4; ML112088833.	Identified and Admitted
APP-016-T	Revised TR RAI Response; Appendices Part 12; App. 2.7-L 2 of 4; ML11208B868.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
APP-016-U	Revised TR RAI response; Appendices Part 13; App. 2.7-L 3 of 4; ML11208B864.	Identified and Admitted
APP-016-V	Revised TR RAI response; Appendices Part 14; App. 2.7-L 4 of 4; ML11208B865.	Identified and Admitted
APP-016-W	Revised TR RAI response; Appendices Part 15; App. Vol. 4 Cover; ML11208B870.	Identified and Admitted
APP-016-X	Revised TR RAI response; Appendices Part 16; App. 2.7-M; ML11208B872.	Identified and Admitted
APP-016-Y	Revised TR RAI response; Appendices Part 17; App.2.9-B through 2.9-K; ML112150229.	Identified and Admitted
APP-016-Z	Revised TR RAI response; Appendices Part 18; App. 3.1-A 1 of 2; ML11208B922.	Identified and Admitted
APP-016-AA	Revised TR RAI response; Appendices Part 19; App. 3.1-A 2 of 2; ML11208B924.	Identified and Admitted
APP-016-BB	Revised TR RAI response; Appendices Part 20; App. 6.1-A through 7.3-C; ML11208B925.	Identified and Admitted
APP-017	Figures to Accompany Demuth Initial Testimony.	Identified and Admitted
APP-018	USGS Water-Supply Paper 2220, Basic Ground-Water Hydrology, 1983.	Identified and Admitted
APP-019	National Mining Association's (NMA) Generic Environmental Report in Support of the Nuclear Regulatory Commission's Generic Environmental Impact Statement for In Situ Uranium Recovery Facilities; ML080170159	Identified and Admitted
APP-020	ISR animation (Video of ISR Operation).	Identified and Admitted
APP-021-A	Dewey-Burdock Project Technical Report (TR); re-submitted August 2009; Part 1; Text thru Sec. 2.7.1; ML092870298	Identified and Admitted
APP-021-B	Dewey-Burdock Project TR; re-submitted August 2009; Part 2; Text Sec. 2.7.2 thru 2.9; ML092870295.	Identified and Admitted
APP-021-C	Dewey Burdock Project TR; Re-submittal August 2009, Part 3; Text Sec 3 thru End; ML092870299.	Identified and Admitted
APP-021-D	Dewey-Burdock Project TR; Re-submitted August 2009; Part 4; Plate 1.5-1; ML092870313.	Identified and Admitted
APP-021-E	Dewey-Burdock Project TR; Re-submitted August 2009; Part 5; Plate 1.5-2; ML092870314.	Identified and Admitted
APP-021-F	Dewey-Burdock Project TR; Re-submittal August 2009; Part 6; Plate 2.5-1; ML092870315.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
APP-021-G	Dewey-Burdock Project TR; re-submitted August 2009; Part 7; Plate 2.6-1; ML092870316.	Identified and Admitted
APP-021-H	Dewey-Burdock Project TR; Re-submitted August 2009; Part 8; Plate 2.6-2; ML092870317.	Identified and Admitted
APP-021-I	Dewey-Burdock Project TR; Re-submittal August 2009; Part 9; Plate 2.6-3; ML092870318.	Identified and Admitted
APP-021-J	Dewey-Burdock Project TR; Re-submittal August 2009; Part 10; Plate 2.6-4; ML092870305.	Identified and Admitted
APP-021-K	Dewey-Burdock Project TR; re-submitted August 2009; Part 11; Plate 2.6-5; ML092870306.	Identified and Admitted
APP-021-L	Dewey-Burdock Project TR; re-submitted August 2009; Part 12; Plate 2.6-6; ML092870307.	Identified and Admitted
APP-021-M	Dewey-Burdock Project TR; Re-submitted August 2009; Part 13; Plate 2.6-7; ML092870309.	Identified and Admitted
APP-021-N	Dewey-Burdock Project TR; re-submitted August 2009; Part 14; Plate 2.6-8; ML092870310.	Identified and Admitted
APP-021-O	Dewey-Burdock Project TR; Re-submitted August 2009; Part 15; Plate 2.6-9; ML092870311.	Identified and Admitted
APP-021-P	Dewey-Burdock Project TR; Re-submitted August 2009; Part 16; Plate 2.6-10; ML092870312.	Identified and Admitted
APP-021-Q	Dewey-Burdock Project TR; re-submitted August 2009; Part 17; Plate 2.6-11; ML092870320.	Identified and Admitted
APP-021-R	Dewey-Burdock Project TR; re-submitted August 2009; Part 18; Plate 2.6-12; ML092870321.	Identified and Admitted
APP-021-S	Dewey-Burdock Project TR; re-submitted August 2009; Part 19; Plate 2.6-13; ML092870322.	Identified and Admitted
APP-021-T	Dewey-Burdock Project TR; Re-submitted August 2009; Part 20; Plate 2.6-14; ML092870323.	Identified and Admitted
APP-021-U	Dewey-Burdock Project TR; re-submitted August 2009; Part 21; Plate 2.6-15; ML092870324.	Identified and Admitted
APP-021-V	Dewey-Burdock Project TR; re-submitted August 2009; Part 22; Plate 2.8-1; ML092870325.	Identified and Admitted
APP-021-W	Dewey-Burdock Project TR; re-submitted August 2009; Part 23; Plate 2.8-2; ML092870326.	Identified and Admitted
APP-021-X	Dewey-Burdock Project TR; re-submitted August 2009; Part 24; Plate 2.8-3; ML092870327.	Identified and Admitted
APP-021-Y	Dewey-Burdock Project TR; re-submitted August 2009; Part 25; Plate 3.1-1; ML092870328.	Identified and Admitted
APP-021-Z	Dewey-Burdock Project TR; re-submitted August 2009; Part 26; Plate 3.1-2; ML092870329.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-021-AA	Dewey-Burdock Project TR; Re-submitted August 2009; Part 27; App. 2.2-A thru 2.6-B; ML092870350.	Identified and Admitted
APP-021-BB	Dewey-Burdock Project TR; re-submitted August 2009; Part 28; App. 2.6-C thru 2.7-B(partial); ML092870351	Identified and Admitted
APP-021-CC	Dewey-Burdock Project TR; Re-submittal August 2009; Part 29, App. 2.7-B (Partial) thru 2.7-F; ML092870370.	Identified and Admitted
APP-021-DD	Dewey-Burdock Project TR; re-submitted August 2009; Part 30; App. 2.7-G thru 2.8-F (partial); ML092870354.	Identified and Admitted
APP-021-EE	Dewey-Burdock TR; Re-submitted August 2009; Part 31; App. 2-8.F (Partial); ML092870357.	Identified and Admitted
APP-021-FF	Dewey-Burdock Project TR; re-submitted August 2009; Part 32; App. 2.8-G thru 2.9-A; ML092870358.	Identified and Admitted
APP-021-GG	Dewey-Burdock Project TR; re-submitted August 2009; Part 33; App. 4.2-A thru 7.3-A (partial); ML092870343.	Identified and Admitted
APP-021-HH	Dewey-Burdock Project TR; re-submitted August 2009; Part 34; App. 7.3-A (partial) thru 7.3-B; ML092870344.	Identified and Admitted
APP-022	Geochemical Data from Groundwater at the Proposed Dewey Burdock Uranium In-situ Recovery Mine, Edgemont, South Dakota: U.S. Geological Survey Open-File Report 2012-1070.	Identified and Admitted
APP-023	Uranium In-Situ Recovery and the Proposed Dewey Burdock Site, Edgemont, South Dakota, Public Meeting Talk Given by Dr. Raymond Johnson, U.S. Geological Survey, in Hot Springs, SD on Feb. 7, 2013 and Custer, SD on May 22, 2013.	Identified and Admitted
APP-024	Pre-Licensing Well Construction, Lost Creek ISR Uranium Recovery Project; ML091520101.	Identified and Admitted
APP-025	Numerical Modeling of Hydrogeologic Conditions, Dewey-Burdock Project, February 2012; ML12062A096.	Identified and Admitted
APP-026	Update on USGS research at the proposed Dewey Burdock uranium in-situ recovery mine, Edgemont, South Dakota, presentation to EPA Region 8 in Denver, CO on Feb. 22, 2012, based on USGS OFR 2012-1070.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-027-A	Report to Accompany Madison Water Right Permit Application, June 2012; ML12193A239.	Identified and Admitted
APP-027-B	Report to Accompany Madison Water Right Permit Application, June 2012, Appendix A; ML12193A234.	Identified and Admitted
APP-027-C	Report to Accompany Madison Water Right Permit Application, June 2012, Appendix B; ML12193A235.	Identified and Admitted
APP-028	Report to the Chief Engineer on Water Permit Application No. 2685-2 [Madison Aquifer], ADAMS Accession No. ML13165A160, November 2, 2012.	Identified and Admitted
APP-029	Letter Agreement between Powertech and Fall River County Commission.	Identified and Admitted
APP-030	NUREG/CR-6733, A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees - Final Report, July 2001; ML012840152.	Identified and Admitted
APP-031	Decision of the TCEQ Executive Director regarding Uranium Energy Corporation's Permit No. UR03075.	Identified and Admitted
APP-032	In-Situ Leach Uranium Mining in the United States of America: Past, Present and Future, by D.H. Underhill, in IAEA TECDOC-720, Uranium In Situ Leaching, Proceedings of a Technical Committee Held in Vienna, 5-8 October 1992, September 1993.	Identified and Admitted
APP-033	Safety Evaluation Report for the Moore Ranch ISR Project in Campbell County, Wyoming, Materials License No. SUA-1596; ML101310291.	Identified and Admitted
APP-034	Safety Evaluation Report for the Nichols Ranch In Situ Recovery Project in Johnson and Campbell Counties, Wyoming, Material License No. SUA-1597; ML102240206.	Identified and Admitted
APP-035	Safety Evaluation Report for the Lost Creek Project in Sweetwater County, Wyoming, Materials License No. SUA-1598; ML112231724.	Identified and Admitted
APP-036	Safety Evaluation Report for the Strata Energy, Inc. Ross ISR Project, Crook County, Wyoming, Materials License No. SUA-1601; ML14002A107.	Identified and Admitted
APP-037	Errol Lawrence Initial Testimony.	Identified and Admitted
APP-038	Errol Lawrence CV.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-039	Materials License SUA-1597 for the Nichols Ranch ISR Project, July 2011; ML111751649.	Identified and Admitted
APP-040-A	Dewey-Burdock Project Environment Report (ER); Re-submittal August 2009; Part 1; Cover thru Sec. 3.4.2.1.1; ML09270345.	Identified and Admitted
APP-040-B	Dewey-Burdock Project Environmental Report (ER); re-submitted August 2009; Part 2; Sec. 3.4.2.1.2 thru 3.12; ML092870346.	Identified and Admitted
APP-040-C	Dewey-Burdock Project Environmental Report (ER); re-submitted August 2009; Part 1; Sec. 4 thru end; ML092870360.	Identified and Admitted
APP-040-D	ER Plate 3.1-1; ML092870380.	Identified and Admitted
APP-040-E	ER Plate 3.3-1; ML0921870381.	Identified and Admitted
APP-040-F	ER Plate 3.3-1; ML092870381.	Identified and Admitted
APP-040-G	ER Plate 3.3-3; ML092870383.	Identified and Admitted
APP-040-H	ER Plate 3.3-4; ML092870591.	Identified and Admitted
APP-040-I	ER Plate 3.3-5; ML092870386.	Identified and Admitted
APP-040-J	ER Plate 3.3-6; ML092870387.	Identified and Admitted
APP-040-K	ER Plate 3.3-7; ML092870388.	Identified and Admitted
APP-040-L	ER Plate 3.3-8; ML092870389.	Identified and Admitted
APP-040-M	ER Plate 3.3-9; ML092870390.	Identified and Admitted
APP-040-N	ER Plate 3.3-10; ML092870592.	Identified and Admitted
APP-040-O	ER Plate 3.3-11; ML092870586.	Identified and Admitted
APP-040-P	ER Plate 3.3-12; ML092870588.	Identified and Admitted
APP-040-Q	ER Plate 3.3-13; ML092870589.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
APP-040-R	ER Plate 3.3-14; ML092870590.	Identified and Admitted
APP-040-S	ER Plate 3.3-15; ML092870394.	Identified and Admitted
APP-040-T	ER Plate 3.5-1; ML092870395.	Identified and Admitted
APP-040-U	ER Plate 3.5-2; ML092870397.	Identified and Admitted
APP-040-V	ER Plate 6.1-1; ML092870593.	Identified and Admitted
APP-040-W	ER Replacement Plates; ML093370652.	Identified and Admitted
APP-040-X	ER App. 3.3-A thru 3.3-E; ML092870411.	Identified and Admitted
APP-040-Y	ER App. 3.3-F thru 3.4-A; ML092870421.	Identified and Admitted
APP-040-Z	ER App. 3.4-B thru 3.4-E; ML092870414.	Identified and Admitted
APP-040-AA	ER App.3.5-A thru 3.5-F; ML092870416.	Identified and Admitted
APP-040-BB	ER App. 3.5-F thru 3.5-I; ML092870422.	Identified and Admitted
APP-040-CC	ER App. 3.5-J thru 3.6-C; ML092870407.	Identified and Admitted
APP-040-DD	ER App. 4.6-A; ML092870409.	Identified and Admitted
APP-040-EE	ER App. 4.14-C thru 6.1-G; ML092870413.	Identified and Admitted
APP-041	Using Groundwater and Solid-phase Geochemistry for Reactive Transport Modeling at the Proposed Dewey Burdock Uranium In-situ Recovery Site, Edgemont, South Dakota, presentation given to EPA on April 11, 2012.	Identified and Admitted
APP-042-A	Dewey-Burdock Project Revised Class III Underground Injection Control Permit Application, Revised July 2012, Cover Letter; ML12244A519.	Identified and Admitted
APP-042-B	Dewey-Burdock Project Revised Class III Underground Injection Control Permit Application, Revised July 2012, Text thru Sec. 4; ML12244A522.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
APP-042-C	Dewey-Burdock Project Revised Class III Underground Injection Control Permit Application, Revised July 2012, Text Sec. 5 thru 8; ML12244A520.	Identified and Admitted
APP-042-D	Dewey-Burdock Project Revised Class III Underground Injection Control Permit Application, Revised July 2012, Text Sec. 9 thru end; ML12244A521.	Identified and Admitted
APP-043	Revised Response to TR RAI 5.7.8-3(b), June 27, 2012, ML12179A534.	Identified and Admitted
APP-044	Results of Acceptance Review for TR RAI Responses; ML110470245.	Identified and Admitted
APP-045	Responses to Technical Review Comments for Dewey-Burdock Large Scale Mine Permit Application; ML13144A182.	Identified and Admitted
APP-046	Doyl Fritz Initial Testimony.	Identified and Admitted
APP-047	Doyl Fritz CV.	Identified and Admitted
APP-048	Report to the Chief Engineer on Water Permit Application No. 2686-2 [Inyan Kara Aquifer], ADAMS Accession No. ML13165A168, November 2, 2012.	Identified and Admitted
APP-049	Water Right Permit No. 2626-2 Application and Permit.	Identified and Admitted
APP-050	ER RAI Responses, transmittal letter and text; ML102380516.	Identified and Admitted
APP-051	Groundwater Discharge Plan (GDP) permit application, as updated with replacement pages through November 2012.	Identified and Admitted
APP-052	Dewey-Burdock BLM Site Determinations; January 10, 2014 letter from BLM to SD SHPO; ML14014A303.	Identified and Admitted
APP-053	Gwyn McKee Initial Testimony.	Identified and Admitted
APP-054	Gwyn McKee CV.	Identified and Admitted
~~APP-055~~	~~Greater Sage-Grouse Management Plan, South Dakota, 2008-2017; ML12241A215.~~	Not Offered
~~APP-056~~	~~A Report on National Greater Sage-Grouse Conservation Measures.~~	Not Offered
~~APP-057~~	~~Greater Sage-grouse (Centrocercus urophasianus) Conservation Objectives: Final Report.~~	Not Offered

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
~~APP-058~~	~~Endangered Species Act Consultation Handbook, Procedures for Conducting Section 7 Consultations and Conferences, U.S. Fish and Wildlife Service and National Marine Fisheries Service,1998~~	Not Offered
~~APP-059~~	~~Frequently Asked Questions on ESA Consultations, USFWS.~~	Not Offered
~~APP-060~~	~~Whooping Crane (Grus americana) 5-Year Review: Summary and Evaluation, USFWS.~~	Not Offered
~~APP-061~~	~~Division of Migratory Bird Management, Important Information for Sandhill Hunters, Fall Whooping Crane Sightings 1943-1999.~~	Not Offered
~~APP-062~~	~~Black-Footed Ferret Recovery Plan, Second Revision, Nov. 2013.~~	Not Offered
APP-063	Answering Testimony of Dr, Lynne Sebastian.	Identified and Admitted
APP-064	Dr. Adrien Hannus Answering Testimony.	Identified and Admitted
APP-065	Hal Demuth Answering Testimony.	Identified and Admitted
APP-066	Errol Lawrence Answering Testimony.	Identified and Admitted
APP-067	Figure to Accompany Errol Lawrence Answering Testimony.	Identified and Admitted
APP-068	Doyl Fritz Answering Testimony.	Identified and Admitted
APP-069	Figures to Accompany Doyl Fritz Answering Testimony.	Identified and Admitted
APP-070	Gwyn McKee Answering Testimony.	Identified and Admitted
APP-071	2013 Wildlife Monitoring Report for the Dewey-Burdock Project.	Identified and Admitted

ADAMS Number	Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
Consolidated Intervenor's Exhibits			
INT-001		Testimony of Dr. Louis Redmond regarding Lakota Cultural Resources.	Identified and Admitted
INT-002		10/31/09 Report of Dr. Richard Abitz on Powertech Baseline Report.	Identified and Admitted
INT-003		Statement of Professional Qualifications of Dr. Louis Redmond.	Identified and Admitted
INT-004		Statement of Professional Qualifications of Dr. Hannan LaGarry	Identified and Admitted
~~INT-005~~		~~Statement of Professional Qualifications of Dr. Richard Abitz.~~	Excluded by Board Order (August 1, 2014)
INT-006		Declaration of Wilmer Mesteth regarding Lakota Cultural Resources.	Identified and Admitted
INT-007		Testimony of Susan Henderson regarding water resources issues and concerns of downflow rancher.	Identified and Admitted
~~INT-008~~		~~Testimony of Dr. Donald Kelley a former forensic pathologist regarding the radiological impact on humans and other animals.~~	Excluded by Board (At Hearing)
~~INT-008a~~		~~Dr. Donald Kelley Affidavit~~	Excluded by Board (At Hearing)
~~INT-009~~		~~Statement of Qualifications of Dr. Kelley.~~	Excluded by Board (At Hearing)
INT-010		Testimony of Peggy Detmers a Wildlife Biologist Regarding the D-B Site and Endangered Species.	Identified as Proffered
INT-010a		Statement of Qualifications of Peggy Detmers.	Identified as Proffered
INT-010b		Map - Beaver Creek Watershed.	Identified as Proffered
INT-010c		Map - Central Flyway.	Identified as Proffered
INT-010d		Map - Whooping Crane Route.	Identified as Proffered
INT-010e		Map - D-B Project Site.	Identified as Proffered
INT-010f		Google Photo - Dewey Project - close.	Identified as Proffered

Consolidated Intervenor's Exhibits			
ADAMS Number	**Exhibit Number**	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
	INT-010g	Google Photo - Dewey Project - Medium Height.	Identified as Proffered
	INT-010h	Google Photo - Dewey Project - Wide.	Identified as Proffered
	INT-010i	Map - 5 state area - D-B Project.	Identified as Proffered
	INT-010j	GPS Google Photo - D-B Project - Close-up.	Identified as Proffered
	INT-010k	GPS Google Photo - D-B Project - Drainage.	Identified as Proffered
	INT-010l	GPS Google Photo - D-B Project - wideshot.	Identified as Proffered
	INT-010m	Map - D-B area.	Identified as Proffered
	INT-010n	GPS Google Photo - D-B Project - triangle.	Identified as Proffered
	INT-010o	Diagram - Whooping Crane Bioaccumulaton.	Identified as Proffered
	INT-010p	Beaver Creek Final Fecal Coliform.	Identified as Proffered
	~~INT-010q~~	~~IPAC~~	NOT FILED
	INT-011	Testimony of Marvin Kammera, a rancher, on potential impacts on down flow ranchers as to Inyan Kara water quantity and quality.	Identified and Admitted
	INT-012	Testimony of Dayton Hyde, Owner/Operator of Black Hills Wild Horse Sanctuary, on Potential Impacts and Concerns about Proposed ISL Mine on Downflow Surface and Underground Water Resources.	Identified and Admitted
	INT-013	Testimony of Dr. Hannon LaGarry a geologic stratigrapher regarding fractures, faults, and other geologic features not adequately considered by Powertech or NRC staff.	Identified and Admitted
	INT-014	Testimony of Linsey McLane, a Bio-chemist Regarding Bioaccumulation of Heavy Metals in Plant and Animal Species.	Identified and Admitted
	~~INT-014a~~	~~Powerpoint of Linsey McLane, a biochemist regarding bioaccumulation of heavy metals in plants and animal species~~	NOT FILED
	NT-014b	Linsey McLane Affidavit	Identified and Admitted

Consolidated Intervenor's Exhibits

ADAMS Number	Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
~~INT-15~~		~~INT Comments on DSEIS , with Exhibits~~	NOT FILED
INT-016		Petition to Intervene, with Exhibits.	Identified and Admitted
INT-017		Statement of Contentions on DSEIS, with Exhibits.	Identified and Admitted
INT-018		INT Statement of Contentions on FSEIS, with Exhibits.	Identified and Admitted
INT-019		Dr. Redmond Rebuttal Letter.	Identified and Admitted
INT-020		Rebuttal Written Testimony of Dr. Hannan LaGarry.	Identified and Admitted
INT-020A		Expert Opinion Regarding the Proposed Dewey-Burdock Project ISL Mine Near Edgemont, South Dakota.	Identified and Admitted
INT-021A		Violation History - Crow Butte ISL mine in Crawford, Nebraska.	Identified and Admitted
INT-021B		Violation History - Crow Butte ISL mine in Crawford, Nebraska.	Identified and Admitted
INT-021C		Violation History - Crow Butte ISL mine in Crawford, Nebraska.	Identified and Admitted
INT-022A		Violation History - Smith Highland Ranch.	Identified and Admitted
INT-022B		Violation History - Smith Highland Ranch.	Identified and Admitted
INT-022C		Violation History - Smith Highland Ranch.	Identified and Admitted
~~INT-023~~		~~Violation History – Irigaray-Christiansen Ranch~~	NOT FILED

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-001	Initial Testimony and Affidavits from Haimanot Yilma, Kellee L. Jamerson, Thomas Lancaster, James Prikryl, and Amy Hester	Identified and Admitted
NRC-002-R	REVISED - Statement of Professional Qualifications of Po Wen (Kevin) Hsueh.	Identified and Admitted
NRC-003	Statement of Professional Qualifications of Haimanot Yilma	Identified and Admitted
NRC-004	Statement of Professional Qualifications of Kellee L. Jamerson	Identified and Admitted
NRC-005	Statement of Professional Qualifications of Thomas Lancaster	Identified and Admitted
NRC-006	Statement of Professional Qualifications of James Prikryl	Identified and Admitted
NRC-007	Statement of Professional Qualifications of Amy Hester	Identified and Admitted
NRC-008-A-1	NUREG-1910, Supplement 4, Vol. 1, Final Report, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental Impact	Identified and Admitted
NRC-008-A-2	NUREG-1910, Supplement 4, Vol. 1, Final Report, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental....	Identified and Admitted
NRC-008-B-1	NUREG-1910, Supplement 4, Vol. 2, Final Report, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental	Identified and Admitted
NRC-008-B-2	NUREG-1910, Supplement 4, Vol. 2., Final Report, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental Impact Statement for In-Situ Leach....	Identified and Admitted
NRC-009-A-1	NUREG-1910, Supplement 4, Vol. 1, Draft Report for Comment, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental Impact Statement....	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-009-A-2	NUREG-1910, Supplement 4, Vol. 1, Draft Report for Comment, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic	Identified and Admitted
NRC-009-B-1	NUREG-1910, S4, V2, DFC, EIS for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Suppl to the GEIS for In-Situ Leach Uranium Milling Facilities (Chapter 5 to 11 and Appendices)....	Identified and Admitted
NRC-009-B-2	NUREG-1910, Supplement 4, Vol. 2, Draft Report for Comment, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic	Identified and Admitted
NRC-010-A-1	NUREG-1910, Vol. 1, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 1 through 4) (May 2009) (ADAMS Accession No.	Identified and Admitted
NRC-010-A-2	NUREG-1910, Vol. 1, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 1 through 4)(May 2009) (ADAMS Accession No. ML091480244 Page 153-512	Identified and Admitted
NRC-010-A-3	NUREG-1910, Vol. 1, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 1 through 4) (May 2009) (ADAMS Accession No. ML091480244) Pages 513-704.	Identified and Admitted
NRC-010-B-1	NUREG-1910, Vol. 2, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 5 through 12 and Appendices) (May 2009) (ADAMS Accession No. ML091480188). Pages 1-272.	Identified and Admitted
NRC-010-B-2	NUREG-1910, Vol. 2, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 5 through 12 and Appendices) (May 2009) (ADAMS Accession No. ML091480188). Pages 273-612.	Identified and Admitted
NRC-011	Dewey-Burdock Record of Decision (Apr. 8, 2014) (ADAMS Accession No. ML14066A466).	Identified and Admitted
NRC-012	Materials License SUA-1600, Powertech (USA), Inc. (Apr. 8, 2014) (ADAMS Accession No. ML14043A392).	Identified and Admitted
NRC-013	NUREG-1569, Standard Review Plan for In-Situ Leach Uranium Extraction License Applications (June 4, 2003) (ADAMS Accession No. ML031550272).	Identified and Admitted
NRC-014	NUREG-1748, Final Report, Environmental Review Guidance for Licensing Actions Associated with NMSS Programs (Aug. 2003) (ADAMS Accession No. ML032450279).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-015	Dewey-Burdock ISR Project Summary of Tribal Outreach Timeline (Apr. 8, 2014) (ADAMS Accession No. ML14099A010).	Identified and Admitted
NRC-016	Submittal of Comments on Draft Programmatic Agreement for the Proposed Dewey-Burdock ISR Uranium Mining Project. (ADAMS Accession No. ML14077A002)	Identified and Admitted
NRC-017	Dewey-Burdock ISR Project Documents Pertaining to Section 106 of the National Historic Preservation Act (June 10, 2014), available at http://www.nrc.gov/info-finder/materials/uranium/licensed-facilities/dewey-burdock/section-106-docs.html	Identified and Admitted
NRC-018-A	Final PA for the Dewey-Burdock Project. (ADAMS Accession Nos. ML14066A347).	Identified and Admitted
NRC-018-B	Final Appendix for the Dewey-Burdock Project PA. (ADAMS Accession No. ML14066A350).	Identified and Admitted
NRC-018-C	NRC PA Signature Page. (ADAMS Accession No. ML14098A464).	Identified and Admitted
NRC-018-D	Letter from ACHP finalizing Section 106. (ADAMS Accession No. ML14099A025).	Identified and Admitted
NRC-018-E	ACHP PA Signature Page. (ADAMS Accession No. ML4098A1550).	Identified and Admitted
NRC-018-F	BLM signature on PA; (Mar. 25, 2014) (ADAMS Accession No. ML14098A102).	Identified and Admitted
NRC-018-G	South Dakota SHPO PA Signature Page. (ADAMS Accession No. ML14098A107).	Identified and Admitted
NRC-018-H	Powertech PA Signature Page. (ADAMS Accession No. ML14098A110).	Identified and Admitted
NRC-019	Summary Report Regarding the Tribal Cultural Surveys Completed for the Dewey-Burdock Uranium In Situ Recovery Project. (Dec. 16, 2013) (ADAMS Accession No. ML13343A142).	Identified and Admitted
NRC-020	NRC Letter transmitting the Applicant's Statement of Work to all consulting parties. (May 7,2012). (ADAMS Accession No. ML121250102).	Identified and Admitted
NRC-021	3/19/2010 NRC sent initial Section 106 invitation letters to 17 tribes requesting their input on the proposed action. ADAMS Accession No. ML100331999.	Identified and Admitted
NRC-022	Letter to Oglala Sioux Tribe Re: Request for Updated Tribal Council Members Consultation (Sep. 8, 2010) ADAMS Accession No. ML102450647).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-023	Powertech Dewey-Burdock Draft Scope of Work and Figures - Identification of Properties of Religious and Cultural Significance (Mar.07,2012) (ADAMS Accession No. ML120870197).	Identified and Admitted
NRC-024	NRC Staff Letter Postponing fall 2012 tribal survey. (12/14/2012). ADAMS Accession No. ML12335A175.	Identified and Admitted
NRC-025-A	HDR, Engineering Inc., "Assessment of the Visual Effects of the Powder River Basin Project, New Build Segment, on Previously Identified Historic Properties in South Dakota and Wyoming"....	Identified and Admitted
NRC-025-B	HDR, Engineering Inc. "Assessment of the Visual Effects of the Powder River Basin Project, New Build Segment, on Previously Identified Historic Properties in South Dakota and Wyoming."....	Identified and Admitted
NRC-026	WY SHPO (Wyoming State Historic Preservation Office). "Dewey-Burdock Line of Sight Analysis." Email (September 4) from R. Currit, Senior Archaeologist, Wyoming State Historic Preservation Office to H. Yilma,NRC. September 4,2013....	Identified and Admitted
NRC-027	ACHP, National Register Evaluation Criteria, Advisory Council on Historic Preservation. (Mar. 11, 2008) (2012 ADAMS Accession No. ML12262A055).	Identified and Admitted
NRC-028	Email from Waste Win Young to NRC Staff re SRST Comments Final Draft PA Dewey-Burdock SRST THPO Comments (Feb. 20, 2014) (ADAMS Accession No. ML14105A367).	Identified and Admitted
NRC-029	Letter to Cheyenne River Sioux Tribe re: Response Received Regarding Tribal Survey for Dewey-Burdock (Dec. 14, 2012) (ADAMS Accession No. ML12335A175).	Identified and Admitted
NRC-030	Standing Rock Sioux Tribe Comments - Final Draft PA Dewey-Burdock SRST-THPO Comments (Feb. 05, 2014) (ADAMS Accession No. ML14055A513).	Identified and Admitted
NRC-031	04/07/2014 Letter from the Advisory Council on Historic Preservation to the Standing Rock Sioux Tribe Concerning the Dewey- Burdock ISR Project, SD. ADAMS Accession No. ML14115A448.	Identified and Admitted
~~NRC-032~~		NOT FILED
NRC-033	09/13/2012 Summary of August 30,2012 Public Meeting with Powertech Inc, to Discuss Powertech's Proposed Environmental Monitoring Program related to the proposed Dewey-Burdock Project. ADAMS Accession No. ML12255A258.	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-034	Letter to Ponca Tribe of Nebraska Re: Invitation for Formal Consultation Under Section 106 of the National Historic Preservation Act (Mar. 4, 2011) (ADAMS Accession No. ML110550372).	Identified and Admitted
NRC-035	Letter to Santee Sioux Tribe of Nebraska Re: Invitation for Formal Consultation Under Section 106 of the National Historic Preservation Act (Mar. 4, 2011) (ADAMS Accession No. ML110550172).	Identified and Admitted
NRC-036	Letter to Crow Tribe of Montana Re: Invitation for Formal Consultation Under Section 106 of the national Historic Preservation Act (Mar. 04,2011) (ADAMS Accession No. ML110550535).	Identified and Admitted
NRC-037	12/3/2010 Yankton Sioux tribe requests face-to-face meeting to discuss past and current project as well as request for TCP survey. Sisseton Wahpeton and Fort Peck tribes also asked for face-to-face meeting via phone....	Identified and Admitted
NRC-038-A	Invitation for Informal Information-Gathering Meeting Pertaining to the Dewey-Burdock, Crow Butte North Trend, and Crow Butte License Renewal, In-Situ Uranium Recovery Projects (May 12, 2011)(ADAMS Accession No. ML111320251).	Identified and Admitted
NRC-038-B	Informal Information Gathering Meeting - Pine Ridge, SD Invitation to Section 106 Consultation Regarding Dewey-Burdock Project (ADAMS Accession No. ML111870622) (Package).	Identified and Admitted
NRC-038-C	Memo to Kevin Hsueh Re: Transcript for the June 8, 2011 Informal Information - Gathering Meeting Held in Pine Ridge, SD (July 8, 2011) (ADAMS Accession No. ML111870623).	Identified and Admitted
NRC-038-D	Attendee List - Informal Information Gathering Meeting Held in Pine Ridge, SD (July 8, 2011) (ADAMS Accession No. ML111870624).	Identified and Admitted
NRC-038-E	Transcript Re: Informal Information-Gathering Meeting Pertaining to Crow Butte Inc. and Powertech Inc. Proposed ISR Facilities (June 8, 2011) (ADAMS Accession No. ML111721938) (Pages 1-195).	Identified and Admitted
NRC-038-F	Presentation Slides for the Section 106 Consultation Meeting Pertaining to the Proposed Dewey-Burdock, Crow Butte North Trend, and Crow Butte LR In-Situ Uranium Recovery Projects (June 8, 2011) (ADAMS Accession No. ML111661428).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-039	Meeting Agenda for Informal Information Gathering Pertaining to Dewey-Burdock, Crow Butte. Accompanying NRC letter with map of the proposed project boundary and digital copies of the Class III	Identified and Admitted
NRC-040	Letter to Richard Blubaugh, Powertech, Re: NRC Information Request Relating to Section 106 and NEPA Reviews for the Proposed Dewey-Burdock Project (Aug. 12, 2011) (ADAMS Accession No. ML112170237).	Identified and Admitted
NRC-041	8/31/2011 NRC letter from Powertech letter and proposal in response to the Aug 12, 2011 request for NHPA Section 106 info. This letter enclosed a proposal which outlined a phased approach to	Identified and Admitted
NRC-042	10/20/2011 NRC provided copies of the 6/8/2011 meeting transcripts to all the Tribes. Thank you Letter to James Laysbad of Oglala Sioux Tribe Enclosing the Transcript of the Information-Gathering Meeting and Unredacted Survey Pertaining....	Identified and Admitted
~~NRC-043~~		NOT FILED
NRC-044	1/19/2012 NRC invitation letters to all THPOs for a planned Feb 2012 meeting to discuss how best to conduct the TCP survey. (ADAMS Accession No. ML12031A280).	Identified and Admitted
NRC-045	2/01/2012 (February 14-15, 2012 meeting agenda). (ADAMS Accession No. ML120320436).	Identified and Admitted
NRC-046	3/28/2012 - NRC transmitted transcripts of the NRC face-to-face meeting in Rapid City, SD to discuss how best to conduct the TCP survey. (ADAMS Accession Nos. ML120670319).	Identified and Admitted
NRC-047	Meeting the "Reasonable and Good Faith" Identification Standard in Section 106 Review (ACHP), availablae at http://www.achp.gov/docs/reasonable_good_faith_identification.pdf.	Identified and Admitted
NRC-048	NEPA and NHPA, A Handbook for Integrating NEPA and Section 106 (CEQ and ACHP), available at http://www.achp.gov/docs/NEPA NHPA Section 106 Handbook Mar2013.pdf.	Identified and Admitted
NRC-049	Letter to Crow Creek Sioux Tribe Re: Transmittal of Applicant's Draft Statement of Work (May 7, 2012) (ADAMS Accession No. ML 121250102).	Identified and Admitted

NRC Staff's Exhibits

Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-050	Letter to Oglala Sioux Tribe Re: Transmittal of Transcript from Teleconference Conducted on April 24, 2012 (June 26, 2012) (ADAMS Accession No. ML12177A109).	Identified and Admitted
NRC-051	NRC Email Re: August 9, 2012 Teleconference Invitation and Revised Statement of Work Transmittal (Aug. 07, 2012) (ADAMS Accession No. ML12261A375).	Identified and Admitted
NRC-052	NRC Request Re: Scope of Work with Coverage Rate, Start Date, Duration, and Cost (Aug 30, 2012) (ADAMS Accession No. ML12261A470).	Identified and Admitted
NRC-053	Letter to Tribal Historic Preservation Officer Re: Transmittal of Tribes' Proposal and Cost Estimate of the Dewey-Burdock ISR Project (Oct. 12, 2012) (ADAMS Accession No. ML12286A310).	Identified and Admitted
NRC-054	Letter to James Laysbad, Oglala Sioux Tribe, Re: Information Related to Traditional Cultural Properties; Dewey-Burdock, Crow Butte North Trend, and Crow Butte LR ISP Projects (Oct. 28, 2011) (ADAMS Accession No. ML112980555)	Identified and Admitted
NRC-055	Letter to Tribal Historic Preservation Officers Re: Request for a Proposal with Cost Estimate for Dewey Burdock Project (Sep. 18, 2012) (ADAMS Accession No. ML12264A594).	Identified and Admitted
NRC-056	H. Yilma Email Re: Draft PA for Dewey-Burdock Project (Nov. 22, 2013) (ADAMS Accession No. ML13329A420).	Identified and Admitted
NRC-057	Dewey-Burdock Project Draft Programmatic Agreement (Nov. 22, 2013) (ADAMS Accession No. ML ML13329A466).	Identified and Admitted
NRC-058	Draft Appendix A for Dewey-Burdock Project PA (Nov. 22, 2013) (ADAMS Accession No. ML13329A468).	Identified and Admitted
NRC-059	Table 1.0 - NRC NRHP Determinations for Dewey-Burdock Draft PA (Nov. 22, 2013) (ADAMS Accession No. ML13329A470).	Identified and Admitted
NRC-060	STB Finance Docket No. 33407, Dakota, Minnesota & Eastern Railroad Corporation Construction into the Powder River Basin: Request for Review and Comment on 21 Archaeological Sites, Surface Transportation Board....	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-061	Letter to Oglala Sioux Tribe Re: Transmittal of TCP Survey Report for Dewey-Burdock Project (Dec. 23, 2013) (ADAMS Accession No. ML13357A234).	Identified and Admitted
NRC-062	NRC Overall Determinations of Eligibility and Assessments of Effects (Dec. 16, 2013) (ADAMS Accession No. ML13343A155).	Identified and Admitted
NRC-063	Draft NRC NRHP Determinations - Table 1.0 for Draft PA (Dec. 13, 2013) (ADAMS Accession No. ML13354B948).	Identified and Admitted
NRC-064	Letter from John Yellow Bird Steele, President of the Oglala Sioux Tribe Re: Refusal to Accept Dewey-Burdock In Situ Project Proposal (Nov. 5, 2012) (ADAMS Accession No. ML13026A005).	Identified and Admitted
NRC-065	Letter from Sisseton Wahpeton Oyaye Tribe Re: Refusal to Accept Dewey-Burdock In Situ Recovery Project Proposal (Nov. 6, 2012) (ADAMS Accession No. ML13036A104).	Identified and Admitted
NRC-066	Letter from Standing Rock Sioux Tribe Re: Tribal Survey Using Persons Without Sioux TCP Expertise to Identify Sioux TCP (Nov. 5, 2012) (ADAMS Accession No. ML13036A110).	Identified and Admitted
NRC-067	Email from Standing Rock Sioux Tribe Providing Comments on Final Draft PA Dewey-Burdock SRST-THPO (Feb. 20, 2014) (ADAMS Accession No. ML14059A199).	Identified and Admitted
NRC-068	Email Re: Transmittal of a Follow-up Email Pertaining to an Upcoming Field Survey for the Dewey-Burdock Project (Feb. 08, 2013) (ADAMS Accession No. ML13039A336).	Identified and Admitted
NRC-069	Letter to Oglala Sioux Tribe Re: Notification of Intention to Separate the NHPA Section 106 Process from NEPA Review for Dewey-Burdock ISR Project (Nov. 6, 2013) (ADAMS Accession No. ML13308B524.	Identified and Admitted
NRC-070	Letter to J. Fowler, ACHP, Re: Notification of Intention to Separate the NHPA Section 106 Process from NEPA Review for Dewey-Burdock IS Project (Nov. 13, 2013) (ADAMS Accession No. ML13311B184).	Identified and Admitted
NRC-071	Letter from Department of State Re: Keystone XL Pipeline Project Traditional Cultural Property (TCP) Studies (Aug. 4, 2009).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-072	A Level III Cultural Resources Evaluation of Powertech (USA) Incorporated's Proposed Dewey-Burdock Uranium Project Locality within the Southern Black Hills, Custer and Fall River Counties, South Dakota, Vol. I, (Page 1.2 through Page 4.18)....	Identified and Admitted
NRC-073	A Level III Cultural Resources Evaluation of Powertech (USA) Incorporated's Proposed Dewey-Burdock Uranium Project Locality within the Southern Black Hills, Custer and Fall River Counties, South Dakota (Pages 5.53 through 5.106)....	Identified and Admitted
NRC-074	NRC (1980). Regulatory Guide 4.14, Radiological Effluent and Environmental Monitoring at Uranium Mills. ADAMS Accession No. ML003739941.	Identified and Admitted
NRC-075	NRC, 2009. Staff Assessment of Ground Water Impacts from Previously Licensed In-Situ Uranium Recovery Facilities, Memorandum from C. Miller to Chairman Jaczko , et al. Washington DC: USNRC, July 10, 2009d ADAMS Accession No. ML091770385.	Identified and Admitted
NRC-076	NUREG/CR-6705, Historical Case Analysis of Uranium Plume Attenuation.. (Feb. 28, 2001) (ADAMS Accession No. ML010460162).	Identified and Admitted
NRC-077	05/28/2010 NRC Staff Request for Additional Information for Proposed Dewey-Burdock In Situ Recovery Facility (ADAMS Accession No. ML101460286).	Identified and Admitted
NRC-078	09/13/2012 NRC Staff RAI: Summary of August 30, 2012 Public Meeting with Powertech Inc, to Discuss Powertech's Proposed Environmental Monitoring Program related to the proposed Dewey-Burdock Project. (ADAMS Accession No. ML12255A258).	Identified and Admitted
NRC-079	09/09/2013 NRC Staff RAI: Email Concerning Review of Powertech's Additional Statistical Analysis of Radium-226 Soil Sampling Data and Gamma Measurements and Request for Information. ADAMS (Accession No.	Identified and Admitted
NRC-080	12/09/2013 NRC Staff RAI: NRC Staff review of revised statistical analysis of the Radium 226 (soil) and gamma radiation correlation for screening surveys at the proposed Dewey-Burdock Project requesting additional information....	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-081	Gott, G.B., D.E. Wolcott, and C.G. Bowles. Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits, Southern Black Hills, South Dakota and Wyoming. ML120310042. U.S. Geological Survey Water Resources Investigation Report....	Identified and Admitted
NRC-082	Driscoll, D.G., J.M. Carter, J.E. Williamson, and L.D. Putnam. Hydrology of the Black Hills Area, South Dakota. U.S. Geological Survey Water Resources Investigation Report 02-4094. (ADAMS Accession No. ML12240A218). 2002.	Identified and Admitted
NRC-083	Braddock,W.A. Geology of the Jewel Cave SW Quadrangle Custer County, South Dakota. U.S. Geological Survey Bulletin 1063-G. (08 April 2013)....	Identified and Admitted
NRC-084-A	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survery for Edgemont, South Dakota, Wyoming. National Uranium Resource Evaluation (NURE) Program....	Identified and Admitted
NRC-084-B	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survey for Edgemont, South Dakota, Wyoming. National Uranium Resource Evaluation (NURE) Program,....	Identified and Admitted
NRC-084-C	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survey for Edgemont, South Dakota, Wyoming. National Uranium....	Identified and Admitted
NRC-084-D	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survery for Edgemont, South Dakota, Wyoming. National Uranium Resource Evaluation (NURE) Program....	Identified and Admitted
NRC-084-E	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survery for Edgemont, South Dakota, Wyoming. National Uranium Resource Evaluation (NURE) Program....	Identified and Admitted
NRC-084-F	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survery for Edgemont, South Dakota, Wyoming. National Uranium	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-085	Darton, N.H. Geology and Water Resources of the Northern Portion of the Black Hills and Adjoining Regions of South Dakota and Wyoming. U.S. Geological Survey Professional Paper 65. 1909....	Identified and Admitted
NRC-086	Epstein, J.B. "Hydrology, Hazards, and Geomorphic Development of Gypsum Karst in the Northern Black Hills, South Dakota and Wyoming. "U.S. Geological Survey Water-Resource Investigation Report 01-4011....	Identified and Admitted
NRC-087	NUREG-1910, Final Report, Supplement 1, Environmental Impact Statement for the Moore Ranch ISR Project in Campbell County, Wyoming, Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities....	Identified and Admitted
NRC-088	NUREG-1910, Final Report, Supplement 1, Environmental Impact Statement for the Moore Ranch ISR Project in Campbell County, Wyoming, Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities....	Identified and Admitted
NRC-089	NUREG-1910, Final Report, Supplement 3, Environmental Impact Statement for the Lost Creek ISR Project in Sweetwater County, Wyoming. Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities....	Identified and Admitted
NRC-090	SDDENR. "Report to the Chief Engineer on Water Permit Application No. 2686-2, Powertech (USA) Inc., November 2, 2012." November 2012a. ADAMS Accession No. ML13165A168.	Identified and Admitted
NRC-091	NRC. "Staff Assessment of Groundwater Impacts from Previously Licensed In-Situ Uranium Recovery Facilities." Memorandum to Chairman Jaczko, Commissioner Klein, and Commissioner Svinicki, NRC from C. Miller....	Identified and Admitted
~~NRC-092~~		NOT FILED
NRC-093	EPA comments on FSEIS; (ADAMS Accession No. ML14070A230).	Identified and Admitted
NRC-094	NRC Regulatory Guide 3.11, Rev. 3, Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities, November 2008, (ADAMS Accession No. ML082380144).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-095	Letter to P. Strobel Re: EPAs Response Comment to FSEIS (Mar. 25, 2014) (ADAMS Accession No. ML14078A044).	Identified and Admitted
NRC-096	Comment (14) of Robert F. Stewart on Behalf of the Dept. of the Interior, Office of Environmental Policy and Compliance on Draft Supplemental Environmental Impact Statement (DSEIS), Dewey-Burdock Project.....	Identified and Admitted
~~NRC-097~~	~~Request for Information Regarding Endangered or Threatened Species and Critical Habitat for the Powertech Inc. Proposed Dewey-Burdock In-Situ Recovery Facility Near Edgemont South Dakota (Mar. 15, 2010).(ADAMS Accession No. ML100331503).~~	Not Offered
~~NRC-098~~	~~FWS. Whooping Cranes and Wind Development - An Issue Paper. (Apr. 2009)....~~	Not Offered
~~NRC-099~~	~~Avian Power Line Interaction Committee. "Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006" (ADAMS Accession No. ML12243A391).~~	Not Offered
~~NRC-100~~	~~Informal Information-Gathering Meetings Trip Summery (Dec. 9, 2010) (ADAMS Accession No. ML093631627).~~	Not Offered
~~NRC-101~~	~~Email from Mitchell Iverson of BLM. (June 25, 2012) & Wildlife Stipulations in the Current 1986 South Dakota Resource Management Plan. (ADAMS Accession No. ML12249A030).~~	Not Offered
~~NRC-102~~	~~USGS. "Fragile Legacy, Endangered, Threatened, and Rare Animals of South Dakota, Black-footed Ferret (Mustela nigripes)." (2006), available at http://www.npwrc.usgs.gov/resource/wildlife/sdrare/species/mustnigr.htm.~~	Not Offered
~~NRC-103~~	~~FWS. "Species Profile, Whooping Crane (Grus Americana)".~~	Not Offered
~~NRC-104~~	~~BLM. "Draft Environmental Impact Statement, Dewey Conveyor Project." DOI-BLM-MT-040-2009-002-EIS. (Jan. 2009b) (ADAMS Accession No. ML12209A089).~~	Not Offered
~~NRC-105~~	~~BLM. "Final Statewide Programmatic Biological Assessment: Black-Footed Ferret (Mustela nigripes)." August, 2005. Cheyenne, Wyoming: U.S. Bureau of Land Management, Wyoming State Office.~~	Not Offered

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
~~NRC-106~~	~~FWS. "South Dakota Field Office, Black-Footed Ferret," (Sep. 9, 2013), available at http://www.fws.gov/southdakotafieldoffice/b-fferret.htm.~~	Not Offered
~~NRC-107~~	~~FWS. "Black-Footed Ferret Draft Recovery Plan." Second Revision, (Feb. 2013), available at....~~	Not Offered
~~NRC-108~~	~~South Dakota State University. "South Dakota GAP Analysis Project." Brookings, South Dakota: South Dakota State University, Department of Wildlife and Fisheries Sciences (Jan. 13, 2012), available at http://www.sdstate.edu/nrm/gap/index.cfm.~~	Not Offered
~~NRC-109~~	~~South Dakota State University. "Suitable Habitat Predicted for the Black-Footed Ferret in South Dakota." available at http://www.sdstate.edu/nrm/gap/mammals/upload/blfootferret-model.pdf.~~	Not Offered
~~NRC-110~~		NOT FILED
~~NRC-111~~	~~Dewey-Burdock Record of Decision (Apr. 8, 2014) (ADAMS Accession No. ML14066A466).~~	Not Offered
~~NRC-112~~	~~Travsky, A., Beauvais, G.P. "Species Assessment for the Whooping Crane (Grus Americana) in Wyoming." October 2004.Cheyenne, Wyoming: United States Department of the Interior, Bureau of Land Management,....~~	Not Offered
~~NRC-113~~	~~Endangered and Threatened Wildlife and Plants; 12-Month Findings for Petitions to List the Greater Sage-Grouse (Centrocercus urophasianus) as Threatened or Endangered. 75 Fed. Reg. 13,909-13,959....~~	Not Offered
~~NRC-114~~	~~Habitat Assessment and Conservation Strategy for Sage Grouse and Other Selected Species on Buffalo Gap National Grassland, U.S. Department of Agriculture, Forest Service (Sep. 2005) (ADAMS Accession No.....~~	Not Offered
~~NRC-115~~	~~Email with Attachments from Mitchell Iverson, BLM, RE: Meeting at 11:30 EST(June 25, 2012) (ADAMS Accession No. ML12250A802).~~	Not Offered
~~NRC-116~~	~~Attachment 1, Appendix C, South Dakota Field Office Mitigation Guidelines (June 25, 2012) (ADAMS Accession No. ML12250A827).~~	Not Offered
~~NRC-117~~	~~Appendix D South Dakota Field Office Reclamation Guidelines.~~	Not Offered

Atomic Safety and Licensing Board Panel

In the Matter of:

Powertech (USA) Inc., (Dewey-Burdock In Situ Uranium Recovery Facility)

Docket No. 40-9075-MLA

ASLBP No. 10-898-02-MLA-BD01

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
~~NRC-118~~	~~BLM. Email Subject "Appendix E Wildlife Stipulations" and attachments. From M. Iverson, BLM, Acting Field Manager, South Dakota Field Office, to A. Hester, CNWRA, Southwest Research Institute. (June 25, 2012.)~~	Not Offered
~~NRC-119~~	~~BLM. Email Subject "Wildlife and Special Status Stipulations in the 1896 South Dakota Resource Management Plan" and attachment. From M. Iverson, BLM, Acting Field Manager, South Dakota Field Office, to H. Yilma, Project Manager....~~	Not Offered
~~NRC-120~~	~~Peterson, R.A. "The South Dakota Breeding Bird Atlas." Jamestown, North Dakota: Northern Prairie Wildlife Research Center. 1995.http://www.npwrc.usgs.gov/%20%20resource/birds/sdatlas/index.htm~~	Not Offered
~~NRC-121~~	~~BLM. "Newcastle Resource Management Plan."(2000) (ADAMS Accession No. ML12209A101).~~	Not Offered
~~NRC-122~~	~~Sage-Grouse Working Group (Northeast Wyoming Sage-Grouse Working Group). "Northeast Wyoming Sage-Grouse Conservation Plan." (2006) (ADAMS Accession No. ML12240A374).~~	Not Offered
~~NRC-123~~	~~SDGFP. "Sage Grouse Population Dynamics."(Nov. 20, 2009), available at http://gfp.sd.gov/hunting/small-game/sage-grouse-population-dynamics.aspx~~	Not Offered
~~NRC-124~~		NOT FILED
~~NRC-125~~	~~U.S. Fish and Wildlife Service Press Release and Draft Report to Help Sage-Grouse Conservation Objectives (August 23, 2012) (ADAMS Accession No. ML12276A248)....~~	Not Offered
~~NRC-126~~	~~U.S. Fish and Wildlife Service. "Greater sage-grouse (Centrocercus urophasianus) Conservation Objectives: Final Report"(Feb. 2013), available at http://www.fws.gov/mountain-prairie/ea/03252013_COT_Report.pdf~~	Not Offered
~~NRC-127~~	~~Department of Environment And Natural Resources Recommendation Powertech (USA) Inc. Large Scale Mine Permit Application. (April 15, 2013), available at http://denr.sd.gov/des/mm/documents/Powertech1/DENRRec4-15-13.pdf.~~	Not Offered

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
~~NRC-128~~	~~SDGFP. "Colony Acreage and Distribution of the Black-Tailed Prairie Dog in South Dakota, 2008" (Aug. 2008), available at http://gfp.sd.gov/wildlife/docs/prairedog-distribution-report.pdf~~	Not Offered
~~NRC-129~~	~~S. Larson, FWS letter re Environmental Comments on Powertech Dewey-Burdock Project, Custer and Fall River County, South Dakota. (Mar. 29, 2010) (ADAMS Accession No. ML1009705560).~~	Not Offered
~~NRC-130~~	~~E-mail from Terry Quesinberry, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, to Amy Hester, Research Scientist, Center for Nuclear Waste Regulatory Analyses, Southwest Research Institute.....~~	Not Offered
~~NRC-131~~	~~E-mail from Terry Quesinberry, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, to Haimanot Yilma, Environmental Project Manager for Dewey-Burdock, Office of Federal and State Materials and Environmental....~~	Not Offered
NRC-132	Improving the Process for Preparing Efficient and Timely Environmental Reviews under NEPA.	Identified and Admitted
~~NRC-133~~		NOT FILED
NRC-134	Safety Evaluation Report for the Dewey-Burdock Project Fall River and Custer Counties, South Dakota. Materials License No. SUA-1600 (April 2014) ADAMS Accession No. ML14043A347.	Identified and Admitted
NRC-135	Safety Evaluation Report for the Dewey-Burdock Project Fall River and Custer Counties, South Dakota, Materials License No. SUA-1600, Docket No. 40-9075 (March 2013), ADAMS Accession No. ML13052A182.	Identified and Admitted
NRC-136-A	A - Palmer, L. and J.M. Kruse. "Evaluative Testing of 20 Sites in the Powertech (USA) Inc. Dewey-Burdock Uranium Project Impact Areas." Black Hills Archaeological Region. Volumes I and II. Archaeological Contract Series No. 251....	Identified and Admitted
NRC-136-B	Palmer, L. and J.M. Kruse Evaluative Testing of 20 Sites in the Powertech (USA) Inc. Dewey-Burdock Uranium Project Impact Areas Black Hills Archaeological Region Volumes I and II....	Identified and Admitted
NRC-136-C	Palmer, L. and J.M. Kruse. "Evaluative Testing of 20 Sites in the Powertech (USA) Inc. Dewey-Burdock Uranium Project Impact Areas." Black Hills Archaeological Region. Volumes I and II. Archaeological	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-137	Department of Environment and Natural Resources, Recommendation, Powertech (USA) Inc, Large Scale Mine Permit Application at 6 (April 15, 2013), available at http://denr.sd.gov/des/mm/documents/Powertech1/DENRRec4-15-13.pdf.	Identified and Admitted
NRC-138	Jack R. Keene (1973). Ground-Water Resources of the Western Half of Fall River County, South Dakota. South Dakota Department of Natural Resource Development, Geological Survey, Report of Investigations, No. 109, 90 pg....	Identified and Admitted
NRC-139	U.S. Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed June 20, 2014, from USGS web site: http//earthquakes.usgs.gov/regional/qfaults/.	Identified and Admitted
~~NRC-140~~		NOT FILED
NRC-141-A	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession No. ML092870155). Pages 1-42	Identified and Admitted
NRC-141-B	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession	Identified and Admitted
NRC-141-C	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession No. ML092870155). Pages 124-132	Identified and Admitted
NRC-141-D	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession No. ML092870155). Pages 133-143	Identified and Admitted
NRC-141-E	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession No. ML092870155).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-142	Submittal of Comments on Draft Programmatic Agreement for the Proposed Dewey-Burdock ISR Uranium Mining Project. (Mar. 17, 2014) (ADAMS Accession No. ML14077A002. Pages 5-1	Identified and Admitted
NRC-143	Letter to Oglala Sioux Tribe re: Invitation for Government-to-Government Meeting Concerning Licensing Actions for Proposed Uranium Recovery Projects. (Mar. 12, 2013) (ADAMS Accession No. ML13071A653).	Identified and Admitted
NRC-144	SRI (SRI Foundation). "Overview of Places of Traditional and Cultural Significance, Cameco/Powertech Project Areas." Rio Rancho, New Mexico: SRI Foundation. (June 8, 2012) (ADAMS Accession No. ML12262A113).	Identified and Admitted
NRC-145-A	Guidelines for Evaluation and Documenting Traditional Cultural Properties. National Register Bulletin, U.S. Department of the Interior. National Park Service. (ADAMS Accession No. ML12240A371). Pages 1-14	Identified and Admitted
NRC-145-B	Guidelines for Evaluation and Documenting Traditional Cultural Properties. National Register Bulletin, U.S. Department of the Interior. National Park Service. (ADAMS Accession No. ML12240A371). Pages 15-18	Identified and Admitted
NRC-146	2013/03/13 Powertech Dewey-Burdock LA - RE: field survey in the spring of 2013. (Mar. 13, 2013) (ADAMS Accession No. ML13078A388).	Identified and Admitted
NRC-147	2013/03/13 Powertech Dewey-Burdock LA - RE: field survey for Dewey-Burdock. (Mar. 13, 2013) (ADAMS Accession No. ML13078A384).	Identified and Admitted
NRC-148	Letter from Oglala Sioux Tribe in response to February 8, 2013 letter to Tribal Historic Preservation Officer March 23, 2013 (ADAMS Accession No. ML13141A362).	Identified and Admitted
NRC-149	2013/08/30 Powertech Dewey-Burdock LA - Request for Availability to discuss development of a PA for the Dewey Burdock Project. (Aug. 30, 2013) (ADAMS Accession No. ML13267A221).	Identified and Admitted
NRC-150	2013/11/14 Powertech Dewey-Burdock LA - Reminder: Teleconference to discuss the development of the PA for the Dewey Burdock project is scheduled for Friday. (Nov. 15, 2013. (ADAMS Accession No. ML13322B658).	Identified and Admitted
NRC-151	NRC Staff Rebuttal Testimony.	Identified and Admitted
NRC-152	Statement of Professional Qualifications of Hope E. Luhman.	Identified and Admitted

NRC Staff's Exhibits

Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-153	Excerpt from Parker, P. and T. King. Guidelines for Evaluating and Documenting Traditional Cultural Properties, National Register of Historic Places Bulletin 38. (1990) (ADAMS Accession No. ML12240A371).	Identified and Admitted
NRC-154	Excerpt from Bates, R. and J. Jackson. Dictionary of Geological Terms 3rd Edition. (1984).	Identified and Admitted
NRC-155	Letter from South Dakota Historical Society re: Dewey-Burdock Project, (Jan. 2014).	Identified and Admitted
NRC-156	Johnson, R. H. "Reactive Transport Modeling for the Proposed Dewey-Burdock Uranium In-Situ Recovery Mine, Edgemont, South Dakota, USA." International Mine Water Association, Mine Water-Managing the Challenges. 2011.	Identified and Admitted

Oglala Sioux Tribe's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
OST-001	Opening Written Testimony of Dr. Robert E. Moran.	Identified and Admitted
OST-002	U.S. EPA, 2007, TENORM Uranium Occupational and Public Risks Associated with In- Situ Leaching; Append. III, PG 1-11.	Identified and Admitted
OST-003	US EPA, 2008, Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining, Volume 1: Mining and Reclamation Background: Previously published on-line and printed as Vol. 1 of EPA 402-R-05-007....	Identified and Admitted
OST-004	U.S. EPA, 2011 (June), CONSIDERATIONS RELATED TO POST-CLOSURE MONITORING OF URANIUM IN-SITU LEACH/IN-SITU RECOVERY (ISL/ISR) SITES, Draft Technical Report; [Includes Attachment A: Development of the Groundwater Baseline for Burdock ISL Site....	Identified and Admitted
OST-005	Powerpoint presentation prepared by Dr. Robert E. Moran.	Identified and Admitted
OST-006	Boggs, Jenkins, ?Analysis of Aquifer Tests Conducted at the Proposed Burdock Uranium Mine Site, Burdock, South Dakota,? Tennessee Valley Authority, Report No. WR28-1-520-109, May 1980.	Identified and Admitted
OST-007	Boggs, Hydrogeologic Investigations at Proposed Uranium Mine Near Dewey, South Dakota (1983).	Identified and Admitted
OST-008	Keene, Ground-water Resources of the Western Half of Fall River County, S.D., Dept. of Natural Resource Development Geological Survey, Univ. S.D., Report of Investigations No. 109 (1973).	Identified and Admitted
OST-009	TVA, Draft Environmental Statement, Edgemont Uranium Mine.	Identified and Admitted
OST-010	OST Petition to Intervene, with Exhibits.	Identified and Admitted
OST-011	OST Statement of Contentions on DSEIS, with Exhibits.	Identified and Admitted
OST-012	OST Statement of Contentions on FSEIS, with Exhibits.	Identified and Admitted
OST-013	OST Statement of Undisputed Facts submitted with OST Motion for Summary Disposition.	Identified and Admitted
OST-014	Declaration of Michael CatchesEnemy.	Identified and Admitted
OST-015	Declaration of Wilmer Mesteth.	Identified and Admitted

Oglala Sioux Tribe's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
OST-016	February 20, 2013 letter from Standing Rock Sioux to NRC Staff.	Identified and Admitted
OST-017	March 22, 2013 letter from Oglala Sioux Tribe to NRC Staff.	Identified and Admitted
OST-018	Rebuttal Testimony of Dr. Robert E. Moran.	Identified and Admitted
OST-019	Powertech Press Release.	Identified and Admitted
OST-020	E-Mail from Chris Pugsley, Powertech, re NRC Proceeding.	Identified and Admitted
OST-021	Powertech Quarterly Management Discussion and Analysis.	Identified and Admitted

Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Powertech USA, Inc.: Dewey-Burdock in Situ Uranium Recovery Facility

Docket Number: 40-9075-ML

ASLBP Number: 10-898-02-MLA-BD01

Location: Rapid City, South Dakota

Date: Wednesday, August 20, 2014

Work Order No.: NRC-1008 Pages 921-1170

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NUCLEAR REGULATORY COMMISSION

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ATOMIC SAFETY AND LICENSING BOARD PANEL

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HEARING

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In the Matter of: : Docket No.
POWERTECH USA, INC. : 40-9075-ML
: ASLBP No.
(Dewey-Burdock In Situ : 10-898-02-MLA-BD01
Uranium Recovery :
Facility) :

------------------------x

Wednesday, August 20, 2014

Hotel Alex Johnson
Ballroom
523 6th Street
Rapid City, South Dakota

BEFORE:

WILLIAM J. FROEHLICH, Chairman
DR. RICHARD F. COLE, Administrative Judge
DR. MARK O. BARNETT, Administrative Judge

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9:00 a.m.

CHAIRMAN FROEHLICH: Good morning, all. We'll come to order.

The first item of business for today is the continuation of our discussion having to do with newly-acquired data. The Board is anxious to get an understanding of exactly what this data is and how this data is used or could be used in relation to the admitted contentions.

Since much of the discussion is going to revolve around geology and hydrology, I think we're going to rely a great deal on our expert witnesses, rather than the attorneys who are translating what they've been told. And to accomplish that, I would like at this point to ask the witnesses in Panel 2 to please rise. Raise your right hand. Do you solemnly swear or affirm that the statements you make in this hearing before the ASLBP will be true and correct to the best of your knowledge and belief?

And while we have you standing, do you adopt your pre-filed testimony as your sworn testimony in this proceeding?

The record will reflect the witnesses responded affirmatively to both. You may be seated.

Thank you, Ms. Henderson.

I'm only going to begin this inquiry, and you'll have to excuse me because I am only a lawyer by training. The Exhibit OST-19 is a press release that Powertech issued dated July 16, 2014. And in there it states that "the data that has been acquired by the company is historical drillhole logs and maps prepared by TVA from the '70s and '80s when the Dewey-Burdock uranium deposit was originally discovered, as well as digitized data generated from this work." To be complete, I'll finish the paragraph. "This data is expected to assist Powertech's planning of wellfields for the Dewey-Burdock uranium property, providing additional quality data to complement Powertech's existing database."

What I'd like to know, I suppose, is what are drillhole logs and how are they used in the industry? We have many qualified experts.

I'd like to hear from the Powertech witnesses. I'm not sure if Mr. Demuth or Mr. Lawrence wants to take the first shot at it.

MR. LAWRENCE: I'll take the first shot. I am Errol Lawrence. I have been a practicing hydrologist for about 25 years now. I wasn't expecting to testify on this particular issue, but I do have some background with the logs. I was a wireline engineer with Dresser Atlas in the late '70s and a wireline engineer basically runs the electric logs, although that was for oil and gas applications, but a lot of the principles are the same.

There's a wide variety of electric logs that can be run to evaluate subsurface conditions, reservoir conditions. Typically, in the uranium industry, it's a more limited sweep. We are looking at gamma ray logs, self-potential or spontaneous potential logs, and resistivity logs.

Gamma logs, as you might expect, measure natural radiation that comes from the formations around the borehole. Let me back up. The way logs are actually procured is typically when you finish drilling a well, you will lower an instrument down to the bottom of the well, and as you retrieve it, you detect -- you have instruments that pick up various responses from the formation, depending on what that instrument is. You can gather different physical characteristics about the formation.

JUDGE COLE: What kind of characteristics, sir?

MR. LAWRENCE: Some of them, for instance, resistivity measures literally the resistance of the formation to an electric current. A gamma ray measures the natural radiation that comes off the formation. Spontaneous potential measures the difference between the ground surface and the --

JUDGE COLE: You've got different instruments taking different measurements?

MR. LAWRENCE: Absolutely. Different instruments taking different measurements. What's important to note is the measurements themselves are not necessarily intrinsic measurements of lithology. It's the interpretation of that data, the signal that allows a geologist to look at a log and determine whether he's in a sand or shale or limestone sequences. So there's an interpretational stage now that goes beyond just gathering the logs.

JUDGE BARNETT: I understand that. Let me ask you, are you familiar in general with the data that we're talking about here?

MR. LAWRENCE: Yes, I am.

JUDGE BARNETT: What kind of logs are in that data?

MR. LAWRENCE: Okay, I was getting to that. The data that has been procured is similar to the data that's already been used. In fact, it's the exact same kind of data. It is the gamma ray log. It is the resistivity and some of the logs have the self-potential, not all of them, probably about half of them. And maybe --

JUDGE COLE: Self-potential. What does that mean?

MR. LAWRENCE: It measures the potential, the difference in electrical energy between -- usually, you have a ground probe and then you have a probe on the instrument. So it's just a relative difference. And typically, you're going to use a self-potential curve to identify lithologic differences, the difference between basically a sand or sandstone versus a shale or a clay. So it's very commonly used for that.

Gamma ray also is typically used to some degree, to a lesser degree for lithology definition or distinction. However, in the uranium industry, the gamma ray's primary role is to identify mineralization since it's measuring natural radiation, as you'd expect. If you run across a uranium mineralized zone, you're going to get a spike or a kick in terms of radioactivity. So that's the primary purpose that gamma ray logs are used for. And they're very good for that.

JUDGE COLE: So all of these different

instruments are on one probe that you insert down into the well. You do it separately.

MR. LAWRENCE: It depends. Sometimes there can be a series of instruments that are tied together. For instance, the gamma ray is a different instrument than the resistivity log. But a lot of times you can run them in sequence so it's a single run and that's most typically the way it's done. If you were running a more elaborate suite of logs, you might have to do several runs in the hole to get all the logs that you wanted to get. Yes.

I guess -- can I pull up an exhibit to show a log?

CHAIRMAN FROEHLICH: Yes.

MR. LAWRENCE: Okay, this is one of the exhibits, it would be APP-016(b) on page 27. And that's a type log, sort of a representative log that was included in the application, primarily for illustrative purposes. You might want to try and zoom in a little bit, the quality of that -- well, you're on the right page, but just if you could zoom in a little bit so we can see the lines on the log a little bit more clearly. Okay.

So the log itself obviously doesn't come with those horizontal lines that are indicating the different zones that have been identified out of this log. What you can see, the right hand most log is a resistivity log. And you can see the nomenclature on the right side where we talk about or show the Fall River formation, the Fuson member, and beneath that is the Chilson member of the Lakota formation.

And so you can see there are some distinct responses there as you go into different lithologic units. I'm not sure, I think the gamma ray -- if you can scroll down a little bit, yes, okay. So the gamma ray log is the one on the farthest right hand side -- left hand side, excuse me. I might have said the thing backwards. And you can see where you have a very large kick in that gamma ray log. I think that's gamma ray. Keep going down even further. Yes. Just above where we have the Morrison contact there, you see a pretty nice kick in that gamma ray log. And that's typically an indication of mineralization.

JUDGE COLE: And with that, you can get the depth of the deposit also.

MR. LAWRENCE: Absolutely, absolutely. And that's really the primary use.

JUDGE COLE: Primary location of it and how far.

MR. LAWRENCE: You got it

. Now a single log by itself doesn't really give you much information. If I just gave you that log you could look at it and say well, I can kind of see the depth of the ore. I can maybe pick the thickness of an interval, but where a log becomes valuable is when you have a lot of logs and then you can start to correlate them and demonstrate the continuity of your deposits, whether there are any breaks in that, basically the geologic dip. So you can get a lot of information, but it comes out of the interpretation of the logs and usually the more logs -- if you have quite a few logs in the area, then you can develop a better picture of what the subsurface looks like.

JUDGE COLE: So you have to know exactly where it's located starting at the surface, so that you can see how far they are apart and compare different levels and what's one level compared to another level.

MR. LAWRENCE: That is correct.

JUDGE COLE: You can pick out discontinuities maybe that way?

MR. LAWRENCE: Yes, you could, if they were present, you would see them.

JUDGE COLE: At a certain elevation at

this particular level it doesn't exist, so it went somewhere?

MR. LAWRENCE: Absolutely, yes, sir, Your Honor.

JUDGE COLE: Okay, thank you.

MR. LAWRENCE: One of the things to keep in mind is these are fluvial deposits. Most of my work was done where you had kind of marine deposits that are very extensive. They go for miles and they don't really change. In this case, things change very quickly locally. You can have some changes in the thickness of the sand bodies.

As you can see on that particular cross section, the Chilson has been subdivided into several subunits and the same thing with the Fall River and the upper portion of the log. They don't just look at well, this is Fall River and this is Chilson. They have enough control here to subdivide these into discrete sand packages.

JUDGE COLE: Why would you do that?

MR. LAWRENCE: Because the ore zones typically are fairly discrete packages. They might be associated with one small sand member out of that --

JUDGE COLE: You're trying to pinpoint the location of the uranium?

MR. LAWRENCE: Correct.

JUDGE COLE: Thank you.

CHAIRMAN FROEHLICH: Mr. Lawrence, I think you described two of the lines. Is the third line --

MR. LAWRENCE: That is the spontaneous potential.

CHAIRMAN FROEHLICH: Thank you.

MR. LAWRENCE: And depending on the environment, that particular curve can be very useful and other times it can be very frustrating because it depends a lot on how good of a connection you have of the surface and some other things. It's a more difficult log to -- it's not necessarily consistent from hole to hole like the gamma ray and the resistivity logs.

JUDGE COLE: You said spontaneous retention?

MR. LAWRENCE: Spontaneous potential.

JUDGE COLE: Oh, potential. Sorry, thank you.

MR. LAWRENCE: Also, it's commonly called a self-potential. You'll hear both terms used.

JUDGE BARNETT: Are these kind of logs, if interpreted by a qualified hydrogeologist, relevant to Contention 3, that is, whether or not there is adequate hydrogeological information to demonstrate ability to contain fluid migration and assess potential impacts to groundwater?

MR. LAWRENCE: The development of the geologic and hydrogeologic models are dependent largely on the logs, primarily the geologic model. And if I could call up another exhibit, to show you a map --

JUDGE BARNETT: I want to follow up. So I guess I didn't quite hear. Was the answer to your question yes, no, or something in between?

MR. LAWRENCE: It is yes.

JUDGE BARNETT: Thank you. Any other experts from Powertech that would like to answer that question? Is data like this available to a qualified hydrogeologist relevant to whether or not there's adequate ability to contain fluid migrations and assess potential impacts to groundwater?

MR. LAWRENCE: Can I add a little bit more since when you rephrase that question it popped in my head a little bit some additional information I'd like to put forth. The logs, the e-logs, they give us borehole data information about the geology. They don't tell us anything about the fluid properties of the aquifer. Wells will do that. When we put in wells and we measure water levels, when we conduct pumping tests, when we extract samples for water quality analysis, that's what gives us the hydrologic information. Together we combine those to come up with our hydrogeologic model. So by themselves, if I just had logs and nothing else, I wouldn't really know much about the hydrogeologic --

JUDGE BARNETT: But they would be part of something that would be relevant to helping you answer the question in Contention 3?

MR. LAWRENCE: Yes. They are and they have been used extensively. I can show you.

JUDGE BARNETT: Would any of the other Powertech experts like to answer that question?

MR. DEMUTH: Yes, sir. If I might, Hal Demuth. First, with all due respect, the relevancy issue, to me that has a legal terminology. So as the technical experts, if we could say useful, we might use that.

JUDGE BARNETT: I meant it in a technical sense.

MR. DEMUTH: Okay. Some of this discussion, there's a question of how much data are necessary. And so if I might talk for a minute about how much information do we need to make an informed decision?

In this case, there was information from over 1,800 wells that was used in the permit application. Data from those wells were reviewed by the NRC. They made a determination in the SER that it could safely be conducted. So as an example, if I may, if we're looking at a foundation design, how much geotechnical information do we need? Well, we need enough information to make the decision. Could more data be obtained than the data that were used for a decision? Certainly. Are they necessary or warranted? Well, in some cases they might be and in others they're not.

And so in this case, I would suggest that the information that Powertech used was sufficient for NRC to make a determination. And in addition, NUREG-1569 talks about a phased process of data accumulation.

JUDGE BARNETT: Okay, so now you're getting into legal things, so I want to ask the question as a hydrogeologist.

MR. DEMUTH: Okay.

JUDGE BARNETT: Is the data that is in these e-logs, if interpreted by a qualified hydrogeologist, could it be relevant to Contention 3?

MR. DEMUTH: In my professional opinion, Powertech has demonstrated that --

JUDGE BARNETT: That's not the question I was asking.

MR. DEMUTH: If I could continue, please?

JUDGE BARNETT: Well, if you could answer the question, and then you can explain your answer.

MR. DEMUTH: There's no more data that are necessary to support the application.

CHAIRMAN FROEHLICH: May I interrupt? I'd like to hear from Dr. Moran and what use or what information would be useful from these logs in addition to -- I suppose what we've heard is how Powertech is using this data. I guess I'm concerned with how others might be able to use this data. Perhaps start with Dr. Moran.

DR. MORAN: Good morning.

CHAIRMAN FROEHLICH: Good morning.

DR. MORAN: Let me ask a procedural question. When I start talking, this is automatically on?

CHAIRMAN FROEHLICH: Yes. In fact, it's always on, so if you want to talk or whisper, whatever, to your colleague there, you hit the off button.

DR. MORAN: Thank you.

JUDGE COLE: And hold it down.

DR. MORAN: Thank you. I'm trying not to be long winded with this. There are all kinds of reasons why these logs are relevant. And let's begin with something that Mr. Lawrence said. And it is simply not correct that these logs don't tell you anything about the water quality. That's just untrue.

These logs will tell you, especially when interpreted together, a great deal about the rock types, the depths at which the formations occur, sometimes where people interpreting logs encountered water, whether it was high conductivity water, meaning somewhat -- it contained high dissolved solids in it, low, etcetera. It can show you, depending on different kinds of logs because we don't really know what logs are there, they could show you whether there a currents, flow areas, fractures.

CHAIRMAN FROEHLICH: Can I interrupt you? May I ask Powertech are all these logs that have been discussed, are they all the gamma ray logs that Mr. Lawrence described?

MR. LAWRENCE: Gamma ray or resistivity and spontaneous potential. To my knowledge, there are no fracture-type logs, frack load or anything that would identify joints or fractures in the suite.

JUDGE COLE: Also, is this the same kind of equipment you use to determine where the water levels are and other things other than the three that are shown on the chart on the e-log? Do you determine where the water levels are by when you're drilling the well before you put instruments down?

MR. LAWRENCE: Yes and no. The logs themselves can give you an indication of where the water is because the resistivity log won't work when it's not in water. So when you first pick up a signal, you'll see the water level. However, that water level is usually not representative of static conditions because they've been drilling, typically with some type of a drilling mud and so the system is not -- that's not a true water level indication. That's a different type of measurement you would take later and hopefully in a well instead of a borehole.

CHAIRMAN FROEHLICH: Okay, I think we interrupted Dr. Moran.

DR. MORAN: I don't really know how far we want to take this. If I were in your position, I would have heard enough to know these are really useful. If you want me to go on, I will.

JUDGE COLE: What is really useless?

DR. MORAN: No, useful.

JUDGE COLE: Oh, useful.

DR. MORAN: I think that an independent group of investigators working with those logs could gain a great deal of information, especially if they integrated them with the information they've already got.

One last comment, they used these logs to create the basis for their computer model, for their cross sections, etcetera. We can talk a long time about this, if you like.

JUDGE COLE: They used the 1,400 logs that they used in their application?

DR. MORAN: If I'm correct, I think I heard Mr. Demuth say 1,800. And to put that in perspective, I've seen various Powertech documents saying that there are more than 4,000 up to 6,000 boreholes on the site. So it would be useful to know some more information from more boreholes.

JUDGE COLE: In your view, the 1,800 logs might not be enough to make the demonstration?

DR. MORAN: I think you'd have to look at the new data. Then you'd have to evaluate it. It's more data. Somebody -- TVA collected that information for a reason. They spent a lot of money to do that.

And if I could add one last thing. In my experience, when an operator purchases a property, they normally have all of these logs right from the beginning. They buy the whole package. They buy the maps that are available. They buy the logs, everything they can. If there were old feasibility studies, we know that in this case. Probably they would have been transferred years ago.

JUDGE BARNETT: I would like to follow up with Mr. Demuth if I could, please. Could you pull up APP-061(g), please?

Good. Just keep scrolling down. Okay, right there. Is this figure, and there are many figures like that in there, relevant to Contention 3?

MR. DEMUTH: Yes, they are.

JUDGE BARNETT: Was this figure constructed, at least in part, from the kinds of data that we're talking about now?

MR. DEMUTH: Yes, it was. In fact, this figure demonstrates that NRC had requested some more level of detail in certain areas and so there was some cross sections that were constructed. Those cross sections do have the electric logs which are shown.

I might add that of these new data that are in the point of discussion, the discussions with

Powertech, only 200 of those logs apparently are new, new information. Twelve hundred of them, they had logs on a reduced scale that they already have in their possession. So I think it's important to understand that in terms of distinctly new information, I think that may be somewhat of a misnomer. There's some additional data. But again, the data density, if I might, 1,880 data points that were used for the application on 10,580 acres is an average of 113 logs per square mile. Obviously, the distribution of those data points is not equal across the site because the focus was on the areas where the ore exists.

These new data are also focused on the area where the ore exists, so there's even more data density. So if 113 logs on average per square mile are not sufficient, how many do you need?

CHAIRMAN FROEHLICH: What use has the Staff made of well logs in the review of the Powertech application? I don't know which Staff witnesses are best able to answer. Mr. Lancaster or Mr. Prikryl?

MR. PRIKRYL: Sir, we used the electric logs -- the electric logs were used to create the isopach maps, the structure maps, the cross sections that were included in Powertech's application. So we reviewed -- in this case, for instance, the cross sections here, we reviewed to make sure that these e-logs were representative of the entire suite of logs that were -- that Powertech used. So we tried to determine whether the density of data was sufficient for our review and to come to a conclusion whether we could do our analysis. And so we determined from the density of data that was provided in the application that we were able to do an assessment under NEPA.

CHAIRMAN FROEHLICH: Just so I'm clear, the density of data, so that first, the data that you reviewed is representative of the data that they had. And then is it representative of the area to be mined?

MR. PRIKRYL: Yes. We looked at the locations, of course, of the electrical logs first to determine if there was an adequate density covering the ore zones.

CHAIRMAN FROEHLICH: And I think you had said that you used the well log data to prepare or confirm isopach maps and something else. Tell me how this data was used by the Staff?

MR. PRIKRYL: Well, what we did was we determined from our guidance, we looked at our guidance to determine if the Applicant had submitted sufficient information to do our analysis. Based on our review, our review procedures, we determined that the Applicant, in our acceptance criteria, we determined if they had submitted the adequate information to do our assessment.

JUDGE COLE: Is that principally based on the number of logs per square mile?

MR. PRIKRYL: No, I don't think it would be based on that.

JUDGE COLE: Did you review very many of the logs yourself?

MR. PRIKRYL: We reviewed the logs that were, for instance, here in the cross section. We reviewed those logs.

JUDGE COLE: But they were taken from a larger group of logs selected as being representative of the others. Is that correct?

MR. PRIKRYL: That's right.

JUDGE COLE: Now of the 1,880 different logs, I had mentioned 1,400, but I misspoke there. Thanks for correcting me there. Of the 1,880 logs, were all of those drilled by Powertech or is that information from other sources?

MR. PRIKRYL: My understanding is that they all came from Powertech.

JUDGE COLE: But did Powertech drill these holes and where did they get the information?

MR. PRIKRYL: These are TVA logs. That's my understanding, they're TVA logs. So they purchased them or acquired them from TVA.

JUDGE COLE: So this was not the 4,000 logs we're talking about today that they purchased. These are other --

MR. PRIKRYL: It's a subset of those logs.

JUDGE COLE: A subset of those logs?

MR. PRIKRYL: Yes. So the 1,800 logs that Powertech has in their possession were used to -- in the application are a subset of the 4,000 logs that we're talking about today.

JUDGE COLE: Okay, thank you.

JUDGE BARNETT: I don't have any more questions about relevance to Contention 3. I did have a question about relevance to Contention 2 which had to do with baseline groundwater quality.

Mr. Lawrence, you stated that you did not get water quality information from these logs, is that correct?

MR. LAWRENCE: Well, one slight correction, with an SP and a resistivity combined, you can come up with sort of general conductance of the formation. But it's not like a laboratory analysis where you would have a definitive number that you would hang your hat on or a defensible number because the SP fluctuates enough where you can get sort of, I guess, order of magnitude changes in water quality based off of that for conductivity, if that makes sense.

JUDGE BARNETT: Dr. Moran.

DR. MORAN: It's incredibly useful. It gives you vertical variations in the general water quality of the water entering from the different horizontal levels. And then when you start comparing those through time, I'm sorry, through space in neighboring boreholes you can start seeing patterns.

And if I might add one other thing and I've said this in my written testimony, when these various investigators were doing aquifer tests, if they had been doing the same kinds of resistivity measurements, they would have learned a lot about the interpretation of their tests. So what I'm saying is yes, in this borehole information you can get a lot of ideas about water quality.

JUDGE BARNETT: You say a lot of ideas, so you can get salinity or conductivity, TDS?.

DR. MORAN: Yes.

JUDGE BARNETT: Anything else?

DR. MORAN: And then when you tie it to the condition of your other logs, you are, of course, getting information on natural radioactivity in your gamma logs. Again, we don't know. They may have other logs in here, too. But they're interpreted in combination. They're usually not interpreting one set of logs by themselves.

Could I suggest one thing? We submitted a PowerPoint presentation that I was to give last year at the state hearing, to you people. I assume it's an official exhibit. I only wanted to show one slide from it. Is there an easy to bring that up? I don't know what its OST number is.

MR. PARSONS: Excuse me, that would be OST-005.

DR. MORAN: On my copy, I'd like to show you the 20th slide, number 20, if you can just skim down. That's the one. And maybe make it a little bigger.

This is a Powertech document. I would come back out a little bit so we can see the box. Basically, what this is showing is the drillhole map. Again, I don't know how many of all of these drillholes this represents. Is it the 1,800? Is it the 4,000? Is the 6,000? But my point of bringing it up is look at the distribution. It's mostly in a few areas. That's normal because as they've said they're focusing on the uranium. But if we're looking at overall hydrogeology, wouldn't you want to know something about the intervening areas? And therefore, wouldn't it be useful to see what's in these new logs?

MR. DEMUTH: Your Honor, might I add to that if I could? And I appreciate having this figure up there because I would like to imagine that we have data from approximately 1,500 points here. And what the dots on the map represent is locations that Powertech is aware that there were historic holes drilled. From that, there's approximately 1,800 that were used to assess the site geology. And then there are some additional data which they did not have in their possession, but they were aware that there was a location and a well drilled at that location.

So in this case, as I mentioned before, approximately out of the 1,400 new logs they've received, 200 of them are actually new data. So if you could, look at this map and say the focus of those would be where the ore is because it's for wellfield development. So pick out 200 points in that map and say what more does that tell us?

JUDGE COLE: Mr. Demuth, could you review how you got the 200 from 4,000?

MR. DEMUTH: The 200 is based on discussions with Powertech this morning. Out of the data set in question here or what's referred to as the new data, that approximately 1,400 of those data set or well logs have been attained and only 200 of those are truly new data points. They had data previously for those points anyway.

So again, if you pick out 200 locations in the data density here, does it tell the operators some new information? Yes, it tells them information about the concentration of uranium and wellfield development.

If I could also follow up on Dr. Moran's statement, the logs in question are single point resistivity. We don't have a deep medium shell induction log on which we can really do accurate calculations for salinity.

As Judge Barnett had asked about, can we calculate salinity concentrations? Well, to do that from a resistivity log, first of all, we need a porosity log which we don't have. If we're going to use Archie's equation to calculate salinity from a resistivity log, which is the normal way of doing it, it's a function of porosity squared. So we can't make that calculation from especially these logs. They're single point resistivity and we don't have porosity logs either.

So I would submit to you that the best data for water quality are from the monitored wells that are actually sampled.

JUDGE COLE: For future.

MR. DEMUTH: Well, the logs that were included in the application where we actually have distinct monitored wells that were sampled and we have real samples and analytical results from the lab.

JUDGE COLE: As part of the application?

MR. DEMUTH: Yes, sir.

MR. LAWRENCE: Can I make a clarification because we're getting confused with numbers a little bit. The initial package of the new data that Powertech has received included 1,400 logs. Those logs are all concentrated in the area of the first proposed Burdock wellfield. Out of that 1,400, there were only 200 new data points.

And if I could pull up one map to show you the density of data, can you go back to that APP-16(d) and it would be the next to last figure on that. Not 16(d), I'm sorry. Hold on one second here. 15(d), page 18. I apologize. I think it's just above this figure right here. That does not look like the right figure. Page 18, I'm sorry. Keep going down. Can you go back to the side where we can see the -- I apologize.

JUDGE BARNETT: Which exhibit are you looking for?

MR. LAWRENCE: It's the Fuson isopach map.

JUDGE BARNETT: Which exhibit is it in?

MR. LAWRENCE: It's --

MR. PUGSLEY: It's APP-015(d) as in dog.

CHAIRMAN FROEHLICH: Thank you, counselor.

MR. LAWRENCE: Yes, that's the one right there. Okay, if you kind of scroll down to the lower portion and you see in the box there, that's the first proposed Burdock wellfield. And the inset on the lower left-hand side is a blow up of that. And if you shoot in even more, you're going to have to really zoom in on that area. And what you're going to see is -- keep zooming in. Keep going.

Okay, those are values. Those are data points that were used to construct this map. And you can see from the density there that you have an awfully good control for an area. A lot of those borings are less than 100 feet or approximately 100 feet apart. And what they do is they follow the ore zone.

I know Dr. Moran said yes, we like to know what's going on outside the ore zone, but really it's within the wellfield that's the concern of a potential fluid migration, subsurface movement of fluids. We have incredibly dense control already. Adding a few more points in there is not really going to improve our picture. We've already got an abundance of data in the area of interest, in the area where injection and extraction is going to occur. And for -- I've been on several license applications. This amount of data far exceeds what I've seen in previous license applications. So I don't really see the relevance of adding additional data into this for licensing this site.

Once they get ready for production, they will have even more data points within that area. They will conduct pump tests. They will have a monitoring well around the entire wellfield, monitoring points above and below. So the additional data is still to come. That's the phased process for conducting ISR.

I know Dr. Moran thinks a couple of guys could knock out something pretty quickly. These maps have been in progress for about six years by a geologist who has spent most of his life working this data and understands these types of formations and these types of roll-front deposits very well. But it's not something that's very easy to do. It takes a full time dedicated geologist to develop this information. That's why the NRC, they only review portions of that, particularly in areas that are contentious or in this particular instance they also wanted to see the Fuson isopach map. They requested the data and generated their own maps and were able to reasonably replicate what Powertech has done.

So again, more density, yes, I'm a scientist. I always want more data. But at the same time, when do you stop? This process is going to continue on. They're going to continue to collect more data throughout the entire production of the project.

CHAIRMAN FROEHLICH: Let me ask you just a couple of questions. Not on the data itself, but in the way it currently exists. When we're talking about 1,400 well logs, are we talking about paper well logs at this point or how many of them have been digitized?

MR. LAWRENCE: Many of them have been digitized, but most of them are still in paper format. I have some examples I would be happy to share with you, although they're not technically exhibits since we didn't know that this was an upcoming event. I can show you what the digitized version looks like in the logs.

CHAIRMAN FROEHLICH: Where are the paper logs currently?

MR. LAWRENCE: I couldn't tell you that. It's in Powertech's possession. The portion of the original -- they haven't received all of the data at this point.

JUDGE COLE: Which is it easier to work with, the digitized or the paper?

MR. LAWRENCE: Depends on your age. I kind of like paper, but nowadays, we're going more and more toward electronic format for everything and probably will be used --

JUDGE COLE: For comparison purposes with other logs would the digitized be a much easier way to compare them?

MR. LAWRENCE: Not necessarily. I know most people who are skilled at correlating logs typically will still slide logs, you call it. You place them side by side and adjust them and see where your zones are lining up.

JUDGE COLE: You just roll out the papers and compare them?

MR. LAWRENCE: Yes. I've tried to do it electronically on some programs. I find it frustrating. I go back to the paper.

JUDGE COLE: I understand. I think for purposes of the motion to -- whether these documents are discoverable or not, I don't think there's any serious question or if there is I'm sure counsel will tell me that this data is either useful or relevant to Contention 3 based on what I've heard from our gamma geological experts this morning. Is there any doubt that this is relevant or relates to the conditions that affect the ability of various layers to confine liquids to address the issues that are before us in Contention 3?

MR. PUGSLEY: Your Honor, thank you for the opportunity. I think one perspective that is lacking in the evaluation here is what -- when we say is it relevant to Contention 3, it is what is Contention 3? Contentions in this proceeding and the issues before the Board is whether or not the information in the record of decision to characterize the Dewey-Burdock site pursuant to 10 CFR Part 40, Appendix A, Criterion 7, requirements for baseline data, is satisfied.

This data we have said in our pleadings, dated August 12th, and we said yesterday, that the relevance of this data, what is it relevant to? This data is relevant to the development as has been cited in OST-019 which is the press release. It says in there to the development of wellfields, okay? We are not as a -- when we were a license applicant, we're not allowed to develop a wellfield. We are prohibited from doing that lest we run the risk of denial of our license under 10 CFR 40.32(e) or otherwise known as the construction rule.

So therefore, we are required by regulation and guidance to submit adequate site characterization data which, as you heard from NRC's experts, was deemed adequate after, and I'd like to supplement that answer which is after the application and the responses to their requests for additional information, where they did request additional data of this type.

What this data that we have acquired is relevant to is as it says in the press release, the development of wellfields which is done post-license issuance, but pre-operations. Pursuant to the Hydro Resources case, the Commission determined under its policy of performance-based licensing that wellfield packaged data, the data itself and what is in there and what is looked at by NRC Staff in their pre-operational inspection before you quote unquote flip the switch on the operation, is not subject to litigation.

What is subject to litigation in this proceeding, especially under Contention 3 is the procedures that Powertech proposes for the development of those wellfields which includes the use of data such as this. That is subject to litigation.

However, I can find nowhere in the Consolidated Intervenors' or the Oglala Sioux Tribe's pleadings where they have challenged those procedures. So as far as Powertech is concerned and the reason we deemed this not to be relevant to Contention 3 is because what it is relevant to per Commission precedent is not subject to litigation in this proceeding regardless of how Contention 3 is worded.

If the Tribe and Consolidated Intervenors wish to state that additional data, NRC Staff should have gotten additional data to render an initial licensing decision on site characterization pursuant to Criterion 7 and NUREG-1569, Chapter 2, they are free to do so and in fact, they have. And that is fine. Our experts are prepared to deal with that issue in your questioning of Panel 2 that is soon to come. But we made a determination that it was not relevant for the very reasons that we just stated. So that is our position.

JUDGE BARNETT: Can I ask you a hypothetical?

MR. PUGSLEY: Yes, sir.

JUDGE BARNETT: You go out to a site and you want to characterize it and you take 100 data points. Your experts decide they only need 80 to develop the license application. The Staff reviews it. They're okay with that. But those other 20 points, even though you didn't use them, are in your possession. Are those discoverable?

MR. PUGSLEY: No, they are not because they were not used to characterize the site. And I think you made a very important point, Judge Barnett, which is it's not just that Powertech's experts and the hypothetical would have determined the 80 data points to be adequate, the reviewing expert agency determined them to be adequate under Commission regulations. So as far as we would be concerned, those 20 data points, would they be used at the end of the day before we flip the switch? Yes. But they would be used in the wellfield package that is developed post license issuance, along with other drilling that we would be required to do because as our experts stated, you can't get a full picture of what's there until you actually put in a wellfield with a complete monitor well ring, which as I said before, we're prohibited from doing.

So to answer your hypothetical, Judge, will those additional 20 data points be used? Yes, but not for purposes of an initial licensing decision which is the subject --

JUDGE BARNETT: Are they discoverable? That's my question.

MR. PUGSLEY: I don't believe they're discoverable because they're not relevant to a contention on an initial licensing decision.

JUDGE BARNETT: I'd like to ask Mr. Clark the same hypothetical. The Applicant goes out, takes 100 samples. They only use 80 of them in developing their application. The Staff says the 80 are fine. But there are 20 additional data points that they have in their possession. Are those discoverable in a contention -- in a hearing?

MR. CLARK: Based on Mr. Lawrence's statements, the Staff wouldn't object to the claim that they're relevant in some way or useful in some to the Staff's findings. Again, I agree with Mr. Pugsley that the focus should be on the analysis in the Final EIS when it was issued in January of 2014. If the Staff had these data, they would conceivably considered them. So the Staff doesn't object to a finding of relevance in some limited sense or some potential, that there's some potential use of these data to support some of the claims the Intervenors made in Contention 3.

JUDGE BARNETT: Thank you.

JUDGE COLE: But it's the Staff's view that they had received sufficient information to justify the issuance of a license based upon their reading of the requirements?

MR. CLARK: Correct. The Staff is confident they had enough information to make the findings on hydrogeology in the Final EIS. The Staff would also note that as Mr. Pugsley explained and as Mr. Lawrence explained, new information continuously comes in. There's new information now. There will be new information months from now, new information a year from now. The Board's role is to rule on the contentions that were admitted and if the Board continues to wait for new information, there will never be any resolution to this hearing.

JUDGE BARNETT: Well, my hypothetical was specifically for data that is in hand now.

MR. CLARK: Correct. And Your Honor, did I answer your question?

JUDGE BARNETT: Yes, you did. Thank you.

CHAIRMAN FROEHLICH: But in your answer, Mr. Clark, the Staff, as well as the parties are under a continuing obligation to disclose data, not that the people are waiting for data, but to disclose data that's relevant to the contentions up to and including the time that the Board issues its decision. Is that correct?

MR. CLARK: That's correct, Your Honor, although they may also -- in this case, they would likely not disclose any data, but log the data as privileged. And depending on the Board's views, the Staff would also like to discuss, although perhaps not now, the form of disclosure. We're talking voluminous data that could only be reproduced, according to Mr. Clement's affidavit, at great cost. And I think under the NRC's rules at 10 CFR 2.336(a), those take into account the difficulties and the costs and time of reproducing certain data. So I submit that for another issue the Board may want to address.

CHAIRMAN FROEHLICH: But should they be

found relevant to the contentions, they would be made available. We would have to determine under what terms and perhaps a confidentiality agreement because I guess some of this data is proprietary and business related. There would have to be restrictions, I'm sure, as well.

MR. CLARK: It would also be consistent with Commission precedent and federal case law to provide an opportunity to view the exhibits rather than requiring Powertech to reproduce the exhibits for the convenience of the Intervenors.

CHAIRMAN FROEHLICH: That may be one way to handle it, thank you.

From the Intervenors, would you care to be heard as to the scope of your contention and the characterization by the Applicant?

MR. PARSONS: Sure, Your Honor. That's a new argument being made here and so it's -- without having dissected it a little more carefully, I'm not sure I fully grasp, it seemed to me, very subtle distinctions Mr. Pugsley was trying to make. Our contention pleadings clearly discuss the inadequate characterization based on inadequate data and now we have data that we're finding out exists not just as newly-acquired data, but apparently there's additional borehole logs that were not used in the application that were not disclosed. Presumably, that's part of the information that I referenced yesterday that was included in that motion on Saturday. But I think any fair reading of the pleadings includes within this contention components of lack of adequate data to characterize, adequately characterize the hydrogeology.

I think Mr. Pugsley's characterization of our contention is off-base. I would be happy to brief it in a much more formal manner and comb through all of our pleadings and point out specifically for the Board where we make those points, but I don't think that's necessary. I think that as the Board has already indicated, the relevance question which is not a high burden in these proceedings has been overcome.

CHAIRMAN FROEHLICH: Okay. Any further argument on this from counsel?

MR. PUGSLEY: Your Honor, just one additional point. And certainly counsel for the Intervenors can feel free to weigh in on this. I know I've been working in this business as counsel for over 13 years and my co-counsel has been in for close to 3 times that much. Our experts have already told you their qualifications. Unless any of these people I've mentioned would like to contradict what I'm about to say which they can feel free to do, I am not aware of any ISR license application and subsequent record of decision where an applicant or a licensee who is seeking an amendment for a satellite wellfield was ever required to disclose every single electronic log they had because it's not, as I said previously, what was necessary for an initial licensing decision under Commission regulations. That is basically how this is done under the regulatory program. So I would respectfully submit that point as well.

CHAIRMAN FROEHLICH: It appears that these documents, these logs are relevant, to use the legal term, or would be useful to use the geological term, to people who are trying to characterize a particular site, to submit with their application support of a position that it would be contained, it wouldn't contained. There's connection, there's not connection. It seems like the data that would come from these type of logs would be relevant to questions that are contained in or subsumed in Contention 3 and therefore, applying the Commission's rules on disclosure, all parties are required to disclose any and all documents and data, compilations in their possession, custody, and control that are relevant to those contentions.

Now I fully appreciate that this data set is voluminous, would be expensive to duplicate, but I am of the opinion and the Board has concluded that it is relevant in a legal sense to the issues in Contention 3.

I don't know and I don't think anyone can know until they've had a chance to look at this whether it supports the conclusions that the Staff reached when it viewed the initial tranche of data or whether it contradicts or provides additional support for the position that the Intervenors advocate that the sites are not well suited for the proposal and that there's communication between various strata.

What we need to do is move forward with our cross examination today. But in addition, set up some opportunity for this data to be viewed by all parties to the case so that they may draw whatever conclusions, both supportive or in opposition to the positions they've already taken in the record of this case. We'll provide an opportunity in the very near future for them to file supplemental testimony, if necessary, either supporting that position or elaborating on positions already taken, not to expand the contentions, because then it would be, as Mr.

Clark pointed out to me yesterday, a new contention, an amended contention. But in the context of the contentions that we have before us, the Board finds that this data is relevant and must be disclosed.

I had asked one of the witnesses this morning where it is physically located. I think that it should be made available wherever it is and the digitized data to the extent that can be reviewed efficiently. I would hope that the parties would be able to come to some conclusions, some kind of resolution on how this could be viewed or how the electronic data can be viewed.

I also would be willing to use the protective order that we have already in place or to amend it as may be necessary to protect this data from disclosure beyond the purposes of this case.

Mr. Pugsley?

MR. PUGSLEY: Judge Froehlich, a few things, if I may, because obviously we'll be the disclosing party.

CHAIRMAN FROEHLICH: Right.

MR. PUGSLEY: One, I'd like my objection to this ruling noted for the record. Secondly, if it would help the Board, I believe Powertech is going to discuss the term how a disclosure is best accomplished for the Consolidated Intervenors and the Tribe. And prior to the cross examination of Panel 3 tomorrow, we would be happy to provide you with a report on potential options for how this can be done. And I think that's it.

CHAIRMAN FROEHLICH: Okay. Yes, Mr. Ellison.

MR. ELLISON: I guess I would like to get an understanding better than I have. It was my understanding that the data that we're talking about was not 1,400 or 1,800 or 200, that we were talking about the purchase of all of the TVA borehole data. And I'm hearing a lot of different numbers. And I would respectfully request that Powertech give a definitive statement as to the number of drilling logs and maps and what not that they have acquired and also why they didn't get the rest if they didn't get the full number. Because what I'm concerned about is that as Dr. Moran said, this data is usually acquired when the property is acquired. And now we're finding out that it's apparently not the 4,000 to 5,000 which would be the overwhelming majority of the holes.

Powertech made a commitment to the NRC, according to NRC communications, that they were going to locate and plug all the boreholes. So it seems illogical to me that that could be accomplished by purchasing less than half or maybe a third of the data. So can we get some kind of an understanding as to the number that was actually acquired and why the rest was required, if it wasn't?

MR. PUGSLEY: Yes, Your Honor. I find Mr. Ellison's request acceptable for a statement of what this quote new data is about. We will provide that tomorrow for you.

Secondly, noting for the record that when we're talking about the number 6,000 boreholes at this site, the location of those were disclosed in the license application. So I don't think that's an issue here, but in terms of Mr. Ellison's request for a statement, that's perfectly fine.

MR. ELLISON: May I add? Thank you, Your Honor. May I add just one thing? I guess for the purposes of the record, I would, on behalf of Consolidated Intervenors, want to object to inquiry on Contention 3 until we have an opportunity to look at this data because unless what the Board is suggesting by a procedure, not only would there be potentially supplemental testimony, but a supplemental hearing whereby there would be examination. I guess I would object.

CHAIRMAN FROEHLICH: Your objection is denied. We're going to go forward with the cross examination of Panel 3. You will have access to this additional data and any subsequent data of like as it becomes in the custody and control and possession of Powertech and to the extent there is information in that data that causes you to file a new contention or to amend an existing contention, you have that right, keeping in mind the Commission's burdens.

However, we will have a deadline or a date for additional testimony that would either support, supplement or maybe nothing will come of it. I can't tell at this point, but we will put in an opportunity after we get a feel for how long it will take for them to get it together and for you to look at it. Have your experts go through it. If, after your examination of that material it changes anything in what you have already filed and what we have already cross examined, you'll have the opportunity to file additional testimony on this existing contention. And we'll take it up as we have. But we'll go forward with the examination on Contentions 2, 3, and 4 today.

MR. PUGSLEY: Your Honor, may I respectfully request a 15-minute recess?

CHAIRMAN FROEHLICH: That's fine.

Granted. We'll reconvene in 15 minutes and we'll start with the cross examination of Panel 2.

MR. PUGSLEY: Are there going to be opening statements as well?

CHAIRMAN FROEHLICH: Yes.

MR. PUGSLEY: Thank you, sir.

CHAIRMAN FROEHLICH: Absolutely.

(Whereupon, the above-entitled matter went off the record at 10:06 a.m. and resumed at 10:28 a.m.)

CHAIRMAN FROEHLICH: We'll be back on the record.

We have now Panel 2 before us, which covers Contentions 2, 3 and 4. We'll begin with opening statements on these three contentions from each of the parties. Please limit your statement to about five minutes, and then we'll proceed with cross-examination of these witnesses. I believe with Panel 1 we had Staff go first. How about we go first with Powertech today?

MR. PUGSLEY: Thank you, Judge Froehlich. May it please the Court, for Panel 2 today Powertech's approach to site characterization of groundwater at the Dewey-Burdock project is consistent with NRC Regulations at 10 CFR Part 4 and Appendix A criteria as implemented under the Atomic Energy Act of 1954, as amended, and NRC Staff's guidance at NUREG-1569, which is Exhibit NRC 013, which represents Staff's expert interpretation of the Commission's Regulations as delegated to under 10 CFR Part 1.41(b)(18) and (19), and "NRC Office Manual," Chapter 0124 at 0321.

With respect to Contention 2, Powertech's license application in the Record of Decision contains more than adequate baseline groundwater quality in accordance with NRC Regulations at Part 40, Appendix A, Criterion 7, and Commission guidance at NUREG-1569, Chapter 2.

A fundamental legal question that sets the stage of Contention 2 is how the Commission's ISR Regulatory Program addresses two stages of groundwater quality data and analysis, the first being the aforementioned Criterion 7, baseline groundwater quality for initial licensing decision and Criterion 5(b)(5), Commission-approved background post-license issuance and pre-operational.

As a general matter, Criterion 7, baseline groundwater quality, is all that is required for an initial NRC licensing decision such as the grant of license SUA-1600. For Criterion 5, Commission-approved background, a license applicant submits procedures for how additional groundwater quality data post-license issuance are obtained and submitted to NRC Staff for review prior to the commencement of operations. Such procedures are implemented by license condition; in this case, license conditions 10.10, 11.3 and 11.4 in NRC Exhibit 012. Criterion 5, Commission-approved background, can only be determined after an entire wellfield, including monitor well network, is installed, which, as stated earlier today, is not permitted under the Commission's construction rule at 10 CFR Part 40.32(e).

As stated previously, NUREG-1569 guidance, the Staff's expert interpretation of ISR Regulations is delegated to them by the Commission. License applicants and their consultants follow this guidance as it defines what is expected of a license applicant in order to satisfactorily satisfy Commission requirements for a license. With that said, Powertech's license application provides more than adequate groundwater quality data.

Powertech submitted this data to reflect site characterization of groundwater at the site at the time of application submission, which is what is required by Commission Regulations. Powertech's characterization of this actually went beyond what is required in the guidance. And as a standard practice, license conditions are imposed to require additional groundwater data.

NRC's FSEIS also addresses many of these issues and other additional issues including, for example, potential cumulative impacts related to the Black Hills Army Depot and other past, present and reasonably foreseeable actions, including mining operations. This approach to pre and post-license groundwater quality data and analysis is explicitly endorsed in Commission precedent in the Hydro Resources case. Two sample citations: LBP 05-20 and CLI 0601. Issues associated with this contention will be addressed by Powertech's experts, Mr. Hal Demuth and Mr. Errol Lawrence.

With respect to Contention 3, the same arguments apply as we just articulated in Contention 2 from a legal perspective regarding Criterion 7 and Criterion 5.

Major points of contention in this contention involve potential presence of unplugged boreholes, breccia pipes, faults and/or fractures at the site. These issues have been addressed in the license application and the Record of Decision through extensive research of site-specific reports, discussing such features and on-the-ground studies to determine if they are present. However, Powertech does submit that this does not preclude post-license data gathering and analysis to address these issues, however, it is done post-license and is not subject to litigation in this proceeding.

Opposing counsel have failed to offer any concrete data studies or analyses that show any of these features are present at the Dewey-Burdock site or will not be dealt with prior to the commencement of the operations. Again, issues associated with this contention will be addressed by Mr. Hall Demuth and Mr. Errol Lawrence.

With respect to Contention 4, Powertech's license application and the Record of Decision adequately address groundwater quantity consumption issues and potential impacts associated with that issue. Major issues in this contention include net groundwater extraction rates during operations and restoration, potential local and regional impacts to private supply wells and water balance.

With respect to extraction rates, Powertech supplied its projections for these rates based on typical ISR processes and in accordance with

NUREG-1569 guidance such as the continuous recirculation of native groundwater with only a one-and-a-half to three percent bleed rate, water disposal via class 5 underground injection control wells or land application and typical restoration rates using commonly accepted water treatment processes such as reverse osmosis.

Project extraction rates are also compared in our expert testimony to a typical center pivot system used for irrigation, which was provided for as an analogy. Opposing testimony completely mischaracterizes the groundwater consumptive use at the project over the life of the project, which is demonstrated in our expert testimony.

With respect to potential local and regional impacts of private supply wells, opposing counsel did not offer any concrete evidence that Powertech's license application and NRC Staff's FSEIS analyses and Record and Decision do not adequately address this issue. Powertech's license application has a comprehensive numerical groundwater model that fully supports its conclusions and NRC Staff's conclusions.

And finally, with respect to water balance, both Powertech's license application and the

Record of Decision provide detailed discussions and analyses of the water balance at the time of the application, including all necessary input and output parameters such as production and re-injection rates, bleed rates, waste water disposal rates and other factors associated with both operations and restoration, and issues associated with this will be addressed by Powertech's witnesses, Mr. Demuth, Mr. Lawrence and Mr. Doyl Fritz.

The last point I would like to make, if I may, is as has been stated in several of our pleadings at no time during this proceeding did Consolidated Intervenors or the Oglala Sioux Tribe attempt to migrate their contentions from Powertech's license application to the NRC's safety evaluation report detailing the safety review of Powertech's license application and RAI responses. Thus, those conclusions in that document are not subject to litigation in this proceeding. It is important to note that many of those conclusions that are not subject to challenge are inextricably linked to the conclusions rendered in the FSEIS. We respectfully request the Board take that into account when rendering its decision.

And thus, in conclusion I would say

Powertech's position is with respect to Contentions 2, 3 and 4 that this Board should find that none of those contentions constitute ground for modification of the Record of Decision or Powertech's NRC license. Thank you.

CHAIRMAN FROEHLICH: Thank you, Mr. Pugsley. Commission Staff?

JUDGE BARNETT: Actually, I have a question for Mr. Pugsley, if that's okay.

CHAIRMAN FROEHLICH: Oh, please. Please.

JUDGE BARNETT: Mr. Pugsley, so make sure I understand. Is it your position that satisfying all the requirements of NUREG-1569 will automatically satisfy all the relevant requirements of NEPA and 10 CFR Part 40?

MR. PUGSLEY: Yes, it is our position.

JUDGE BARNETT: Okay. Do you have any citations or authority that binds the Board to that conclusion?

MR. PUGSLEY: I do indeed, Your Honor. In NUREG-1569, which was a document issued for public comment on two occasions, there was a response to comments in there that addresses this issue, if I'd be maybe given a moment, or I can provide the citation to you later, whichever is easier.

JUDGE BARNETT: That will be fine, if you would like to do that.

MR. PUGSLEY: All right. Thank you, sir. I will provide that to you at the end of opening statements.

JUDGE BARNETT: Thank you.

CHAIRMAN FROEHLICH: Okay. Thank you.

Mr. Clark?

MR. CLARK: As the Staff explained in its written testimony and as it will explain further today, the Staff thoroughly considered the baseline quality of groundwater in the Dewey-Burdock area, the hydrogeology in the area and the amount of water Powertech will use during the Dewey-Burdock project.

The Staff's witnesses on all contention are Jim Prikryl, a geochemist and geologist, and Tom Lancaster, who's the hydro-geologist. Both Mr. Prikryl and Mr. Lancaster have extensive experience in their fields.

The Staff's findings draw support from the extensive information it considered during its review. This includes the information Powertech submitted with its application. This also includes significant new information that Powertech submitted in the Staff's numerous requests for additional information. The

Staff found that Powertech's application, including the RAI responses. met the NRC Standard Review Plan for in situ recovery applications. That's NUREG-1569, which Mr. Pugsley referred to. And in the record that's Exhibit NRC 13. This is the NRC's guidance for determining whether an applicant has met both the safety and the environmental findings necessary for the Staff to issue a license.

Now, the Intervenors argue that Powertech needs to provide more information in several areas, but particularly baseline water quality and hydrogeology. There are two important points, however, that the Board should keep in mind.

First, the Standard Review Plan acknowledges that it's appropriate for an applicant to submit certain information after it receives a license. This includes certain information relevant to both baseline water quality and hydro-geological confinement. In other words, this information doesn't need to be included at the pre-license stage.

Second, and as Mr. Pugsley noted, the NRC's commission has ruled that this approach complies with both the Atomic Energy Act and the National Environmental Policy Act. The best example is the case which Mr. Pugsley cited, the January 2006 decision in Hydro Resources. And I'm referring to pages 5 and 6 of that decision. I don't know the NRC volume, but it's the first decision, so it begins at page 1 of that volume.

As the Commission further explained in Hydro Resources, it's appropriate for the Staff to use license conditions to require a licensee to submit additional information on water quality in aquifer confinement after it receives a license. In this case I'll mention the NRC's license that the Staff issued to Powertech is Exhibit NRC 12.

In this case, again as Mr. Pugsley mentioned, one of the more significant license conditions is License Condition 10.10. This condition requires Powertech to submit more information on baseline water quality and also confinement. Powertech needs to submit this information before it can begin operations in specific wellfields. Now, License Condition 10.10 lists 11 specific types of information Powertech needs to provide. In this proceeding, while the Intervenors object generally to the use of license conditions to gather more information, they fail to specifically challenge the sufficiency of License Condition 10.10 and they fail to address specifically those 11 data sets that

Powertech will need to submit in the future.

But also note that apart from License Condition 10.10, Powertech's license includes numerous other conditions that are relevant to protecting groundwater. For example, License Condition 10.5 requires mechanical integrity testing of wells. Condition 10.6 describes the groundwater restoration process and all the steps that Powertech needs to follow to restore the groundwater in the aquifers. Condition 11.5 requires Powertech to monitor for any possible excursions of wellfield solutions and to take corrective actions if necessary.

Turning to Contention 4, the Staff also closely considered the amount of water Powertech will use during the Dewey-Burdock project. The Staff reviewed a water balance that Powertech submitted with its application and this provides comprehensive information on water inputs and outputs for various phases of the Dewey-Burdock project. The Staff also prepared itself a numerical modeling report to estimate drawdown in the Madison aquifer. And as the Board on Monday, the water in the Madison aquifer is very important to the citizens of Hot Springs, Rapid City and also Edgemont. The Staff from that Powertech's water use will not affect the water supplies even in Edgemont, which is the city closest to the project.

In addition, the Staff considered the water rates applications that Powertech filed with the State of South Dakota. It's important to note that the state found that Powertech's annual water consumption will not exceed the recharge rates of either the Madison aquifer or the Inyan Kara aquifer, which the Board also heard about on Monday.

In sum, the Staff carefully considered each of the issues raised in Contentions 2 through 4, and Mr. Prikryl and Mr. Lancaster look forward to answering the Board's questions.

CHAIRMAN FROEHLICH: Thank you.

JUDGE BARNETT: I have a question for Mr. Clark.

CHAIRMAN FROEHLICH: Okay.

JUDGE BARNETT: I'm going to ask the question I did of Mr. Pugsley. I think I know the answer, but I just want to make sure I get this explicit.

So, is it your position, is it the Staff's position that satisfying all the requirements of NUREG-1569 will automatically satisfy all of the relevant requirements of NEPA and 10 CFR Part 40?

MR. CLARK: That is the Staff's position. As I mentioned, the guidance in NUREG-1569 is directed to both the safety and environmental findings and it reflects the Staff's judgment that if an applicant provides sufficient information in the areas addressed in the NUREG, then the Staff can make the findings required under NEPA.

JUDGE BARNETT: Do you have any citations or authority that binds this Board to that conclusion?

MR. CLARK: The numerous decisions in Hydro Resources relied on the Staff's review and the findings that the Staff made consistent with the Standard Review Plan. In terms of a direct case stating that compliance with the NUREG satisfies NEPA, I'm not aware of any recent Commission precedent. I'd be happy to look into that and report back.

JUDGE BARNETT: Okay. Yes, if you can find citations or authority that binds this Board to that conclusion, that would help me. And I know that in your arguments both of you have addressed this with Hydro Resources. And I've looked through some of that and I can't find anything really explicit, but maybe I missed it.

MR. THOMPSON: Your Honor, let me just say guidance is not a regulation. We understand that.

And we understand that even the licensee is not bound by the guidance. But if you want to do something different, you have to justify it in much greater detail. If you follow the guidance, you're supposed to be able to get your license. So if the Board finds the guidance inadequate, it presumably will have to have some rather serious technical and scientific justifications to do so.

MR. CLARK: And, Judge Barnett, if I could just mention that the Staff is aware of the Board's footnote toward the end of its recent ruling and summary disposition motions in Strata.

JUDGE BARNETT: That's exactly where this question came from.

MR. CLARK: And we're not aware of any Commission precedent saying that the Staff's guidance is binding on this Board, but our argument is that the guidance is sufficient to comply with NEPA and the Board should -- for the same reasons the Staff adopted the guidance, the Board should likewise understand that the guidance ensures that an applicant provides sufficient information to allow the Staff to make the findings. But we're aware of that footnote and we're also aware that -- is it Judge White from the Strata Board is in attendance?

JUDGE BARNETT: Yes.

MR. CLARK: So we want to make sure that the Staff fully recognizes the issues raised in Strata.

MR. PUGSLEY: And to answer your question, Judge Barnett, the first citation -- I concur with Mr. Thompson's opinion. The citation I would give you is 68 Federal Register 51034, which is --

JUDGE BARNETT: Just a little bit slower, please.

MR. PUGSLEY: I'm sorry.

JUDGE BARNETT: I've 68 Federal Register --

MR. CLARK: 51034.

JUDGE BARNETT: 034.

MR. CLARK: And the pin cite is 036 with a quote of, "Standard practices that have been found acceptable in demonstrating compliance at in situ leach uranium extraction facilities have been placed in the Standard Review Plan as one approach that the Staff may use in determining in compliance." And I would respectfully submit that while I do agree with you that the Hydro Resources cases do not have a specific statement saying the Board is bound to the guidance, it is worth noting that the guidance, the final version of the guidance in 2003 was developed after those Hydro Resources decisions, so it goes -- it would make you think that the Staff would take Commission precedent into account when developing its guidance.

JUDGE BARNETT: Certainly I do want to take Commission precedence into account, but I want to take the explicit precedence into account.

MR. CLARK: Understood, sir.

CHAIRMAN FROEHLICH: All right. Next from the Oglala Sioux Tribe?

MR. PARSONS: Thank you, Your Honor. With respect to Contention 2, failure to -- deals with the failure to adequately determine water quality, baseline water conditions at the site. What we have in this case essentially is a deferral of substantial baseline data collection until a time in the future. You heard Mr. Clark talk about the license conditions that specifically defer collection of baseline data to the future. I understand that there is an additional package of data that comes in with wellfield development, but Criterion 7 in 10 CFR Part 40, Appendix A specifically requires a pre-operational monitoring program to, quote, "provide complete baseline data on the site in its environs."

Mr. Pugsley asserts that the construction rule somehow prohibits them from providing that complete baseline data, but the construction rule exempts baseline data collection. So that is not an impediment to complying with Criterion 7, which requires that complete, again complete baseline data.

The current data and methodology are not adequate to assess the environmental impacts under NEPA either. NEPA requires all relevant data be included in an EIS. To the extent that an EIS -- it is argued that an EIS is not intended to be a research document, I think is the words used in the briefing on this matter. And our NEPA Regulations at 1502.22, 40 CFR 1502.22 do require agencies to gather additional data and evidence unless the costs are exorbitant. No such argument or showing has been made here. The testimony confirms that the FSEIS lacks the detailed analysis of water quality as we briefed and as we submitted. Under NEPA this data is critical to informing the public and the decision makers and in assessing the environmental impacts.

With respect to Contention 3, which deals with the failure to assess the hydro-geological conditions at the site, a key aspect in this contention is the lack of sufficient data and improper assumptions regarding the connectivity or lack there of of underlying aquifers. The testimony in our briefly thus far in this case shows that the application and the FSEIS ignored extensive evidence and failed to gather evidence of faults, fractures, breccia formations, collapses and historical boreholes, again deferring that information to some point in the future.

It's our contention that in order to have a complete baseline in order to comply with NEPA you must present that data on the front end and not simply defer it to later analysis. Instead of assessing this information, as with water quality, this data is simply deferred and this analysis are deferred to the future. This approach violates NRC Regulations and NEPA.

Contention 4 deals with a failure to assess water quantity impacts, particularly a failure to adequately review and determine the water consumption for the project. A central feature of this argument is the lack of an appropriate water balance capable of showing the amounts of water that will be used and consumed in this process. Again, the lack of this analysis violates NEPA, cannot under NEPA be deferred to a later time and deprives the public and decision makers of an opportunity to meaningfully review the impacts from this project.

JUDGE BARNETT: I have a question for Mr. Parsons, if it's okay.

So is it your position that the procedure for FSEIS review outlined in NUREG-1569 is not consistent with the relevant requirements of NEPA and/or relevant NRC Regulations?

MR. PARSONS: Thank you. I think that as was explained, NUREG-1569 is guidance. It's not a regulation. It's not a statute. It's not case law. And so while it provides a road map, the requirements for compliance with NRC Regulations and NEPA are only found in those themselves. So I understand that it provides aid to companies and NRC Staff in developing their NEPA, but it's not conclusive. And so to the extent that there are identified gaps in the data or analyses that are incomplete, I don't think -- and don't meet to the level of the regulations or the statutes, that a guidance can somehow cover for that or overcome those requirements. So I'm not as familiar with the proceedings in other cases as Mr. Clark. I have made notes and will be sure to be researching that. But guidance is just guidance.

JUDGE BARNETT: Thank you.

JUDGE COLE: Sir, you agree that if you're going to do something different than the guidance in the NUREG-1569, you have to make a demonstration of that and convince the Staff that this is a proper way to do it?

MR. PARSONS: Well, I think guidance is a general approach to things. What we have I think in this case is based on the site-specific characteristics. We have a unique situation here. We have a site that's been extensively explored with boreholes and other disturbances. And so to the extent that a site-specific case requires that additional analysis, I don't think you need some vast justification to provide additional data. NEPA requires that hard look. And to the extent that a -- the guidance or the approach taken at another mine site that may not pose the same complications doesn't -- to the extent that that general guidance doesn't provide for a hard look at this particular site, then I would say that you need to follow the regulations and the statute and provide all the information necessary.

JUDGE COLE: Thank you.

CHAIRMAN FROEHLICH: All right. The Consolidated Intervenors, please?

MR. ELLISON: Thank you. Echoing what Mr. Parsons said, we certainly concur that NEPA requires that all available data be reviewed in the FSEIS process, and one of the things that we believe the evidence would show that one of the failures was to include pre-mining baseline data that should have been available from TVA from those earlier studies as to the pre-mining baseline water quality. The evidence clearly shows that the baseline water quality varies sometimes dramatically within the various parts of the proposed project area within Burdock and within Dewey.

And I guess one of the questions that I have, because I'm confused -- I keep hearing a lot of references to baselines of each wellfield, but it's confusing to me whether that means some kind of a parameter of baseline water data up to the eight large wellfields that are being proposed, or is this being talked about for each of the individual seven wells? And because if it is the larger grouping, multiple wellfields lumped together as one wellfield, then the question would seem to me to become is it the best water quality or the worst water quality which should have been looked at and presented and to determine what in fact the baseline would be for that particular wellfield?

As to Contention 3, does the hydrology and geology of the area allow for containment of the mining solutions under existing technology? And noting that the down-flow impact of -- you know, once operations are over or an excursion are currently under study at the Smith Ranch. And again, the NRC should have looked at all available data, both pro and con. This concept of a certain minimal threshold doesn't seem to me to be the hard look that is required under NEPA, but yet which is being suggested by NRC Staff and Powertech and seems to be a rather constant theme throughout the proceedings.

The FSEIS does not mention that there were two rejections by the DNER, that the Powertech had failed to show the state agency that it was not able to protect water resources and that in fact Powertech in its 2009 application for application of the Inyan Kara -- that the Inyan Kara was so leaky it was treated as one aquifer. And then upon DNER recommendations was changed to, well, it's still sufficient to contain these mine solutions. Was there a hard look at that? Was it simply language change or was there some evidence that was presented that would have cause for a different conclusion?

Also there's a question of the simple

modeling that was used by Powertech and assumingly approved by the NRC Staff. We would submit it shows it was not really based on real site conditions, but on some kind of generalized statement leaving out all of the most difficult parts such as showing whether the Fuson layer was actually a confined layer which sufficiently isolates an ISR process.

We've already discussed there is new data regarding potentially thousands of boreholes that had not been disclosed to Staff and analyzed with regard to the preparation of the FSEIS and a question as to when that data was obtained, when it could have been obtained, when Powertech was aware of the existence of such data. And there's no evidence that I think the Board is going to hear as to when the NRC Staff concludes that there is sufficient hydro-geological characteristics within the Dewey-Burdock area to with existing technology contain these fluids. There's no evidence that was presented showing of a similar ISR site that had really the same site characteristics with a plan to mine two hydrologically connected aquifers at the same time which overlap each other.

And then there of course is the absence of much of a discussion even though Powertech in one of its exhibits discusses how the area at the

Dewey-Burdock area has an oxidized core and how that might affect such things as mitigating or even controlling excursions, let alone ultimate reclamation.

There's also -- lacks a study of the so-called -- the reduction area that's supposedly down-flow outside of the project area. Between the Burdock area down-flow of that immediately is that open pit which is exposed to the rain, which goes all the way down to the top of the Fall River formation, which would seem to be providing additional oxidation. That's in the flow. Has that been really studied so that once these mine solutions hit that what then is the effect as it goes further as it travels initially southwest from the project area?

The evidence from Dr. Moran and Dr. LaGarry will also show that in addition to potential new data potentially showing faults and fractures with the borehole data that satellite photographs in fact show that there are faults and fractures within this area. We've heard some testimony about earthquakes in the area, but it doesn't really address what would happen if there was a five point magnitude earthquake in the area. A 4.8 one was not too far away. How would that affect the ability to prevent migration of fluids? Same thing if it damaged piping.

There's also the question of flooding of the mine site with the holding ponds being in the 100-year flood area. Last May there was a flood through that area with rainfall twice the 100-year level, and that doesn't seem to be addressed in terms of protecting surface waters.

There was a fire in 2012 very close to this site, and the FSEIS has not seriously discussed that fire. Well, it doesn't discuss it at all. It doesn't seriously address what would happen if a fire swept through that area in terms of any issues in terms of keeping the pumps going, you know, affecting the ability of those pumps to keep operating and prevent excursions.

And there's also a serious lack within the FSEIS of worst case scenarios situations. What happens if a 500-year flood comes through? What happens if a catastrophic earthquake occurs, or a fire, or there are unknown geo-hydrological features that create a serious problem? We know from Three Mile Island, Chernobyl and Fukushima that regulators told the public -- were told by the companies that the projects were safe, that an unspeakable catastrophe would never happen. If an unspeakable catastrophe were to happen at this site, we feel the FSEIS fails to seriously address that.

As to Contention 4 regarding groundwater quantity impacts, notice that there seems to be a lot of guessing that's going on as to -- and it's back to gross estimate. It's the amount of recharge that would be of the Inyan Kara right in this particular area. It's generally a very low rainfall-type of type area. And with 9,000 gallons per minute being used -- because it's our position that contrary to Powertech's position that you really only looked at the bleed. If you further contaminate water, isn't that a use of that water? And that the FSEIS fails to consider that that increased contaminated water -- and in some areas here there were drinking water wells within the project area that Powertech has now bought up. So if there is a contamination at 9,000 gallons per minute, there's nothing really about the full volume within this entire 16-square-mile area that is potentially going to be impacted. And is that not a use? We would submit that it was and it should have been something that would be looked at by the FSEIS.

And I apologize. I'm not feeling very well today. I will end my remarks there. Thank you.

JUDGE BARNETT: I was going to ask a

question of the Consolidated Intervenors. It doesn't have to be to you, Mr. Ellison, if -- yes, you don't look like you're feeling very well. Hope you feel better soon.

MR. ELLISON: Thank you.

JUDGE BARNETT: Same question that I asked the tribe. Is it your position that the procedures for FSEIS review that is outlined in NUREG-1569 is not consistent with relevant requirements in NEPA and NRC Regulations?

MR. FRANKEL: Thank you, Your Honor. David Frankel speaking for Consolidated Intervenors. It is our position -- we echo the position that Mr. Parsons described, that this is simply a guidance, while extremely helpful and generated with much industry and regulatory input. We're not saying it's entirely inconsistent, but we're saying it's not always automatically adequate and compliant.

JUDGE BARNETT: Fair enough.

CHAIRMAN FROEHLICH: Thank you for the opening statements. If my colleagues are ready, we can begin.

JUDGE BARNETT: Mr. Ellison, do you need a break for just a minute?

MR. ELLISON: With other counsel here, I'm fine. Thank you.

JUDGE BARNETT: Okay. I want to say before I get started I appreciate the questions submitted by the parties. I looked through all those very carefully and I will go through them again. It was probably not possible time-wise to ask everyone's questions; there were a lot of them, but I did look at them and in some cases incorporated them. And so I appreciate that.

Also, to the witnesses, I have been in your shoes before. So I served as an expert witness on cases, not uranium mines, but I know that's challenging to do. So I appreciate your willingness to be here.

My first question is for Dr. Moran, and this is in relation to Contention 2, failure to include necessary information for adequate determination of baseline groundwater quality. Would you please briefly describe your professional experience with ISR facility licensing or operation?

DR. MORAN: I'd have to go back and look at my résumé for all the details, but truthfully I don't have much licensing, formal licensing experience. I have a lot of experience looking at the hydrogeology and the geochemistry and water quality of various kinds of uranium sites and other radioactive sites, but I'm -- let me think a little bit more about specific licensing experience. Not much. Let's leave it at that.

JUDGE BARNETT: Okay. Thank you. You state, and I'm looking at OST-1 at page 17; I'm quoting here, "The delayed production of this critical baseline information until after licensing is not scientifically defensible as it prevents establishment of a baseline on which to identify, disclose and analyze the environmental impacts, alternatives and mitigation measures involved with the Dewey-Burdock project proposal. Scientifically defensible monitoring and mitigation of operating project is not possible based on the baseline data and analyses I have reviewed," close quote.

And I understand you're not a lawyer, but what is your understanding? Is there a specific regulation that you believe is not being met?

DR. MORAN: Again, I'm not going to try to talk about the legal aspects of that. I'm not trying to avoid answering your question. Part of what I'm saying is a lot of the area in three dimension of the Dewey-Burdock site, in my opinion, hasn't been characterized either geochemically, water quality, etcetera, just by my definition.

When I look also at the relevant documents from EPA where they've been sort of coerced into commenting on the new ISL guidance. I think they started getting pushed in about 1999 to start giving their opinions on it. They also say that you have to have a more stringent kind of baseline and they say that it has to be released before application approval. That's their guidance. But it's in TENORM documents. It's not in NRC documents.

JUDGE BARNETT: Okay. Is it in anything that's in evidence in this case?

DR. MORAN: Yes.

JUDGE BARNETT: The EPA regulations that you were just citing?

DR. MORAN: Their guidance.

JUDGE BARNETT: Or the guidance. I'm sorry.

DR. MORAN: Yes, would you let me take one minute?

JUDGE BARNETT: Sure. Go ahead. If you could just tell me the exhibit number, that's fine.

DR. MORAN: I'm not sure I can. What I've got are some notes to the document. Maybe it would be more useful if I give it to you later, but --

JUDGE BARNETT: That's fine. That's fine.

DR. MORAN: Yes.

JUDGE BARNETT: That's fine.

DR. MORAN: The point is it's in the EPA TENORM documents that NRC requested EPA to give them guidance on and it's suggesting changes to procedures. And one of the sections which I'll give you talks about providing the information before application approval.

JUDGE BARNETT: Okay. Thank you. You also state; I'm quoting from your testimony here, OST-1 at 18, quote, "Analytical results that rely entirely on data provided by the project proponent are not considered reliable by professional hydro-geologists and other water experts." Is that your opinion or do you have a more authoritative reference for that?

DR. MORAN: That's my opinion, but I would add that it's the opinion of most of the people I've ever worked with in way more than 42 mores of doing hydrogeology when they're able to say what they really think. You want independent sources of information.

JUDGE BARNETT: Okay. You state also on the same page, quote, "The employment of self-serving analytic methodology does not stand up to accepted scientific methods," close quote. What self-serving analytical methodology are you referring to there?

MR. ELLISON: Well, one of them would be if I were beginning the application process myself let's say five or six years ago, you certainly would have added in a section to look at geologic structure using air photos and satellite imagery and then you would integrate it with all of the other information rather than having them be kept in separate boxes.

I this situation they haven't done any significant satellite imagery interpretation, air photo interpretation. They did bring up some agricultural imagery after we criticized the fact that they hadn't in one of the earlier stages of review. They've not integrated the water quality and the hydrogeology. So all of these are in separate boxes. That's part of what I mean by that section.

JUDGE BARNETT: Okay. Thank you. What is your understanding of the relationship of NUREG-1569, which is, quote -- or the title is, "Standard Review Plan for In Situ Leach Uranium Extractions License Applications to NEPA Compliance?" Are you familiar with NUREG-1569?

DR. MORAN: I've read large portions of it. Again, to me it's guidance. It leaves out a great many important specifics. I don't think I'm the right person to say how it relates to NEPA guidance. Probably that's a legal issue.

But let me just add one other thing: In my experience there are many aspects of at least the water quality and the hydrogeology that I think the -- and the geochemistry which NUREG-1569 doesn't specifically talk about, which I think would be required in NEPA. But that's a technical opinion, not a legal one.

JUDGE BARNETT: Yes, I understand. I'm not a lawyer, too, so --

DR. MORAN: Okay.

JUDGE BARNETT: -- you're walking a fine line, but you're not talking to an attorney.

DR. MORAN: Okay. Good. Thank you.

(Laughter.)

JUDGE BARNETT: So I'm a technical person also.

Okay. Following up on that, in NUREG-1569 there is a statement -- that's in Exhibit NRC 13. There's a statement on page 12 that says, quote, "The Standard Review Plan is general guidance to the Staff on the type of information that is commonly acceptable for evaluating the environmental impacts of a proposed license action," close quote.

Do you agree with that statement?

DR. MORAN: Would you highlight that again? So let me read it again.

I would assume that's reasonable and that's their guidance, yes.

JUDGE BARNETT: Okay. Same document at 143 states that pre-operational monitoring is conducted as part of site characterization and is addressed in Section 2 of this technical evaluation report, whereas restoration monitoring is conducted during groundwater restoration and is addressed in Section 6 of this technical evaluation report.

Do you agree that all the relevant portions of NUREG-1569 regarding pre-operational monitoring occur in Section 2?

DR. MORAN: I can't answer that. I don't know that to be the case.

JUDGE BARNETT: Okay. Continuing on, same document at 63, Table 2.7.3-1 lists typical baseline water quality indicators to be determined during pre-operational data collection. The accompanying text at page 64 also says, "At least four sets of samples spaced sufficiently in time to indicate seasonal variability should be collected and analyzed for each listed constituent for determining baseline water quality conditions," close quote.

Are there water quality indicators in that table that were not measured, or are you alleging that not enough samples were taken to satisfy that criteria in NUREG-1569?

DR. MORAN: Let me break that up into one question.

JUDGE BARNETT: Sure.

DR. MORAN: I'm not sure I understand exactly how you worded it, but let me try a shot at it since we're not in a court. I don't know if every one of those constituents was included on every sample that they took. There's just so much information in so many different places I can't say.

What I am -- well, first, what I would say is there are several other constituents I would require if I were doing this myself, and have done it in similar cases. And these are not just to be picky. These are really hydro-geologically important constituents and --

JUDGE BARNETT: Well, what would you pick that's not there?

DR. MORAN: For one, one of the most common metals that's in a roll-front water quality is strontium. Lithium. But again, this is off the top of my head.

JUDGE BARNETT: Sure.

DR. MORAN: Did I understand your question correctly, sir?

JUDGE BARNETT: Yes, I think so. What I'm asking is are there things in that table that are missing? And as I understood, your answer was you could not answer that specifically because there's so much data. Is that right?

DR. MORAN: Of this specific table --

JUDGE BARNETT: Correct.

DR. MORAN: -- compared to what they actually determined?

JUDGE BARNETT: Correct.

DR. MORAN: That I can't answer. I mean, it's voluminous.

JUDGE BARNETT: Sure.

DR. MORAN: But what I am also saying is that there are constituents that are obviously hydro-geologically important --

JUDGE BARNETT: That aren't --

MR. ELLISON: -- and they're also in EPA-recommended documents for ISL.

JUDGE BARNETT: Okay. Thank you. That's

fair enough. Are you familiar with NRC Exhibit 091? It's title is "Staff Assessment of Groundwater Impacts From Previously Licensed In Situ Uranium Recovery Facilities." It's a memorandum to Chairman Jaczko, Commissioner Klein and Commission Svinicki from C. Miller 2009?

DR. MORAN: Yes.

JUDGE BARNETT: If so, do you disagree with the statement there that, quote, "The Staff is unaware of any situation indicating that: (1) the quality of groundwater at a nearby water supply well has been degraded; (2) the use of a water supply well has been discontinued; or (3) a well has been relocated because of impacts attributed to an ASR facility?" Do you agree with that statement, or do you disagree with that statement?

DR. MORAN: Well, again, let me walk that fine line. A statement is possibly true in the strictest legalistic sense, but only because based on my review of the literature and the information that supposedly was included with this memo they haven't made public the information necessary to really answer the question. There's supposedly data from three sites that this memo refers to. When you go to the actual document, the data aren't there. They have statements about the data, but the data themselves are not there. And that's for 3 sites out of maybe 30 or 40 that have operated. So to me it's not a -- they really haven't answered the question.

JUDGE BARNETT: So if I understood correctly, you say that the Staff does not have proper foundation for that conclusion? Is that what --

DR. MORAN: I think, yes, that's a good way to say it.

JUDGE BARNETT: Okay. Finally, and then I'll move on to someone else, have you submitted any evidence that either the Black Hills Army Depot or past mining activities have impacted the baseline groundwater quality at the Dewey-Burdock site?

DR. MORAN: We have not submitted any information about the -- what will we call it, the Igloo site. What's the other term for that site? Yes. Well, we don't have any specific data. I do not anyway. We haven't submitted any for that. But there's plenty of information in the historical documents that we've referenced in my opinions talking about the impacts from the historical mining.

JUDGE BARNETT: Okay. Thank you.

DR. MORAN: Sure.

JUDGE BARNETT: Mr. Demuth, you stated;

I'm looking at Exhibit APP 013 at pages 7 and 8, quote, "NUREG-1569 clearly defines three phases of groundwater monitoring." Then you're quoting NUREG-1569. "There are three distinct phases of groundwater and surface water monitoring: pre-operational, operational and restoration."

So the operational and restoration monitoring, will that occur outside of the NEPA process?

MR. LAWRENCE: Are you addressing the question to me?

MR. DEMUTH: He's asking me.

JUDGE BARNETT: Oh, I'm sorry. Mr. Demuth. I'm sorry.

MR. DEMUTH: Judge Barnett, I'm not sure I understand that question in terms of the legal aspects of it. Certainly that operational monitoring will occur under the regulation and reporting to NRC. And so those data will be collected, analyzed and reported in the manner specified by 1569, and certainly in a manner specified in the TR and the ER. To what extent that jumps to NEPA, I'm not the lawyer, so I can't answer that question.

JUDGE BARNETT: Well, who will have access to that data and can it be challenged? I'm talking about the operational and restoration data now. Will that data be publicly available, or just the applicants have that data?

MR. DEMUTH: My understanding is that information will be submitted to NRC. It will be publicly available certainly on ADAMS. NRC Staff could specify the exact method. But that would be public information that could be reviewed by anyone.

JUDGE BARNETT: Okay. You also on page 8 of your testimony, quote NUREG-1569 as follows: "Wellfield hydrologic and water chemistry data are collected before in situ leach operations to establish a basis for comparing operational monitoring data. Hydrologic data are used to: (1) evaluate whether the wellfield can be operated safely."

So you need additional information other than what's available today to determine whether the wellfield can be operated safely? Am I reading that correctly?

MR. DEMUTH: Yes, you are. It would be additional confirmatory information on a wellfield scale, and that is one of the premises of 1569 and historic regulation of ISR facilities. 1569 mandates us really to collect data on a regional scale for a permit application which is prudent and warranted. As we move into a wellfield scale, then there's additional information. And one example is the pump test where you verify that your monitor wells are connected and there are valid monitoring points and also demonstrate confinement above and below. So, yes, that would be further confirmation, but it's part of a well-established process.

JUDGE COLE: In the latter part you're referring to the information contained in well packages?

MR. DEMUTH: Yes, sir.

JUDGE COLE: Prior to operation?

MR. DEMUTH: That is correct.

JUDGE BARNETT: Okay. Something that doesn't have anything to do with this hearing, but were the sampling results from the domestic wells shared with the property owners?

MR. DEMUTH: I can't answer that question. I would guess that it would be, but Powertech would have to answer that question, sir.

JUDGE BARNETT: Okay. If those wells are still being used, I would recommend that be done. Doesn't have anything to do with this hearing.

Finally, have you testified in NRC proceedings about other ISR projects?

MR. DEMUTH: No.

JUDGE BARNETT: Okay. Thank you. Same question to Mr. Lawrence. Have you testified in NRC proceedings about other ISR projects?

MR. LAWRENCE: No, I have not.

JUDGE BARNETT: Thank you. That's all I have on Contention 2.

JUDGE COLE: Dr. Moran, you were asked a lot of questions about NUREG-1569. I assume you're familiar with that. If the Applicant meticulously follows the procedures in 1569, is it your view that that is or is not sufficient to qualify for obtaining a license from NRC?

DR. MORAN: Well once again, I don't like to avoid answering simply, but the truth is I don't know the permitting process that well, so I'm not sure I can say. But to me technically a lot of information I would require for just a hydro-geologic study that's reasonable isn't in there, in the document, in the NUREG-1569.

JUDGE COLE: In the well tests that they have to conduct after licensing and prior to operations, are you familiar with what the Applicant has to do then?

DR. MORAN: I am in general, yes, but --

JUDGE COLE: Has to conduct a well package?

DR. MORAN: Yes.

JUDGE COLE: What does he have to do in that well package? What kind of information does he have to present?

DR. MORAN: Well --

JUDGE COLE: Let me give you a little more information. First of all, he has to have a wellfield. And before he operates the first one he has to conduct all those tests necessary to present the well package to NRC. Are you familiar with the things he has to do to collect the information in that well package?

DR. MORAN: In a general sense I am.

JUDGE COLE: Yes.

DR. MORAN: Can I respond a little bit further?

JUDGE COLE: Sure.

DR. MORAN: When I have asked colleagues about the availability of the information from comparable well package studies at other sites, nobody can point to any of them being public. So for me, part of the reason I'm pushing on this issue is if we wait to allow them to do that after permit approval, then that data goes into a black box. I don't disagree at all that they have to do some significant work, but a lot of it I'm arguing should be done earlier.

Can I add one other thing related to that?

JUDGE COLE: Sure.

DR. MORAN: If you compare the quality of the studies done by TVA in the late '70s and early '80s to the quality of the kinds of studies done now and the detail, what I'm arguing is they did most of what we're talking about pre-license approval in the late '70s and early '80s. We would probably have many fewer arguments if that level of work had been done.

JUDGE COLE: Yes, but they weren't under the NRC supervision either, too.

DR. MORAN: Well, they were doing this under AEC, as I recall.

JUDGE COLE: Okay. The purpose of this well test is to make sure that the system will function properly and they run through -- not a lixiviated solution, but regular water through this system to check to see if they have connection between the monitoring wells and whether the system is hydraulically functioning property, they've got the right amount of flow coming in. Is that your understanding also, sir?

DR. MORAN: We're talking about the --

JUDGE COLE: The test --

DR. MORAN: -- post-approval?

JUDGE COLE: -- associated with the pump package.

DR. MORAN: Post-license?

JUDGE COLE: Post-licensing, pre-operational.

DR. MORAN: Yes, that's my general understanding.

JUDGE COLE: Now, what would they learn from this information in the well package? Would this identify problems they have with operation prior to actual operation?

DR. MORAN: If the testing is designed in a manner that's complete, they will learn those details, but if it isn't, they won't.

JUDGE COLE: Well, they're going to conduct a test. They're just not going to use lixiviated water. They're going to us plain water and they're going to run a pump test and they're going to collect samples that's going to -- they'll run samples and collect the information contained in Table 7.3-1, which is quite similar to the table that you were shown before with all the chemicals on it, about 20 or 25 chemicals. Looks like a pretty complete list.

So if they were to have a problem with boreholes or some hydraulic flow problems, would they be identified at this stage?

DR. MORAN: The reason I was being a little circular in my previous answer is it depends on who designed the locations of the wells and the completions of them. I mean, I seem to recall in some documents, the tens of thousands of pages we've all seen, that Powertech has been arguing that in many of these post-approval well packages that they not have to monitor some of the aquifers below the production zones. I'm not really trying to argue whether that's exactly correct. What I'm saying is you get the information you need if you put the wells in the right places and you run the tests correctly. And I can't control that here.

JUDGE COLE: So you're saying that you're not sure whether they test for any excursions during this pre-operational test into the lower level or the aquifer above and outside of the aquifers containing uranium?

DR. MORAN: I'm sure they'll do some of that. What I'm arguing is how extensive will it be?

That's my answer.

JUDGE COLE: I don't know what you mean by how extensive.

DR. MORAN: Well --

JUDGE COLE: They're going to have an established connection and they'll run the test for so long to see if there is any hydraulic connection between the monitoring wells and the upper aquifers.

DR. MORAN: Right.

JUDGE COLE: And also they've got monitoring wells in this aquifer some distance out from the location of the wells.

DR. MORAN: Well, I can't speak exactly to what they're going to do in the future, but what we can already see from the thousands of pages of documents that they disagree with the existing literature. Most of the literature says there's leakage there. And they, Powertech, have disagreed with that. So I can envision similar problems in the future.

JUDGE COLE: Okay. But if there is leakage and it would -- and sufficient leakage such that the aquifer is not isolated, what's the consequence of that, and when you're looking at the results of the pump package?

DR. MORAN: Could you repeat the question?

JUDGE COLE: What's the consequence of that when that when the Staff looks at it? Do you know?

DR. MORAN: Well --

JUDGE COLE: Maybe we should ask the Staff.

DR. MORAN: Yes, clearly the key is that the Staff has to have severe or really significant oversight capability here. But I mean, these are kind of theoretical questions to me right now, because I don't know the placements of the wells and the durations of the tests and so on.

JUDGE COLE: Well, let's ask the Staff members. Are you familiar with the subject we just discussed right now?

MR. PRIKRYL: Yes, I am.

JUDGE COLE: If you were to -- in your review of the pump package information what kind of problems would you be looking for and what would be the consequence of certain kinds of problems?

MR. PRIKRYL: Well, basically what the package has to demonstrate; and I think you already alluded to this, that the hydrologic test package has to demonstrate that the production zone is confined.

That is, the monitor wells are in hydrologic communication with the production zone and also that any underlying or overlying wells are hydrologically isolated from the production zone.

JUDGE COLE: But how long do you have to have that test run to determine whether they are isolated?

MR. PRIKRYL: To tell you the truth, I'm not a hydrologist.

JUDGE COLE: I mean, are we talking about three days? Two days? Two hours? A week?

MR. LANCASTER: Yes, it wouldn't be hours. They have to have the flow rate that they would have in production and it would be not hours. That's for sure. But we'll be looking for isolation of the production aquifer and hydraulic connection between the patterned wells the monitoring wells that are in the same aquifer. In this case we'll also be looking specifically at this issue with the abandoned boreholes that weren't properly abandoned and are causing some leakage possibly. Those we'll have to --

JUDGE COLE: How would that manifest itself in the information in the well test package?

MR. LANCASTER: Well --

JUDGE COLE: Hydraulic flows?

MR. LANCASTER: It would be manifested in the case of a communication of fluids through the Fuson into their ore zone. During the pump test -- let's say it's in the lower Chilson and you have monitoring wells in the Fall River above the Fuson, then during that pump test if there is a reaction, a drawdown of the Fall River, that would signify that there's a communication. In this case the Applicant has committed to abandoning the bore holes that have been shown to be linked to this communication in the pump tests that have been done thus far.

JUDGE COLE: What kind of demonstration do they have to make for plugging these boreholes? Because there's caps and their plugs and then there's real plugs. What do they have to do?

MR. LANCASTER: Well, their commitment is plugging in accordance with state requirements, as I recall, the abandonment and plugging. And that should suffice from what I understand or recall at this point.

JUDGE COLE: Now, let's say they have an excursion during this pump test but you're not using lixiviant. What do you measure oat the stationary well if you're just pumping water in the system?

MR. LANCASTER: Yes, you're measuring --

it's measurements of head. The measurements of water levels, if you will.

JUDGE COLE: Okay.

MR. LANCASTER: Or head.

JUDGE COLE: Water elevation, yes.

(Simultaneous speaking.)

MR. LANCASTER: -- service measurements. It's not measurement -- it's not using lixiviant obviously. It's not in the chemical realm.

JUDGE COLE: But that's the procedure you would use during the initial test?

MR. LANCASTER: Procedure? I'm not following you.

JUDGE COLE: Well, you said we're running the tests necessary to develop the well package.

MR. LANCASTER: Yes.

JUDGE COLE: Which the Applicant then has to present to the NRC to demonstrate that the system is working fine, there are no problems.

MR. LANCASTER: Right.

JUDGE COLE: What kind of problems do you look for and how do we measure -- is it just elevation at that point, water elevation?

MR. LANCASTER: Well, it's here in 1569 under Section 5783, Acceptance Criteria No. 4. It specifies what we were just talking about. It also talks about verification of the accepted conceptual model of hydrology; that is, the conceptual model that has been defined under the licensing action. It will verify that as well, as well as these other actions we're looking at.

JUDGE COLE: Yes, do they also --

MR. LANCASTER: It talks to that.

JUDGE COLE: Do they also mention the drawdown?

MR. LANCASTER: Well, the way it's worded here is hydraulic -- let's see here. Isolation -- let's see here. Let me see if I can see how it's stated in here. Yes, so hydraulic isolated from the vertical excursion monitoring wells.

JUDGE COLE: Right.

MR. LANCASTER: So they're demonstrating hydraulic isolation of their production zone from the vertical monitoring wells, the overlying monitoring wells. In this case we don't have underlying, and that's a whole other -- that's defined in the SER why that's not be done.

JUDGE COLE: Okay. And you do that by the elevation of the water?

MR. LANCASTER: Yes.

JUDGE COLE: In the upper monitoring well?

MR. LANCASTER: Right. And those pump tests that you were referring to --

JUDGE COLE: Yes.

MR. LANCASTER: -- when you were --

JUDGE COLE: Yes.

MR. LANCASTER: Okay.

JUDGE COLE: Do they also take measurements on the hydraulic grade line?

MR. LANCASTER: Hydraulic?

JUDGE COLE: Hydraulic grade line. The elevation of the water with a drawdown towards the center well, towards the production well. Do they measure that during the test to demonstrate what it is?

MR. LANCASTER: I haven't directly reviewed a wellfield package yet, but they will be measuring for hydraulic connectivity between the patterned wells and the perimeter monitoring wells which are in the production aquifer, and those measurements will be hydraulic heads to show that there is a hydraulic connection. And that's the purpose of --

(Simultaneous speaking.)

JUDGE COLE: Okay. But they also measure

flow in each of the pipe systems so that --

MR. LANCASTER: Yes. Yes, right.

JUDGE COLE: -- you know what goes in, comes out or stays there?

MR. LANCASTER: That's right. Right. So they'll be reporting flow to us as well.

JUDGE COLE: Well, maybe we'll ask one of the Applicant's witnesses --

MR. LANCASTER: Sure.

JUDGE COLE: -- if they want to add to that situation with respect to the well pump packages.

Are you familiar with the work that's being done on the well packages, development of a well package? Have you ever done that?

MR. DEMUTH: Yes, sir. If I could answer that question?

JUDGE COLE: Okay.

MR. DEMUTH: Several things. The development of a wellfield package starts with a pump test design. Commonly there's interaction with NRC Staff, so they have some understanding of what the wellfield looks like, what the duration is going to be, those types of things. In some cases we'll perform numerical modeling to assess how long the test should be run based on the hydraulic parameters of the formation so that we see that we can actually have a cause and effect of we pump the well in the middle and we see a response at the monitor wells and that effect can be distinguished between background fluctuations, barometric fluctuations, etcetera.

And just so you know, sir, we have had instances where there were problem wells. And so the wellfield test does exactly what it's supposed to do, in that we run a test and we see that there's a problem.

JUDGE COLE: Now this is a system where you have the injection wells just as it is when you're going to go into full-time operation, and the production well is in the center, and you run through just as if you're putting in lixiviant material. Is that how you conduct your test?

MR. DEMUTH: No, sir. This would be what we call a pumping test where there's no injection that happens during this test. So we have a production well in the middle of a wellfield. We have monitor wells which are horizontal monitor wells surrounding the area outside where the patterns would be developed. And then we also have monitor wells in overlying and underlying sands as appropriate.

JUDGE COLE: Okay. So the injection wells are not used in the development of the pump package?

MR. DEMUTH: Commonly not. We have done some test scenarios where we've done some injection, but the typical pump test for wellfield development is a pumping process, not a pumping and injecting process. And the reason is when we're pumping and injecting during wellfield operation, the stress on the system is relatively low because most of the water is being re-injected, whereas during a pumping phase we can stress the system, as Mr. Lancaster said, to a greater degree than we'll see during operations. And also at that point we don't have approval to inject lixiviant. We only have approval to pump water out for the purposes of the pump test.

JUDGE COLE: Okay.

MR. DEMUTH: But we have founds wells that were a problem. We've gone and fixed those wells and we've rerun the test. Likewise, we've had cases where we may have a geologic pinch-out between the pumping well and a monitor well, and 1569 tells us that we have to show that this monitor well is a valid monitoring point. If we don't see a hydraulic connection between the two in the same zone, then it's not a valid monitor point.

JUDGE COLE: So if the water level in the monitoring well is going lower, you have a problem?

MR. DEMUTH: Not if you're in the same zone. We would expect it to --

JUDGE COLE: Oh, I understand that. I'm talking about above the aquiclude.

MR. DEMUTH: Correct. And so we've had instances where we've seen that and we've gone and plugged wells and we've rerun the test to show that that problem was fixed. We've also had instances where geologically a well wasn't in the right spot and we've put additional wells in to make sure that we have sufficient monitor wells to monitor that operation. So in that sense the hydraulic test packages and that approach it works to assure the safe operation of that wellfield.

JUDGE COLE: Prior to the time you used the pumping test or conduct the pumping test do you have to have the injection wells in place?

MR. DEMUTH: No, you do not. And in fact --

JUDGE COLE: Well, it's not a complete package, right?

MR. DEMUTH: Well, 1569 and the NRC Regulations do not allow us to construct all the injection wells before we have approval for the wellfield package.

JUDGE COLE: Okay. But you do have to conduct your monitoring wells and the center production well?

MR. DEMUTH: That is correct, as well as we have monitor wells within the area that will be mined that are also installed. But they're only monitor wells. They're not production wells at that point.

JUDGE COLE: Okay. All right, sir. Thank you.

DR. MORAN: Is it possible to ask a question?

JUDGE COLE: Did you want to say something, sir?

DR. MORAN: I wanted to ask a question.

JUDGE COLE: I might not know how to answer it, but go ahead.

(Laughter.)

DR. MORAN: Well, it's sort of a rhetorical question. If you wanted to understand more about this process, wouldn't it be wise for us to be able to go to the various state and federal agencies that hold the historic data for these well packages and put that information together and see how well we've done with all of this historically?

JUDGE COLE: How many instances has the preparation and conduct of a -- development of a well package identified problems that resulted in additional work and correction of problems? Is it a common thing or is it an uncommon thing?

MR. DEMUTH: I would say that we've done at least 40 wellfield pump tests over the years and probably 4 of those have identified some problems that resulted in additional work. So 10 or 20 percent might reveal that there needs to be some modification in terms of the wellfield design. The more normal circumstance is that it does not, and in fact it confirms the regional geology and the regional understanding that was presented during the original application.

JUDGE COLE: I understand. And according to the NRC rules don't they have to go through the same process for every additional wellfield that they construct before they operate it? So if they've got -- this is an example, they have five, six injection wells and a production in the middle. They conduct the necessary tests on that. Before they go to the next one they have to do the same thing. Is that your understanding?

MR. DEMUTH: That is correct. Each wellfield has to be tested, not only the pumping test to determine hydraulic characteristics, connection for the monitor wells, etcetera, but also water quality monitoring.

JUDGE COLE: Right. All right, sir. Thank you.

This is a question for Dr. Moran. Chapter 5 of the FSEIS assesses the cumulative impacts on groundwater from past, present and reasonably foreseeable future actions including past mining activities. Is that your understanding, that that's correct?

DR. MORAN: I don't recall if that's the correct wording. I'll accept that you're reading it as it's stated, but I don't recall seeing that they did what I would call a reliable cumulative evaluation.

JUDGE COLE: There's been some discussion about what's required under Criterion 5 and Criterion 7 in 1569. Are you familiar with the difference there between --

DR. MORAN: No, I'm not.

CHAIRMAN FROEHLICH: -- Criterion 7 and Criterion 5?

DR. MORAN: No, I don't recall.

CHAIRMAN FROEHLICH: You can't do much with Criterion 5. You got to complete Criterion 7 first and then Criterion 5 requires you to collect information on really prior to operational systems. If you're not familiar with that, I can't ask a question on that.

DR. MORAN: I'm not familiar with the details.

JUDGE COLE: Yes. I think the Intervenors have criticized the Applicant, and it looks like there's some confusion about what's required under Criterion 5 and Criterion 7. Are you familiar with that situation, sir? I'll ask the NRC Staff.

MR. PRIKRYL: Yes, in the testimony that has been submitted by the Intervenors it seems like they don't understand the difference between Criterion 7 and Criterion 5. Yes.

JUDGE COLE: And what do we have to do under Criterion 5? We have to develop a certain kind of water quality data that's identified as Commission-approved data?

MR. PRIKRYL: Yes, under Criterion 5 the Applicant or the Licensee will have to -- based on its hydro-geologic test packets and the water quality data that is collected there they will have to establish what's called Commission-approved background. And this is used to set aquifer restoration goals and it also is used to establish what's called upper contaminant levels for excursion monitoring.

JUDGE COLE: Yes, and they have to do that over what period, minimum period prior to operation? Is this the criterion that says you have to collect four samples over a one-year period and then collect your water quality data and average the data to start developing the Commission-approved standard?

MR. PRIKRYL: Yes, the criteria for establishing -- I believe it's four samples over a yearly -- quarterly sampling, yes. And that's to include the constituents that are included in NUREG-1569. The table; I believe it's 2.3.7-1, has to include all those constituents.

JUDGE COLE: Yes, but I've got a different number. But is it the same thing as the background water quality parameters and indicators for operational groundwater monitoring?

MR. PRIKRYL: Could you clarify that question, please?

JUDGE COLE: Is it the same list of chemicals? And it's identified as background water quality parameters and indicators for operational groundwater monitoring. It seems to have the same number of chemicals on it.

MR. PRIKRYL: Yes. Yes. That's correct. Yes.

JUDGE COLE: All right. Thank you.

CHAIRMAN FROEHLICH: While on the subject, at page 26 of the Staff testimony, I guess answer 2.10, there's a discussion where the Staff wishes to emphasize that, quote, "Powertech provided an analysis of historical water quality data collected by TVA and recent water quality data at or near the Dewey-Burdock site only to demonstrate the consistency of groundwater quality over time."

With that statement in mind, at the end of the paragraph the Staff concludes, "For that reason pre-operational baseline groundwater data should not include data from historical groundwater conditions which might bias the data set." Could you explain for me? I'm not quite sure -- if you're looking at historical or what it is, how does that bias the data?

MR. PRIKRYL: Well, the TVA groundwater data was collected back in the late '70s, early '80s, so there's really no way to determine whether that groundwater quality is representative of the groundwater quality that currently exists at the site.

JUDGE COLE: Because there are still people drilling holes?

(Laughter.)

MR. PRIKRYL: Yes. So in a NEPA analysis what we're doing is we're looking at -- we're trying to describe the affected environment for baseline conditions or existing conditions, or existing groundwater conditions at this time so we can do our NEPA analysis. We can compare the impacts of the proposed action on existing conditions. So using the TVA data would possibly -- if it's not representative of existing conditions, it's going to bias the data set.

JUDGE COLE: It might be better. It might be worse.

MR. PRIKRYL: Exactly.

CHAIRMAN FROEHLICH: Okay. Thank you. That clarifies it.

I see from my colleagues that they have completed their questions, I think for the most part, on Contention 2. I note also it is noon. Would this be a convenient time to take our lunch break and then begin with the Board's cross-examination on Contention 3 after lunch? Is this a convenient time?

MR. PUGSLEY: NO objection.

MR. PRIKRYL: Your Honor, it turns out that everyone goes to the same closest restaurants and then they get jammed up. And would it be possible; I don't know where we are with the schedule, to have an extra 20 minutes for the lunch break to accommodate being able to get our food and consume it?

CHAIRMAN FROEHLICH: Seems reasonable. If we start at 1 hour and 20 minutes from when we break -- if we start promptly, that's certainly fine.

Why don't we break then for 1 hour and 20 minutes and resume here at 1:20? Our intention is to begin cross-examination on Contention 3.

(Whereupon, the above-entitled matter went off the record at 11:59 a.m. and resumed at 1:20 p.m.)

CHAIRMAN FROEHLICH: Good afternoon, all. We'll be back on the record. At this point, I'd like to swear in the remaining three witnesses for this panel so that we can proceed with questions. So if Linsey McLean, Susan Henderson, and Marvin Kammerer would rise, please? Raise your right hand, please?

Do you solemnly swear or affirm that the statements that you will make in the hearing before the ASLBP will be true and correct to the best of your knowledge and belief?

Remain standing. Do you adopt your pre-filed testimony as your sworn testimony in this proceeding?

The record will reflect that all three witnesses responded in the affirmative. Thank you. You may be seated.

Judge Barnett, I believe you had a follow up on Contention 2?

JUDGE BARNETT: Yes, in reference to NRC-091. Ms. Henderson?

MS. HENDERSON: Yes.

JUDGE BARNETT: Thank you for coming today. What I have here, if you remember earlier this morning I asked another witness this question. This is NRC-091 and it's a memorandum to the Commission from Ms. Miller in 2009 called Staff assessment of groundwater impacts from previously licensed in situ uranium recovery facilities. And there is a statement there that -- well, you can read the statement.

So my question is do you have any information that would contradict that statement?

MS. HENDERSON: I would tell you that the process for testing for chemical warfare agents is extremely expensive and difficult. There are only six laboratories in the United States that test for these things. The Government has long manufactured these things under extreme secrecy. They have been unwilling to divulge what they have in those chemicals. The chances that anyone could have easily tested for it would be surprising to me.

JUDGE BARNETT: Thank you. Mr. Kammerer, same question to you, please. Are you aware of any information that would contradict that statement from NRC Staff to the NRC Commission?

MR. KAMMERER: My awareness of these weapons is rather limited. However, we don't know the consequences of this type of activity, unfortunately.

JUDGE BARNETT: Thank you.

MS. HENDERSON: Could I make an additional comment?

JUDGE BARNETT: Sure.

MS. HENDERSON: Many years ago, we began to have difficulties with dead animals on the Black Hills Army Depot which is a 21,000-acre site. And I had a neighbor that lost 1,200 sheep in a 4-day period on the east side of the depot. The animals died of violent convulsions. They had grass in their mouth. No flies would land on the carcasses. We posted the carcasses with the state veterinarian in Brookings and he said I have no idea what this is. It is not an animal disease. It is not anything that I've ever seen before.

Now, the problem that we have with detecting contamination is we don't know exactly what chemicals are there. We don't know what the breakdown has been of them and then we have the secrecy of the Federal Government. The Federal Government does not want to admit that it is killing anybody's 1,200 sheep.

We went to Washington to try to get somebody to help us with this. The CDC came out and said whatever you do, don't give up on this because there are terrible, horrible things there that can kill any kind of animal or human life that is exposed to it. We know there's a huge problem here, but we are powerless to deal with it.

JUDGE BARNETT: Okay, thank you. And I will note that Mr. Kammerer, do you have something else you'd like to say?

MR. KAMMERER: I wish to inform you that I had a brother and a nephew who died, a brother who had very much complications with Agent Orange and a nephew who died of the same in 'Nam.

JUDGE BARNETT: Okay, thank you and I will note that I have read your testimony and appreciate that in this case.

CHAIRMAN FROEHLICH: Let's move on to Contention 3.

JUDGE BARNETT: Okay, Dr. Moran, in support of this contention, you site references that the Fuson shale, am I pronouncing that correctly?

DR. MORAN: I've heard Mr. Demuth say it differently. What's the correct pronunciation?

MR. DEMUTH: Fuson.

JUDGE BARNETT: Fuson. I'll probably butcher that several times, but I'll try to get it straight. In support of this contention, you cite references that the Fuson shale is leaky. Is that correct?

DR. MORAN: Yes.

JUDGE BARNETT: Are you alleging that any other confining layer at the site is leaky?

DR. MORAN: I don't think we know. I don't think we have adequate information from these studies to say.

JUDGE BARNETT: But you're not alleging based on any information that you have that anything else is leaky. Your testimony is you just don't know. Is that correct?

DR. MORAN: In general, I don't think

we've done the testing to answer it, yes.

JUDGE BARNETT: Understand. Okay, I'm going to throw out this question to the experts from the Applicant and I'm going to ask the Staff the same question so whoever wants to answer can. Is the Fuson shale necessary to contain ISR fluid migration at this site?

MR. LAWRENCE: I would say no, it is not. Some of the testing that has been done at the site has identified some vertical impediments to flow within the Chilson and within the Fall River. If you remember the type log that we had up earlier where we had subdivisions within the Fall River and also in the Chilson, some of the pump tests that were conducted had wells that were completed in different intervals within those two stratigraphic units. And there were delays in the response during pumping which would indicate there is some vertical restriction to groundwater flow.

JUDGE BARNETT: I understand that, but is this necessary? If that is leaky, does it make a difference in the environmental impact of this site if it is leaky?

MR. LAWRENCE: I don't think so. It just has to be taken into consideration in your wellfield design and how you produce the -- or how you extract the minerals.

JUDGE BARNETT: I ask the same question to the Staff, either one can answer.

MR. PRIKRYL: I believe the question is whether the Fuson is leaky or not and whether those would cause a greater impact?

JUDGE BARNETT: Yes, the question is not whether it's leaky, but are you depending on it not being leaky to approve the site? It is a confining layer in terms of approving the site is my question?

MR. PRIKRYL: No, no. I don't think so.

JUDGE COLE: Sir, and why is that? Because there are aquitards above and below that could take the place of the Fuson?

MR. PRIKRYL: Well, I guess maybe I didn't understand the question, but there are thick aquitards both above and below the Inyan Kara aquifer which consists of the Fall River and the Chilson member.

JUDGE COLE: But if the Fuson were a very leaky aquitard, is there a way you could operate mining uranium without the help of any barrier in the Fuson aquitard?

MR. PRIKRYL: I think it would be the degree of leakiness would probably play into it.

JUDGE COLE: Let's say it's infinitely leaky.

MR. PRIKRYL: If it's infinitely leaky, then yes, it would play a role in the mining operations.

JUDGE BARNETT: Well, it would play a role, but would it play a role in containing the fluids?

MR. PRIKRYL: If it was infinitely leaky, it would not.

JUDGE COLE: So you could just use uranium mining from the Fall River and the Chilson, so two aquifer for mining.

MR. PRIKRYL: That's a possibility, yes.

JUDGE COLE: Has that been considered?

MR. PRIKRYL: I'm not sure if the Applicant or the Licensee has considered that, no.

JUDGE COLE: Thank you.

MR. DEMUTH: Judge Barnett, if I could weigh in on that question?

JUDGE BARNETT: Yes.

MR. DEMUTH: Sometimes the definition of leaky can become kind of nebulous. The room is kind of dark here, well, what's dark to me is different than what's dark to you.

And so 1569 states that we have to have demonstrated that we can control fluids and there's different ways to do that. One way to do that is with geology. One way to do that is operational practices where you maintain a net bleed or a combination thereof.

JUDGE BARNETT: Maintain what, sir?

MR. DEMUTH: A net bleed meaning you over produce, you produce more fluid than you re-inject.

JUDGE COLE: That's what controls the flow.

MR. DEMUTH: Correct.

JUDGE COLE: Where you have a hydraulic radiant that's flowing towards the collection wells.

MR. DEMUTH: Even -- well, 1569, the verbiage is an aquitard, meaning restricting flow, not an aquiclude meaning that it doesn't allow any flow to occur at all. So concrete, depending on how long it's cured has a permeability that one can measure under enough stress. We refer to it typically as impermeable.

So in this case, the Fuson shale, has it been demonstrated that it is a confining unit such that ISR operations can be safely conducted. Yes, it has. But to add to that, we've had sites before where we had what looked like an unplugged exploration borehole that penetrated the confining zone, but yet, through engineering practices and hydraulic control, we were able to safely mine that as well.

JUDGE BARNETT: Okay, could we put up APP-017, please? And I believe this is page 2. I'm not trying to trap anybody here, I'm just trying to make sure I understand. Is it possible to blow that up a little bit so we can read the formations?

So as I understand it, the recovery is going to be done in the Chilson member of the Lakota formation and the Fall River formation, is that correct

MR. DEMUTH: Yes.

JUDGE BARNETT: So my question is if the Fuson shale is leaking, what difference does that make?

MR. LAWRENCE: It depends on the locations. The wellfields in some areas you might only have a Chilson wellfield or a Chilson mineralized zone that you're going to extract from. In other areas, it might just be the Fall River. There are locations where they are stacked where you have ore in both units. We're required, the Applicant is required, to maintain the fluids within the wellfield that's being mined. So in the case where you would have an overlying Fall River that did not have mineralization and you were producing from the Chilson, you would be required to maintain your fluid control in that Chilson. So you would place monitoring points in the Fall River to demonstrate that you were not losing control of your fluids.

JUDGE COLE: So you wouldn't have any screens taking in liquid from the Fall River?

MR. LAWRENCE: No stream, no, sir.

JUDGE COLE: Screen.

MR. LAWRENCE: Oh, screen. Correct, yes, right. The wells will be designed so that they are discretely screened in the zones that they need to be for purposes of monitoring. If we are trying to monitor, if there are impacts to the overlying aquifer, then those monitor wells would be screened specifically in that zone and not through the confining unit into the deeper zone.

JUDGE BARNETT: So if I understood it then, you do need for the Fuson shale to be relatively impermeable. Is that correct?

MR. LAWRENCE: Correct.

JUDGE COLE: Unless you're going to mine two aquifers.

MR. LAWRENCE: You would technically still need to maintain fluid control in each of the specific wellfields. At the end of the day you have to go through restoration for both of those wellfields, so it might be a little confusing if fluids are moving back and forth. But you still have to clean them both up to a year.

JUDGE COLE: Wouldn't it be one wellfield with a leaky aquitard in the middle?

MR. LAWRENCE: Well, keep in mind the Fall River and the Chilson are both over 100 feet thick. Typically, your ore zones are only 5 to 10 to 15 feet at the maximum. So when we kind of look at the Chilson, we say we're going to produce out of the Chilson, it's actually a very small portion of the Chilson that we're really producing out of. So those wells, the screens are set up so they're screened only across the mineralized portion of aquifer. So it's a very controlled system.

Each one of these well patterns, there's typically 100 feet on the side, so a little bit bigger than this room. We have very tight control in the geology. We have very good control on how the fluids are being transferred back and forth where they're being injected and how they're being pumped out.

And so we're not really -- we look at the Chilson, but we're not producing the entire thickness of the Chilson or the entire thickness of the Fall River at any one point.

JUDGE COLE: So using two mines is a pretty rare event?

MR. LAWRENCE: It happens. You can have contiguous production, but you get into difficulties because you start getting interference between the different pumping units. So it's a lot easier to produce one unit and typically I think what they'll do is they'll start from the bottom and work their way up. Keep in mind, you might have two or three different ore bodies just within the Chilson and they may be stacked vertically. So you'd want to produce one and extract as much as you could. Do the restoration, and then move up the hole, up the stratigraphic sequence.

JUDGE COLE: Thank you.

JUDGE BARNETT: Mr. Clark, what is the exhibit number for the FSEIS? I'm having trouble finding that.

MS. JEHLE: 009, NRC-009. It's four or five -- five or six parts.

JUDGE BARNETT: I didn't mark my citations as clearly as I had hoped.

MS. JEHLE: Excuse me, 008A through B.

JUDGE COLE: The Final EIS is four parts, NRC-008-A1, A2, B1, and B2.

JUDGE BARNETT: So on page 3-34 of the FSEIS, I'm going to address this question to the Staff and the Applicant. It's page 206 of the PDF.

Go to the last paragraph. There you go, right there, it's fine.

So I'm reading from the second sentence of the last paragraph in the FSEIS and it says, "Based on the 1979 aquifer test, Boggs & Jenkins, 1980, suggested there may be a direct connection between the Fall River and the Chilson aquifers with the Fuson. Additional aquifer pumping tests conducted in the Burdock area in 2008 also demonstrated hydraulic connection between the Fall River and the Chilson through the intervening Fuson shale. Interpretations of both the 1979 and 2008 pumping test results were found to be consistent with a leaky confined aquifer model. The Applicant developed a numerical groundwater model using site-specific geological hydrologic information. Based on the results of the numerical model, the Applicant concluded that vertical leakage through the Fuson shale is caused by improperly installed wells or improperly abandoned boreholes."

So it appears in the FSEIS that it acknowledges that it is leaky, whether it's coming from boreholes or whatever else, it is leaky.

I'll ask the Staff, is that correct? Am I reading that correctly?

MR. PRIKRYL: Yes, that's correct.

JUDGE BARNETT: Would you concur with Powertech experts -- concur that the Fuson is leaky, for whatever reason? Improperly plugged boreholes or whatever reason?

MR. LAWRENCE: You're asking Powertech?

JUDGE BARNETT: Yes, asking Powertech.

MR. LAWRENCE: Yes, there were certainly conditions that demonstrated communication.

JUDGE BARNETT: Back to my question, if these things -- if it has to be -- if you're depending on it not being permeable and it is leaky, regardless of what's causing it, how then are you meeting your criteria for not impacting the environment?

MR. LAWRENCE: That goes back to the development of the wellfield data package. If you run a specific test in the area that you plan to mine, and identify leakage that is occurring, particularly if you can identify that it is an improperly abandoned borehole or improperly constructed well, as was the case in these tests, you can remedy that situation, plug that borehole, rerun the tests and show that basically you have retained confinement.

JUDGE BARNETT: And all that would occur outside the FSEIS?

MR. LAWRENCE: Yes.

JUDGE BARNETT: Also, if I go to OST-9 please. And this is at page 61. It's actually on page 63 of the document. I'm sorry, 63 of the exhibit, page 53 of the document. Right there. Actually, you can see somebody has made the notation in the margin there.

So I'm reading from this. This was TVA's report of how do you respond -- I'm going to ask this of the Applicant and the Staff, how do you respond to TVA's conclusion that the "results of the aquifer tests at the project site suggested that the Fuson shale is not an effective barrier near and northeast of the shaft site"?

MR. LAWRENCE: If you'll notice in the top of that paragraph, the very first line says "a second aquifer test was run in which an inflatable packer was used to isolate the two aquifers."

The problem with these tests was they drilled one well as you pointed out and screened it in both intervals at the same time and they counted on running an inflatable packer between the two zones of interest to run two different tests. Personally or professionally, I would never do that. I'm not sure why they ran it that way. Some people feel like packers are an adequate way to isolate zones, but in a case like this where you're trying to demonstrate you have isolation, I think that was a terribly designed pumping test.

JUDGE BARNETT: So your conclusion is TVA was incorrect?

MR. LAWRENCE: I am.

MR. DEMUTH: If I might add to that, Judge Barnett, the objective of these tests were to evaluate underground mining operations. This was not conducted for ISR operations. And in addition, the pumping rate as noted in the second to top paragraph was 261 gallons a minute.

A different objective is a different type of test.

JUDGE BARNETT: I understand that, but if the aquifer -- I'm sorry, the aquitard is leaky, it's leaky, right? It doesn't leak under certain tests and not under others. Maybe you can see it better in certain tests and not others, but if it's leaky, it's leaky. Is that correct?

MR. DEMUTH: I would not dispute that, but again, what type of flux do you need to have where it's a problem or it's not a problem?

JUDGE BARNETT: That's what I'm asking you.

MR. DEMUTH: Okay. Well, in this case, our data indicates that there is not sufficient flow across the Fuson where it's an issue, except in one area where we have a well which is completed in both zones and allows it to communicate. There may be one or two unplugged exploration boreholes which are identified in the application. So in that area, the wellfield, any wellfield test is going to have to be examined very carefully.

Other areas of the site we don't see the same issues.

JUDGE BARNETT: So do you contend now that based on the information you have, the Fuson shale is not leaky?

MR. DEMUTH: I'm not saying that. I'm saying that the Fuson shale has properties which support safe ISR mining for the site. And again, leaky is kind of a nebulous term. We have to define that. How much flow do we have across there? An aquifer sufficiently restricts flow such that ISR operations can be safely conducted. That's what we're looking for.

JUDGE BARNETT: I'll ask the Staff the same question. How do you respond to that statement from TVA, their conclusion that the Fuson was leaky or I'm sorry, that it is not an effective barrier near and northeast of the shaft site, understanding there's no shafts in this case? I understand that.

MR. PRIKRYL: Judge Barnett, I don't see that statement on this page anywhere.

DR. LaGARRY: Judge, I think as you were scrolling down from where you initially stopped on the page, I think one or two pages upwards I believe I did see that statement.

JUDGE BARNETT: Correct, correct, you're right. It's at the bottom of that page. Bottom of document page 53. Do you see it there now? I'm sure I saw it a minute ago. I have it in my notes.

DR. LaGARRY: Right at the bottom of page 51 in the document.

JUDGE BARNETT: Oh, page 51, okay.

DR. MORAN: I thought it was on page 53.

JUDGE BARNETT: Yes, I see it.

MR. PARSONS: Your Honor, if I may, Jeff Parsons, over here. It is on page 51. It appears to be in the third full paragraph.

JUDGE BARNETT: There we go. Third full paragraph, right there. "Results of aquifer tests at the project site suggest that the Fuson shale is not an effective barrier near and northeast of the shaft site." What is the Staff's response to that?

MR. PRIKRYL: Well, I'm not familiar with this pump test, what shaft they're talking about or what the location of the pump test itself.

JUDGE BARNETT: So this is --

MR. PRIKRYL: So I don't know if I can comment on this.

JUDGE BARNETT: This is in evidence. It is OST-009, TVA Draft Environmental Statement Edgemont Uranium Mine. So has the Staff looked at that document?

MR. LANCASTER: 1979 document or 1980 something document?

DR. MORAN: It's 1980.

JUDGE BARNETT: Has the Staff looked at that document?

MR. LANCASTER: These TVA -- we requested this information in our REIs and I think as I recall their conclusions were it's leaky because of a variety of reasons. And one could be the boreholes not being properly abandoned or not being abandoned at all with the correct procedure for plugging and that sort of thing.

We recognize that the pump tests show that there is leakiness. We also recognize that the modeling of effort performed by Powertech that we reviewed as far as it's set up and assumptions and input data and that sort of thing.

That model, as I understand it, that Powertech did using the site data showed that this leakiness can only be explained by -- or the model would only work if it was a leaky borehole situation. And so, with the pump test showing this leaky nature and the model effort showing that it's plausible or a plausible explanation would be the unplugged boreholes.

Errol could respond to this better than I could, but we've looked at these documents under the safety review.

JUDGE BARNETT: Yes, I'm not doing that. My question is how do you respond to TVA's conclusion that there was not an effective barrier? Do you reject their conclusion? You've looked at it.

MR. LANCASTER: Well, their wording of effective barrier, that's sort of an ambiguity to me. What are they really trying to say there? Effective barrier. An aquitard -- and depending on the use of the groundwater, what you're trying to do, it could be you may need hydrologic conductivities that are much higher and thicknesses that are much higher. It depends on the application.

I would -- see, that's -- as far as the effective barrier question, I don't want to skirt the answer here, but I would say that Staff recognize that we're dealing with a leaky aquitard and our conclusion was that it's associated primarily with the borehole situation. Does that answer the question?

JUDGE BARNETT: My understanding, see if I've got this right, from the Applicant and the Staff is you can see that it is leaky. Your conclusion is that it's due to unplugged boreholes. Am I correct in that?

MR. LAWRENCE: For the most part correct. Now the data that was derived out of these pump tests was incorporated into the numerical model to address the site conditions. So we didn't ignore this data. The numbers that you see up there for the Fuson vertical hydraulic conductivity, the permeability of the Fuson are on the order of the 10 to the minus 4 feet per day. The conductivities, the hydraulic conductivities for the Chilson and the Fall River, are more on the order of one to ten feet per day. So there's a five order of magnitude difference between the horizontal hydraulic conductivity of the zones we want to mine and the vertical conductivity of the confining it.

If you look at standard textbooks, Freeze & Cherry will tell you a ten-fold difference -- a one order difference in magnitude is enough to cause predominantly horizontal flow when you've got a pumping scenario going on. So even though there is some measurable drawdown in the overlying or underlying units when we run the pump test, it is small relative to the impact within the aquifer that's going to be mined. And I think that was shown well with the modeling that honored this data.

JUDGE BARNETT: Can you answer questions about the model?

MR. LAWRENCE: Yes, I can. I developed the model.

JUDGE BARNETT: So the model, as I understand it, it's been a long time since I've had groundwater, the model as I understand it, you're fitting a drawdown curve with your model. Is that correct?

MR. LAWRENCE: No, actually, this is a numerical model where we construct --

JUDGE BARNETT: It's a numerical model. But you're trying to fit a drawdown curve -- drawdown data, not a curve.

MR. LAWRENCE: It's more extensive than that. You're talking about using an analytical curve matching methods?

JUDGE BARNETT: No, I don't mean that. The data that you're trying to model is the water levels, is that right?

MR. LAWRENCE: Water levels, drawdowns, correct. But on a regional scale.

JUDGE BARNETT: But you had to add leakiness of this aquitard to fit your data, is that correct?

MR. LAWRENCE: What I did was I put the parameter values in that were measured in the field. So I was honoring the data that was available and again, we get back to this nothing is impermeable. Under enough stress, you can cause concrete to leak. So these particular tests were designed to evaluate for dewatering of an open pit mine. They were much higher rates. They were ten times greater than the type of rates that we're going to see certainly any particular well pattern. So the stresses were greater in this than they would be for ISR mining.

JUDGE BARNETT: But your modeling showed that that Fuson was leaking, correct? Your conclusion was that it was unplugged boreholes, but it was leaking. You had to add that to your model to fit the data, is that correct?

MR. LAWRENCE: Yes.

JUDGE COLE: So if you were planning to use that for ISR mining, the commitment that the Applicant has to plug these holes would apply. Is that correct?

MR. LAWRENCE: That is correct. That is a license condition.

JUDGE COLE: Then you have to change your model to account for that.

MR. LAWRENCE: If the Applicant wishes to use the model for additional predictive simulation, yes, we would have to update the model. But then again, if that was the case, we would update the model based on whatever new information we'd gathered from additional well installation, additional pumping tests.

JUDGE COLE: When you describe it as an effective barrier, it's not perfect. It has some leakage, but it's within a range that you considered to be acceptable and it will not modify what you want to do significantly?

MR. LAWRENCE: That is correct. It is in the same range that we see at other ISR facilities that operate.

JUDGE COLE: Thank you.

MR. DEMUTH: If I might add to that, Judge Cole, it also has to be within a range that NRC Staff who have reviewed the wellfield data package feel is acceptable. So it's not just the opinion of Powertech. NRC Staff would review that information.

JUDGE COLE: So the Staff has some parameters that they apply to this to say what's acceptable to become an effective barrier?

MR. DEMUTH: Yes, sir.

JUDGE COLE: All right, thank you.

JUDGE BARNETT: Okay, Dr. Moran. So still on the leakiness or not of the Fuson shale. In Mr. Demuth's written testimony, he says that if two aquifers are hydraulically connected, the potentiometric surfaces will be approximately the same. Do you agree with that?

DR. MORAN: Could I see the original?

JUDGE BARNETT: Yes. It is Exhibit APP-013 at Answer 32. Answer 32, it is the next to the last sentence in the first paragraph, "If there were a strong hydraulic connection between the two aquifers at this location, the water elevations would be similar." Do you agree with that?

DR. MORAN: I would agree with it in a static situation, unpumped, unstressed.

JUDGE BARNETT: Okay. Then if we look at APP-017, it's the third figure, I believe, right there. This is from Mr. Demuth's testimony and he's showing that there is differences in the head between the Fall River and the Chilson and he's alleging that if it was leaky those heads would be approximately the same. What is your conclusion based on that figure?

DR. MORAN: I don't know that I would conclude much from the figure. It's again that these are static situations and we have a lot of other information from active pumping tests where we see evidence of leakage. And the authors of the actual pump tests did not claim that it -- they made mention of the fact that in some cases there could be leakage through boreholes, but in other cases they were alleging or interpreting the results as though it was general leakage through the confining unit.

JUDGE BARNETT: I need just a minute if somebody else wants to go.

JUDGE COLE: This is for Dr. Moran and Dr. LaGarry. I don't know whose pre-filed testimony this appeared in, but you refer to regional structural features such as the Dewey fault zone. This might have been yours, Dr. LaGarry. And the Long Mountain structural zone. Now the location of those, the Dewey fault zone is about one mile north of the mining area.

DR. LaGARRY: Yes.

JUDGE COLE: And the Long Mountain structural zone is about 14 miles southwest.

DR. LaGARRY: Yes.

JUDGE COLE: So they're not contained within the mining area.

DR. LaGARRY: Yes.

JUDGE COLE: You suggested features associated with these zones may provide pathways for ISR solutions to migrate outside the production zone.

DR. LaGARRY: Yes.

JUDGE COLE: However, you do not refer to any publications identifying site-specific faults within or adjacent to the Dewey-Burdock site unless you consider a mile away close.

DR. LaGARRY: I do consider a mile away close.

JUDGE COLE: Even when the groundwater is traveling, you know, somewhere between one and six feet per year?

DR. LaGARRY: In my previous experience, I was a geological mapper and stratigrapher with the Nebraska Geological Survey. And we mapped many, many, many faults in northwestern Nebraska and adjacent South Dakota. And our finding is that these things occur in sets. And so you would have perhaps scores of joints and faults all aligned, going in the same direction because the rocks they pass through are brittle.

So then what's quite often the case is that the most dominant of these features stands as a representative for the whole set. So if somebody found a fault and they called it the Dewey fault, then what they might, in fact, be seeing is a zone several miles wide in which the largest crack with the most offset is, in fact, the one they identified.

This is true of well-known faults like the Toadstool Park fault; the White Clay-Sandoz Ranch fault in which a major fault of perhaps 100 meters of offset is well noted in the scientific literature. But you can go north and south of the White Clay fault and find multiple sets of these things. And the reason why I considered the faults noted close to Dewey-Burdock is that faults and fractures are ubiquitous throughout the entire region and it seemed entirely implausible to me that these sets of faults across the entire southern Black Hills region prevalent in rocks that we've been mapping for upwards of 20 years, that there should suddenly be a blank spot in a map.

It seemed far more likely to me that whatever United States Geological Survey studies that were done used this practice of assuming that the joints don't matter or the small offset faults don't matter and that instead they identify and recognize the major fault. These things are such that if you're not specifically looking for them, then you often don't find them and for some structural geological purposes all you have to do is identify the major one. For example, in the case of the White Clay fault which goes from the southern Black Hills into Nebraska to the border of Cherry County, there is one fault in the scientific literature.

However, we repeatedly demonstrated and

published that there are scores of ancillary things. It's called an imbricated fault in which the entire region is fractured. The faults might be a couple of tenths of a mile apart, but the largest crack is chosen as a representative of the entire set. And so that's why in my opinion that a well-marked, well-known fault identified in the -- prior to the work there at Dewey-Burdock could, in fact, be a representative of a standing of an entire set of faults.

JUDGE COLE: Okay, so you say it's possible.

DR. LaGARRY: In my opinion, it's most likely that that fault represents --

JUDGE COLE: Even though there are no reports of faults or structural problems within the 16 square mile area proposed for ISR mining?

DR. LaGARRY: Prior to geological mapping that we conducted with the Nebraska Geological Survey, there were no faults recognized in northwestern Nebraska either, except for these major ones that had been noted in the older literature.

Depending on what a geologist's purpose is, sometimes they note them, sometimes they don't. Other times, they are so ubiquitous and so common that the geologist doing the work just assumes that everybody is aware that they're there. So in the case of this mining activity in a place such as Dewey-Burdock, it's no different than the areas in northwest Nebraska that had gone 150 years of geological research, at least research going back to the early 1890s, didn't notice any of these faults. However, they are there and we've discovered them subsequently. So to me, it's clear that in an area that hasn't been prospected specifically for sets of joints and faults, that they might not have been noted in the older scientific literatures.

JUDGE COLE: We've got 6,000 holes poked in the 16 square mile area.

DR. LaGARRY: That's right.

JUDGE COLE: Wouldn't these have identified faults somewhere in that area?

DR. LaGARRY: If the faults are not -- if the boreholes are not cherry picked, because let's say there's 4,000 boreholes --

JUDGE COLE: I don't know what that means, cherry picked.

DR. LaGARRY: Cherry picked means picking the ones that support what it is you want to do.

JUDGE COLE: I assume they didn't do that.

They were looking for something else.

DR. LaGARRY: Now the discussions earlier about the new data that's available, it's very likely that if you have 4,000 boreholes to look at --

JUDGE COLE: Six thousand.

DR. LaGARRY: Six thousand. But then you select say a thousand of those, you select one sixth that suits your purpose. There may be faulting, fracturing, jointing, all sorts of secondary porosity present that you could see in the ones you didn't select because not all of these things are going to go through. Let's say your interest is an ore zone and you're interested in defining where the thickest parts of the ore is. Very few of them might actually go through the orebody, but there may be scores of them surrounding the orebody that could eventually have some bearing on the activity being conducted.

JUDGE COLE: TVA poked a lot of holes in the ground some years ago.

DR. LaGARRY: They did.

JUDGE COLE: In any of TVA's reports that you might be familiar with, did they indicate that there might be some faults in structural zones there?

DR. LaGARRY: That one that was just shown that we were just discussing, the TVA concluded that the leakage might have been caused by an unplugged borehole or some previously as yet undescribed structural feature in that very page we were just reviewing.

JUDGE BARNETT: Yes, actually, if I can follow up here, Judge Cole.

JUDGE COLE: Sure.

JUDGE BARNETT: Could we pull up OST-009 again at 60. This is the TVA environmental report. I think what we're looking for is page 51 again. Actually, page 50 of the document. I'm sorry, page 50 of the report. Page 60 of the exhibit. Go down to the next to the last paragraph. There you go, right there.

So I'm reading the next to the last paragraph. "Faults and fractures associated with the Dewey and Long Mountain structural zones which trend northwesterly (sic) through northwestern Fall River County are believed to affect groundwater movement and may be of considerable influence in future aerial effects of drawdown caused by mining."

I'd like to have the Applicant and the Staff respond to that. How do you interpret that? How have you addressed that?

MR. LAWRENCE: That looks to me more like a statement of recognition that we have the Dewey and Long Mountain structural zones. It doesn't say that those faults are within the permit area.

JUDGE BARNETT: They are wherever they're going to cause considerable influence in future effects of drawdown.

MR. LAWRENCE: And that's true. One of the things that happened in the test that was done up near Dewey was they put a well on the north side of the Dewey fault and that well had no response during the pumping test. When I developed the groundwater model, I used that as a no-flow boundary, because that's what the data had shown us.

In other words, I was limiting, so there was no flow across either way. Well, if you have a boundary when your drawn down cone expands out with time, once you intercept that boundary, that's as far as it can go. So it would limit the drawdown certainly from the pumping. That doesn't mean that it's going to, in any way, control the migration of fluids out of your control.

JUDGE BARNETT: I believe that Powertech's conclusion was that there were no faults or fractures on the site. Is that correct?

MR. LAWRENCE: Correct, on the site.

JUDGE BARNETT: Does this paragraph seem consistent with that?

MR. LAWRENCE: Again, I think that is regarding the faults and fractures in the zones that are outside the permit area.

JUDGE BARNETT: I'd like to hear the Staff's response to that.

MR. PRIKRYL: Well, with regard to the faults and fractures, the Dewey fault zone is outside the license area and it's about one mile outside the license area. And the Long Mountain structural zone is about 14 miles southeast of the licensed area.

JUDGE BARNETT: So TVA's conclusion, it may be of considerable influence in future aerial effects of drawdown caused by mining, that's happening outside of the area? Is that not in the Dewey-Burdock site, but outside?

MR. LAWRENCE: Correct. You get a drawdown cone that expands out. The modeling that I did show that you have some effects a couple of miles away from the site in terms of drawdown, but into the north, you're limited, and to the east because you actually run out of Fall River and Chilson, it's eroded away there. So in those areas outside of the permit boundary, you are still going to have some impacts from mining and that's been demonstrated with the model.

JUDGE COLE: Dr. Moran?

DR. MORAN: I would actually like to take a quick fluid break myself before continuing because I think there are some important things to add on that, but I'd like to -- is that possible?

CHAIRMAN FROEHLICH: We can keep going.

DR. LaGARRY: Can I direct you to the next paragraph below the one we just reviewed? "According to Walcott and Bowles, large volumes of water may migrate upward from the Minnelusa along solution collapses in breccia pipes associated with fractures." So the TVA recognizes that the area is fractured, but yet those individual fractures have remained unmapped.

So the older literature, in my experience, considers a lot of the things that concern me. I mean it doesn't have to be a fault with offset. There's joints. Joints are cracks in the rock, often closely spaced. They don't show any offset or structural movement. But these joints fall under what hydrologists call secondary porosity. They can hold and transmit water. But if they're ubiquitous in an area, they're often unmapped and ignored because they're ubiquitous.

So what people are after is the new, the different, the unique, the showy, the big offset of a big fault that you can tie to some sort of other events in the region. So this TVA report recognizes that the whole area is fractured and that breccia pipes form along these fractures, but they didn't make it into the scientific literature for maps. But if I was to take a geological mapping field crew out there, we would find them because we're looking for them.

JUDGE COLE: With these 6,000 plus boreholes in this relatively small area, wouldn't there be some evidence there of discontinuities in the --

DR. LaGARRY: If we could review them all, there very might well be. And in fact, there may be many because that's the -- although that kind of data density isn't necessarily useful for something like defining an orebody or perhaps hydrological modeling, for stratigraphic work which is what I do, they're essential because if you have 100 feet between 2 data points, between 2 boreholes that can accommodate dozens of joints that would be invisible otherwise. So the more data you have, the more data points with 6,000 boreholes to look at, one very well might find many, many, many of these cracks and fractures and might be able to trace them all through the project area.

JUDGE COLE: Well, in looking at an e-log, how -- is it easy or difficult to identify if there's a fault somewhere in that pile?

DR. LaGARRY: You have to look at the closely spaced ones and look for small differences in offset between them. And so it will largely depend on the quality of the logs, but if the logs are standard quality and there's enough of them and you can follow lithologic breaks as noted in the logs, you will see small amounts of offset. It's typical, the example I cited earlier of the White Clay fault which has the big one that everybody maps, has tens of meters and sometimes scores of meters of offset. But you go to the ancillary ones, the ones that radiate north and south of it and they might have a meter, two meters, three meters, four meters, five meters of offset which the original investigator didn't think was worthy of mentioning so they only mapped the big one. But for the purposes of such projects and containing fluids and the maintenance of confining layers, you know if you can recognize these things, what you're doing is you're recognizing an open pipe across which -- through which fluids can migrate, both up and down and side to side. So the more dense the data, the better.

JUDGE COLE: And you're saying that this hasn't been investigated?

DR. LaGARRY: It hasn't been specifically investigated. I would find it -- enough of these things might be fatal to such an activity, and so there's really no incentive to spend a lot of time hunting for faults and joints, unless of course, that's your structural geologist or geologic mapper and you're looking for faults and joints.

JUDGE COLE: So the people that were reviewing these logs just weren't looking for that kind of thing?

DR. LaGARRY: They may not have been. One of the things I find in my own work is that prior to the widespread adoption of plate tectonics theory in the 1980s and '90s, and this includes a lot of the older scientific literature from this region, people made the assumption that rocks were more bend-y than break-y. And so they would go around -- because they used modeling clay. They used Plasticine and a big vice and they pressed the vice and they watched all the Plasticine bend and they said oh, yes, that's the geological structure we've got here. But since the advent of plate tectonics theory and the idea that the earth's crust is thin and brittle, work that's done in the 1990s and younger, makes this assumption in their work that any time there's a fault or a fold, people expect to see lots of these joints and fractures in the rock.

So it's a thing commonly overlooked in older scientific literature which is why site characterization on the ground is so important in a situation like this because as mining goes forward and they get to the wellfield specific data and they go forward in mining, these things pop up. And they're not considered and they're not taken into account.

From my reading of the technical reports and the maps provided, you can -- there's faults in the area are visible from outer space, from space shuttle radar. We've used them at other ISL sites in northwest Nebraska to locate faults that bisect the orebodies that were never found in Environmental Impact Statements or planning documents for mines. If you're specifically looking for them, then you find them. If you're not specifically looking for them or your focus is some other aspect of the geology, then typically you don't see them.

JUDGE COLE: Mr. Moran, you had indicated to me that you had a contribution to make in this other discussion we were having and part of this.

DR. MORAN: What I've heard of Dr. LaGarry's comment, I totally agree with, first. Secondly, essentially all of the old TVA-related reports and the AEC-funded reports and the old USGS reports from the '60s, '70s, and '80s, all state that there are faults and fractures that affect groundwater movement in the area. In most cases, it is true that they're not talking specifically about that specific site, but many of them are right around it. And when you overlay the site boundary for Dewey-Burdock on top of some of the new satellite images, you can see that you're darn close and that some of the other structure goes right through it.

MR. DEMUTH: Dr. Cole, if I could add to that. I agree with Dr. LaGarry in some situations. In regional structures, you can have multiple features. They're not a line on the map. And often you can have a disturbed zone that might occur over several miles and we see that with mapping that's been done on the Long Mountain structural zone and with the Dewey fault. The southernmost identified portion of the Dewey fault is to the north of the site and does not occur on the site.

Secondly, contrary to what Dr. LaGarry

stated, Powertech is in the business of moving fluid to produce uranium. So a thorough understanding of the subsurface geology is really key to that. And if there are faults that impacts their operation in terms of producing uranium. So their interest, rather than being to not pay attention to the details rather is to pay great attention to the details.

In addition, we have worked several ISR projects that successfully mined with faults in the orebody. So the fact that there might be some small scale features in the orebody is not a deal killer and in addition, as hydrogeologists, we have other information. We have water level information. We have gradient information. We have all this other information that tells us about continuity or lack thereof in the groundwater system. So there's more than just the geology. There's more than a surface liniment that goes into understanding the conceptual model. So we have lots of pieces of information to support the conceptual model that's been presented here.

JUDGE COLE: All right, thank you.

JUDGE BARNETT: Okay, we've talked about the leaky aquitards or not, and faults and fractures a little bit. So I want to switch gears and talk about breccia. And my question is for Dr. Moran. I'm going to quote something from your testimony here and you can see it if you want. As you state, "Breccia pipe solutions or collapsed features are present in the project area that are critical to analyzing the hydrological baseline and project impacts." Is that your testimony?

DR. MORAN: Could I see the original, please?

JUDGE BARNETT: Sure. OST-1 at 21. So your expert opinion. Is that -- do you stand by that?

DR. MORAN: Yes.

JUDGE BARNETT: Okay. In the FSEIS which is NRC-008-A1 and it's at 191, and the very last paragraph. And I will let you read that. Very last paragraph about breccia pipes.

DR. MORAN: Okay.

JUDGE BARNETT: And I'm going to ask a question about the last sentence. "The Applicant presented further evidence against the presence of breccia pipes in the proposed project area including field investigations for breccia pipes, a valuation of Inyan Kara water temperatures, regional pumping test results, and evaluation of color infrared imagery."

Have you examined that data?

DR. MORAN: Yes.

JUDGE BARNETT: And that is the basis of your expert opinion is from looking at this data, that there are breccia pipes?

DR. MORAN: It's from the review of the whole package of everything I've read, all the data, all the other reports. It's the sum total.

JUDGE BARNETT: So you disagree with the Staff's conclusion here as stated in the last sentence? Do you disagree with the Staff's conclusion?

DR. MORAN: Yes.

JUDGE BARNETT: Thank you. You've also cited Mr. Demuth's testimony that "results of pumping tests will be provided to NRC and EPA Staff for review and will have to demonstrate adequacy of the minestream that worked prior to our breaking each wellfield." Is that correct?

DR. MORAN: Could I see the original? I don't remember how I said that.

JUDGE BARNETT: Sure. That's OST-018 at pages 3 and 4.

DR. MORAN: And what was your question, sir?

JUDGE BARNETT: Let me pull it up here to make sure I'm getting it right. Okay, it's the very top paragraph on page 3.

So your contention is that the results of this pumping test aren't there now, is that correct? And that they need these results to evaluate the site?

DR. MORAN: Correct. I'm assuming those are the detailed testing that they're proposing to do after license approval.

JUDGE BARNETT: Right. So your contention is that needs to be done now, is that correct?

DR. MORAN: Yes.

JUDGE BARNETT: Based on the procedures that they've outlined, do you have any concerns with the tests that they've proposed doing other than they should have been done now?

DR. MORAN: I don't know the details of all of what they're proposing to do in the future. My main concern was for the public and the regulators to really understand these issues, they have to be able to see the detailed information first, not at the same level that they're going to do later, but at greater level than what we have now.

JUDGE BARNETT: Okay, Dr. LaGarry. This is with reference to your testimony. INT-020 at 1.

I'm looking in your -- looks like the third sentence in your first paragraph there. It says "appears by their testimonies that the Demuth and Lawrence concede that there will be excursions."

DR. LaGARRY: Yes, and what I mean by that is that in the reviews of the technical reports and the Final Environmental Impact Statement, all those documents concede that there are unplugged boreholes, that the confining layers are leaky. But the purpose of the licensing process is not to address those issues individually, that those issues will be addressed individually as individual wellfield plans are developed and pumping begins.

So in our discussions, in the discussions presented here earlier about the -- I consider the Fuson to be not -- to be unconfined. I mean that's not a confining layer. There are the TVA reports and other documents support this idea that the confining layers leak. They might be boreholes. They might be unrecognized structural features, but the bottom line is that they leak. And when the Applicant concedes and the experts, the Applicant's experts concede that yes, this is leaky and it's okay because when we develop a wellfield plan, we're going to detect these things and we're going to fix them as they happen.

The question arose earlier about the pump tests that go on without lixiviant, but when one pumps lixiviant into one of these orebodies, I mean the purpose of the lixiviant is to mobilize what was once a stable mineral contained in a sandstone and mobilize it along with everything else associated with it and then suck it out of the orebody.

So the process of adding lixiviant, let's say I'm going to create a hypothetical situation since we haven't established that there's faults and fractures, but suppose the area was riddled with joints and faults and these were full of the mineral of interest and then when you do a pump test, they're corked up and they're plugged with minerals and they don't have any impact on the pumping test.

But then once you begin to dissolve these things and extract the minerals from the cracks and the joints, you're essentially uncorking the pathways that were previously corked and so now fluids can migrate around. So when writing my opinion, I envisioned a scenario where a wellfield plan was developed and it was tested and provided sound and adequate. But then as the wellfield continues to develop, some of these unplugged boreholes come into play. Some of the unrecognized faults, joints, and fractures come into play. And then the mineralization being taken away from the -- in the pore spaces in the sandstone and any cracks that might pass through there, are creating a situation that the mining process, as it develops, reveals a continuous string of small excursions and minor problems that go on as the mining progresses. Because in my opinion, the site isn't adequately characterized. So that's what I intended to convey in that sentence and also in the following paragraph.

JUDGE BARNETT: Okay, let me go on. Mr. Demuth and Mr. Lawrence, do you concede that there will be excursions?

MR. DEMUTH: No, I do not.

JUDGE BARNETT: Mr. Lawrence?

MR. LAWRENCE: No, I do not.

JUDGE BARNETT: Okay, Dr. LaGarry, you don't question the advisability of having an excursion plan in place, the advisability of including a plan to deal with possible excursions in the FSEIS and in the various documents. It's not a problem that you have procedures to deal with an excursion in the event that they happen. You're not saying that, is that correct?

DR. LaGARRY: That's correct. What I'm saying is in my professional opinion, they'll likely happen and once they do happen, the genie is out of the bottle. What I would have preferred to see through the entire permitting process is rather than defer site characterization to the wellfield stage, I would have liked, like the other expert here to my left to have seen that information to characterize the site beforehand. Otherwise, the potential risk to the public and to the contamination of other aquifers, in my opinion, it's impossible to evaluate that risk adequately.

JUDGE COLE: But they do characterize a site before they start drilling?

DR. LaGARRY: They do.

JUDGE COLE: Before they start mining uranium?

DR. LaGARRY: They do. They --

JUDGE COLE: You mean they do do that?

DR. LaGARRY: They do do that.

JUDGE COLE: Okay.

DR. LaGARRY: But it's like being in a dark room, dark means different to different people. So what's adequate for the purposes of getting a permit in mining is not adequate enough for me to feel safe drinking the local groundwater once mining begins.

JUDGE COLE: I understand, sir.

MR. LAWRENCE: Can I make one point of clarification? An excursion is not a violation of the Clean Water Act. It is an indication that some fluids are moving away from the control of the operator and it allows them the opportunity to adjust their operating parameters so that they can pull those fluids back. So yes, excursions do happen, but that's the whole point of having the monitoring system in place so that they're identified early enough that they can be reversed.

And usually, the indicated parameters are constituents that are not particularly dangerous. They're chloride, conductivity, alkalinity. Those are relatively conservative constituents. They travel basically at the same speed and power.

JUDGE COLE: Well, they're just indicators of what's there.

MR. LAWRENCE: They're indicators. So that is the whole point. We have the monitoring system in place to let us know if there is a problem and then allow sufficient time to respond to that using engineering controls. And you can do a lot of things with pumping a well. You can control things pretty well.

JUDGE COLE: Well, what are the tools at your disposal to control an excursion?

MR. LAWRENCE: Typically, the first thing that would be done is you would change up your operating parameters. Often, when you have an excursion it may be a system, a situation where you have a slightly out of balance wellfield or well pattern. Maybe one of your injectors is putting in a little bit too much water on the corner and so you don't have the hydraulic containment you need. So the quickest way to resolve that is either shut that injector off so that now you get a greater draw in toward the pumping well than you would if the injector was operating. So it's hydraulics. We've been doing this kind of stuff for 50 years. The Russians have been doing it a long time very successfully. It's not new technology. And it's effective.

Where it doesn't work is where you have an undetected release that goes on for a long period of time, then it's a little bit more difficult to pull it back.

JUDGE COLE: How could they have undetected release? Aren't you required to check for excursions in a relatively short time period?

MR. LAWRENCE: Yes. It's usually every

two weeks.

MR. LANCASTER: Your Honor, just if I may refer to a license condition, 11-5. It's every two weeks. We've memorialized their excursion monitoring requirement as well as establishing the upper control limits that he talked about, the chloride, alkalinity, and conductivity.

JUDGE COLE: Yes, I was wondering about that. They're relatively easy to test for. That's why they're indicators because they'll increase if you have an excursion. So if you have an increase in that by a certain percentage, hey, I've got a problem, so I've got to use the tools that I have to take this, get this under control.

But they're so easy to measure. Why don't you do it continuously, rather than once every two weeks? Or do we do it continuously?

MR. LAWRENCE: I don't believe any operators do it continuously. It's certainly an idea. The technology is getting better where you can potentially put continuous monitoring devices in the hole. At that point, I'm sure it's probably a cost issue, just to maintain that equipment.

MR. LANCASTER: Well, I would interject that looking at our existing facilities, I don't think there would be increased benefit to that.

JUDGE COLE: So it's not a problem when you just check this every two weeks in operation?

MR. LAWRENCE: That's right.

JUDGE COLE: And during that two-week period, you also collect some chemical samples, right? Every two weeks during operation.

MR. LAWRENCE: You collect chemical samples if you have an indication based on your excursion parameters that you have an excursion occurring. Then you would go back out and resample, make sure that you still do have a legitimate excursion and then I forget the exact sequence or the timing, but that sort of initiates the whole series of more aggressive sampling to determine if you have any constituents other than the excursion parameters that are showing up.

JUDGE COLE: I thought that in operation every two weeks you check your indicator chemicals and then collect the sample, run everything on that series of chemicals.

MR. LAWRENCE: I don't believe that is every two weeks. I think it's just the excursion parameter because as you said --

JUDGE COLE: Whatever the rules say. That was my read on it.

JUDGE BARNETT: Dr. LaGarry, I'm going to ask you the same question that I've asked several other witnesses. Are you familiar with NRC-091 which is the Staff assessment of groundwater impacts from previously licensed in situ uranium recovery facilities?

DR. LaGARRY: Is that the one that was shown previously that you had highlighted in yellow? Yes. Well, not in the scientific literature. I mean I've been at other hearings like this, not on necessarily a panel, but in the peanut gallery, where a local dentist reported lixiviant coming out of his tap and a local landowner five miles north of the in situ leach mine talked about drilling a water well that turned out to be an artesian fountain spewing yellow-green lixiviant into her yard.

JUDGE BARNETT: Do you have any documentation, anything in the record, any exhibits that will contradict that statement?

DR. LaGARRY: Just the ones that come from the discussion, the testimony presented in 2008 at a hearing like this one. So in the documentation from the Crow Butte case, just those anecdotal instances I mentioned which I believe are in the record of that proceeding.

JUDGE BARNETT: So based on that, you do not agree with that statement, is that correct?

DR. LaGARRY: I disagree with that statement, yes, that's correct.

JUDGE BARNETT: Thank you.

CHAIRMAN FROEHLICH: Dr. LaGarry, in your testimony, INT-013 at page 5, there's a sentence there, you read it one way or you're not familiar exactly what the strata that are being referred to or what's meant by the strata. I guess it would cause some concern. That's the first -- second sentence after perforations by new and existing wells. It's the parenthetical there. The parenthetical says "Along with wells that supply drinking water (the uranium bearing strata that are a local drinking water supply and water for the livestock)" -- can you explain maybe to me what you meant there and the connection between the uranium-bearing strata and local drinking water supplies?

DR. LaGARRY: Okay, so the third pathway --

CHAIRMAN FROEHLICH: Mr. Welkie, it's the fourth line after perforations in the parenthetical. There we go. Thank you.

DR. LaGARRY: Okay, it was my understanding from the documentation I read that the rocks being mined, people drink out of.

CHAIRMAN FROEHLICH: Beg your pardon?

DR. LaGARRY: People drink out of the rocks being mined.

CHAIRMAN FROEHLICH: That's your understanding of the document?

DR. LaGARRY: The documentation I read, yes.

CHAIRMAN FROEHLICH: Could I hear from the Staff and the applicant as to the parenthetical there because at least to a lay person this seems like it would be of concern.

MR. PRIKRYL: If I could take that question?

CHAIRMAN FROEHLICH: Please.

MR. PRIKRYL: The licensee is going to have to get a permit from the EPA to exempt the uranium-bearing aquifer before operations begin. So it would not be a local drinking water supply.

JUDGE COLE: But they could be before they exempt it?

MR. PRIKRYL: Yes. And I think there are some wells that people are drinking the water out of those wells. And I wouldn't advise them to do that.

JUDGE BARNETT: If this site eventually goes forward and everything is restored and Powertech has moved on and there's no evidence out there of Powertech anymore, how will that groundwater exemption be enforced? What would keep somebody new from coming along and then putting a well in the Inyan Kara even though you're not supposed to do that any more?

MR. PRIKRYL: I'm just not sure about how the state or the EPA would enforce their regulations.

JUDGE BARNETT: Fair enough.

MR. DEMUTH: Judge Barnett, if I could weigh in on that. Aquifer exemptions through 40 CFR 146, the underground injection control program, those are permitted exemptions. So that water is removed from being considered as a source of drinking water. However, it's not the entire permit area. The aquifer exemption that's been applied for in the Class III UIC permit prepared by Powertech is an area that surrounds the proposed wellfields and if more wellfields were discovered, then it would be around those wellfields. And within those areas, there certainly would not be an area that somebody would want to go in 50 years post and install a drinking water well. But it wouldn't be of the quality where they would want to do it today anyway.

MR. LAWRENCE: And that exemption applies for drinking water. The wells can be utilized again for stock irrigation purposes if it's suitable for that.

JUDGE COLE: Question for the Staff on excursions, the Applicant or the Licensee, is obligated to -- when they determine an excursion, they've got to pass that information on to the NRC Staff. What are the requirements, time requirements for them to do that?

MR. LANCASTER: Yes, Your Honor, that's also within the same license condition that I referred to before. I think it was 11-5 here. But as soon as they -- the licensee shall notify the NRC project manager by telephone or email within 24 hours of confirming a lixiviant excursion. And then seven days later, they have to submit a letter, something in writing concerning this.

And the requirement goes on with the 60 days, they've got to send us a report, a follow-up report of the corrective actions that were taken and the results of the corrective actions.

JUDGE COLE: Including chemical analyses?

MR. LANCASTER: Yes. So these

requirements are all aid out in our license. We memorialized what has been written and what -- it's consistent with 1569.

JUDGE COLE: License conditions.

MR. LANCASTER: Its license conditions is consistent with 1569, the license condition for excursion monitoring and associated reporting.

JUDGE COLE: Okay. Now so the Staff is then kept up to speed on what's happening and what sort of time limits are involved in that before the Applicant and/or the Staff must do something?

MR. LANCASTER: Well, if it hasn't been corrected within -- I think it's 60 days. Give me a moment, Your Honor.

JUDGE COLE: Okay.

MR. LANCASTER: Okay, yes, so within this license condition which again is consistent with NUREG-1569, if an excursion is not corrected within 60 days of confirmation, the licensee shall either terminate injection of lixiviant within the wellfield until the excursion is corrected, or increase their surety amount, surety estimates, the amount to cover a third-party cost to correct -- cost of correcting and cleaning up the excursion.

JUDGE COLE: That happens after 60 days?

MR. LANCASTER: Sixty days, after 60 days.

JUDGE COLE: Do you have any information on the number of excursions that a typical line operator might have? How often do they get excursions? Are they rare? Do they get one every two years? Do they get one every three months? And on average, how long does it take them to correct the excursion? Do you have any information on that?

MR. LANCASTER: Yes, I don't have any --

JUDGE COLE: Ballpark.

MR. LANCASTER: Well, I deal with a particular operating facility, but I don't deal with all the operating facilities. From my experience with that one operating facility, you know, maybe one to four a year at the most it seems like. These excursions, and some of them are related to fluctuations of groundwater and other things. And it's hard to discern. But regardless, I don't think it's every day that we get an excursion, if that's what you're trying to -- we get reports on excursions.

JUDGE COLE: I don't know. I was asking the question.

MR. LANCASTER: For other operating facilities, I can't talk about those, you know. I'm not involved with those other operators.

JUDGE COLE: Okay, but you have some experience with at least one plant?

MR. LANCASTER: Yes.

MR. PRIKRYL: Judge Cole, can I say something? I think there may be some information about excursions in the GEIS which may provide some information on how many excursions might have occurred during the year or every couple of years or whatever. Thank you.

JUDGE COLE: Do you have any information about frequency of excursions? I'll get to you in a minute, Ms. Henderson.

MR. LAWRENCE: I believe the SER identifies or makes some statements that most excursions are recovered within a day or several days or weeks, so they're relatively short lived.

JUDGE COLE: Ma'am?

MS. HENDERSON: There is a wonderful website called wise-uranium.org that has a huge report on excursions on ISL mining throughout the West, hundreds and hundreds and hundreds of examples where the operator never did anything about it, sometimes for years. And I submit, gentlemen, that a great many of these problems that we are having with groundwater are occurring because of these excursions.

I also would refer you to a National Research Defense Council report called "Uranium Mining, the Dirty Little Secret of Uranium Mining."

JUDGE COLE: Thank you, ma'am.

JUDGE BARNETT: Okay, Dr. Moran, you stated that in your OST-001 at 21 and 22, that "satellite imagery 'shows clearly that this area is intersected by numerous faults and features.' Both circular topographic features can be seen on modern satellite imagery of the D-B site and surrounding area. It is my opinion that these circular features likely represent solution collapsed structures."

Do you remember that?

DR. MORAN: I do. I'll assume that you're reading it as is.

JUDGE BARNETT: Have you introduced any satellite images into the record?

DR. MORAN: I gave to our attorneys last fall a PowerPoint presentation. I was going to give to the state hearing groups and it was sent in to your group last fall.

MR. PARSONS: Your Honor, if I may, the Exhibit 005, those are slides contained within Dr. Moran's PowerPoint.

JUDGE BARNETT: This looks like the

twelfth slide maybe, even thirteenth? Is that what you're referring to?

DR. MORAN: Yes, those images, yes.

JUDGE BARNETT: So I would like to ask the Applicant and the Staff how they would respond to his testimony in that figure?

MR. PRIKRYL: Well, first off, I would probably ask Dr. Moran if he's done any -- had any ground truthing to determine if those are actually faults.

JUDGE BARNETT: Okay, let's ask Dr. Moran. That you done any ground truthing to determine if those are fault?

DR. MORAN: I've been on the site, but I haven't done formal ground truthing, no.

JUDGE BARNETT: Thank you. I interrupted you.

MR. PRIKRYL: And that's also the case for the sinkhole. He's arguing that that possibly could be a breccia pipe. Is that true?

JUDGE BARNETT: Is that the case?

DR. MORAN: That's the case. What I'm -- if I might elaborate a second?

JUDGE BARNETT: Sure.

DR. MORAN: As I said earlier, to me this is just fundamental work that should have been done years ago in this study and it's not -- I don't have all of this confirmed, but I'm simply making the suggestion that these images, one of the most likely interpretations of these images is you've got these kinds of sinkhole features, collapsed structures, yes. Yes, that's my interpretation.

JUDGE BARNETT: Applicants, any response?

MR. DEMUTH: Judge Barnett, if I could, there are USGS publications that have mapped features in and around the site, peer-reviewed documents. So as a scientist, I could take such a satellite image and draw some lines on it, but that would be my opinion and it would really hold no bearing unless there were other experts that had looked at it, reviewed it, and there was some basis in my opinion.

So with all due respect, there's no evidence for this type of interpretation.

JUDGE BARNETT: So you argue that he's interpreting it incorrectly or that he does not have an adequate basis for his interpretation?

MR. DEMUTH: I would not agree with his interpretation.

JUDGE BARNETT: Have you looked at satellite images of the site?

MR. DEMUTH: We've looked at color infrared radar, yes, images, in pretty good detail.

JUDGE BARNETT: Yes, Dr. Moran.

DR. MORAN: If the figures that they have made public are the ones he's talking about, they're not radar.

MR. DEMUTH: You are correct. It's color infrared imagery. Excuse me.

DR. MORAN: I would also add, let me emphasize. I'm saying this is a preliminary interpretation, but I had two of the very best remote sensors in the world confer with me when I put it together. They helped to train the earliest of the astronauts.

MR. LANCASTER: Yes, I would concur, it is very preliminary. I mean this is not hard evidence.

JUDGE BARNETT: Let me interrupt you. I agree it's -- it has been filed as evidence for a long time. I'm asking you now how do you respond to it?

MR. LANCASTER: Well, my response is with my colleague here, ground truthing is always necessary for a preliminary review of aerial photographs and things like that to pinpoint areas where you want to concentrate your study. In this case, we have plenty of data for this area that Staff feels has demonstrated our conclusions. And those conclusions don't agree with this preliminary evaluation method or this information that's being displayed here. We don't see any evidence of this.

JUDGE BARNETT: Did you ground truth this?

MR. LANCASTER: I didn't.

JUDGE BARNETT: Did the Applicant?

MR. LANCASTER: That was our question to -- our question to Dr. Moran is did you ground truth this?

JUDGE BARNETT: And now my question is these satellite images are in the record. Have you ground truthed it?

MR. LANCASTER: Have I gone back into the application documents and ground truthed it? I know we have data in this area and we've come to our conclusions. We don't see -- like for example, for that sinkhole to be a breccia pipe, I'm not sure of the scale of this, but I guess maybe 100 feet.

Dr. Moran, what's the scale on this?

DR. MORAN: I'd have to back up to some of the other images. I'm not sure. But could I clarify one other thing? You can't ground truth it by just looking at the documents. It was submitted, I think, in September or October of last year and part of the reason that I submitted is so that either members of the Board or members of Powertech would go out into the field and ground truth with their own imagery or air photos or something because we're not the permit applicants.

MR. LANCASTER: That sinkhole, what was the answer to the question whether that's -- you were trying to display a breccia pipe maybe? Is that the case here? I need the answer to that question. Is that sinkhole a depiction of a breccia pipe?

DR. MORAN: What I'm saying is it looks like a sinkhole and in the bigger context of the larger image, it's repeated multiple times in other places. And the most logical conclusion of my own conclusion, and these two other absolutely world class remote sensors, is it's probably a solution feature that's being expressed at the surface. And the most likely explanation in this geology is the surface expression of a breccia pipe. And if I might add, numerous government scientists over decades have been alleging that in the area. And I admit that they haven't nailed it down firmly within your site, but it's the most logical explanation given all of the information. And it's up to you guys to have ground truthed it.

MR. LAWRENCE: Can I make a comment? We have wells, monitor wells in that area. If it was a breccia pipe and it was supplying a significant amount of water, we would see evidence of it in terms of the potentiometric surface. We would see a huge recharge mound where that water is coming up. We don't see anything like that. We certainly don't see a huge discharge -- it looks like maybe there's moisture there, but I don't know if that's a topographic effect. There's certainly no running water at the surface. So even if it was a breccia pipe, what's the significance of it based on the data that we have in the area?

MR. LANCASTER: Errol, that's what I was going after was what was our evaluation. Recognize that the underlying aquifers underneath the Inyan Kara are at a different potentiometric situation, so if there is a breccia pipe that comes up through the Minnelusa up into the Inyan Kara, we would have what you were describing or possibly -- you would have some effect on the potentiometric surface and we would see that.

As far as the fault zone there, the -- you're talking about a major fracture system so I'm assuming it's a fault zone. We would see the displacement in the structure maps that were provided. As far as -- I can't read what those two circles down there -- they're dotted, but I mean if you were to take the effort to take the data from the application that's specific to this area and as far as the hydrogeology data, the whole conceptual model that Staff accepted, and all the data that supports that model, I see disagreement in terms of just initial ground truthing.

JUDGE BARNETT: So Dr. Moran states in his testimony, "Neither Powertech nor the NRC Staff have presented any detailed interpretations of the D-B structural geology using high quality satellite imagery." Is he correct?

MR. LAWRENCE: Other than the color infrared, I would say that is correct.

JUDGE BARNETT: Staff?

MR. PRIKRYL: That's my understanding, yes.

MR. LANCASTER: That is our understanding.

JUDGE BARNETT: So why are satellite images not needed? What is your opinion about why you don't need to do that?

MR. LAWRENCE: If we were in an area where we had no subsurface control and doing initial reconnaissance, I would say absolutely, that would be the easiest and quickest way to get a rapid assessment of the site conditions. But keep in mind we have something like 4,000 to 6,000 boreholes of data here that have been used to do extensive subsurface mapping. And that's what we're concerned about is those subsurface units. So it's extra information. It wouldn't hurt, but I think given the stage of this project, it wasn't deemed necessary.

JUDGE BARNETT: Staff.

MR. PRIKRYL: We agree with that. We reviewed the cross sections and the structural maps and they don't indicate any kind of displacement of beds which would indicate a fault.

JUDGE BARNETT: Thank you. Dr. LaGarry, you state in your -- in several places, example OST-013 at 5, that the Applicant and the FSEIS concede that the Inyan Kara is unconfined in some places in the project area. I'm not quoting you exactly there.

DR. LaGARRY: I agree with that statement.

JUDGE BARNETT: Okay. And now quoting, you say "based on this admission, confinement does not exist at the site." Is that your --

DR. LaGARRY: Yes. That's correct. I said that earlier right in front of this microphone.

JUDGE BARNETT: Are you aware that the application states that Powertech does not propose ISR operations in the Fall River and there is where the Fall River is geologically unconfined?

DR. LaGARRY: I do a lot of stratigraphy. And my experience is specifically in terrestrial rocks like these. And most of these things, like I think Bob Moran had a slide that we saw in his presentation, but the systems that create the sandstones, the sandstones are in the shape of ribbons and so depending on the density of data available, if these deposits are generally -- well, there's areas that are discontinuous.

In my opinion, the density of data presented does not conclusively demonstrate that these areas are unconfined. So in the technical report and in the Final Environmental Impact Statement, those two documents acknowledge that it's a leaky aquifer to boreholes or unidentified structures or thinning to zero of the confining layers. They have been -- that situation has been recognized in different places and in different spots.

But I also recognize that based on my mapping experience that without the significant, without more dense data, if you find say a dozen places where it's unconfined, there may, in fact, be several dozen places where it's unconfined. So what I want to see from the Environmental Impact Statement, I want to see if I'm going to look at these studies and be confident oh, and say that's a confined mining situation, I don't want to see admissions and concessions that they found places where it's unconfined.

JUDGE BARNETT: Back to my original question though, are you aware that the application states that Powertech does not propose ISR operations in the Fall River areas and areas where the Fall River is geologically unconfined?

DR. LaGARRY: Yes.

JUDGE BARNETT: Thank you. So this is Exhibit NRC-081 at page 7 on the PDF. So this is that USGS report. I'm going to ask the Applicant and the Staff, are you familiar with that report? It's a Staff exhibit.

MR. PRIKRYL: Yes.

JUDGE BARNETT: Is the Applicant familiar with that exhibit? Okay. I notice that on page 7 and let me -- go on down, please. Yes, stop right there. So I'm looking at the next to the last paragraph, last sentence or two starting with the word "collapse of beds." See where I am there? There you go. Wait a second. Let me make sure I'm at the right place here.

Does everybody see where I am there? I'm reading "collapse of beds overlying the evaporite zone resulted in substantive breccias and breccia pipes that extend upward to the Inyan Kara group. The same process continues today at the margin of the Black Hills. Breccia pipes constitute part of a plumbing system through which artesian waters transported low concentrations of uranium into the formation of the Inyan Kara where sandstone uranium deposits were formed."

Does that have any relevance to the FSEIS?

MR. PRIKRYL: Yes, I think we cite this publication. And also note that we agree that there are breccia pipes near the margin of the Black Hills and these have been identified, but again, no breccia pipes, we don't see any evidence of breccia pipes within the licensed area.

JUDGE BARNETT: Applicant?

MR. DEMUTH: Yes, sir. One of the challenges of permitting this project has been distinguishing the site geology from the regional geology. And there's a lot of good, published information regarding regional geology to Black Hills.

And we certainly don't dispute in any way that there are breccia pipes associated with Black Hills.

However, Gott's own map which is APP-015(f) at 5 clearly shows us that he did not map any breccia pipes on the site. Moreover, the dissolution --

JUDGE BARNETT: I'm sorry, so Gott -- you're referencing his figure?

MR. DEMUTH: I am. Correct.

JUDGE BARNETT: And what exhibit is that?

MR. DEMUTH: APP-015(f) at 5. And this is Gott's map with -- if you could zoom in on kind of the middle left portion, yes, right in there. As you'll notice, the Dewey-Burdock permit area is listed, shown in the black here. And Gott discussed breccia pipes in that they are found in proximity to the outcrop of the Minnelusa formation which is up in this area.

Gott and other USGS researchers have identified a dissolution front. And basically what they're saying is that the breccia pipe features have occurred between the outcrop and down to the front, but they've not been identified in other areas farther downdip. And in particular, he shows no evidence of those features on the site.

JUDGE BARNETT: So this figure in Gott's

report, he comes to the -- I know he wasn't talking about the Dewey-Burdock site, but that dissolution front is his -- that's his or that's something you've drawn in there?

MR. DEMUTH: That dissolution front is from the previous page 4 of this attachment which is a USGS base and they have identified a dissolution front which you'll have to kind of zoom in up in this area. And that dissolution front that is mapped on Gott's figure came from this USGS work. So if I understand, if I read that report more carefully, you contend that I will find that where he is talking about does not extend out to Dewey-Burdock, is that correct?

MR. DEMUTH: Yes, sir.

JUDGE COLE: Is that because the material, the conditions required for formation of breccia pipes involves a certain chemical like anhydride and something else? And when those aren't present, both of them you're not going to have breccia systems?

MR. DEMUTH: That is correct. It's dissolution in the anhydride that results in the collapse features.

JUDGE COLE: Dr. Moran?

DR. MORAN: I'm going to be a little bit

careful and just say I very much disagree with the conclusions that have just been mentioned and I'll say that my opinions on that are in writing. But I'll just add that that dissolution figure is not Gott's original figure. Gott's original figure has been submitted with my written testimony.

JUDGE BARNETT: What exhibit is that?

DR. MORAN: It's in my PowerPoint. I don't know the number. If you want to go back to that PowerPoint, we can.

JUDGE COLE: Number 5 is it?

DR. MORAN: I don't recall. You might back up one just for context. This is a re-drawing of Gott's -- one of his figures. And you'll notice at the top, the stratigraphic position of uranium deposits, just to sort of give you a feel for what he thinks, thought was going on. I'll just add that these were done, the field work was done years before '74. And it would have been before satellite imagery was used routinely. But the figure I was going for is a little further on.

There is the version that Powertech has created. And I think we have, if you go another figure beyond, this is Gott's actual figure. I think I'd rather just be quiet and stick with my written testimony.

JUDGE BARNETT: Well, one of the problems with your testimony is I don't believe that you referred specifically to these figures in your PowerPoint presentation.

DR. MORAN: I thought I did, but maybe I'm wrong.

JUDGE BARNETT: If you can find that, I'd be -- I'd like to see it. I could not find it.

DR. MORAN: Can we find the actual language on the slide of my OST-1?

JUDGE BARNETT: Why don't we take a break and see if we can find it?

CHAIRMAN FROEHLICH: All right, I believe a ten-minute break would be in order. We'll reconvene at 3:34.

(Whereupon, the above-entitled matter went off the record at 3:19 p.m. and resumed at 3:37 p.m.)

CHAIRMAN FROEHLICH: We'll come to order. We'll be back on the record.

MR. PRIKRYL: Judge Froehlich?

CHAIRMAN FROEHLICH: Yes?

MR. PRIKRYL: Could I add something?

CHAIRMAN FROEHLICH: Yes. Yes.

MR. PRIKRYL: I just wanted to get this

into the record. Judge Cole asked about data on excursions earlier.

JUDGE COLE: Yes.

MR. PRIKRYL: And that information is in the GEIS, and that's Exhibit NRC 010-A-1 at page 141.

JUDGE COLE: Could you repeat that, please? I just put my fan in my hand.

MR. PRIKRYL: Okay. It's Exhibit NRC 010-A-1, and page 141.

JUDGE COLE: Thank you. Appreciate that.

MR. LANCASTER: Yes, while we're at it, as far as this operating facility I'm working with, it's more like maybe two every three years that we have excursions reported. I said one to four per year. It's a lot less than that. But it's relatively small. It's not every day. That was the whole point of that, but for the record there you go.

JUDGE COLE: Okay. Thank you.

JUDGE BARNETT: Dr. Moran, I think we left off -- and I'd asked you was that figure cited in your testimony somewhere, I believe. Is that where we were?

DR. MORAN: Yes, and I was reminded that it's on page 22 of my written testimony. OST-1, is it? The second full paragraph I think is what you're asking about.

JUDGE BARNETT: Okay.

MR. LAWRENCE: Can we go back to that map? I would like to see where exactly it is that Dr. Moran seems to think that breccia pipes were located within the permit boundary.

JUDGE BARNETT: Yes, do you have an exhibit number so we can pull it up?

MR. LAWRENCE: It's that one right there.

JUDGE BARNETT: Oh, okay. I'm sorry.

MR. LAWRENCE: Yes. Could you zoom in on the area then where you see the kind of little dog leg and the pink-colored -- yes.

JUDGE BARNETT: Dr. Moran, can you show me where you think the closest breccia pipe to the site would be?

DR. MORAN: Let me respond slightly differently. I have here a paper version of that, which is the original Gott figure. And if you go down and to the right a bit, you'll start to see -- actually, maybe it's better to go to the key, the legend over on the explanation of the -- yes. I'm sorry. Up above. Keep going up, please, and a little bit to the right. Up.

So right in the right-hand column, third grouping from the bottom, topographic depression in Inyan Kara group or Younger rocks. That's what the team that worked with Gott mapped. So anything with a symbol like that or the ones above, area containing structures of possible solution origin, those are what I'm referring to. And several of those symbols are down below. If we go back onto the map, you can see where the USGS in the early '70s had mapped several of those within the Inyan Kara rock.

Now, you have to enlarge it a bit. And some of them would be -- yes, let's go -- it may break up if you enlarge it more, I don't know, but I can hand you the paper copy.

MR. LAWRENCE: Because the permit boundary starts a little bit south of the word "Dewey" there and extends down and over. It starts somewhere about -- in here is about the northern extent and goes down here. So I'm not seeing anything in that area.

DR. MORAN: I think we're doing two things that get us all in trouble, but -- because now you've got the permit boundary going into the Dewey fault zone. But what I'm really saying is --

MR. LAWRENCE: I said south of the Dewey. It says down here.

DR. MORAN: I'm saying that the other

figure which you showed misrepresents what Gott and his field team were saying. And their information on their original map gives you -- maps several locations of possible collapse structures. He didn't prove that there were breccia pipes, but they again are these depressions that a logical geologist would say, hey, I better go out and ground truth it.

JUDGE BARNETT: And your contention is that some of those are on the site, the project site?

DR. MORAN: Or very close, yes.

MR. LAWRENCE: Not according to that map.

DR. MORAN: Well, do you have one of the figures in front of you here? Or we can show it to --

MR. LAWRENCE: No.

JUDGE BARNETT: We can't do this.

DR. MORAN: Do you want to take it back?

JUDGE BARNETT: How do you want to handle this.

CHAIRMAN FROEHLICH: Is that map -- the one that's there, I mean. Is that --

DR. MORAN: It is that figure.

CHAIRMAN FROEHLICH: That's that figure? And can we make lines on the map like we do in Rockville? Can you draw?

PARTICIPANT: I cannot draw.

CHAIRMAN FROEHLICH: Can't draw?

MR. LAWRENCE: If you go back up to the previous -- our version of the map or Powertech's version of the map, you can kind of get a sense of where that property boundary is. And it's basically in the area that's -- where there's nothing.

JUDGE BARNETT: How hard would it be to tonight just hand sketch the site on that and give it to us tomorrow? Is that possible? It doesn't have to be neat or anything, just --

MR. LAWRENCE: I think we could do that.

JUDGE BARNETT: Dr. Moran, could you do the same thing?

DR. MORAN: It's already done on some of the other figures.

JUDGE BARNETT: Well, but it's not on that one.

DR. MORAN: You want it on that particular one?

JUDGE BARNETT: Yes.

DR. MORAN: Well, I mean, it can be done. But it's already on several of my other slides.

JUDGE BARNETT: In this exhibit?

DR. MORAN: No. Of the OST-1, yes. No, I'm sorry. Whatever this is. This is OST-5? Is this --

JUDGE BARNETT: Yes, there no figures in OST-1, I do not believe.

DR. MORAN: Oh, I'm sorry. I misspoke.

CHAIRMAN FROEHLICH: Much of this dialogue won't be helpful since we're going to be working from a written record. I think what has to be done is if there are those depressions or the breccia pipes, you'll have to indicate in what quadrant on the grid that is in this map they appear. And then Mr. Demuth and Mr. Lawrence can look and see if in that quadrant, in that dotted line, that square or rectangular box there is a -- well, I don't think by pointing or drawing we're going to get it very clear. Would that help? Can you --

DR. MORAN: We can do that tonight, sir.

CHAIRMAN FROEHLICH: -- do that tonight?

DR. MORAN: Yes.

MR. PARSONS: Your Honor, if I might add as well, when the question of breccia pipes came up three years ago, the Powertech Staff, including their chief geologist, went and researched and individually looked for these features. In addition, the features that Dr. Moran listed on his satellite imagery, they went on and looked for those features as well.

CHAIRMAN FROEHLICH: Let me make sure I understood that. So they have taken, someone from Powertech took the satellite images that Dr. Moran has introduced into the record and ground truthed those?

MR. PARSONS: That is my understanding, yes, sir.

CHAIRMAN FROEHLICH: Is that person here to testify today?

MR. PARSONS: He's here. I don't know if we can put him under oath or not.

CHAIRMAN FROEHLICH: There's nothing to prevent us from doing that. I'm not sure how many questions we'll have for him or how far you want to take this. If it's just a matter of corroborating whether that had been ground truthed and logical follow-ons from that and it's very limited, there would be no problem, at least from the Board's perspective. I don't know if Staff or the Intervenors would object to such a procedure.

MR. PARSONS: Your Honor, if I may, it sounds like there may have also been some analysis done or some report or other information that I'm not sure -- I mean, we're getting back into some of the issues of disclosure. If there are additional data or any other information like that, documents, I think that that may be part of the inquiry as well.

CHAIRMAN FROEHLICH: Do I understand that you don't oppose the swearing in of a live witness in the proceeding to follow up on the questions that have been raised thus far?

MR. PARSONS: I may need to confer with co-counsel. I'm not sure we've had any presentation of any qualifications or other indication that this witness would be qualified to do what they say he did or she did.

CHAIRMAN FROEHLICH: I'd be glad to voir dire him or her prior to that. And if there are any gaps, you'd be allowed to follow up.

MR. PARSONS: Would you give us a moment to confer?

CHAIRMAN FROEHLICH: Yes.

(Pause.)

MR. PARSONS: Thank you, Your Honor. I appreciate that courtesy. I think with those caveats that we would like to make part of the inquiry as to whether there's any documents or data or other indication of other disclosures that may not have been made related to this inspection, we would not object to swearing in a witness if they're amenable.

CHAIRMAN FROEHLICH: Keep in mind we're

not authorizing a data fishing expedition here. We're merely confirming or clarifying the exhibit that shows the satellite image exhibit.

Powertech, do you have any objection?

MR. PUGSLEY: No.

CHAIRMAN FROEHLICH: And Commission Staff?

MR. CLARK: No objection.

CHAIRMAN FROEHLICH: Who is this witness that you refer to, Mr. Demuth?

MR. DEMUTH: I would defer to counsel, if he would introduce, please.

MR. PUGSLEY: The witness Mr. Demuth is referring to is Mr. Frank Lichnovsky who is the senior geologist for Powertech.

CHAIRMAN FROEHLICH: Okay. Without objection from the parties, if you'd he'd forward, raise his right hand?

PARTICIPANT: Your Honor?

CHAIRMAN FROEHLICH: Yes, sir?

PARTICIPANT: If I might, my client, Mr. Dayton Hyde has shown up and taken his seat. While you're swearing in witnesses, if you wouldn't mind including him.

CHAIRMAN FROEHLICH: Yes, you need not stand however.

PARTICIPANT: Thank you, Your Honor.

CHAIRMAN FROEHLICH: Okay. Sir, would you raise your right hand? Mr. Hyde as well. Thank you. Do you solemnly swear or affirm the statements you are about to make in this hearing before the ASLBP will be true and correct to the best of your knowledge and belief?

MR. HYDE: Yes.

MR. LICHNOVSKY: Yes.

CHAIRMAN FROEHLICH: Okay. The record will reflect that each witness has responded in the affirmative.

And do you, Mr. Hyde, adopt your pre-filed testimony as your sworn testimony in this proceeding?

The witness has responded in the affirmative. Thank you. You can take a seat in the back row, please.

Would you please state your name and employer for the record?

MR. LICHNOVSKY: Frank Lichnovsky with Powertech.

CHAIRMAN FROEHLICH: And what is your position with Powertech?

MR. LICHNOVSKY: I'm chief geologist.

CHAIRMAN FROEHLICH: And are you familiar with OST-005 which Dr. Moran has been referring to?

MR. LICHNOVSKY: Is that the map on the screen?

CHAIRMAN FROEHLICH: No.

JUDGE BARNETT: Well, I believe that comes from that exhibit, yes.

CHAIRMAN FROEHLICH: Okay.

MR. LICHNOVSKY: Yes.

CHAIRMAN FROEHLICH: Yes? All right. And what was the question here?

JUDGE BARNETT: Where is the satellite image in there?

CHAIRMAN FROEHLICH: Right.

JUDGE BARNETT: It's the satellite images on page 13 or slide 13.

CHAIRMAN FROEHLICH: Okay. Got it. Now ask your question.

JUDGE BARNETT: Have you seen this before?

MR. LICHNOVSKY: Yes.

JUDGE BARNETT: So Dr. Moran has testified that this image is what he believes could potentially be a sinkhole at the site. So my question is have you done anything to confirm or refute his interpretation of this image?

MR. LICHNOVSKY: Yes, I went out and

looked at the site. It is not a circular feature on the ground. It's open to the southwest. It's just a low spot that a little bit of drainage goes through.

JUDGE BARNETT: I guess I'm confused. Isn't that a sinkhole?

MR. LICHNOVSKY: No.

JUDGE BARNETT: A low site that a little bit of drainage goes through?

MR. LICHNOVSKY: Yes, it's more of an erosional feature. It's not a sinkhole.

JUDGE BARNETT: So drainage just goes in there?

MR. LICHNOVSKY: It goes through it.

JUDGE BARNETT: Through it? Okay.

MR. LICHNOVSKY: Yes.

JUDGE BARNETT: Okay. That's all I have.

CHAIRMAN FROEHLICH: Okay. We now have the opinion as to whether this is a sinkhole or a breccia pipe. Are there any questions from counsel to follow up with this witness?

We're going to need about a five-minute break while we adjust the sound system.

(Whereupon, the above-entitled matter went off the record at 3:55 p.m. and resumed at 3:55 p.m.)

CHAIRMAN FROEHLICH: I believe we're back in business. Take your seats, please.

Mr. Parsons, did you have any questions for the witness?

MR. PARSONS: Thank you, Your Honor. I appreciate it.

Just one question as to whether as part of that assessment there were any written reports or other documents or data produced as a result?

CHAIRMAN FROEHLICH: You may answer.

MR. LICHNOVSKY: No. I took a picture of it and I thought I sent it to the Petrotek guys here, but they don't seem to have gotten it, so, no, there was not.

CHAIRMAN FROEHLICH: Staff, do you have any questions of the witness?

MR. CLARK: No questions, Your Honor.

CHAIRMAN FROEHLICH: Mr. Pugsley?

MR. PUGSLEY: Just one, Your Honor. If that feature on the map was indeed a breccia pipe, would it be possible for the orebody label there to be going through it?

MR. LICHNOVSKY: No.

JUDGE BARNETT: And why is that?

MR. LICHNOVSKY: It would be limited porosity and permeability and the solution just would not have flowed into it.

JUDGE BARNETT: In the breccia pipe?

MR. LICHNOVSKY: Yes.

JUDGE BARNETT: I thought the whole thing with the breccia pipe is solutions flowed quickly through it.

MR. LICHNOVSKY: It would be down-dropped and you'd have the shale from above down in there. It would disrupt the sands.

JUDGE BARNETT: So it's impossible to have a breccia pipe in the ore zone? Is that your testimony?

MR. LICHNOVSKY: No, in the -- or -- I lost it -- Grand Canyon area the breccia pipes do contain ore, but here it would not.

JUDGE BARNETT: Okay. I'm almost finished with Contention 3, fortunately, and that was the one I had the most questions about.

So I have a question for the Applicant. You refer to this process of operating a mine in accordance with NUREG-1569 as a phased process, is that correct, to collect some data up front and then as you go and install the wellfields you're collecting more data. Is that correct?

MR. DEMUTH: That is correct.

JUDGE BARNETT: Okay. So my question is when you collect new data is that evaluated outside of the NEPA process, and who will have access to that data and can it be challenged, or is that just your data then?

MR. DEMUTH: I can't speak to the legal aspect of the NEPA process. What I can tell you is that the information will be submitted to NRC and it will be public information within the guise of regulatory reporting. Now, does that mean that Powertech is under obligation to submit all data that might refer to the grade of ore that they see in their logs? I would think not. In terms of data to support the source material license in the SER, absolutely that would be public information.

JUDGE BARNETT: And challengeable information?

MR. DEMUTH: I would have to defer to the NRC Staff in terms of whether that could be challenged or not.

JUDGE BARNETT: Mr. Pugsley, your argument is this is a phased process in accordance with 1569?

MR. PUGSLEY: It's a phased process in accordance with regulation and 1569, yes.

JUDGE BARNETT: Okay. For data that comes up later, does Powertech have an obligation to share that data with anyone?

MR. PUGSLEY: Okay. Just making sure I understand your question, are you talking, for example, data in a wellfield package?

JUDGE BARNETT: Correct.

MR. PUGSLEY: Okay. We have an obligation to share it with NRC because per license condition; and I referenced this previously, but I'll do it again, the verbiage in license conditions now for wellfield packages come in three sets. They're called review, review and written verification, review and approve. Powertech has some of that in different license conditions. But the most basic one is review.

Now that means that NRC has to receive a copy of the wellfield package in the information, and any information that is not declared protected under 10 CFR 2.390 is -- when submitted to NRC, NRC makes it publicly available under ADAMS database. And I would ask NRC Staff counsel to tell me if I'm wrong, but that would make it publicly available. However, the data itself in those is not subject to litigation per the Hydro Resources case in this proceeding.

JUDGE BARNETT: Mr. Clark?

MR. CLARK: If I could address that? I

think Mr. Pugsley is correct, there are a few nuances. When the Staff receives information, as Mr. Pugsley said, it will apply 10 CFR 2.390 to determine whether information is public or non-public. Staff also applies Management Directive 3.4, which is titled, "Release of Information to the Public." So before we see this information it would be difficult to give a good idea of just which information would be released and which wouldn't, but I believe the vast majority of the information would be released.

In terms of review, review and verification and review and approval, that is the licensing scheme. Review and approval, if the Board -- can I ask to bring up Exhibit NRC 12 at page 9 of the PDF. This is an example where Powertech will need a license amendment. I'm referring to the very top. This is License Condition 10.10(b). Powertech will submit for NRC review and approval hydrologic test packages for Burdock wellfields 6, 7 and 8. Powertech will need to submit a license amendment. The review and approval means the Staff will need to review and approve, if appropriate, the packages before Powertech can operate in those wellfields.

Any time there's a license amendment, there's an opportunity under the Atomic Energy Act under Section 189 for members of the public to request a hearing. There's also the obligation under 10 CFR Part 51 for the Staff to either perform an environmental assessment or prepare an environmental impact statement. I do not believe any of these actions would be categorically excluded from NEPA review. So the short answer is for these types of license conditions there will be further NEPA review and the public will have additional opportunities to request a hearing.

Now for review and review and verification, all that means is that Powertech will not necessarily need to seek a license amendment. If Powertech submits information and the Staff can't confirm that it satisfies the license conditions, the Staff will notify Powertech and inform them that if they proceed, they'll be in violation of their license conditions and that would lead to an enforcement action.

In that case, Powertech will either need to not take action so that they won't be violated their license conditions or they will need to seek a license amendment so that their license can be amended to conform with their planned course of action. In that case there will be another request for a license amendment, there will be another opportunity for the public to seek a hearing, and there will be further NEPA review.

JUDGE BARNETT: So if I remember 1569, Chapter 2 is the pre-operational data, is that correct?

MR. CLARK: Yes, sir.

JUDGE BARNETT: And then Chapter 5, what is that?

MR. PUGSLEY: That's entitled, "Operations."

JUDGE BARNETT: Right.

MR. PUGSLEY: That is post-license.

JUDGE BARNETT: Right. So that's specifically what I'm asking about. That data there, will that be available to the public and can it be challenged?

MR. PUGSLEY: I believe that the data in Chapter 5 is not subject to challenge unless it is subject to a license amendment proceeding. If it's under review, it's simply the hydrologic packet. The wellfield package is submitted to NRC and it is made -- unless it's protected under 2.390, it is made publicly available.

MR. CLARK: If I could respond?

JUDGE BARNETT: Sure.

MR. CLARK: And I guess to reframe the question, if the data show a need for a -- if there is a licensing action, there's an opportunity for public hearing requests and also a requirement that the Staff do additional NEPA review. The question is whether the additional data show the need for a licensing action or whether they fall within this licensing action that's before the Board today.

In terms of whether the data will be made available for public review, some data may be proprietary, and consistent with 10 CFR 2.390 it may be withheld from public view, but the vast majority of the data will be entered into the NRC's Agencywide Documents Access Management System.

JUDGE BARNETT: Okay. Thank you. That's all I have on 3.

Ms. McLean, thank you for coming today. I have a question about your testimony in INT-014, and that is, could you just briefly summarize your testimony with regards to the concerns about the pond lining?

MS. McLEAN: Yes. One second here. The ponds are a shallow design and this is designed to allow for more contact, what you get between the highly chemical active wastewater and the plastics in the liner facilitating faster degradation. All the plastics do degrade over time even without this chemical exposure. We know plastics do degrade. The high levels of oxidizing chemicals will speed degradation dramatically. And this is what these chemicals do and why they are used in the ISL process to degrade the rocks.

The plastics used in the liners are polypropylene and polyethylene. That's taken from the permit. These are common plastics we use every day. These plastics are so easily degraded that they are the principal plastics used in the food and bottled water industry and they're easily recycled by adding chemicals to degrade and disintegrate them, and hence that's the ones that we recycle. The warranty by the manufacturer is only one year for the polypropylene and two years for the polyethylene in the project, and that is without being exposed to highly degrading chemicals. And the project is supposed to last 20 years.

The strips of plastic will be bonded together by seams of heat or glue, and these have been shown in other EPA tests to leak. The plasticizers that are integral in all plastics give them their softness and pliability and are well known endocrine disrupters and hormone mimics. We've known that since probably the early '90s. And they're also well known to leach into foods, hence the warnings of plastic bottled juices, foods and waters. When these plasticizers are leached from the plastics, the plastics also become brittle and will then break and leak, which is why we see plastic bags that are fractured and become brittle lying on the sides of the highway and in woods after exposure to air, ozone and sunlight.

I would expect these --

MR. PUGSLEY: Your Honor, we'd like to register an objection to this testimony as I am having trouble -- I'd like an offer of relevance to hydro-geological information.

CHAIRMAN FROEHLICH: Your objection is noted. I believe Ms. McLean's testimony, pre-filed INT-014, discusses the problem with the ponds and the potential for water within that pond to leach into the groundwater. And I believe the bottom line of her testimony is that none of this data or this concern has been considered in the environmental assessment.

MR. PUGSLEY: Your Honor, I appreciate you noting my objection. Thank you.

CHAIRMAN FROEHLICH: Okay. Is that an accurate statement?

MS. McLEAN: Yes.

CHAIRMAN FROEHLICH: Okay. All right. Thank you, Ms. McLean.

MS. McLEAN: When these plasticizers are leached from the plastics by the lixiviants, the plastics become brittle and will break and then leak. And then that's why we see plastics that have been lying on the side of the road even exposed to UV light, you know, sunlight and ozone in the air and stuff over time, and rain and such -- they fracture and break and pulverize.

CHAIRMAN FROEHLICH: Okay. Thank you. And I will read your testimony in detail, but thank you for summarizing it briefly.

MS. McLEAN: Okay. I'm not finished yet.

CHAIRMAN FROEHLICH: You've submitted the written testimony. I think that's --

MS. McLEAN: Okay.

CHAIRMAN FROEHLICH: I think I can get the details out myself. Thank you.

And I would have, I guess, one follow-up for the NRC Staff and ask if the concerns with the liner and the ponds are addressed in any of the environmental documents?

MR. PRIKRYL: Yes, I'm looking for that right now. Just give me a second.

CHAIRMAN FROEHLICH: Sure.

MR. PRIKRYL: Okay. I think I found it. If we go to -- I believe this is Exhibit 008-A-1.

CHAIRMAN FROEHLICH: The EIS?

MR. PRIKRYL: This is the SEIS. And if we go to page 2-22. Now you go to the -- right above the bullets. I'll just go ahead and read this paragraph right above the bullets. "The classified injection well disposal option requires surface impoundments or ponds for storage and settling of uranium before injection into the deep disposal wells." And as described in SEIS Section 2.1.1.2.1, these problems are going to be designed following NRC requirements. So they have to be designed -- NRC requirements.

Now if we go to page 225, and let's look at the second paragraph. And do you all want to just -- let's see. This describes how the ponds are going to be designed, or the liners for the ponds.

JUDGE COLE: Now the purpose of the liners is just to prevent flow downward?

MR. PRIKRYL: Yes. Yes, to prevent contamination. If you back to the middle of the paragraph, the radium settling, spare and central plant ponds will be constructed with a lining system consisting of the following: An 80-mil HDPE primary liner, 60-mil HP secondary liner. And then there's going to be a clay liner beneath that and then a geonet drainage layer sandwiched between the primary and secondary liners. It will also have a leak detection and sump access port system. So this is how they designed in order -- so that water will not leak through the ponds.

JUDGE BARNETT: Okay. And Ms. McLean had submitted testimony regarding her concerns for the plastic, and we will evaluate that.

MR. PRIKRYL: Yes.

JUDGE BARNETT: And along with all your entire testimony. So thank you.

MR. LANCASTER: Just to add to that, License Condition 12.25 requires that monitoring wells that surround these ponds further adds for leak detection.

MS. McLEAN: Can I add something, please?

CHAIRMAN FROEHLICH: Yes, go ahead.

MS. McLEAN: HDPE is high-density polyethylene. The chemical is the same and the constituency is the same not matter how thick you make it. It just takes maybe a little longer to eat through. But the chemical constituency still only has a one to two-year length of life, and that is without being exposed to the high oxidative processes of the stuff in the ponds. So you can layer it and layer it and layer it and it will still eat through because it's the same type of plastic constituency.

And clay is not considered to be an adequate barrier either. We found that with Superfund sites in Michigan where I came from.

JUDGE BARNETT: Yes, I did read that it in your testimony. I remember reading that.

MS. McLEAN: Yes.

JUDGE BARNETT: So, thank you. That's all I have for Contention 3.

JUDGE COLE: Yes, just one more question. This is both Dr. Moran and Dr. LaGarry. In your previous testimony you indicated that Powertech needs to provide additional hydro-geological data on specific wellfields in the Dewey and Burdock area. Mr. Clark was talking about special conditions in the permit and he talked about special conditions in Permit 10.10(b), but are you aware that Special Permit Condition 10.10(a) has 11 specific items pertaining to hydro-geochemical testing and actions that are necessary for the well package design and operation?

DR. LaGARRY: Oh, am I aware of that? I don't recall the details of that.

JUDGE COLE: Yes, that's on page 8 of the permit. You have a copy of the permit.

DR. LaGARRY: Yes.

JUDGE COLE: But it lists 11 hydro-geochemical geological actions that have to be taken in conducting the well package, so it's a requirement that the Applicant has to abide by.

DR. MORAN: Okay. My comments were simply intended to allow the public to understand more before the license was awarded.

JUDGE COLE: This is for pre-operational.

DR. MORAN: Right.

JUDGE COLE: This is what you have to do to prepare the well package.

DR. LaGARRY: Yes, my comments were intended to convey my reservations about -- I mean, I limited my initial testimony to the issues of confinement, which is within my area. And it tied into something that I was asked about earlier about the phased process and the fact that there be the ongoing excursions issue, so that it's all part of that same thing I was trying to bring up that for me as a scientist and for the public at large we would like to have the confidence of knowing that things aren't going to be patched as they go.

With every iterative effort or requirement to try to patch an issue as it goes forward, it would be better in my professional opinion to deal with those at the front end so that we the public and the we scientific community can look at that and say, okay, look, this wellfield isn't going to be a continuous serious of excursions and patches and problems and issues. It's all been dealt with up front and we're confident that mining can proceed more or less problem free. There's always unanticipated things.

But if the Applicant is conceding that the confining layers are perforated or leaky, then it comes to question that if they know it's going to be leaky and they know there's going to be a series of iterative issues that follow on once mining starts, why don't we get an opportunity to address and potentially forestall those at the front end of the proceeding? So that was my intent with that particular part of my opinion.

JUDGE COLE: Thank you.

CHAIRMAN FROEHLICH: All right. We will

move now I guess to Contention 4 dealing with groundwater quantity impacts.

JUDGE BARNETT: Okay. Can we see OST-001 at 27, Dr. Moran's testimony? Search for detailed water balance.

Okay. Your first sentence there and the basis for your opinion says, "In order to evaluate the adequacy of mine water-related data and management practices, it is standard practice for EISs and similar mine environmental reports to include a detailed water balance." Is that correct?

DR. MORAN: Yes.

JUDGE BARNETT: Can you cite any NRC-led EISs that include the kinds of detailed water balances that you're referring to?

DR. MORAN: No.

JUDGE BARNETT: Okay. Can we see NRC 008-A-1 at 130? Correct. Can we see the whole -- yes, there you go.

Okay. There's the figure. It's from FSEIS Figure 2.1-14. What do you contend that's either missing or out of balance there?

DR. MORAN: One of the issues I was trying to bring out is how much water will be lost through evaporation, for example, from the holding ponds if they choose to go in that direction. So you need to quantify it, or it's standard practice to do it in mining projects. The same would be how much water will be say pumped out of the Inyan Kara and then injected into some other aquifer if that is concluded to be the approach for waste disposal? Those details aren't in this document.

JUDGE BARNETT: Okay. If you can give me just a second here to catch up. It's hard to --

DR. MORAN: Sorry.

JUDGE BARNETT: Okay. So do make any contention that the flows that are shown there do not balance?

DR. MORAN: No, that's not what I said.

JUDGE BARNETT: Okay. I'm making sure I get it correct. So would you concur that the flows that are shown there do balance? Is that correct?

DR. MORAN: The truth is I haven't gone through to see if they balance. My point is that I was trying to bring up the issue that a reader can't discriminate what part is related to what. For example, evaporation and road watering and things like that, those are huge amounts of water.

JUDGE BARNETT: Okay. That's a fair question. I'd like to ask the Applicant how does water lost to evaporation -- how does that figure into this? I guess one of Dr. Moran's concerns is that there's no evaporation shown in the water balance.

MR. DEMUTH: Your Honor, I believe that that is addressed in some of the responses. First of all, the evaporation that I believe Dr. Moran is referring to in the case of small ponds prior to the Class 5 disposal, that doesn't affect the water balance. If there's some evaporation from the ponds, then less goes down the well. So the evaporation in that situation is not an issue. Either you have some that evaporates or you have less that evaporates and it goes down the disposal well. So with due respect, I fail to see the magnitude of concern of the question.

JUDGE BARNETT: So your conclusion is that evaporation is effectively shown in stream I and N, is that correct?

MR. DEMUTH: That would be correct.

JUDGE COLE: Evaporation is a maximum in those two because there might be some putting down underground?

MR. DEMUTH: Yes, the vast majority would be underground. In that situation the evaporation would actually be very small.

JUDGE BARNETT: Where else could evaporation occur in the process other than those ponds?

MR. DEMUTH: In the deep disposal well option there should be no other evaporative losses simply because the water that's pumped out of the wellfields runs through the plant and it a contained system and it either goes to the disposal wells or it goes back to the wellfield. So we don't have an opportunity for great evaporative losses.

JUDGE BARNETT: Staff, would you like to weigh in on this on the --

MR. PRIKRYL: The Staff --

JUDGE BARNETT: Yes, anyone from the Staff, would you like to weigh in on Dr. Moran's concern that evaporation is not shown explicitly in the water balance?

CHAIRMAN FROEHLICH: We would sort of agree with Powertech's explanation. In the Staff's view water loss to evaporation is basically counted for in this water balance, and this is because evaporation would only take place for the wastewater that is diverted to the radium settling and holding ponds for disposal. So the diverted wastewater represents the water consumed by the project and therefore evaporation would not represent any additional consumptive use.

JUDGE BARNETT: Dr. Moran, what was your other concerns besides evaporation?

DR. MORAN: I think I'll just stay with my written testimony. In most of the mining world this is not a water balance. The specific ins and outs and water losses are not specified in this table.

JUDGE BARNETT: Well, I guess that's why I'm struggling. What is missing from this table, I guess is what --

DR. MORAN: Well, as I said, there is no --

JUDGE BARNETT: Evaporation? Okay.

DR. MORAN: Is one.

JUDGE BARNETT: Okay. But what else?

DR. MORAN: Any infiltration through the bottoms of the ponds. None of that is specified. If water is taken out of the Inyan Kara and then later you have to pump the residual water into a different deep formation, that's lost to the Inyan Kara. But we haven't quantified it here. At a theoretical level it's being recirculated, but not in fact.

JUDGE BARNETT: Is it correct that water taken from the Inyan Kara and injected in deep wells would be counted for inflows I and N? Is that the Applicant's and the Staff's --

MR. PRIKRYL: That's correct, yes.

JUDGE BARNETT: Anything else about this?

MR. FRITZ: I'd like to say something about that. If you'd scroll up to the upper part of the figure, it does show the -- if you look to the left, the amount that's coming Fall River and Chilson and the amount from the Madison, those streams are shown for both the Dewey and the Burdock wellfield as inputs to the water balance.

JUDGE BARNETT: Anything else you'd like to say, Dr. Moran, about the water balance?

Okay. If we could see OST-1 at 26 and NRC 008-A-2 at 360?

MR. CLARK: I think I heard the page number as 360. Is that correct?

JUDGE BARNETT: Correct, of NRC 008-A-2. Oh, I'm sorry. Yes, I'm sorry. It's getting late. It's document page 360. Well, it's page 55 in the PDF. Now, could you go down to the -- yes, the top of page 4-55. Okay. I'm referring to the first paragraph. So, Dr. Moran, you state that 274.2 acre-feet per year of water is to be withdrawn from the Inyan Kara as evidence that the groundwater quantity impacts have not been properly assessed, is that correct?

DR. MORAN: That isn't what I said.

JUDGE BARNETT: Okay. What is your concern with the 274 acre-feet water?

DR. MORAN: I haven't mentioned any specific concern about that number.

JUDGE BARNETT: Okay. So I'm reading from page 26 of OST-1. Your expert opinion is that the Applicant will use and contaminate tremendous quantities of groundwater thereby preventing/restricting the use of these waters by others. Is that correct?

DR. MORAN: Where is that? I'm sorry, I didn't see where it was.

JUDGE BARNETT: It's getting late.

DR. MORAN: Oh, I'm sorry. Yes.

JUDGE BARNETT: Yes. Okay. Is that correct?

DR. MORAN: Right.

JUDGE BARNETT: And then a little bit lower you mention that -- you cite the figure of the 270.2 acre-feet of water from the Inyan Kara and the 888.8 acre-feet from the Madison, is that correct?

DR. MORAN: Correct.

JUDGE BARNETT: So now if I look at the first paragraph in the FSEIS -- and it says here; and I'll read this out: "Based on a review of the water permit application which concluded an analysis of water availability and existing water rights, South Dakota Department of the Environment and Natural Resources concluded: (1) approval of the application will not result in annual recharge withdrawals from Inyan Kara that exceed the annual recharge to the aquifer; (2) there is a reasonable probability that at least 274.2 acre-feet of unappropriated water will be available; (3) SDDENR Water Rights Program observation well data indicate that unappropriated water is available from the Inyan Kara; and (4) there is a reasonable probability that the withdrawals proposed in the application can be made without unlawful impairment of existing water rights or domestic wells."

Do you agree that the FSEIS correctly summarizes the South Dakota Department of Environmental and Natural Resources' conclusion?

DR. MORAN: I don't know if they've correctly summarized it. This is from the final SEIS, is that correct?

JUDGE BARNETT: Correct.

DR. MORAN: I have to assume that they have, but I don't know that for a fact.

JUDGE BARNETT: Okay.

DR. MORAN: But more importantly, I don't see any of the backup for defending those conclusions.

JUDGE BARNETT: Okay. And then the second paragraph, it looks like the last sentence of the second paragraph, in very similar kind of language, but in this case with respect to the Madison, the FSEIS also states, "Based on a review of the application which concluded an analysis of water availability and existing water rights SDDENR concluded: (1) there's a reasonable probability that unappropriated water is available in the Madison aquifer to supply the proposed appropriation; (2) approval of the application will not result in annual withdrawals from the Madison aquifer that exceed the annual average recharge to the aquifer; and (3) there is a reasonable probability that the withdrawal proposed in the application can be made without impacting existing water rights including domestic users."

Do you agree with the FSEIS' summary of SDDENR's analysis of the Madison withdrawals?

DR. MORAN: I don't agree with the

analysis. I'm willing to admit that they probably summarized it correctly, but I don't see any backup for those statements, technical backup.

JUDGE BARNETT: Okay. So you cite some numbers: 274 acre-feet per year from the Inyan Kara, 888 acre-feet from the Madison . And I can't remember the exact language in your testimony, but you were concerned with the quantity of water. And based on SDDENR's analysis as spelled out in the FSEIS, do you still allege that they failed to adequately analyze groundwater quantity impacts?

DR. MORAN: Yes.

JUDGE BARNETT: Okay. Thank you.

CHAIRMAN FROEHLICH: On that subject using the figures Judge Barnett just used, the 274 acre-feet and the 888.8 acre-feet, you come up with I guess a 20-year water consumption of 89.4 billion gallons over 20 years for the Inyan Kara and 5.8 billion gallons over 20 years. I was wondering if that is still your contention that that is the quantity of water to be used or taken for this project.

DR. MORAN: As described, yes.

CHAIRMAN FROEHLICH: Okay. As described. Then perhaps, Mr. Fritz, can you clarify or respond to the figures over the 20-year life that Dr. Moran has put forth?

MR. FRITZ: Yes, I can. You're talking about the Inyan Kara water, right? The 274.2 acre-feet of water annually is the most we can have for a net diversion. We can't divert the 8,500 gallons per minute, which is how you have to convert in units to get to the other number because 98 percent of that water is re-injected as a part of the process. Our net diversion limited by the water right can only be a maximum of 274.2 acre-feet per year.

CHAIRMAN FROEHLICH: Okay.

JUDGE COLE: Could you put back on the flow diagram, the typical flow rates you had on before from figure TR RAI PNR-14 C-1, from the Dewey-Burdock RAI responses? I don't have it on this. It's in the RAI responses. You had it on earlier. It would be page 69. Here it is.

Now, I'd like to look at the top one there for the Fall River and Chilson and the flow diagram and look at the numbers that are coming in there. And if we follow through that flow diagram, it looks like we're taking out A from the Fall River and Chilson independent of the water that's recirculating 21 gallons per minute, and B coming out of the wellfield is 2,400 gallons per minute.

DR. MORAN: D is what you said?

JUDGE COLE: B.

DR. MORAN: B. I'm sorry.

JUDGE COLE: B. Then we pass it through an ion exchange, and in the ion exchange we remove the uranium. It's an ion exchange that's specific for uranium. Now, there are a lot of other chemicals in there that are not removed at that point. They're still in the solution, the lixiviant solution. And we take out less than one percent. And here it's 0.875 percent. That's about 170 gallons a minute. And that's what we consider to be taken out of the system. We send the rest back and recirculate it and we keep recirculating it, adding a certain amount and then -- well, before we do that we re-oxygenate it and send it back, but we've got contaminants that were picked up in the first cycle and we keep recirculating those. We get some dilution of that because we're taking about one percent each time. It's called a bleed.

Now, my question is the quality of that recirculated water deteriorates with time, and how many cycles can you have before it's a non-productive use of that water? Because there are more and more toxic chemicals being built up in that. So also, the bleed water, even the one percent, is going to be more concentrated. Then we can either put that either directly in a pipe and pump it down to a deep well or we put it in a pond losing at that rate of 170 gallons a minutes. So maximum evaporation we can have is 170 gallons a minute. And how often do we have to treat this water that's being recirculated to maintain the quality that's going to effectively do the job of picking up additional uranium? And I don't know the answer to that, but is it anywhere in our record? And I'd like to ask both the NRC and the Powertech people, do they have answer to that?

MR. DEMUTH: Judge Cole, I'm not a chemical engineer, so with reservation I'll speak to that a little bit. The quality of that water, if it degraded to a point where it simply was not useful to optimize the mining process, they could certainly pull more bleed out of that and then run more down the disposal well. So it's to the operator's interest to maintain the quality of that water so that it's most beneficial for the mining process.

The exact specifics of how they would manage that in the plant, that would really be up to Powertech Staff to --

(Simultaneous speaking.)

JUDGE COLE: Yes, are you aware that

that's a problem?

MR. DEMUTH: I wouldn't call it a problem necessarily.

JUDGE COLE: All right.

MR. DEMUTH: I'm aware that it's something the plant operations has to include, but in terms of a problem, I wouldn't characterize it in that way.

JUDGE COLE: All right, sir. Yes, they have a reverse osmosis unit somewhere in that building, and it's got to be used for something.

And I'm also concerned about the quality of the water that's going to the pond, because that's going to have a radioactive material in it. It's going to have a lot of the contaminants; arsenic and selenium, that's going to go into the pond. Now, okay, they have barriers underneath it, clay barriers and different kinds of layers of protective material that prevent it from going downward, but what about the animals that would be using this for water? Is that a serious problem and how do you prevent that? And do they use the reverse osmosis treatment units that they have to bring the quality of that water up so that it's not as a danger as it seems to me to be?

MR. FRITZ: I can give a quick description of that. I'm not a chemical engineer either, but I'm familiar with pond design and layout.

Remember in the application there are two basic methods of water disposal. One is the deep well injection and the other is land application. Deep well injection is the preferred method. If we can get our permits and if we can get suitable wells to inject the subsurface water, then the RO unit is used, because then we can get rid of the brine, which is the highly saline water that accumulates as you were saying.

JUDGE COLE: Wait a minute. I must have misheard your first part. If you can get permission to dump it into a deep well, it's then you want to use the RO unit?

MR. FRITZ: Yes.

JUDGE COLE: Why?

MR. FRITZ: Because the deep wells give us the only opportunity to get rid of the brine that's generated from an RO unit. RO unit, about 30 percent comes out as brine and 70 percent is real pure water and will go back into the process.

JUDGE COLE: But you're putting it into a deep well that probably has a lot of other contaminants in it. That's why it was selected as a well to accept wastewater.

MR. FRITZ: Yes, that's exactly right. That's the only way we can get it permitted to accept wastewater.

JUDGE COLE: Now tell me again why you would want to use a reverse osmosis unit to treat the water before you put it in there?

MR. FRITZ: Well, one of the big goals in all this is to minimize your waste stream, because there's regulatory and cost associated with water disposal. If we can reduce the waste stream by going through the RO unit down to a concentrated brine, then we can go to a deep injection well and take the other 70 percent and go back into the wellfield with it. It doesn't accumulate the dissolved solids that you were talking about.

If we can't for one reason or another inject the water into a deep disposal well and we go to land application, then we have to bring more makeup water from the Madison and go out to the land application because the brine from the RO unit would be too saline to put on a land application.

JUDGE COLE: Right. But you have to dilute it with the fresh water to use it on land?

MR. FRITZ: Yes, you wouldn't run it through the process as many times. It would go out to the evaporation disposal.

JUDGE COLE: Yes, I would also think you'd want to use the reverse osmosis to remove the chemicals in it because you wouldn't want those; arsenic and selenium and other dangerous chemicals and radioactive materials, on the land application.

MR. FRITZ: Well, let me clarify one thing first. There's no radioactive chemicals going out to anything. That would be an 11(e)2 waste. That has to be taken out of these ponds by barium precipitation or some method. It can't be injected or go to the land application.

JUDGE COLE: But you precipitate the radium and the radium with barium sulfate in the ponds?

MR. FRITZ: Yes.

JUDGE COLE: And then you --

MR. FRITZ: Yes, there's no radioactive waste going out anywhere.

JUDGE COLE: Then you take the water from the top and remove the precipitate in the bottom?

MR. FRITZ: Right.

JUDGE COLE: And deal with it the same way you have to with radioactive materials --

MR. FRITZ: Yes, it goes out as an 11(e)2 waste during the clean-up of the site. That's right.

But to get back to your question about the RO unit, if we don't have a deep disposal well, we can't use the RO because it generates a brine that we can't go to land application with. It has to go down a deep well. So the preferred method is to get these deep wells permitted and proven for disposal.

JUDGE COLE: I understand.

MR. FRITZ: And that's a pending permit right now with the EPA.

JUDGE COLE: And the alternative is diluting it so it's satisfactory for use on a land application?

MR. FRITZ: Well, not exactly diluted, but not concentrating it to the level you were talking about before. That's right.

JUDGE COLE: Okay. Thank you.

CHAIRMAN FROEHLICH: Ma'am, you wanted to add something?

MS. McLEAN: Yes, I would. That's not totally true because there are heavy metals that are generated that have radioactive capabilities. Thorium, strontium. They don't even measure for strontium on their list. You know, chromium, vanadium. Those things are all radioactive and they're going to be in the ponds.

And there's no fence that you can ever fence out Mother Nature. You're going to have small animals going in there, insects, whatever, to access the water. This is a dry area. This is a semi-arid area. And there's going to be animals and insects and all kinds of things going in there to seek that water that then take those hazardous compounds out into the environment to be bioaccumulated up the food chain. So there are going to be radioactive elements in there. There are.

RO actually kind of a misunderstood process really in that RO wastes about 10 times -- the typical RO wastes about 10 times more water than it purifies.

JUDGE COLE: Well, it dilutes what you have and you wind up with a certain percentage of pure water.

MS. McLEAN: It's not going to be pure, no. RO is not 100 percent. Only distillation --

JUDGE COLE: I understand.

MS. McLEAN: -- is 100 percent. So, and the other thing is is when you keep applying that over a period of 20 years you're going to increase the concentration of the stuff in the land anyway. So it doesn't matter how much you dilute it. You're still going to concentrate the metals in the land that you're doing land application or water application anyway.

JUDGE COLE: Thanks.

JUDGE BARNETT: Ms. McLean brought up a good point, a good question. How do you keep birds out of these ponds?

MS. McLEAN: You don't. They're going to eat insects and they're going to eat any sort of crawly things that are going to go in there. There's no way to fence out Mother Nature. There's just not.

JUDGE BARNETT: I want to ask the Applicant. How do you keep birds out of these ponds?

MR. FRITZ: I can't tell you the exact page, but there's quite an extensive mitigation plan for the ponds to exclude wildlife in both the -- and I know it's in the state permits, the land application permit, which is a related permitting action that we have to do to get the land application. It is a permit from the state. And that's got an extensive wildlife mitigation plan in it.

MR. PUGSLEY: Your Honor, may I ask a question, please?

CHAIRMAN FROEHLICH: Sure.

MR. PUGSLEY: Judge Cole, was this question that you just asked that we were getting answers on was geared toward Contention 4? That's what we're discussing right now?

JUDGE COLE: Well, it might be a stretch, but I'm interested in it.

(Laughter.)

MR. PUGSLEY: No, I'm not questioning that, sir. I apologize. That totally came out wrong, sir.

(Laughter.)

MR. PUGSLEY: I apologize. I would like to note an objection for the record to Ms. McLean's response to this, because her CI INT-014 specifically states that she's offering testimony on Contention 3 and not on Contention 4. So I'd like to register an objection to her answer.

CHAIRMAN FROEHLICH: Noted.

MS. McLEAN: I'd like to add one more thing. The heavy metals that I track are not going to be degraded. They don't go into anything different. They don't change. They don't become toxic -- less toxic over time. And so, when Powertech in 20 years pulls up stakes and leaves, the heavy metals are going to be still there and there's no kind of fences that are going to last as long as those radioactive heavy metals.

MR. PUGSLEY: Your Honor, same objection.

CHAIRMAN FROEHLICH: Noted. Your answer, Ms. McLean, though was related to the effect of the those heavy metals on groundwater? Am I correct?

MS. McLEAN: It will seep into groundwater eventually. Water always goes down.

CHAIRMAN FROEHLICH: Thank you.

MS. McLEAN: That's how nature recharges her aquifers.

JUDGE BARNETT: I have a question for Mr. Hyde. Mr. Hyde?

MR. HYDE: Yes.

JUDGE BARNETT: I have read your testimony. Thank you for including that. I want to make sure that I understand that one of your big concerns is that the Beaver Creek and Pass Creek flow through the Dewey-Burdock project area and into the Cheyenne River and that could potentially impact your wild horse sanctuary. Is that one of your big concerns?

MR. HYDE: Anything that flows into the Cheyenne is going to impact the wild horse sanctuary. We're talking 600 or so horses here that have to drink every day, plus a lot of wildlife. We already know from testimony from my neighbor Byron Cox that during the mining of uranium in the Edgemont area the beaver were wiped out. There are no beavers left in that whole river. You've got to consider the effect of these things on the people that have to live here. Nobody's going to come along and sweep away the damage that people from somewhere else have done to us locals. So I have no compunction about --

JUDGE BARNETT: Okay. Thank you, sir.

MR. HYDE: -- getting a little bit worried about this. I've spent 25 years building this. It could be wiped out very shortly.

JUDGE BARNETT: Thank you.

CHAIRMAN FROEHLICH: I believe that the Board has concluded with its questions for Panel 2. I'd like at this point even though it's 5:00 to give the parties a few minutes to propose any follow-on questions that they might feel are appropriate to submit to the Board to ask of Panel 2.

Would 10 minutes be sufficient?

MR. PUGSLEY: Yes, sir.

MR. PARSONS: That would be fine. Thank you.

CHAIRMAN FROEHLICH: Okay. Let's take a

break for 10 minutes while the counsel prepare any proposed questions.

(Whereupon, the above-entitled matter went off the record at 4:59 p.m. and resumed at 5:17 p.m.)

CHAIRMAN FROEHLICH: We'll be back on the record. I'm pleased to report I've only received two questions that the parties have asked the -- I think going past 5:00 has its advantages.

(Laughter.)

CHAIRMAN FROEHLICH: Two follow-on questions. First for Mr. Demuth and Mr. Lawrence. Do you agree with the characterization of the license area as unique with respect to the presence of historical exploration drilling?

MR. DEMUTH: Your Honor, I would not consider that unique. It's very common for historic uranium projects to have thousands of exploration boreholes that there's been historic activities over time. So it's more common really than unique.

JUDGE COLE: Within 16 square miles 6,000 holes?

MR. DEMUTH: Yes, sir. It's very, very common that we have uranium projects, many cases smaller project areas than this with thousands of historic wells. This exploration activity has been going on for a number of years.

CHAIRMAN FROEHLICH: For Drs. Moran and LaGarry. Do you agree that the net inward hydraulic radiant Powertech must maintain under License Condition 10.7 reduces the likelihood of fluids migrating away from the production zone?

DR. LaGARRY: I agree that it reduces it, but it may not eliminate it.

JUDGE COLE: It may not what?

DR. LaGARRY: Eliminate.

JUDGE COLE: Oh.

DR. LaGARRY: Yes, I agree with that statement. It does reduce it.

CHAIRMAN FROEHLICH: Dr. Moran?

MS. McLEAN: If we assume that it reduces it compared to a situation where you don't have it? Is that what we're saying? Is that what we're assuming?

JUDGE COLE: That's a fair assumption.

MS. McLEAN: Then I agree.

CHAIRMAN FROEHLICH: Okay. At this point we can dismiss Panel 2, except I realize some of the witnesses on Panel 2 will be joining us tomorrow as we'll take on Panel 3. Tomorrow we'll have to take care of a number of procedural matters, one of which being the discussion that was held concerning the map. There was some disagreement between Witness Demuth and Witness Moran. If the parties could get together after today's session and perhaps come up with a single sheet of paper or whatever, a single map that shows the well depression, whatever it was that the conflict was between the two versions of the same map. If we could have one map that I guess depicts the points that both sides were trying to make, I think that would be helpful to the record. So if the parties could get together and come up with a single map that shows the line, or if we can take one of the exhibits that is currently in the record and adjust it, mark it in some way, make it so that it reflects accurately the arguments of both parties. If that's possible, I'd like to try to do that for tomorrow's record.

I'd also like the parties overnight to discuss how we're going to handle the additional disclosure, what protective measures we have to put in for the data, where it will be held, what kind of access the parties will have to it and some kind of a schedule so that it will be available to them for inspection. We'll also set a date for when any additional testimony based on that additional data will have to be filed should there be any.

Are there any other procedural matters that I should consider overnight or that we need to address before we reconvene tomorrow morning?

MR. PARSONS: Your Honor, Jeff Parsons for the tribe.

CHAIRMAN FROEHLICH: Yes, sir.

MR. PARSONS: I just again wanted to flag for you the existence of a pending motion with regard to the additional disclosure matters. I realize that with the ruling this morning for additional disclosure some of the time pressure may not be quite as intense, maybe allowing for the normal course of briefing, if that's what the parties would like to do. But I just wanted to --

CHAIRMAN FROEHLICH: Right. I hadn't forgotten that. I was waiting to receive answers per our rules from the other parties, and then we'll be able to address that.

MR. PARSONS: Thank you, Your Honor.

CHAIRMAN FROEHLICH: Okay.

MR. PUGSLEY: Your Honor, would I be correct that per the rules any answers from Staff or Powertech would be due next Tuesday?

CHAIRMAN FROEHLICH: It came in on

Saturday?

MR. PUGSLEY: Ten days I believe, yes.

CHAIRMAN FROEHLICH: Yes, sir, 10 days.

MR. PUGSLEY: Okay. Thank you.

CHAIRMAN FROEHLICH: Are there any other matters that the Board should consider overnight? Mr. Clark?

MR. CLARK: Just the availability of witnesses for tomorrow. For the witnesses that won't be testifying on Panel 3, do they need to return tomorrow?

CHAIRMAN FROEHLICH: No. No, we'll begin tomorrow -- that's why we ran late. We've finished with Panel 2. So those people who are not on Panel 3 are excused and we thank them for their testimony.

MR. CLARK: Thank you.

CHAIRMAN FROEHLICH: Panel 3 includes those witnesses with filed testimony on Contentions 6 and 9.

All right. Nothing else being necessary for today, we'll stand adjourned until 9 in the morning.

(Whereupon, the above-entitled matter went off the record at 5:23 p.m.)

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-001	Dr. Lynne Sebastian Initial Testimony.	Identified and Admitted
APP-002	Dr. Lynne Sebastian CV.	Identified and Admitted
APP-003	Dr. Adrien Hannus Initial Testimony.	Identified and Admitted
APP-004	Dr. Adrien Hannus CV.	Identified and Admitted
APP-005	Representative Sample of ALAC Projects.	Identified and Admitted
APP-006	ACHP Section 106 Regulations: Text of ACHP's Regulations, "Protection of Historic Properties: (36 CFR Part 800) (incorporates amendments effective Aug. 5, 2004)".	Identified and Admitted
APP-007	National Park Service, Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation, 1983	Identified and Admitted
APP-008	South Dakota State Historic Preservation Office, Guidelines for Cultural Resource Surveys and Survey Reports in South Dakota (For Review and Compliance), 2005.	Identified and Admitted
APP-009	Level III Cultural Resources Evaluation of Powertech (USA) Inc.'s Proposed Dewey-Burdock Uranium Project (Public Version), Vol. 3 Part 6; ML100670366.	Identified and Admitted
APP-010	Michael Fosha Initial Testimony.	Identified and Admitted
APP-011	Michael Fosha CV.	Identified and Admitted
APP-012	February 11, 2013 letter from Michael Fosha to SDDENR.	Identified and Admitted
APP-013	Hal Demuth Initial Testimony.	Identified and Admitted
APP-014	Hal Demuth CV.	Identified and Admitted
APP-015-A	Revised Technical Report (TR) for the Dewey-Burdock Project; Part 1 of 22; Transmittal Letter, Change Index and Revised TR RAI Responses; ML14035A052.	Identified and Admitted
APP-015-B	Revised TR for the Dewey-Burdock Project; Part 2 of 22; Text through Sec. 2.8.5.7; ML14035A029.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
APP-015-C	Revised TR for the Dewey-Burdock Project; Part 3 of 22; Text Sec. 2.9 through 10.2; ML14035A030.	Identified and Admitted
APP-015-D	Revised TR for the Dewey-Burdock Project; Part 4 of 22; Plates 1.5-1 through 2.6-8; ML14035A031.	Identified and Admitted
APP-015-E	Revised TR for the Dewey-Burdock Project; Part 5 of 22; Plates 2.6-9 through 2.6-12; ML14035A032.	Identified and Admitted
APP-015-F	Revised TR for the Dewey-Burdock Project; Part 6 of 22; Plates 2.6-13 through 2.6-15; ML14035A033.	Identified and Admitted
APP-015-G	Revised TR for the Dewey-Burdock Project; Part 7 of 22; Plates 2.6-16 through 2.7-2; ML14035A034.	Identified and Admitted
APP-015-H	Revised TR for the Dewey-Burdock Project; Part 8 of 22; Plates 2.8-1 through 5.7-1; ML14035A035.	Identified and Admitted
APP-015-I	Revised TR for the Dewey-Burdock Project; Part 9 of 22; App. 2.2-A through 2.5-F; ML14035A036.	Identified and Admitted
APP-015-J	Revised TR for the Dewey-Burdock Project; Part 10 of 22; App. 2.6-A through 2.6-G; ML14035A037.	Identified and Admitted
APP-015-K	Revised TR for the Dewey-Burdock Project; Part 11 of 22; App. 2.6-H through 2.7-E; ML14035A038.	Identified and Admitted
APP-015-L	Revised TR for the Dewey-Burdock Project; Part 12 of 22; App 2.7-F through 2.7-G; ML14035A039.	Identified and Admitted
APP-015-M	Revised TR for the Dewey-Burdock Project; Part 13 of 22; App. 2.7-H 1 of 3; ML14035A040.	Identified and Admitted
APP-015-N	Revised TR for the Dewey-Burdock Project; Part 14 of 22; App. 2.7-H 2 of 3; ML14035A041.	Identified and Admitted
APP-015-O	Revised TR for the Dewey-Burdock Project; Part 15 of 22; App. 2.7-H 3 of 3; ML14035A042.	Identified and Admitted
APP-015-P	Revised TR for the Dewey-Burdock Project; Part 16 of 22; App. 2.7-J through 2.7-L 1 of 2; ML14035A043.	Identified and Admitted
APP-015-Q	Revised TR for the Dewey-Burdock Project; Part 17 of 22; App.2.7-L 2 of 2; ML14035A044	Identified and Admitted
APP-015-R	Revised TR for the Dewey-Burdock Project; Part 18 of 22; App. 2.7-M; ML14035A045.	Identified and Admitted
APP-015-S	Revised TR for the Dewey-Burdock Project; Part 19 of 22; App 2.7-N through 2.8-H; ML14035A046.	Identified and Admitted
APP-015-T	Revised TR for the Dewey-Burdock Project; Part 20 of 22; App. 2.8-I through 2.9-L; ML14035A047.	Identified and Admitted
APP-015-U	Revised TR for the Dewey-Burdock Project; Part 21 of 22; App. 2.9-M through 3.1-A; ML14035A048.	Identified and Admitted
APP-015-V	Revised TR for the Dewey-Burdock Project; Part 22 of 22; App. 3.1-B through 7.3-D; ML14035A049.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-016-A	Revised Response to the Request for Additional Information (RAI) for the Technical Report (TR) for the Dewey-Burdock Project; Cover Letter; ML11207A711.	Identified and Admitted
APP-016-B	Revised TR RAI Response; Text Part 1: ML11208B712.	Identified and Admitted
APP-016-C	Revised TR RAI response; Text Part 2; ML11208B719.	Identified and Admitted
APP-016-D	Revised TR RAI response; Text Part 3; ML11208B714.	Identified and Admitted
APP-016-E	Revised TR RAI Response; Exhibits Part 1; Exh. 2.6-1 through 2.6-4; ML11208B716.	Identified and Admitted
APP-016-F	Revised TR RAI response; Exhibits Part 2; Exh. 2.6-5; ML11208B763.	Identified and Admitted
APP-016-G	Revised TR RAI response; Exhibits Part 3; Exh. 2.6-6 through 3.1-1; ML11208B764.	Identified and Admitted
APP-016-H	Revised TR RAI Responses; Exhibits Part 4; Exh. 3.1-2 through 5.7-1; ML11208B767.	Identified and Admitted
APP-016-I	Revised TR RAI response; Appendices Part 1; App. 2.5-D through 2.6-G; ML11208B765.	Identified and Admitted
APP-016-J	Revised TR RAI response; Appendices Part 2; App. 2.6-H 1 of 3; ML11208B766.	Identified and Admitted
APP-016-K	Revised TR RAI response; Appendices Part 3; App. 2.6-H 2 of 3; ML11208B769.	Identified and Admitted
APP-016-L	Revised TR RAI response; Appendices Part 4; App. 2.6-H 3 of 3; ML11208B770.	Identified and Admitted
APP-016-M	Revised TR RAI response; Appendices Part 5; App. 2.7-B through 2.7-G; ML11208B771.	Identified and Admitted
APP-016-N	Revised TR RAI response; Appendices Part 6; App. 2.7-H 1 of 4; ML11208B777.	Identified and Admitted
APP-016-O	Revised TR RAI response; Appendices Part 7; App. 2.7-H 2 of 4; ML11208B778.	Identified and Admitted
APP-016-P	Revised TR RAI Response; Appendices Part 8; App. 2.7-H 3 of 4; ML11208B784.	Identified and Admitted
APP-016-Q	Revised TR RAI Response; Appendices Part 9; App 2.7-H 4 of 4; ML11208B827.	Identified and Admitted
APP-016-R	Revised TR RAI response; Appendices Part 10; App. 2.7-K; ML11208B832.	Identified and Admitted
APP-016-S	Revised TR RAI Response; Appendices Part 11; App. 2.7-L 1 of 4; ML112088833.	Identified and Admitted
APP-016-T	Revised TR RAI Response; Appendices Part 12; App. 2.7-L 2 of 4; ML11208B868.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
APP-016-U	Revised TR RAI response; Appendices Part 13; App. 2.7-L 3 of 4; ML11208B864.	Identified and Admitted
APP-016-V	Revised TR RAI response; Appendices Part 14; App. 2.7-L 4 of 4; ML11208B865.	Identified and Admitted
APP-016-W	Revised TR RAI response; Appendices Part 15; App. Vol. 4 Cover; ML11208B870.	Identified and Admitted
APP-016-X	Revised TR RAI response; Appendices Part 16; App. 2.7-M; ML11208B872.	Identified and Admitted
APP-016-Y	Revised TR RAI response; Appendices Part 17; App.2.9-B through 2.9-K; ML112150229.	Identified and Admitted
APP-016-Z	Revised TR RAI response; Appendices Part 18; App. 3.1-A 1 of 2; ML11208B922.	Identified and Admitted
APP-016-AA	Revised TR RAI response; Appendices Part 19; App. 3.1-A 2 of 2; ML11208B924.	Identified and Admitted
APP-016-BB	Revised TR RAI response; Appendices Part 20; App. 6.1-A through 7.3-C; ML11208B925.	Identified and Admitted
APP-017	Figures to Accompany Demuth Initial Testimony.	Identified and Admitted
APP-018	USGS Water-Supply Paper 2220, Basic Ground-Water Hydrology, 1983.	Identified and Admitted
APP-019	National Mining Association's (NMA) Generic Environmental Report in Support of the Nuclear Regulatory Commission's Generic Environmental Impact Statement for In Situ Uranium Recovery Facilities; ML080170159	Identified and Admitted
APP-020	ISR animation (Video of ISR Operation).	Identified and Admitted
APP-021-A	Dewey-Burdock Project Technical Report (TR); re-submitted August 2009; Part 1; Text thru Sec. 2.7.1; ML092870298	Identified and Admitted
APP-021-B	Dewey-Burdock Project TR; re-submitted August 2009; Part 2; Text Sec. 2.7.2 thru 2.9; ML092870295.	Identified and Admitted
APP-021-C	Dewey Burdock Project TR; Re-submittal August 2009, Part 3; Text Sec 3 thru End; ML092870299.	Identified and Admitted
APP-021-D	Dewey-Burdock Project TR; Re-submitted August 2009; Part 4; Plate 1.5-1; ML092870313.	Identified and Admitted
APP-021-E	Dewey-Burdock Project TR; Re-submitted August 2009; Part 5; Plate 1.5-2; ML092870314.	Identified and Admitted
APP-021-F	Dewey-Burdock Project TR; Re-submittal August 2009; Part 6; Plate 2.5-1; ML092870315.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-021-G	Dewey-Burdock Project TR; re-submitted August 2009; Part 7; Plate 2.6-1; ML092870316.	Identified and Admitted
APP-021-H	Dewey-Burdock Project TR; Re-submitted August 2009; Part 8; Plate 2.6-2; ML092870317.	Identified and Admitted
APP-021-I	Dewey-Burdock Project TR; Re-submittal August 2009; Part 9; Plate 2.6-3; ML092870318.	Identified and Admitted
APP-021-J	Dewey-Burdock Project TR; Re-submittal August 2009; Part 10; Plate 2.6-4; ML092870305.	Identified and Admitted
APP-021-K	Dewey-Burdock Project TR; re-submitted August 2009; Part 11; Plate 2.6-5; ML092870306.	Identified and Admitted
APP-021-L	Dewey-Burdock Project TR; re-submitted August 2009; Part 12; Plate 2.6-6; ML092870307.	Identified and Admitted
APP-021-M	Dewey-Burdock Project TR; Re-submitted August 2009; Part 13; Plate 2.6-7; ML092870309.	Identified and Admitted
APP-021-N	Dewey-Burdock Project TR; re-submitted August 2009; Part 14; Plate 2.6-8; ML092870310.	Identified and Admitted
APP-021-O	Dewey-Burdock Project TR; Re-submitted August 2009; Part 15; Plate 2.6-9; ML092870311.	Identified and Admitted
APP-021-P	Dewey-Burdock Project TR; Re-submitted August 2009; Part 16; Plate 2.6-10; ML092870312.	Identified and Admitted
APP-021-Q	Dewey-Burdock Project TR; re-submitted August 2009; Part 17; Plate 2.6-11; ML092870320.	Identified and Admitted
APP-021-R	Dewey-Burdock Project TR; re-submitted August 2009; Part 18; Plate 2.6-12; ML092870321.	Identified and Admitted
APP-021-S	Dewey-Burdock Project TR; re-submitted August 2009; Part 19; Plate 2.6-13; ML092870322.	Identified and Admitted
APP-021-T	Dewey-Burdock Project TR; Re-submitted August 2009; Part 20; Plate 2.6-14; ML092870323.	Identified and Admitted
APP-021-U	Dewey-Burdock Project TR; re-submitted August 2009; Part 21; Plate 2.6-15; ML092870324.	Identified and Admitted
APP-021-V	Dewey-Burdock Project TR; re-submitted August 2009; Part 22; Plate 2.8-1; ML092870325.	Identified and Admitted
APP-021-W	Dewey-Burdock Project TR; re-submitted August 2009; Part 23; Plate 2.8-2; ML092870326.	Identified and Admitted
APP-021-X	Dewey-Burdock Project TR; re-submitted August 2009; Part 24; Plate 2.8-3; ML092870327.	Identified and Admitted
APP-021-Y	Dewey-Burdock Project TR; re-submitted August 2009; Part 25; Plate 3.1-1; ML092870328.	Identified and Admitted
APP-021-Z	Dewey-Burdock Project TR; re-submitted August 2009; Part 26; Plate 3.1-2; ML092870329.	Identified and Admitted

Applicant's Exhibits

Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
APP-021-AA	Dewey-Burdock Project TR; Re-submitted August 2009; Part 27; App. 2.2-A thru 2.6-B; ML092870350.	Identified and Admitted
APP-021-BB	Dewey-Burdock Project TR; re-submitted August 2009; Part 28; App. 2.6-C thru 2.7-B(partial); ML092870351	Identified and Admitted
APP-021-CC	Dewey-Burdock Project TR; Re-submittal August 2009; Part 29, App. 2.7-B (Partial) thru 2.7-F; ML092870370.	Identified and Admitted
APP-021-DD	Dewey-Burdock Project TR; re-submitted August 2009; Part 30; App. 2.7-G thru 2.8-F (partial); ML092870354.	Identified and Admitted
APP-021-EE	Dewey-Burdock TR; Re-submitted August 2009; Part 31; App. 2-8.F (Partial); ML092870357.	Identified and Admitted
APP-021-FF	Dewey-Burdock Project TR; re-submitted August 2009; Part 32; App. 2.8-G thru 2.9-A; ML092870358.	Identified and Admitted
APP-021-GG	Dewey-Burdock Project TR; re-submitted August 2009; Part 33; App. 4.2-A thru 7.3-A (partial); ML092870343.	Identified and Admitted
APP-021-HH	Dewey-Burdock Project TR; re-submitted August 2009; Part 34; App. 7.3-A (partial) thru 7.3-B; ML092870344.	Identified and Admitted
APP-022	Geochemical Data from Groundwater at the Proposed Dewey Burdock Uranium In-situ Recovery Mine, Edgemont, South Dakota: U.S. Geological Survey Open-File Report 2012-1070.	Identified and Admitted
APP-023	Uranium In-Situ Recovery and the Proposed Dewey Burdock Site, Edgemont, South Dakota, Public Meeting Talk Given by Dr. Raymond Johnson, U.S. Geological Survey, in Hot Springs, SD on Feb. 7, 2013 and Custer, SD on May 22, 2013.	Identified and Admitted
APP-024	Pre-Licensing Well Construction, Lost Creek ISR Uranium Recovery Project; ML091520101.	Identified and Admitted
APP-025	Numerical Modeling of Hydrogeologic Conditions, Dewey-Burdock Project, February 2012; ML12062A096.	Identified and Admitted
APP-026	Update on USGS research at the proposed Dewey Burdock uranium in-situ recovery mine, Edgemont, South Dakota, presentation to EPA Region 8 in Denver, CO on Feb. 22, 2012, based on USGS OFR 2012-1070.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-027-A	Report to Accompany Madison Water Right Permit Application, June 2012; ML12193A239.	Identified and Admitted
APP-027-B	Report to Accompany Madison Water Right Permit Application, June 2012, Appendix A; ML12193A234.	Identified and Admitted
APP-027-C	Report to Accompany Madison Water Right Permit Application, June 2012, Appendix B; ML12193A235.	Identified and Admitted
APP-028	Report to the Chief Engineer on Water Permit Application No. 2685-2 [Madison Aquifer], ADAMS Accession No. ML13165A160, November 2, 2012.	Identified and Admitted
APP-029	Letter Agreement between Powertech and Fall River County Commission.	Identified and Admitted
APP-030	NUREG/CR-6733, A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees - Final Report, July 2001; ML012840152.	Identified and Admitted
APP-031	Decision of the TCEQ Executive Director regarding Uranium Energy Corporation's Permit No. UR03075.	Identified and Admitted
APP-032	In-Situ Leach Uranium Mining in the United States of America: Past, Present and Future, by D.H. Underhill, in IAEA TECDOC-720, Uranium In Situ Leaching, Proceedings of a Technical Committee Held in Vienna, 5-8 October 1992, September 1993.	Identified and Admitted
APP-033	Safety Evaluation Report for the Moore Ranch ISR Project in Campbell County, Wyoming, Materials License No. SUA-1596; ML101310291.	Identified and Admitted
APP-034	Safety Evaluation Report for the Nichols Ranch In Situ Recovery Project in Johnson and Campbell Counties, Wyoming, Material License No. SUA-1597; ML102240206.	Identified and Admitted
APP-035	Safety Evaluation Report for the Lost Creek Project in Sweetwater County, Wyoming, Materials License No. SUA-1598; ML112231724.	Identified and Admitted
APP-036	Safety Evaluation Report for the Strata Energy, Inc. Ross ISR Project, Crook County, Wyoming, Materials License No. SUA-1601; ML14002A107.	Identified and Admitted
APP-037	Errol Lawrence Initial Testimony.	Identified and Admitted
APP-038	Errol Lawrence CV.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-039	Materials License SUA-1597 for the Nichols Ranch ISR Project, July 2011; ML111751649.	Identified and Admitted
APP-040-A	Dewey-Burdock Project Environment Report (ER); Re-submittal August 2009; Part 1; Cover thru Sec. 3.4.2.1.1; ML09270345.	Identified and Admitted
APP-040-B	Dewey-Burdock Project Environmental Report (ER); re-submitted August 2009; Part 2; Sec. 3.4.2.1.2 thru 3.12; ML092870346.	Identified and Admitted
APP-040-C	Dewey-Burdock Project Environmental Report (ER); re-submitted August 2009; Part 1; Sec. 4 thru end; ML092870360.	Identified and Admitted
APP-040-D	ER Plate 3.1-1; ML092870380.	Identified and Admitted
APP-040-E	ER Plate 3.3-1; ML0921870381.	Identified and Admitted
APP-040-F	ER Plate 3.3-1; ML092870381.	Identified and Admitted
APP-040-G	ER Plate 3.3-3; ML092870383.	Identified and Admitted
APP-040-H	ER Plate 3.3-4; ML092870591.	Identified and Admitted
APP-040-I	ER Plate 3.3-5; ML092870386.	Identified and Admitted
APP-040-J	ER Plate 3.3-6; ML092870387.	Identified and Admitted
APP-040-K	ER Plate 3.3-7; ML092870388.	Identified and Admitted
APP-040-L	ER Plate 3.3-8; ML092870389.	Identified and Admitted
APP-040-M	ER Plate 3.3-9; ML092870390.	Identified and Admitted
APP-040-N	ER Plate 3.3-10; ML092870592.	Identified and Admitted
APP-040-O	ER Plate 3.3-11; ML092870586.	Identified and Admitted
APP-040-P	ER Plate 3.3-12; ML092870588.	Identified and Admitted
APP-040-Q	ER Plate 3.3-13; ML092870589.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-040-R	ER Plate 3.3-14; ML092870590.	Identified and Admitted
APP-040-S	ER Plate 3.3-15; ML092870394.	Identified and Admitted
APP-040-T	ER Plate 3.5-1; ML092870395.	Identified and Admitted
APP-040-U	ER Plate 3.5-2; ML092870397.	Identified and Admitted
APP-040-V	ER Plate 6.1-1; ML092870593.	Identified and Admitted
APP-040-W	ER Replacement Plates; ML093370652.	Identified and Admitted
APP-040-X	ER App. 3.3-A thru 3.3-E; ML092870411.	Identified and Admitted
APP-040-Y	ER App. 3.3-F thru 3.4-A; ML092870421.	Identified and Admitted
APP-040-Z	ER App. 3.4-B thru 3.4-E; ML092870414.	Identified and Admitted
APP-040-AA	ER App.3.5-A thru 3.5-F; ML092870416.	Identified and Admitted
APP-040-BB	ER App. 3.5-F thru 3.5-I; ML092870422.	Identified and Admitted
APP-040-CC	ER App. 3.5-J thru 3.6-C; ML092870407.	Identified and Admitted
APP-040-DD	ER App. 4.6-A; ML092870409.	Identified and Admitted
APP-040-EE	ER App. 4.14-C thru 6.1-G; ML092870413.	Identified and Admitted
APP-041	Using Groundwater and Solid-phase Geochemistry for Reactive Transport Modeling at the Proposed Dewey Burdock Uranium In-situ Recovery Site, Edgemont, South Dakota, presentation given to EPA on April 11, 2012.	Identified and Admitted
APP-042-A	Dewey-Burdock Project Revised Class III Underground Injection Control Permit Application, Revised July 2012, Cover Letter; ML12244A519.	Identified and Admitted
APP-042-B	Dewey-Burdock Project Revised Class III Underground Injection Control Permit Application, Revised July 2012, Text thru Sec. 4; ML12244A522.	Identified and Admitted

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
APP-042-C	Dewey-Burdock Project Revised Class III Underground Injection Control Permit Application, Revised July 2012, Text Sec. 5 thru 8; ML12244A520.	Identified and Admitted
APP-042-D	Dewey-Burdock Project Revised Class III Underground Injection Control Permit Application, Revised July 2012, Text Sec. 9 thru end; ML12244A521.	Identified and Admitted
APP-043	Revised Response to TR RAI 5.7.8-3(b), June 27, 2012, ML12179A534.	Identified and Admitted
APP-044	Results of Acceptance Review for TR RAI Responses; ML110470245.	Identified and Admitted
APP-045	Responses to Technical Review Comments for Dewey-Burdock Large Scale Mine Permit Application; ML13144A182.	Identified and Admitted
APP-046	Doyl Fritz Initial Testimony.	Identified and Admitted
APP-047	Doyl Fritz CV.	Identified and Admitted
APP-048	Report to the Chief Engineer on Water Permit Application No. 2686-2 [Inyan Kara Aquifer], ADAMS Accession No. ML13165A168, November 2, 2012.	Identified and Admitted
APP-049	Water Right Permit No. 2626-2 Application and Permit.	Identified and Admitted
APP-050	ER RAI Responses, transmittal letter and text; ML102380516.	Identified and Admitted
APP-051	Groundwater Discharge Plan (GDP) permit application, as updated with replacement pages through November 2012.	Identified and Admitted
APP-052	Dewey-Burdock BLM Site Determinations; January 10, 2014 letter from BLM to SD SHPO; ML14014A303.	Identified and Admitted
APP-053	Gwyn McKee Initial Testimony.	Identified and Admitted
APP-054	Gwyn McKee CV.	Identified and Admitted
~~APP-055~~	~~Greater Sage-Grouse Management Plan, South Dakota, 2008-2017; ML12241A215.~~	Not Offered
~~APP-056~~	~~A Report on National Greater Sage-Grouse Conservation Measures.~~	Not Offered
~~APP-057~~	~~Greater Sage-grouse (Centrocercus urophasianus) Conservation Objectives: Final Report.~~	Not Offered

Applicant's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
~~APP-058~~	~~Endangered Species Act Consultation Handbook, Procedures for Conducting Section 7 Consultations and Conferences, U.S. Fish and Wildlife Service and National Marine Fisheries Service,1998~~	Not Offered
~~APP-059~~	~~Frequently Asked Questions on ESA Consultations, USFWS.~~	Not Offered
~~APP-060~~	~~Whooping Crane (Grus americana) 5-Year Review: Summary and Evaluation, USFWS.~~	Not Offered
~~APP-061~~	~~Division of Migratory Bird Management, Important Information for Sandhill Hunters, Fall Whooping Crane Sightings 1943-1999.~~	Not Offered
~~APP-062~~	~~Black-Footed Ferret Recovery Plan, Second Revision, Nov. 2013.~~	Not Offered
APP-063	Answering Testimony of Dr, Lynne Sebastian.	Identified and Admitted
APP-064	Dr. Adrien Hannus Answering Testimony.	Identified and Admitted
APP-065	Hal Demuth Answering Testimony.	Identified and Admitted
APP-066	Errol Lawrence Answering Testimony.	Identified and Admitted
APP-067	Figure to Accompany Errol Lawrence Answering Testimony.	Identified and Admitted
APP-068	Doyl Fritz Answering Testimony.	Identified and Admitted
APP-069	Figures to Accompany Doyl Fritz Answering Testimony.	Identified and Admitted
APP-070	Gwyn McKee Answering Testimony.	Identified and Admitted
APP-071	2013 Wildlife Monitoring Report for the Dewey-Burdock Project.	Identified and Admitted

Atomic Safety and Licensing Board Panel

In the Matter of:

Powertech (USA) Inc., (Dewey-Burdock In Situ Uranium Recovery Facility)

Docket No. 40-9075-MLA

ASLBP No. 10-898-02-MLA-BD01

Consolidated Intervenor's Exhibits

ADAMS Number	Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
	INT-001	Testimony of Dr. Louis Redmond regarding Lakota Cultural Resources.	Identified and Admitted
	INT-002	10/31/09 Report of Dr. Richard Abitz on Powertech Baseline Report.	Identified and Admitted
	INT-003	Statement of Professional Qualifications of Dr. Louis Redmond.	Identified and Admitted
	INT-004	Statement of Professional Qualifications of Dr. Hannan LaGarry	Identified and Admitted
	~~INT-005~~	~~Statement of Professional Qualifications of Dr. Richard Abitz.~~	Excluded by Board Order (August 1, 2014)
	INT-006	Declaration of Wilmer Mesteth regarding Lakota Cultural Resources.	Identified and Admitted
	INT-007	Testimony of Susan Henderson regarding water resources issues and concerns of downflow rancher.	Identified and Admitted
	~~INT-008~~	~~Testimony of Dr. Donald Kelley a former forensic pathologist regarding the radiological impact on humans and other animals.~~	Excluded by Board (At Hearing)
	~~INT-008a~~	~~Dr. Donald Kelley Affidavit~~	Excluded by Board (At Hearing)
	~~INT-009~~	~~Statement of Qualifications of Dr. Kelley.~~	Excluded by Board (At Hearing)
	INT-010	Testimony of Peggy Detmers a Wildlife Biologist Regarding the D-B Site and Endangered Species.	Identified as Proffered
	INT-010a	Statement of Qualifications of Peggy Detmers.	Identified as Proffered
	INT-010b	Map - Beaver Creek Watershed.	Identified as Proffered
	INT-010c	Map - Central Flyway.	Identified as Proffered
	INT-010d	Map - Whooping Crane Route.	Identified as Proffered
	INT-010e	Map - D-B Project Site.	Identified as Proffered
	INT-010f	Google Photo - Dewey Project - close.	Identified as Proffered

Atomic Safety and Licensing Board Panel

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Consolidated Intervenor's Exhibits			
ADAMS Number	**Exhibit Number**	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
INT-010g		Google Photo - Dewey Project - Medium Height.	Identified as Proffered
INT-010h		Google Photo - Dewey Project - Wide.	Identified as Proffered
INT-010i		Map - 5 state area - D-B Project.	Identified as Proffered
INT-010j		GPS Google Photo - D-B Project - Close-up.	Identified as Proffered
INT-010k		GPS Google Photo - D-B Project - Drainage.	Identified as Proffered
INT-010l		GPS Google Photo - D-B Project - wideshot.	Identified as Proffered
INT-010m		Map - D-B area.	Identified as Proffered
INT-010n		GPS Google Photo - D-B Project - triangle.	Identified as Proffered
INT-010o		Diagram - Whooping Crane Bioaccumulaton.	Identified as Proffered
INT-010p		Beaver Creek Final Fecal Coliform.	Identified as Proffered
~~INT-010q~~		~~IPAC~~	NOT FILED
INT-011		Testimony of Marvin Kammera, a rancher, on potential impacts on down flow ranchers as to Inyan Kara water quantity and quality.	Identified and Admitted
INT-012		Testimony of Dayton Hyde, Owner/Operator of Black Hills Wild Horse Sanctuary, on Potential Impacts and Concerns about Proposed ISL Mine on Downflow Surface and Underground Water Resources.	Identified and Admitted
INT-013		Testimony of Dr. Hannon LaGarry a geologic stratigrapher regarding fractures, faults, and other geologic features not adequately considered by Powertech or NRC staff.	Identified and Admitted
INT-014		Testimony of Linsey McLane, a Bio-chemist Regarding Bioaccumulation of Heavy Metals in Plant and Animal Species.	Identified and Admitted
~~INT-014a~~		~~Powerpoint of Linsey McLane, a biochemist regarding bioaccumulation of heavy metals in plants and animal species~~	NOT FILED
NT-014b		Linsey McLane Affidavit	Identified and Admitted

Consolidated Intervenor's Exhibits

ADAMS Number	Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
~~INT-15~~		~~INT Comments on DSEIS , with Exhibits~~	NOT FILED
INT-016		Petition to Intervene, with Exhibits.	Identified and Admitted
INT-017		Statement of Contentions on DSEIS, with Exhibits.	Identified and Admitted
INT-018		INT Statement of Contentions on FSEIS, with Exhibits.	Identified and Admitted
INT-019		Dr. Redmond Rebuttal Letter.	Identified and Admitted
INT-020		Rebuttal Written Testimony of Dr. Hannan LaGarry.	Identified and Admitted
INT-020A		Expert Opinion Regarding the Proposed Dewey-Burdock Project ISL Mine Near Edgemont, South Dakota.	Identified and Admitted
INT-021A		Violation History - Crow Butte ISL mine in Crawford, Nebraska.	Identified and Admitted
INT-021B		Violation History - Crow Butte ISL mine in Crawford, Nebraska.	Identified and Admitted
INT-021C		Violation History - Crow Butte ISL mine in Crawford, Nebraska.	Identified and Admitted
INT-022A		Violation History - Smith Highland Ranch.	Identified and Admitted
INT-022B		Violation History - Smith Highland Ranch.	Identified and Admitted
INT-022C		Violation History - Smith Highland Ranch.	Identified and Admitted
~~INT-023~~		~~Violation History - Irigaray-Christiansen Ranch~~	NOT FILED

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-001	Initial Testimony and Affidavits from Haimanot Yilma, Kellee L. Jamerson, Thomas Lancaster, James Prikryl, and Amy Hester	Identified and Admitted
NRC-002-R	REVISED - Statement of Professional Qualifications of Po Wen (Kevin) Hsueh.	Identified and Admitted
NRC-003	Statement of Professional Qualifications of Haimanot Yilma	Identified and Admitted
NRC-004	Statement of Professional Qualifications of Kellee L. Jamerson	Identified and Admitted
NRC-005	Statement of Professional Qualifications of Thomas Lancaster	Identified and Admitted
NRC-006	Statement of Professional Qualifications of James Prikryl	Identified and Admitted
NRC-007	Statement of Professional Qualifications of Amy Hester	Identified and Admitted
NRC-008-A-1	NUREG-1910, Supplement 4, Vol. 1, Final Report, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental Impact	Identified and Admitted
NRC-008-A-2	NUREG-1910, Supplement 4, Vol. 1, Final Report, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental....	Identified and Admitted
NRC-008-B-1	NUREG-1910, Supplement 4, Vol. 2, Final Report, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental	Identified and Admitted
NRC-008-B-2	NUREG-1910, Supplement 4, Vol. 2., Final Report, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental Impact Statement for In-Situ Leach....	Identified and Admitted
NRC-009-A-1	NUREG-1910, Supplement 4, Vol. 1, Draft Report for Comment, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental Impact Statement....	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-009-A-2	NUREG-1910, Supplement 4, Vol. 1, Draft Report for Comment, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic	Identified and Admitted
NRC-009-B-1	NUREG-1910, S4, V2, DFC, EIS for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Suppl to the GEIS for In-Situ Leach Uranium Milling Facilities (Chapter 5 to 11 and Appendices)....	Identified and Admitted
NRC-009-B-2	NUREG-1910, Supplement 4, Vol. 2, Draft Report for Comment, Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic	Identified and Admitted
NRC-010-A-1	NUREG-1910, Vol. 1, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 1 through 4) (May 2009) (ADAMS Accession No.	Identified and Admitted
NRC-010-A-2	NUREG-1910, Vol. 1, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 1 through 4)(May 2009) (ADAMS Accession No. ML091480244 Page 153-512	Identified and Admitted
NRC-010-A-3	NUREG-1910, Vol. 1, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 1 through 4) (May 2009) (ADAMS Accession No. ML091480244) Pages 513-704.	Identified and Admitted
NRC-010-B-1	NUREG-1910, Vol. 2, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 5 through 12 and Appendices) (May 2009) (ADAMS Accession No. ML091480188). Pages 1-272.	Identified and Admitted
NRC-010-B-2	NUREG-1910, Vol. 2, Final Report, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (Chapters 5 through 12 and Appendices) (May 2009) (ADAMS Accession No. ML091480188). Pages 273-612.	Identified and Admitted
NRC-011	Dewey-Burdock Record of Decision (Apr. 8, 2014) (ADAMS Accession No. ML14066A466).	Identified and Admitted
NRC-012	Materials License SUA-1600, Powertech (USA), Inc. (Apr. 8, 2014) (ADAMS Accession No. ML14043A392).	Identified and Admitted
NRC-013	NUREG-1569, Standard Review Plan for In-Situ Leach Uranium Extraction License Applications (June 4, 2003) (ADAMS Accession No. ML031550272).	Identified and Admitted
NRC-014	NUREG-1748, Final Report, Environmental Review Guidance for Licensing Actions Associated with NMSS Programs (Aug. 2003) (ADAMS Accession No. ML032450279).	Identified and Admitted

Atomic Safety and Licensing Board Panel

In the Matter of:

Powertech (USA) Inc., (Dewey-Burdock In Situ Uranium Recovery Facility)

Docket No. 40-9075-MLA

ASLBP No. 10-898-02-MLA-BD01

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-015	Dewey-Burdock ISR Project Summary of Tribal Outreach Timeline (Apr. 8, 2014) (ADAMS Accession No. ML14099A010).	Identified and Admitted
NRC-016	Submittal of Comments on Draft Programmatic Agreement for the Proposed Dewey-Burdock ISR Uranium Mining Project. (ADAMS Accession No. ML14077A002)	Identified and Admitted
NRC-017	Dewey-Burdock ISR Project Documents Pertaining to Section 106 of the National Historic Preservation Act (June 10, 2014), available at http://www.nrc.gov/info-finder/materials/uranium/licensed-facilities/dewey-burdock/section-106-docs.html	Identified and Admitted
NRC-018-A	Final PA for the Dewey-Burdock Project. (ADAMS Accession Nos. ML14066A347).	Identified and Admitted
NRC-018-B	Final Appendix for the Dewey-Burdock Project PA. (ADAMS Accession No. ML14066A350).	Identified and Admitted
NRC-018-C	NRC PA Signature Page. (ADAMS Accession No. ML14098A464).	Identified and Admitted
NRC-018-D	Letter from ACHP finalizing Section 106. (ADAMS Accession No. ML14099A025).	Identified and Admitted
NRC-018-E	ACHP PA Signature Page. (ADAMS Accession No. ML4098A1550).	Identified and Admitted
NRC-018-F	BLM signature on PA; (Mar. 25, 2014) (ADAMS Accession No. ML14098A102).	Identified and Admitted
NRC-018-G	South Dakota SHPO PA Signature Page. (ADAMS Accession No. ML14098A107).	Identified and Admitted
NRC-018-H	Powertech PA Signature Page. (ADAMS Accession No. ML14098A110).	Identified and Admitted
NRC-019	Summary Report Regarding the Tribal Cultural Surveys Completed for the Dewey-Burdock Uranium In Situ Recovery Project. (Dec. 16, 2013) (ADAMS Accession No. ML13343A142).	Identified and Admitted
NRC-020	NRC Letter transmitting the Applicant's Statement of Work to all consulting parties. (May 7,2012). (ADAMS Accession No. ML121250102).	Identified and Admitted
NRC-021	3/19/2010 NRC sent initial Section 106 invitation letters to 17 tribes requesting their input on the proposed action. ADAMS Accession No. ML100331999.	Identified and Admitted
NRC-022	Letter to Oglala Sioux Tribe Re: Request for Updated Tribal Council Members Consultation (Sep. 8, 2010) ADAMS Accession No. ML102450647).	Identified and Admitted

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Docket No. 40-9075-MLA

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NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-023	Powertech Dewey-Burdock Draft Scope of Work and Figures - Identification of Properties of Religious and Cultural Significance (Mar.07,2012) (ADAMS Accession No. ML120870197).	Identified and Admitted
NRC-024	NRC Staff Letter Postponing fall 2012 tribal survey. (12/14/2012). ADAMS Accession No. ML12335A175.	Identified and Admitted
NRC-025-A	HDR, Engineering Inc., "Assessment of the Visual Effects of the Powder River Basin Project, New Build Segment, on Previously Identified Historic Properties in South Dakota and Wyoming"....	Identified and Admitted
NRC-025-B	HDR, Engineering Inc. "Assessment of the Visual Effects of the Powder River Basin Project, New Build Segment, on Previously Identified Historic Properties in South Dakota and Wyoming."....	Identified and Admitted
NRC-026	WY SHPO (Wyoming State Historic Preservation Office). "Dewey-Burdock Line of Sight Analysis." Email (September 4) from R. Currit, Senior Archaeologist, Wyoming State Historic Preservation Office to H. Yilma,NRC. September 4,2013....	Identified and Admitted
NRC-027	ACHP, National Register Evaluation Criteria, Advisory Council on Historic Preservation. (Mar. 11, 2008) (2012 ADAMS Accession No. ML12262A055).	Identified and Admitted
NRC-028	Email from Waste Win Young to NRC Staff re SRST Comments Final Draft PA Dewey-Burdock SRST THPO Comments (Feb. 20, 2014) (ADAMS Accession No. ML14105A367).	Identified and Admitted
NRC-029	Letter to Cheyenne River Sioux Tribe re: Response Received Regarding Tribal Survey for Dewey-Burdock (Dec. 14, 2012) (ADAMS Accession No. ML12335A175).	Identified and Admitted
NRC-030	Standing Rock Sioux Tribe Comments - Final Draft PA Dewey-Burdock SRST-THPO Comments (Feb. 05, 2014) (ADAMS Accession No. ML14055A513).	Identified and Admitted
NRC-031	04/07/2014 Letter from the Advisory Council on Historic Preservation to the Standing Rock Sioux Tribe Concerning the Dewey- Burdock ISR Project, SD. ADAMS Accession No. ML14115A448.	Identified and Admitted
~~NRC-032~~		NOT FILED
NRC-033	09/13/2012 Summary of August 30,2012 Public Meeting with Powertech Inc, to Discuss Powertech's Proposed Environmental Monitoring Program related to the proposed Dewey-Burdock Project. ADAMS Accession No. ML12255A258.	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-034	Letter to Ponca Tribe of Nebraska Re: Invitation for Formal Consultation Under Section 106 of the National Historic Preservation Act (Mar. 4, 2011) (ADAMS Accession No. ML110550372).	Identified and Admitted
NRC-035	Letter to Santee Sioux Tribe of Nebraska Re: Invitation for Formal Consultation Under Section 106 of the National Historic Preservation Act (Mar. 4, 2011) (ADAMS Accession No. ML110550172).	Identified and Admitted
NRC-036	Letter to Crow Tribe of Montana Re: Invitation for Formal Consultation Under Section 106 of the national Historic Preservation Act (Mar. 04,2011) (ADAMS Accession No. ML110550535).	Identified and Admitted
NRC-037	12/3/2010 Yankton Sioux tribe requests face-to-face meeting to discuss past and current project as well as request for TCP survey. Sisseton Wahpeton and Fort Peck tribes also asked for face-to-face meeting via phone....	Identified and Admitted
NRC-038-A	Invitation for Informal Information-Gathering Meeting Pertaining to the Dewey-Burdock, Crow Butte North Trend, and Crow Butte License Renewal, In-Situ Uranium Recovery Projects (May 12, 2011)(ADAMS Accession No. ML111320251).	Identified and Admitted
NRC-038-B	Informal Information Gathering Meeting - Pine Ridge, SD Invitation to Section 106 Consultation Regarding Dewey-Burdock Project (ADAMS Accession No. ML111870622) (Package).	Identified and Admitted
NRC-038-C	Memo to Kevin Hsueh Re: Transcript for the June 8, 2011 Informal Information - Gathering Meeting Held in Pine Ridge, SD (July 8, 2011) (ADAMS Accession No. ML111870623).	Identified and Admitted
NRC-038-D	Attendee List - Informal Information Gathering Meeting Held in Pine Ridge, SD (July 8, 2011) (ADAMS Accession No. ML111870624).	Identified and Admitted
NRC-038-E	Transcript Re: Informal Information-Gathering Meeting Pertaining to Crow Butte Inc. and Powertech Inc. Proposed ISR Facilities (June 8, 2011) (ADAMS Accession No. ML111721938) (Pages 1-195).	Identified and Admitted
NRC-038-F	Presentation Slides for the Section 106 Consultation Meeting Pertaining to the Proposed Dewey-Burdock, Crow Butte North Trend, and Crow Butte LR In-Situ Uranium Recovery Projects (June 8, 2011) (ADAMS Accession No. ML111661428).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-039	Meeting Agenda for Informal Information Gathering Pertaining to Dewey-Burdock, Crow Butte. Accompanying NRC letter with map of the proposed project boundary and digital copies of the Class III	Identified and Admitted
NRC-040	Letter to Richard Blubaugh, Powertech, Re: NRC Information Request Relating to Section 106 and NEPA Reviews for the Proposed Dewey-Burdock Project (Aug. 12, 2011) (ADAMS Accession No. ML112170237).	Identified and Admitted
NRC-041	8/31/2011 NRC letter from Powertech letter and proposal in response to the Aug 12, 2011 request for NHPA Section 106 info. This letter enclosed a proposal which outlined a phased approach to	Identified and Admitted
NRC-042	10/20/2011 NRC provided copies of the 6/8/2011 meeting transcripts to all the Tribes. Thank you Letter to James Laysbad of Oglala Sioux Tribe Enclosing the Transcript of the Information-Gathering Meeting and Unredacted Survey Pertaining....	Identified and Admitted
~~NRC-043~~		NOT FILED
NRC-044	1/19/2012 NRC invitation letters to all THPOs for a planned Feb 2012 meeting to discuss how best to conduct the TCP survey. (ADAMS Accession No. ML12031A280).	Identified and Admitted
NRC-045	2/01/2012 (February 14-15, 2012 meeting agenda). (ADAMS Accession No. ML120320436).	Identified and Admitted
NRC-046	3/28/2012 - NRC transmitted transcripts of the NRC face-to-face meeting in Rapid City, SD to discuss how best to conduct the TCP survey. (ADAMS Accession Nos. ML120670319).	Identified and Admitted
NRC-047	Meeting the "Reasonable and Good Faith" Identification Standard in Section 106 Review (ACHP), availablae at http://www.achp.gov/docs/reasonable_good_faith_identification.pdf.	Identified and Admitted
NRC-048	NEPA and NHPA, A Handbook for Integrating NEPA and Section 106 (CEQ and ACHP), available at http://www.achp.gov/docs/NEPA NHPA Section 106 Handbook Mar2013.pdf.	Identified and Admitted
NRC-049	Letter to Crow Creek Sioux Tribe Re: Transmittal of Applicant's Draft Statement of Work (May 7, 2012) (ADAMS Accession No. ML 121250102).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-050	Letter to Oglala Sioux Tribe Re: Transmittal of Transcript from Teleconference Conducted on April 24, 2012 (June 26, 2012) (ADAMS Accession No. ML12177A109).	Identified and Admitted
NRC-051	NRC Email Re: August 9, 2012 Teleconference Invitation and Revised Statement of Work Transmittal (Aug. 07, 2012) (ADAMS Accession No. ML12261A375).	Identified and Admitted
NRC-052	NRC Request Re: Scope of Work with Coverage Rate, Start Date, Duration, and Cost (Aug 30, 2012) (ADAMS Accession No. ML12261A470).	Identified and Admitted
NRC-053	Letter to Tribal Historic Preservation Officer Re: Transmittal of Tribes' Proposal and Cost Estimate of the Dewey-Burdock ISR Project (Oct. 12, 2012) (ADAMS Accession No. ML12286A310).	Identified and Admitted
NRC-054	Letter to James Laysbad, Oglala Sioux Tribe, Re: Information Related to Traditional Cultural Properties; Dewey-Burdock, Crow Butte North Trend, and Crow Butte LR ISP Projects (Oct. 28, 2011) (ADAMS Accession No. ML112980555)	Identified and Admitted
NRC-055	Letter to Tribal Historic Preservation Officers Re: Request for a Proposal with Cost Estimate for Dewey Burdock Project (Sep. 18, 2012) (ADAMS Accession No. ML12264A594).	Identified and Admitted
NRC-056	H. Yilma Email Re: Draft PA for Dewey-Burdock Project (Nov. 22, 2013) (ADAMS Accession No. ML13329A420).	Identified and Admitted
NRC-057	Dewey-Burdock Project Draft Programmatic Agreement (Nov. 22, 2013) (ADAMS Accession No. ML ML13329A466).	Identified and Admitted
NRC-058	Draft Appendix A for Dewey-Burdock Project PA (Nov. 22, 2013) (ADAMS Accession No. ML13329A468).	Identified and Admitted
NRC-059	Table 1.0 - NRC NRHP Determinations for Dewey-Burdock Draft PA (Nov. 22, 2013) (ADAMS Accession No. ML13329A470).	Identified and Admitted
NRC-060	STB Finance Docket No. 33407, Dakota, Minnesota & Eastern Railroad Corporation Construction into the Powder River Basin: Request for Review and Comment on 21 Archaeological Sites, Surface Transportation Board....	Identified and Admitted

NRC Staff's Exhibits

Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-061	Letter to Oglala Sioux Tribe Re: Transmittal of TCP Survey Report for Dewey-Burdock Project (Dec. 23, 2013) (ADAMS Accession No. ML13357A234).	Identified and Admitted
NRC-062	NRC Overall Determinations of Eligibility and Assessments of Effects (Dec. 16, 2013) (ADAMS Accession No. ML13343A155).	Identified and Admitted
NRC-063	Draft NRC NRHP Determinations - Table 1.0 for Draft PA (Dec. 13, 2013) (ADAMS Accession No. ML13354B948).	Identified and Admitted
NRC-064	Letter from John Yellow Bird Steele, President of the Oglala Sioux Tribe Re: Refusal to Accept Dewey-Burdock In Situ Project Proposal (Nov. 5, 2012) (ADAMS Accession No. ML13026A005).	Identified and Admitted
NRC-065	Letter from Sisseton Wahpeton Oyaye Tribe Re: Refusal to Accept Dewey-Burdock In Situ Recovery Project Proposal (Nov. 6, 2012) (ADAMS Accession No. ML13036A104).	Identified and Admitted
NRC-066	Letter from Standing Rock Sioux Tribe Re: Tribal Survey Using Persons Without Sioux TCP Expertise to Identify Sioux TCP (Nov. 5, 2012) (ADAMS Accession No. ML13036A110).	Identified and Admitted
NRC-067	Email from Standing Rock Sioux Tribe Providing Comments on Final Draft PA Dewey-Burdock SRST-THPO (Feb. 20, 2014) (ADAMS Accession No. ML14059A199).	Identified and Admitted
NRC-068	Email Re: Transmittal of a Follow-up Email Pertaining to an Upcoming Field Survey for the Dewey-Burdock Project (Feb. 08, 2013) (ADAMS Accession No. ML13039A336).	Identified and Admitted
NRC-069	Letter to Oglala Sioux Tribe Re: Notification of Intention to Separate the NHPA Section 106 Process from NEPA Review for Dewey-Burdock ISR Project (Nov. 6, 2013) (ADAMS Accession No. ML13308B524.	Identified and Admitted
NRC-070	Letter to J. Fowler, ACHP, Re: Notification of Intention to Separate the NHPA Section 106 Process from NEPA Review for Dewey-Burdock IS Project (Nov. 13, 2013) (ADAMS Accession No. ML13311B184).	Identified and Admitted
NRC-071	Letter from Department of State Re: Keystone XL Pipeline Project Traditional Cultural Property (TCP) Studies (Aug. 4, 2009).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-072	A Level III Cultural Resources Evaluation of Powertech (USA) Incorporated's Proposed Dewey-Burdock Uranium Project Locality within the Southern Black Hills, Custer and Fall River Counties, South Dakota, Vol. I, (Page 1.2 through Page 4.18)....	Identified and Admitted
NRC-073	A Level III Cultural Resources Evaluation of Powertech (USA) Incorporated's Proposed Dewey-Burdock Uranium Project Locality within the Southern Black Hills, Custer and Fall River Counties, South Dakota (Pages 5.53 through 5.106)....	Identified and Admitted
NRC-074	NRC (1980). Regulatory Guide 4.14, Radiological Effluent and Environmental Monitoring at Uranium Mills. ADAMS Accession No. ML003739941.	Identified and Admitted
NRC-075	NRC, 2009. Staff Assessment of Ground Water Impacts from Previously Licensed In-Situ Uranium Recovery Facilities, Memorandum from C. Miller to Chairman Jaczko , et al. Washington DC: USNRC, July 10, 2009d ADAMS Accession No. ML091770385.	Identified and Admitted
NRC-076	NUREG/CR-6705, Historical Case Analysis of Uranium Plume Attenuation.. (Feb. 28, 2001) (ADAMS Accession No. ML010460162).	Identified and Admitted
NRC-077	05/28/2010 NRC Staff Request for Additional Information for Proposed Dewey-Burdock In Situ Recovery Facility (ADAMS Accession No. ML101460286).	Identified and Admitted
NRC-078	09/13/2012 NRC Staff RAI: Summary of August 30, 2012 Public Meeting with Powertech Inc, to Discuss Powertech's Proposed Environmental Monitoring Program related to the proposed Dewey-Burdock Project. (ADAMS Accession No. ML12255A258).	Identified and Admitted
NRC-079	09/09/2013 NRC Staff RAI: Email Concerning Review of Powertech's Additional Statistical Analysis of Radium-226 Soil Sampling Data and Gamma Measurements and Request for Information. ADAMS (Accession No.	Identified and Admitted
NRC-080	12/09/2013 NRC Staff RAI: NRC Staff review of revised statistical analysis of the Radium 226 (soil) and gamma radiation correlation for screening surveys at the proposed Dewey-Burdock Project requesting additional information....	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-081	Gott, G.B., D.E. Wolcott, and C.G. Bowles. Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits, Southern Black Hills, South Dakota and Wyoming. ML120310042. U.S. Geological Survey Water Resources Investigation Report....	Identified and Admitted
NRC-082	Driscoll, D.G., J.M. Carter, J.E. Williamson, and L.D. Putnam. Hydrology of the Black Hills Area, South Dakota. U.S. Geological Survey Water Resources Investigation Report 02-4094. (ADAMS Accession No. ML12240A218). 2002.	Identified and Admitted
NRC-083	Braddock,W.A. Geology of the Jewel Cave SW Quadrangle Custer County, South Dakota. U.S. Geological Survey Bulletin 1063-G. (08 April 2013)....	Identified and Admitted
NRC-084-A	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survery for Edgemont, South Dakota, Wyoming. National Uranium Resource Evaluation (NURE) Program....	Identified and Admitted
NRC-084-B	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survey for Edgemont, South Dakota, Wyoming. National Uranium Resource Evaluation (NURE) Program,....	Identified and Admitted
NRC-084-C	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survey for Edgemont, South Dakota, Wyoming. National Uranium....	Identified and Admitted
NRC-084-D	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survery for Edgemont, South Dakota, Wyoming. National Uranium Resource Evaluation (NURE) Program....	Identified and Admitted
NRC-084-E	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survery for Edgemont, South Dakota, Wyoming. National Uranium Resource Evaluation (NURE) Program....	Identified and Admitted
NRC-084-F	Butz, T.R., N.E. Dean, C.S. Bard, R.N. Helgerson, J.G. Grimes, and P.M. Pritz. Hydrogeochemical and Stream Sediment Detailed Geochemical Survery for Edgemont, South Dakota, Wyoming. National Uranium	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-085	Darton, N.H. Geology and Water Resources of the Northern Portion of the Black Hills and Adjoining Regions of South Dakota and Wyoming. U.S. Geological Survey Professional Paper 65. 1909....	Identified and Admitted
NRC-086	Epstein, J.B. "Hydrology, Hazards, and Geomorphic Development of Gypsum Karst in the Northern Black Hills, South Dakota and Wyoming. "U.S. Geological Survey Water-Resource Investigation Report 01-4011....	Identified and Admitted
NRC-087	NUREG-1910, Final Report, Supplement 1, Environmental Impact Statement for the Moore Ranch ISR Project in Campbell County, Wyoming, Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities....	Identified and Admitted
NRC-088	NUREG-1910, Final Report, Supplement 1, Environmental Impact Statement for the Moore Ranch ISR Project in Campbell County, Wyoming, Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities....	Identified and Admitted
NRC-089	NUREG-1910, Final Report, Supplement 3, Environmental Impact Statement for the Lost Creek ISR Project in Sweetwater County, Wyoming. Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities....	Identified and Admitted
NRC-090	SDDENR. "Report to the Chief Engineer on Water Permit Application No. 2686-2, Powertech (USA) Inc., November 2, 2012." November 2012a. ADAMS Accession No. ML13165A168.	Identified and Admitted
NRC-091	NRC. "Staff Assessment of Groundwater Impacts from Previously Licensed In-Situ Uranium Recovery Facilities." Memorandum to Chairman Jaczko, Commissioner Klein, and Commissioner Svinicki, NRC from C. Miller....	Identified and Admitted
~~NRC-092~~		NOT FILED
NRC-093	EPA comments on FSEIS; (ADAMS Accession No. ML14070A230).	Identified and Admitted
NRC-094	NRC Regulatory Guide 3.11, Rev. 3, Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities, November 2008, (ADAMS Accession No. ML082380144).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-095	Letter to P. Strobel Re: EPAs Response Comment to FSEIS (Mar. 25, 2014) (ADAMS Accession No. ML14078A044).	Identified and Admitted
NRC-096	Comment (14) of Robert F. Stewart on Behalf of the Dept. of the Interior, Office of Environmental Policy and Compliance on Draft Supplemental Environmental Impact Statement (DSEIS), Dewey-Burdock Project.....	Identified and Admitted
~~NRC-097~~	~~Request for Information Regarding Endangered or Threatened Species and Critical Habitat for the Powertech Inc. Proposed Dewey-Burdock In-Situ Recovery Facility Near Edgemont South Dakota (Mar. 15, 2010).(ADAMS Accession No. ML100331503).~~	Not Offered
~~NRC-098~~	~~FWS. Whooping Cranes and Wind Development - An Issue Paper. (Apr. 2009)....~~	Not Offered
~~NRC-099~~	~~Avian Power Line Interaction Committee. "Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006" (ADAMS Accession No. ML12243A391).~~	Not Offered
~~NRC-100~~	~~Informal Information-Gathering Meetings Trip Summery (Dec. 9, 2010) (ADAMS Accession No. ML093631627).~~	Not Offered
~~NRC-101~~	~~Email from Mitchell Iverson of BLM. (June 25, 2012) & Wildlife Stipulations in the Current 1986 South Dakota Resource Management Plan. (ADAMS Accession No. ML12249A030).~~	Not Offered
~~NRC-102~~	~~USGS. "Fragile Legacy, Endangered, Threatened, and Rare Animals of South Dakota, Black-footed Ferret (Mustela nigripes)." (2006), available at http://www.npwrc.usgs.gov/resource/wildlife/sdrare/species/mustnigr.htm.~~	Not Offered
~~NRC-103~~	~~FWS. "Species Profile, Whooping Crane (Grus Americana)".~~	Not Offered
~~NRC-104~~	~~BLM. "Draft Environmental Impact Statement, Dewey Conveyor Project." DOI-BLM-MT-040-2009-002-EIS. (Jan. 2009b) (ADAMS Accession No. ML12209A089).~~	Not Offered
~~NRC-105~~	~~BLM. "Final Statewide Programmatic Biological Assessment: Black-Footed Ferret (Mustela nigripes)." August, 2005. Cheyenne, Wyoming: U.S. Bureau of Land Management, Wyoming State Office.~~	Not Offered

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
~~NRC-106~~	~~FWS. "South Dakota Field Office, Black-Footed Ferret," (Sep. 9, 2013), available at http://www.fws.gov/southdakotafieldoffice/b-fferret.htm.~~	Not Offered
~~NRC-107~~	~~FWS. "Black-Footed Ferret Draft Recovery Plan." Second Revision, (Feb. 2013), available at....~~	Not Offered
~~NRC-108~~	~~South Dakota State University. "South Dakota GAP Analysis Project." Brookings, South Dakota: South Dakota State University, Department of Wildlife and Fisheries Sciences (Jan. 13, 2012), available at http://www.sdstate.edu/nrm/gap/index.cfm.~~	Not Offered
~~NRC-109~~	~~South Dakota State University. "Suitable Habitat Predicted for the Black-Footed Ferret in South Dakota." available at http://www.sdstate.edu/nrm/gap/mammals/upload/blfootferret-model.pdf.~~	Not Offered
~~NRC-110~~		NOT FILED
~~NRC-111~~	~~Dewey-Burdock Record of Decision (Apr. 8, 2014) (ADAMS Accession No. ML14066A466).~~	Not Offered
~~NRC-112~~	~~Travsky, A., Beauvais, G.P. "Species Assessment for the Whooping Crane (Grus Americana) in Wyoming." October 2004.Cheyenne, Wyoming: United States Department of the Interior, Bureau of Land Management,....~~	Not Offered
~~NRC-113~~	~~Endangered and Threatened Wildlife and Plants; 12-Month Findings for Petitions to List the Greater Sage-Grouse (Centrocercus urophasianus) as Threatened or Endangered. 75 Fed. Reg. 13,909-13,959....~~	Not Offered
~~NRC-114~~	~~Habitat Assessment and Conservation Strategy for Sage Grouse and Other Selected Species on Buffalo Gap National Grassland, U.S. Department of Agriculture, Forest Service (Sep. 2005) (ADAMS Accession No.....~~	Not Offered
~~NRC-115~~	~~Email with Attachments from Mitchell Iverson, BLM, RE: Meeting at 11:30 EST(June 25, 2012) (ADAMS Accession No. ML12250A802).~~	Not Offered
~~NRC-116~~	~~Attachment 1, Appendix C, South Dakota Field Office Mitigation Guidelines (June 25, 2012) (ADAMS Accession No. ML12250A827).~~	Not Offered
~~NRC-117~~	~~Appendix D South Dakota Field Office Reclamation Guidelines.~~	Not Offered

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
~~NRC-118~~	~~BLM. Email Subject "Appendix E Wildlife Stipulations" and attachments. From M. Iverson, BLM, Acting Field Manager, South Dakota Field Office, to A. Hester, CNWRA, Southwest Research Institute. (June 25, 2012.)~~	Not Offered
~~NRC-119~~	~~BLM. Email Subject "Wildlife and Special Status Stipulations in the 1896 South Dakota Resource Management Plan" and attachment. From M. Iverson, BLM, Acting Field Manager, South Dakota Field Office, to H. Yilma, Project Manager....~~	Not Offered
~~NRC-120~~	~~Peterson, R.A. "The South Dakota Breeding Bird Atlas." Jamestown, North Dakota: Northern Prairie Wildlife Research Center. 1995.http://www.npwrc.usgs.gov/%20%20resource/birds/sdatlas/index.htm~~	Not Offered
~~NRC-121~~	~~BLM. "Newcastle Resource Management Plan."(2000) (ADAMS Accession No. ML12209A101).~~	Not Offered
~~NRC-122~~	~~Sage-Grouse Working Group (Northeast Wyoming Sage-Grouse Working Group). "Northeast Wyoming Sage-Grouse Conservation Plan." (2006) (ADAMS Accession No. ML12240A374).~~	Not Offered
~~NRC-123~~	~~SDGFP. "Sage Grouse Population Dynamics."(Nov. 20, 2009), available at http://gfp.sd.gov/hunting/small-game/sage-grouse-population-dynamics.aspx~~	Not Offered
~~NRC-124~~		NOT FILED
~~NRC-125~~	~~U.S. Fish and Wildlife Service Press Release and Draft Report to Help Sage-Grouse Conservation Objectives (August 23, 2012) (ADAMS Accession No. ML12276A248)....~~	Not Offered
~~NRC-126~~	~~U.S. Fish and Wildlife Service. "Greater sage-grouse (Centrocercus urophasianus) Conservation Objectives: Final Report"(Feb. 2013), available at http://www.fws.gov/mountain-prairie/ea/03252013_COT_Report.pdf~~	Not Offered
~~NRC-127~~	~~Department of Environment And Natural Resources Recommendation Powertech (USA) Inc. Large Scale Mine Permit Application. (April 15, 2013), available at http://denr.sd.gov/des/mm/documents/Powertech1/DENRRec4-15-13.pdf.~~	Not Offered

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
~~NRC-128~~	~~SDGFP. "Colony Acreage and Distribution of the Black-Tailed Prairie Dog in South Dakota, 2008" (Aug. 2008), available at http://gfp.sd.gov/wildlife/docs/prairedog-distribution-report.pdf~~	Not Offered
~~NRC-129~~	~~S. Larson, FWS letter re Environmental Comments on Powertech Dewey-Burdock Project, Custer and Fall River County, South Dakota. (Mar. 29, 2010) (ADAMS Accession No. ML1009705560).~~	Not Offered
~~NRC-130~~	~~E-mail from Terry Quesinberry, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, to Amy Hester, Research Scientist, Center for Nuclear Waste Regulatory Analyses, Southwest Research Institute.....~~	Not Offered
~~NRC-131~~	~~E-mail from Terry Quesinberry, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, to Haimanot Yilma, Environmental Project Manager for Dewey-Burdock, Office of Federal and State Materials and Environmental....~~	Not Offered
NRC-132	Improving the Process for Preparing Efficient and Timely Environmental Reviews under NEPA.	Identified and Admitted
~~NRC-133~~		NOT FILED
NRC-134	Safety Evaluation Report for the Dewey-Burdock Project Fall River and Custer Counties, South Dakota. Materials License No. SUA-1600 (April 2014) ADAMS Accession No. ML14043A347.	Identified and Admitted
NRC-135	Safety Evaluation Report for the Dewey-Burdock Project Fall River and Custer Counties, South Dakota, Materials License No. SUA-1600, Docket No. 40-9075 (March 2013), ADAMS Accession No. ML13052A182.	Identified and Admitted
NRC-136-A	A - Palmer, L. and J.M. Kruse. "Evaluative Testing of 20 Sites in the Powertech (USA) Inc. Dewey-Burdock Uranium Project Impact Areas." Black Hills Archaeological Region. Volumes I and II. Archaeological Contract Series No. 251....	Identified and Admitted
NRC-136-B	Palmer, L. and J.M. Kruse Evaluative Testing of 20 Sites in the Powertech (USA) Inc. Dewey-Burdock Uranium Project Impact Areas Black Hills Archaeological Region Volumes I and II....	Identified and Admitted
NRC-136-C	Palmer, L. and J.M. Kruse. "Evaluative Testing of 20 Sites in the Powertech (USA) Inc. Dewey-Burdock Uranium Project Impact Areas." Black Hills Archaeological Region. Volumes I and II. Archaeological	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
NRC-137	Department of Environment and Natural Resources, Recommendation, Powertech (USA) Inc, Large Scale Mine Permit Application at 6 (April 15, 2013), available at http://denr.sd.gov/des/mm/documents/Powertech1/DENRRec4-15-13.pdf.	Identified and Admitted
NRC-138	Jack R. Keene (1973). Ground-Water Resources of the Western Half of Fall River County, South Dakota. South Dakota Department of Natural Resource Development, Geological Survey, Report of Investigations, No. 109, 90 pg....	Identified and Admitted
NRC-139	U.S. Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed June 20, 2014, from USGS web site: http//earthquakes.usgs.gov/regional/qfaults/.	Identified and Admitted
~~NRC-140~~		NOT FILED
NRC-141-A	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession No. ML092870155). Pages 1-42	Identified and Admitted
NRC-141-B	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession	Identified and Admitted
NRC-141-C	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession No. ML092870155). Pages 124-132	Identified and Admitted
NRC-141-D	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession No. ML092870155). Pages 133-143	Identified and Admitted
NRC-141-E	Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February 2009, Prepared by Powertech (USA) Inc. Greenwood Village, Colorado, CO. (Aug 31, 2009) (ADAMS Accession No. ML092870155).	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-142	Submittal of Comments on Draft Programmatic Agreement for the Proposed Dewey-Burdock ISR Uranium Mining Project. (Mar. 17, 2014) (ADAMS Accession No. ML14077A002. Pages 5-1	Identified and Admitted
NRC-143	Letter to Oglala Sioux Tribe re: Invitation for Government-to-Government Meeting Concerning Licensing Actions for Proposed Uranium Recovery Projects. (Mar. 12, 2013) (ADAMS Accession No. ML13071A653).	Identified and Admitted
NRC-144	SRI (SRI Foundation). "Overview of Places of Traditional and Cultural Significance, Cameco/Powertech Project Areas." Rio Rancho, New Mexico: SRI Foundation. (June 8, 2012) (ADAMS Accession No. ML12262A113).	Identified and Admitted
NRC-145-A	Guidelines for Evaluation and Documenting Traditional Cultural Properties. National Register Bulletin, U.S. Department of the Interior. National Park Service. (ADAMS Accession No. ML12240A371). Pages 1-14	Identified and Admitted
NRC-145-B	Guidelines for Evaluation and Documenting Traditional Cultural Properties. National Register Bulletin, U.S. Department of the Interior. National Park Service. (ADAMS Accession No. ML12240A371). Pages 15-18	Identified and Admitted
NRC-146	2013/03/13 Powertech Dewey-Burdock LA - RE: field survey in the spring of 2013. (Mar. 13, 2013) (ADAMS Accession No. ML13078A388).	Identified and Admitted
NRC-147	2013/03/13 Powertech Dewey-Burdock LA - RE: field survey for Dewey-Burdock. (Mar. 13, 2013) (ADAMS Accession No. ML13078A384).	Identified and Admitted
NRC-148	Letter from Oglala Sioux Tribe in response to February 8, 2013 letter to Tribal Historic Preservation Officer March 23, 2013 (ADAMS Accession No. ML13141A362).	Identified and Admitted
NRC-149	2013/08/30 Powertech Dewey-Burdock LA - Request for Availability to discuss development of a PA for the Dewey Burdock Project. (Aug. 30, 2013) (ADAMS Accession No. ML13267A221).	Identified and Admitted
NRC-150	2013/11/14 Powertech Dewey-Burdock LA - Reminder: Teleconference to discuss the development of the PA for the Dewey Burdock project is scheduled for Friday. (Nov. 15, 2013. (ADAMS Accession No. ML13322B658).	Identified and Admitted
NRC-151	NRC Staff Rebuttal Testimony.	Identified and Admitted
NRC-152	Statement of Professional Qualifications of Hope E. Luhman.	Identified and Admitted

NRC Staff's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
NRC-153	Excerpt from Parker, P. and T. King. Guidelines for Evaluating and Documenting Traditional Cultural Properties, National Register of Historic Places Bulletin 38. (1990) (ADAMS Accession No. ML12240A371).	Identified and Admitted
NRC-154	Excerpt from Bates, R. and J. Jackson. Dictionary of Geological Terms 3rd Edition. (1984).	Identified and Admitted
NRC-155	Letter from South Dakota Historical Society re: Dewey-Burdock Project, (Jan. 2014).	Identified and Admitted
NRC-156	Johnson, R. H. "Reactive Transport Modeling for the Proposed Dewey-Burdock Uranium In-Situ Recovery Mine, Edgemont, South Dakota, USA." International Mine Water Association, Mine Water-Managing the Challenges. 2011.	Identified and Admitted

Oglala Sioux Tribe's Exhibits		
Exhibit Number	Exhibit Title (as reflected in ADAMS)	Exhibit Status
OST-001	Opening Written Testimony of Dr. Robert E. Moran.	Identified and Admitted
OST-002	U.S. EPA, 2007, TENORM Uranium Occupational and Public Risks Associated with In- Situ Leaching; Append. III, PG 1-11.	Identified and Admitted
OST-003	US EPA, 2008, Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining, Volume 1: Mining and Reclamation Background: Previously published on-line and printed as Vol. 1 of EPA 402-R-05-007....	Identified and Admitted
OST-004	U.S. EPA, 2011 (June), CONSIDERATIONS RELATED TO POST-CLOSURE MONITORING OF URANIUM IN-SITU LEACH/IN-SITU RECOVERY (ISL/ISR) SITES, Draft Technical Report; [Includes Attachment A: Development of the Groundwater Baseline for Burdock ISL Site....	Identified and Admitted
OST-005	Powerpoint presentation prepared by Dr. Robert E. Moran.	Identified and Admitted
OST-006	Boggs, Jenkins, ?Analysis of Aquifer Tests Conducted at the Proposed Burdock Uranium Mine Site, Burdock, South Dakota,? Tennessee Valley Authority, Report No. WR28-1-520-109, May 1980.	Identified and Admitted
OST-007	Boggs, Hydrogeologic Investigations at Proposed Uranium Mine Near Dewey, South Dakota (1983).	Identified and Admitted
OST-008	Keene, Ground-water Resources of the Western Half of Fall River County, S.D., Dept. of Natural Resource Development Geological Survey, Univ. S.D., Report of Investigations No. 109 (1973).	Identified and Admitted
OST-009	TVA, Draft Environmental Statement, Edgemont Uranium Mine.	Identified and Admitted
OST-010	OST Petition to Intervene, with Exhibits.	Identified and Admitted
OST-011	OST Statement of Contentions on DSEIS, with Exhibits.	Identified and Admitted
OST-012	OST Statement of Contentions on FSEIS, with Exhibits.	Identified and Admitted
OST-013	OST Statement of Undisputed Facts submitted with OST Motion for Summary Disposition.	Identified and Admitted
OST-014	Declaration of Michael CatchesEnemy.	Identified and Admitted
OST-015	Declaration of Wilmer Mesteth.	Identified and Admitted

Oglala Sioux Tribe's Exhibits		
Exhibit Number	**Exhibit Title (as reflected in ADAMS)**	**Exhibit Status**
OST-016	February 20, 2013 letter from Standing Rock Sioux to NRC Staff.	Identified and Admitted
OST-017	March 22, 2013 letter from Oglala Sioux Tribe to NRC Staff.	Identified and Admitted
OST-018	Rebuttal Testimony of Dr. Robert E. Moran.	Identified and Admitted
OST-019	Powertech Press Release.	Identified and Admitted
OST-020	E-Mail from Chris Pugsley, Powertech, re NRC Proceeding.	Identified and Admitted
OST-021	Powertech Quarterly Management Discussion and Analysis.	Identified and Admitted

Geochemical Consulting Services, LLC
Solubility, Speciation, and Reaction-Path Modeling
Groundwater and Soil Geochemistry
Environmental Assessment
Risk Assessment

October 31, 2009

Coloradoans Against Resource Destruction (CARD)
PO Box 143
Wellington, CO 80549

Members of CARD:

Geochemical Consulting Services, LLC (GCS) is submitting the following comments on Powertech's proposed Baseline Plan (R Squared, 2009). The comments are based on best-industry practice, sound scientific analysis, and over 20-years of GCS experience in the fields of environmental investigations, sampling and analysis plans, groundwater monitoring, and remediation of contaminated groundwater and soil.

Comment 1. Section 2.1 Groundwater Monitoring

The importance of groundwater sampling procedures and the collection of 8 representative samples from each well is noted. However, the discussion fails to recognize the importance of using valid statistical methods for locating the wells (e.g., systematic grid or random selection; Gilbert, 1987; EPA, 2002; Matzke et al., 2007) to ensure representative samples are collected from the aquifer. EPA (2002, p. 8) notes that *"A well-planned sampling design is intended to ensure that resulting data are adequately representative of the target population and defensible for their intended use."*

The ore zone is a very small fraction of the total aquifer volume in the proposed exemption zone. The frequency of wells placed in the ore zone should reflect a very small percentage of the wells sampled for baseline water quality of the aquifer (e.g., less than 5 percent of the wells should be placed in the ore zone, or 1 in 20 wells can be in the ore zone). This small percentage of wells in the ore body is accounted for by using a valid statistical method for locating the wells, such as a systematic grid placed over the proposed aquifer exemption zone. For a systematic grid, a 400-by-400 foot grid should be placed over the proposed aquifer exemption area to ensure that a minimum of one well is placed in every 4 acres (NRC, 2003; p. 5-39).

The importance of sampling all horizons of the aquifer is also omitted from the discussion of representative samples. If screened intervals are limited to 20 ft (SOP 5, Section 5.2.1.1, bullet #5), nested wells must be used to obtain water samples from screened intervals throughout the entire aquifer thickness. A sample from a single 20 ft interval (e.g., the ore zone) of a much thicker aquifer is not a representative sample. This situation is well described by EPA (2002, p. 8) *"In this case, the sampling units are defined by the investigator and need to be appropriate for selecting a representative sample of material from the medium of interest."* Well completion logs are necessary to determine if the collected samples are representative of the various sand horizons in the aquifer, but do not appear to have been provided for previously drilled wells.

Comment 2. Section 2.1 Groundwater Monitoring

The last paragraph describes the field parameters that will be measured prior to sample collection. Standard Operating Procedure 8, Section 5.2.3 and 5.2.4 note that dissolved oxygen and Eh will be measured in the sampling container. This procedure is problematic in that it introduces oxygen from the atmosphere into the groundwater being measured, which yields a non-representative measurement of the indicated parameters.

Additionally, there is no mention of turbidity measurements in Section 2.1. Standard Operating Procedure 8, Section 5.2.5 states that turbidity may be measured at the time of sample collection. However, the applicant provides no basis for omitting the required turbidity measurement. Proper well development is needed to remove the sediment and contamination prior to collecting the first round of water-quality samples (EPA, 1992b; p. 6-46), and the nephelometric turbidity unit (NTU) should be below 5 NTU prior to sample collection (EPA, 1992b; p. 6-48).

Section 5.3.1 of Standard Operating Procedure 8 describes the acceptance criteria for Quality Control ("QC") checks on field measurements. The QC checks are a standard practice. However, they should not serve as an illusion that fulfillment of the criteria means the measurement is representative of the media sampled. For example, turbidity measurements of 28 NTU and 30 NTU are within 10% (the acceptance criterion), but they indicate significant suspended material in the sample, which may bias analytical results to high levels. Also, meeting the acceptance criteria for DO and Eh measurements is meaningless when the measurements are made on groundwater contacting the atmosphere, as the sample does not represent conditions in the aquifer.

Comment 3. Section 2.4.2 Monitoring of Particulates in Air

Monitoring should be performed around the vacuum dryer and drum loading facility, as a release here could result in significant exposure to workers. Without active monitoring, there is no way to recreate the dose that a worker receives during a release. (Note: this may be covered under an operations plan)

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Comment 4. Section 2.4.3 Monitoring of Radionuclides in Air

In general, high-volume air sampling stations should be placed N, NE, E, SE, S, SW, W, and NW of the property or facility center point. Winds can be highly variable during storms and two stations in the primary down wind direction are inadequate to capture the true distribution of wind-blown particulate. It is unclear why such monitoring is not proposed, as it is an insignificant cost relative to the cost of operations.

Comment 5. Section 2.4.4 Radon in Air

Monitoring should be performed around the ion exchange columns or other equipment that receives pregnant lixiviant. Without active monitoring, there is no way to recreate the dose that a worker receives during a release. (Note: this may be covered under an operations plan)

Comment 6. Section 3.1.

DQOs are briefly discussed, but Powertech does not address how the selected well locations fulfill the objective to obtain representative groundwater samples from the Fox Hills aquifer. In general, the boundary of the project needs to be defined and representative samples must be collected from the proposed aquifer exemption zone (See Comment 1).

Comment 7.

There is no discussion in the plan on an acceptable statistical methodology which will be used to generate baseline values. Guidance on statistical analysis of groundwater data is readily available. (EPA, 1989; EPA 1992a; ASTM, 1998). These widely used standards make it clear that the use of the mean (or average) and standard deviation to establish baseline water quality are only applicable if it can be demonstrated that the data are representative of the media (Comments 1 and 2) and the data set follows a normal or lognormal distribution. However, Powertech relies on the mean and standard deviation to develop the baseline values without the proper testing of data distributions.

The first test that must be performed on a data set is a test to determine if the data follow a normal or lognormal distribution. Statistical tests for normality are widely available through spreadsheet programs (e.g., Microsoft Excel with Analyse It), and the Shapiro-Wilk Test is generally the most robust test for demonstrating that data follow a normal distribution (Shapiro and Wilk, 1965; Shapiro, Wilk and Chen, 1968; Madansky, 1988).

The probability statistic, *p*, returned by the Shapiro-Wilk Test determines whether the data follow a normal distribution for the stated confidence interval. For a stated confidence level of 95 percent, *p* must be greater than 0.05 to accept the null hypothesis that the data follow a normal distribution. If the data do not follow a normal distribution, the data may be log transformed (using the natural logarithim) and re-run to determine if the log-transformed data follow a lognormal distribution. If neither the original data nor log-transformed data pass the Shapiro-Wilk Test (i.e., *p* less than 0.05), then it must be concluded that the data do not follow a normal or lognormal distribution. When the data do not follow a normal or lognormal distribution, the mean and standard deviation are meaningless because these parameters are defined ONLY for a normal or lognormal distribution.

Data sets that do not follow a normal or lognormal distribution generally include those sets that have a large number of results at or near the detection limit or some results at very high values (i.e., an asymmetrical distribution). This type of data set is a non-normal data set, and it's sample distribution must be analyzed with nonparametric techniques (Gilbert, 1987; Madansky, 1988) to define the median, quantiles, and inter-quantile range (IQR), provided the results at the detection limit do not exceed approximately 75 percent of the data points. The non-normal data sets are ordered, from lowest to highest values, and the median is the central value in the ordered data set, while the 0.25, 0.5 and 0.75 quantiles are the values such that 25%, 50% and 75% of all values fall below that value. The IQR is the difference between the 0.75 and 0.25 quantiles. Median and IQR are better indicators of the distribution in a non-normal, asymmetric distribution, because these statistical quantities are influenced less, relative to the mean and standard deviation, by very large or very small values.

Powertech should describe the valid statistical methods that will be used to develop the baseline values in accordance with accepted guidance.

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Sincerely,

Richard J. Abitz, PhD
Principal Geochemist/Owner

SUMMARY OF TELECONFERENCE WITH THE OGLALA SIOUX TRIBE REGARDING THE DEWEY-BURDOCK IN SITU URANIUM RECOVERY PROJECT

JANUARY 31, 2017

Meeting Participants and Affiliation:
Trina Lone Hill, Tribal Historic Preservation Officer, Oglala Sioux Tribe
Jeff Parsons, Counsel, Oglala Sioux Tribe
Travis Stills, Counsel, Oglala Sioux Tribe
Kellee Jamerson, Project Manager, U.S. Nuclear Regulatory Commission
Diana Diaz-Toro, Project Manager, U.S. Nuclear Regulatory Commission
Cinthya I. Román, Environmental Review Branch Chief, U.S. Nuclear Regulatory Commission
Emily Monteith, Attorney, U.S. Nuclear Regulatory Commission
David Cylkowski, Attorney, U.S. Nuclear Regulatory Commission
Sabrina Allen, Paralegal Specialist, U.S. Nuclear Regulatory Commission

Summary:

The U.S. Nuclear Regulatory Commission (NRC) staff met with representatives of the Oglala Sioux Tribe on January 31, 2017, via teleconference. The purpose of the meeting was to (1) continue consultation and exchange views regarding the methodology to identify and survey cultural resources at the Dewey-Burdock in situ uranium recovery (ISR) project site, (2) discuss the Tribe's concerns with the Dewey-Burdock Programmatic Agreement, and (3) discuss the role of other Tribes in the survey.

The NRC staff expressed its commitment to working with the Oglala Sioux Tribe to conduct a tribal survey in the near future. The NRC staff presented its preliminary tribal survey approach, which would consist of the following parameters:

- Open site survey of the Dewey-Burdock license area
- Opportunity to conduct the survey as early as April-May 2017 timeframe
- Per diem and mileage reimbursement for up to three Tribal representatives
- An honorarium of $10,000

The NRC staff stated that the open site approach provides the flexibility of conducting a tribal survey using any survey methodology that the Tribe finds acceptable to identify cultural sites of importance to them. The Oglala Sioux Tribe expressed its disappointment with this proposal and noted that it was the same proposal offered to Tribes and rejected by the Oglala Sioux Tribe during the NRC's licensing review of the Dewey-Burdock ISR Project.

The Oglala Sioux Tribe expressed its commitment to work with the NRC and its desire to reach an agreement on a survey of the license area that identifies the Oglala Sioux and other Tribes' cultural resources and traditional cultural properties impacted by the Dewey-Burdock project. The Oglala Sioux Tribe expressed its preference to develop a survey methodology similar in nature to the Makoche Wowapi survey proposal that was submitted to the NRC in September 2012. The Oglala Sioux Tribe stated its opinion that NRC staff never provided input on the methodology set out in the Makoche Wowapi proposal, which the Oglala Sioux Tribe proposed should serve as the basis for future discussions of a methodologically sound survey. The Oglala Sioux Tribe also stated its desire to include other interested Tribes in the development of the survey approach and recommended that those Tribes participate in conducting the tribal survey.

In addition, the Oglala Sioux Tribe stated that the Programmatic Agreement contemplates that a survey would need to be conducted for the transmission line corridor area. The Tribe asked whether the licensee, Powertech, could better define the transmission line route and recommended that such routes be included as part of the tribal survey. The NRC staff also expressed interest in receiving information about the survey methodology/approach, number of tribal representatives to participate, cost/reimbursement, and timeframe. The Oglala Sioux Tribe committed to provide the NRC staff with information about a tribal survey approach by mid-March 2017 to aid the discussion and establishment of a survey. The NRC staff and the Tribe agreed to hold a teleconference tentatively scheduled for the beginning of April 2017 to continue consultation on a cultural resources survey.

The NRC staff asked the Tribe whether it would be willing to share information about known cultural and historic resources that may be impacted by the Dewey-Burdock project. The Tribe discussed the significance of the Black Hills to the Tribe’s history and culture. The Tribe expressed its willingness to share historical information about the significance of the Black Hills region with the NRC staff.

During the teleconference, the Oglala Sioux Tribe also shared its concerns regarding the Programmatic Agreement. The Tribe expressed concerns focused on how some information was presented and characterized in the Programmatic Agreement; the Tribe’s opinion that Powertech is responsible for identification of cultural resources and historic properties, assessment of adverse effects and identification of mitigation measures; and the role of the Oglala Sioux Tribe in the Programmatic Agreement. The Tribe committed to providing the NRC staff with a more detailed list of its concerns with the Programmatic Agreement.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of	)	
	)	
POWERTECH (USA) INC.	)	Docket No. 40-9075-MLA
	)	ASLBP No. 10-898-02-MLA-BD01
(Dewey-Burdock In Situ Uranium	)	
Recovery Facility)	)	November 21, 2014

WRITTEN SUPPLEMENTAL TESTIMONY OF DR. HANNAN LAGARRY

I, Dr. Hannan LaGarry, hereby declare as follows:

1. I am an expert in the above-captioned proceeding; my testimony, CV, and area of expertise are already in the record. To summarize, I am a stratigraphic mapper and full-time professor at Oglala Lakota College in Kyle, South Dakota. In preparing this declaration, I relied on the expertise gained through my training and experience in reviewing and interpreting borehole logs and other geologic data to create and review narratives, representations, and maps of subsurface geology and hydrogeology.

2. My testimony herein is based on my review of Powertech's recently disclosed borehole logs, maps, and other data. My testimony is also based on my review of the testimony and exhibits submitted by both NRC Staff and Powertech to the Nuclear Regulatory Commission Atomic Safety and Licensing Board, and my expert opinions offered before and during the hearing in Rapid City, South Dakota.

3. On November 12, 14, and 15, 2014 myself and 3 student assistants continued to review drillers' notes and borehole logs prepared by the Tennessee Valley Authority and recently disclosed by Powertech. This review was conducted at the Powertech offices in Edgemont, South Dakota.

   The available data consists of paper files contained in 28 bankers' boxes, 5 file cabinets, and 31 sets of mini logs (reduced to about 1/10th of the full-sized logs). Based on records I reviewed during my initial visit to the Powertech offices on September 14-16, 2014 these boxes, cabinets, and mini logs contain ***at least***:

   7515 total borehole logs
   7454 known borehole logs prior to acquisition of the recently described data
   3920 borehole logs owned prior to acquisition of the recently disclosed data
   3075 digitized data logs

These totals may underreport the number of logs made available, as I was not able to confirm whether my count was inclusive of all logs made available. Our understanding was that the newly disclosed borehole logs numbered over 4,000 data sets.

In total, my assistants and I were able to review drillers' notes from 4,177 boreholes (56% of the 7515 listed above) in 2.5 bankers' boxes, with at least 2.5 bankers' boxes of similar records remaining unexamined. We also examined 488 full-sized (in 3 boxes) and 1774 "mini" resistivity and gamma log pairs (30% of the 7515 listed above), with at least 6 bankers' boxes and 5 file cabinets of similar records remaining unexamined. The number of notes and logs examined was likely 5% fewer than the total number of records reviewed because some logs and notes were discovered to be moved or missing (see below). Also, there is overlap between the drillers' notes and the "mini" borehole logs reviewed. The "mini" logs, although briefly reviewed, did not contribute to the observations listed below.

My review confirmed my previous testimony that the raw data was not presented by modern modeling I would expect to find in such data compilations. Because of the limited time available and the lack of modelling, we did not attempt to reconstruct the geology of the proposed license area. Rather, we focused on the first-hand accounts of the geology of the site and the drilling conditions recorded by the geologists logging the wells. Based on our review of the data, we documented the following unique instances:

140	open, uncased holes
16	previously cased, redrilled open holes
4	records of artesian water
13	records of holes plugged with wooden fenceposts
6	records of holes plugged with broken steel
12	records of faults within or beside drilled holes
1	drawing of 2 faults and a sink hole within a drilled transect
7	notations "do not record this value on drill hole maps"
2	notations "do not return this to landowner"
63	redacted borehole logs

Many notes contained references to water at various levels and poor, muddy, or destroyed samples. We also found that, in the data sets we reviewed, blocks of records had been moved or were missing.

4. Based on the observations noted above, I offer the following expert opinions:

Sample size

We examined drillers' notes from 4,177 boreholes, which is at least 56% of the available data. In my expert opinion, while this sample likely underrepresents the total number of features listed above, it is sufficiently large to characterize the data and to reasonably reflect the geological conditions in the licensed area. In contrast, the NRC review of 34 boreholes constitutes less than 1% of the available data, grossly misrepresents the sample, and is not scientifically valid or useful in any meaningful way.

Open, uncased holes, including redrilled open holes
(Exhibit SNT25)
Casing of boreholes prevents the unwanted migration, transfer, and cross-contamination of water within a borehole. Uncased holes allow unrestricted communication between water-bearing strata at the site. Each uncased hole is a breach of the confining layers assumed to restrict the movement of mining fluids and contaminants. Redrilling of previously cased holes destroys the pre-existing casing and returns the borehole to the open, uncased condition. In my expert opinion, while it is possible that confinement may yet exist in undrilled areas, there is no reasonable expectation that confinement remains in drilled areas.

Artesian water
(Exhibits TRT44, ELT4)
Artesian water is water that flows under pressure exerted by connected waters at higher elevations. The presence of artesian water in the licensed area clearly demonstrates such connections, and that there is communication of water between the aquifers onsite and offsite. Artesian flow allows the rapid transfer of water along the subsurface conduits through which it flows, and greatly increases the likelihood of large amounts of highly contaminated subsurface water reaching the surface and contaminating it. In my expert opinion, artesian flow demonstrates a lack of containment at the site and poses a significant risk of unexpected, serious contamination of the Cheyenne River and its tributaries.

Plugged holes
Typically, boreholes are plugged with concrete. Plugs made of wood rot and disappear. Plugs made of ferrous metals, including steel, rust and disappear. It is my expert opinion that, for purposes of determining aquifer isolation, boreholes plugged in such a way should be considered open, uncased boreholes.

Faults and sinkholes
(Exhibits DS178 back side, DS392, IHK2, IHM32, IHM62, TRR17, TRT16, FBM95)
During hearings before the ASLB in August of 2014, Powertech repeatedly asserted that faults and sinkholes were not present in the license area, and that the license was somehow unique in that regard. In my previous testimony, I offered the expert opinion that faults were almost certainly present, and the license area was most likely crossed by numerous faults. The observations I document herein demonstrate that my previous expert testimony was correct, and there are numerous faults present in the licensed area. Likewise, the drillers' notes document a sinkhole along a drilled transect associated with two closely spaced faults also intersecting the drilled transect. Sinkholes typically form along faults, as the fault allows the initial penetration of acidic surface waters, which then dissolve a conduit through the rock which eventually forma a cave that subsequently collapses to for the sinkhole.

Suppression and redaction of data
(Exhibit TRJ111)
Notations in the drillers' notes to withhold data imply that there was an attempt to deceive somebody about the character of particular boreholes. The possible motivation for withholding the data was not clear from our limited review in these instances. More troubling is the deliberate masking (redaction) of borehole log data. This information may not be recoverable without additional drilling adjacent to the original borehole, and is clear evidence that information was withheld for some reason. As in the previously mentioned withholding of data, what this is and why it was withheld cannot be determined. A competent and complete scientific review upon which a determination could be based that containment of mining solution can be achieved at the Dewey-Burdock property would account for this missing data.

Water in boreholes
The presence of water at various levels in the drill holes suggests that there are multiple aquifers present at the site, and in the case of uncased holes, open communication and unrestricted flow between water-bearing strata at the site.

Poor, muddy, and destroyed samples
Problems with samples can bias rock descriptions and create circumstances in which the confining units would be misidentified, leading to miscorrelations of strata and confining layers considered present when in fact they are not. In order to determine if miscorrelation or false identifications have occurred would require detailed redescription of the available data. In my expert opinion, conclusions based on such samples, such as the presence or absence of a confining layer, should remain tentative at best.

Moved or missing data
The amount of moved or missing data and its significance is difficult to ascertain from our brief review. It may have been extracted from the set it is part of and relocated to another box, withheld, or destroyed. Only a thorough review and inventory can determine the disposition of the missing data. A review of this data is necessary to form concrete conclusions as to the confining properties of the geological strata.

5. In conclusion, the numerous records of open holes, artesian water, faults, and sinkholes. My prior testimony and opinions regarding Contentions 2 and 3 are supported by the observations recounted here.

6. It is my further expert opinion that NRC-directed "spot check" of 34 borehole logs from somewhere between 1750 and 6000 available borehole logs does not provide a scientifically recognized analysis that can support any hydrogeological conclusion about the project area. In my professional experience, there are numerous methodologies for analyzing the raw data contained in borehole logs. There are also numerous methodologies for presenting the results of the analysis of the raw data. Modern methods typically result in GIS/three-dimensional visualization and modeling of systems or similar computer modelling based on the raw data

in borehole logs. A copy of the website is attached to confirm the widespread and accepted use of these methodologies within the profession.

7. A "spot check" of borehole logs is not proper where analysis has not been carried out and recorded by GIS/three-dimensional visualization and modeling or similar technique. The NRC Staff testimony indicates that Powertech has not conducted the necessary mapping of available data. In such a circumstance, NRC Staff's conclusions are not reliable where NRC Staff accepts assertions of scientific fact made by Powertech that are not supported by accepted methodologies used to review data in borehole logs.

8. The NRC Staff testimony makes no mention of the information contained in the drillers' notes. Drillers' notes are an important source of interpretive information, often revealing information not disclosed by sliding logs. For example, drillers' notes can reveal the location of caves, artesian water, and the intermittent absence of confining layers. Although my review is not complete, the drillers' notes I have reviewed do contain this type of information.

9. The NRC "spot check" of 34 data points does not provide a statistically reliable testimony or basis for any conclusions regarding confinement or hydrology. I teach various math and statistics courses at Oglala Lakota College. Multivariate statistics is one of the formal research tools required for my PhD in Geology from the University of Nebraska-Lincoln. I am charged with review of research students at OLC who frequently apply statistical methods in their capstone research sequence required for their BS in Natural Science. NRC Staff's "random" analysis lacks the basic safeguards applicable to those who would rely on statistical methods.

10. The minimum number of data points for a statistically valid and meaningful sample is generally 10%. In the Powertech instance the minimum acceptable sample size would be a randomly selected sample of at least 175 borehole logs. Based on the recent disclosure of over 4,000 previously withheld borehole logs, the appropriate sample would be 10% of the entire set, or about 575+ borehole logs checked. NRC Staff presents no basis for its so-called "random" selection. Without such information, professionals in my field cannot accept such assertions where it is possible that the limited data set resulted in poor methodology that is the hallmark of modern junk science. Having examined only 37 data points out of thousands available, NRC would have failed my Math 123 Introduction to Statistics class. None of my student researchers would be allowed to publish or present their research findings had they made such a fundamental error.

11. In my experience and training, NRC Staff's methodology is fundamentally flawed and the testimony based on the NRC Staff's review cannot be relied upon for any legitimate scientific purpose.

12. Although I relied on student assistants as appropriate, the testimony and opinion provided herein are based on my direct professional review and personal knowledge. Any errors or misinterpretations of data herein are exclusively my own.

I declare under penalty of perjury that the foregoing is true and correct of my own knowledge. Executed in accord with 10 CFR 2.304(d).

Executed in Chadron, Nebraska on November 21, 2014

Hannan E. LaGarry, Ph.D.

SUMMARY OF MEETING WITH THE OGLALA SIOUX TRIBE
REGARDING THE DEWEY-BURDOCK IN SITU URANIUM RECOVERY PROJECT

Date: May 19, 2016

Location: Pine Ridge, South Dakota

Meeting Participants and Affiliation:

James Red Willow, Oglala Sioux Tribe, Executive Committee 5th Member
Trina Lone Hill, Oglala Sioux Tribe, Tribal Historic Preservation Officer
Jeff Parsons, Oglala Sioux Tribe, Counsel
Lillias Jarding, Clean Water Alliance
Craig Erlanger, Division Director, U.S. Nuclear Regulatory Commission
Christopher Hair, Attorney, U.S. Nuclear Regulatory Commission
Kellee Jamerson, Project Manager, U.S. Nuclear Regulatory Commission
Diana Diaz-Toro, Project Manager, U.S. Nuclear Regulatory Commission

Summary:

The U.S. Nuclear Regulatory Commission (NRC) staff met with representatives of the Oglala Sioux Tribe on May 19, 2016, in Pine Ridge, South Dakota. The purpose of the meeting was twofold: (i) to introduce the NRC's new management team responsible for the consultation process with the Oglala Sioux Tribe and the Tribe's new Tribal Historic Preservation Office staff, and (ii) to start the dialogue, on a Government-to-Government basis, regarding a path forward for consultation with the Oglala Sioux Tribe to address the Atomic Safety and Licensing Board's (ASLB's) findings regarding the NRC's environmental review conducted under the National Environmental Policy Act and Section 106 review conducted under the National Historic Preservation Act of 1966.[1] This meeting constituted the first step and building block for moving forward with the consultation process to gather information about historic and cultural resources of significance to the Oglala Sioux Tribe that could be affected by the construction and operation of the Dewey-Burdock in situ uranium recovery (ISR) project located in Fall River and Custer Counties, South Dakota.

The NRC discussed the re-organization of the Office of Nuclear Material Safety and Safeguards (NMSS)[2] including the management changes that occurred within the last two years. The NRC also provided an update of the Dewey-Burdock ISR project. The NRC published the supplemental environmental impact statement[3] in January 2014, executed the programmatic agreement (PA) (in accordance with the Section 106 process) in April 2014, and issued the Record of Decision and license in April 2014.[4] The licensee, Powertech (USA) Inc., has not begun construction activities. Prior to the start of construction and operations, the licensee

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[1] Atomic Safety and Licensing Board Order dated April 30, 2015 (LBP-15-16). ML15120A299
[2] NMSS is responsible for regulating activities which provide for the safe and secure production of nuclear fuel used in commercial nuclear reactors (including uranium recovery activities); the safe storage, transportation and disposal of high-level radioactive waste and spent nuclear fuel; and the transportation of radioactive materials regulated under the Atomic Energy Act.
[3] NUREG-1910, Supplement 4, "Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota." ML14024A477, ML14024A478
[4] 79 Federal Register 21302. ML14043A392, ML14066A466

Enclosure

would need to obtain additional permits from the U.S. Environmental Protection Agency for disposing liquid waste through the underground injection control program and the State of South Dakota for mining activities before proceeding with construction and operation activities. In response to inquiries from the Oglala Sioux Tribe, the NRC confirmed that neither NRC nor the licensee has conducted any additional activities or surveys at the site.

The Oglala Sioux Tribe explained that Tribal Treaties and their Tribal laws and ordinances are the law of the land. The Oglala Sioux Tribe noted that Tribal ordinances prohibit nuclear activities within Treaty lands and asked that these be taken into consideration, even if the project site is beyond the borders of the Tribe's reservation. The Oglala Sioux Tribe, Tribal Historic Preservation Officer will provide specific citations to the ordinances regarding the prohibition of nuclear activities. The NRC noted it will consider these laws and ordinances as part of this consultation process.

The Oglala Sioux Tribe also noted its objection to both the PA and the continued effectiveness of the license in light of the ASLB ruling finding the Record of Decision for the license incomplete. The Tribe also stated that the PA would need to be revisited and strengthened based, in part, due to the inadequacies of the surveys of the Dewey-Burdock ISR project site conducted in 2013. Additionally, the Oglala Sioux Tribe noted that the process described in the PA lacks meaningful opportunities for Tribes to provide input or raise objections about the management of historic and cultural resources. The NRC clarified that, although the PA has been executed, certain activities related to the identification of historic properties, and assessment and resolution of adverse effects still need to be carried out to fully implement the PA. Accordingly, the NRC noted that revisiting the PA could be one of the avenues available to address the ASLB's findings regarding historic and cultural resources. The Tribe requested that the NRC consider staying the effectiveness of the license until the ASLB findings can be addressed.

With respect to the survey, the Oglala Sioux Tribe noted that the tribal survey conducted in 2013 was incomplete and the survey methodology lacked scientific integrity. The Oglala Sioux Tribe asked that additional comprehensive and meaningful surveys be conducted and that other Tribes should also be involved. The NRC discussed the possibility of another survey opportunity and clarified that coordination with the licensee would be necessary to gain access to the project site.

Oglala Lakota

Cultural Affairs & Historic Preservation

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May 31, 2017

Cinthya I. Román, Chief
Environmental Review Branch
Division of Fuel Cycle Safety, Safeguards
and Environmental Review
Office of Nuclear Material Safety
and Safeguards

Dear Ms. Román,

This letter seeks to make a positive contribution to the discussions initiated at the in-person meeting on May 19, 2016 on the Pine Ridge Reservation. As NRC Staff set out in its summary of that meeting, the NRC and Tribe may be able to identify a mutually acceptable survey methodology. As we have subsequently discussed, however, there is a fundamental lack of accepted methodology in the informal approach most recently proposed by NRC Staff and the applicant, Powertech. This letter first addresses the shortcomings of the NRC Staff proposal and then outlines the basis for further discussions with NRC Staff in carrying out the NRC's statutory duties and government-to-government consultations.

The Oglala Sioux Tribe Cultural Affairs and Historic Preservation Office ("the Office") received the letter dated April 14, 2017 regarding NRC Staff's proposal for effecting a survey of cultural resources on the Dewey-Burdock site. While the Office appreciates the proposal, it appears to be virtually identical to the former "open-site" proposals made by NRC Staff that have been rejected by every single Lakota Sioux tribe that has considered this approach. For the multiple reasons presented to NRC Staff on the record in the past, and reiterated in this letter, this proposal remains unacceptable in its current form.

However, as NRC Staff is aware, the Office remains focused on and committed to ensuring a competent and complete survey of cultural resources at the site. To further develop and encourage a detailed discussion between the affected Lakota Sioux tribes and NRC Staff over the parameters necessary for an acceptable cultural resources survey, the Office has gone back through the record in this matter, and in other relevant proceedings, involving the Office and NRC Staff's attempts to fulfill its obligations under the National Historic Preservation Act (NHPA) and National Environmental Policy Act (NEPA). This effort reveals opportunities to address the Office's concerns, meet NRC Staff's legal obligations, and ensure the meaningful involvement of other affected tribal historic preservation offices.

In the meantime, the Office is compelled to reassert its strong objection to NRC Staff's continued support for keeping the license issued to the applicant in this matter active and effective despite the express findings of illegalities by the Atomic Safety Licensing Board and Nuclear Regulatory Commission. As the Office has repeatedly informed NRC Staff, the Office believes this decision to leave the license in place violates federal laws and serves to hamper trust, communication, and the ability to develop a better relationship for purposes of resolving the present issues with NHPA and NEPA compliance.

With respect to the "open-site" survey NRC Staff has recently re-proposed, the past communications between the Office and other tribal historic preservation offices demonstrates the serious frailties with this approach. As is evident in the administrative record for both the Dewey-Burdock licensing proceeding and the Crow Butte Resources licensing renewal proceeding, the "open-site" survey approach has been repeatedly and forcefully rejected by all of the Lakota Sioux tribes. For instance, multiple letters from the Standing Rock Sioux Tribal Historic Preservation Office, included in the referenced Dewey-Burdock and Crow Butte records, provide a detailed basis for the Tribes' disapproval of the "open-site" approach. These letters demonstrate that as early as 2011 the Tribes had specifically objected to any NRC Staff approach that lacks identification of acceptable protocols and methodologies for cultural site identification. October 15, 2012 letter from Terry Clouthier, Standing Rock Sioux Tribal Archaeologist, to Kevin Hseuh, Chief, Environmental Review Branch (ML12298A142). That October 2012 letter was sent to Mr. Hseuh after NRC Staff had informed the Tribes on October 12, 2012 that despite the significant effort, time, and resources the Tribes had expended in soliciting, discussing, and preparing their own cultural resources survey proposal, NRC Staff would not consider the Tribes' proposal – nor provide any detailed basis or discussion for its rejection.

Again on February 20, 2013, the Tribes provided to NRC Staff an even more explicit rejection of the "open-site" approach. Letter from Terry Clouthier, Standing Rock Sioux Tribal Archaeologist, to Kevin Hseuh, Chief, Environmental Review Branch (ML14247A401). In the February 2013 letter, the Tribes objected not only to the NRC Staff's evident fidelity to the applicant's fiscal constraints over the requests of the Tribes (and the NRC Staff NEPA and NHPA obligations), but also the lack of effort to ensure any survey involves a proper methodological framework to conduct the necessary cultural resources survey. That letter provides a detailed review of the financial shortcomings of the proposal with its "honorarium" given the technical investigation and reporting necessary for a competent survey. That letter also objects to the manner in which NRC Staff has made the "open-site" proposal – as much more on an ultimatum than any invitation for a detailed discussion of what components such a survey should involve.

The Office refers NRC Staff to these letters as they were included and referenced in the Office's comments and filings during the previous NEPA and ASLB hearing process and continue to fairly represent the Office's current position regarding the most recent "open-site" proposal, which remains virtually identical to those previously proposed. The Office sincerely hopes, however, that the NRC Staff does not intend the current proposal as an ultimatum, but rather a starting point for more detailed discussions. Simply put, such an ultimatum would not provide the Office a reasonable opportunity to identify concerns, advise on identification of resources, articulate its views on impacts, and participate in the resolution of adverse effects.

In this spirit of further discussing a mutually acceptable proposal, the Office wishes to bring to NRC Staff's attention a number of points reflected in the administrative records for both the Dewey-Burdock proceeding and the Crow Butte expansion proceeding, which the Office believes bear directly on the issues at hand. As an initial matter, it important to recognize that a physical survey of the site must be conducted in order to allow for identification of cultural resources, and that a simple literature review, background check, or some similar effort is not sufficient. This was the testimony of the NRC Staff's expert, Dr. Nickens, in the Crow Butte expansion license proceeding, to which the Oglala Sioux Tribe was a party, when discussing the "statement of work" for conducting such a survey:

> 2 DR. NICKENS: Well, the Statement of Work
> 3 is the approach. The background check I wouldn't
> 4 really consider a suitable technique. That's really
> 5 a literature search usually to identify potential
> 6 TCPs, but that's usually done outside of tribal
> 7 effort.
> 8 CHAIR GIBSON: And that would be something
> 9 that would sort of augment one of these other
> 10 approaches, is that right, doing these historical
> 11 background checks?
> 12 DR. NICKENS: That's correct. And in my
> 13 opinion, should be a corollary to any of the studies.

Transcript of Hearing conducted August 27, 2015 (Docket No. 40-8943-OLA) (ML15244B278) at p. 2024. Also of great importance is the fact that the expertise of the Lakota Sioux is essential to a meaningful and comprehensive survey. As NRC Staff's expert Mr. Goodman testified, also in the Crow Butte expansion license proceeding:

> 10 MR. GOODMAN: No, I would not say that,
> 11 Your Honor. I would say one of the big take aways
> 12 from that meeting is that TCP surveys are -- the
> 13 tribes have a unique expertise to identify these
> 14 surveys. So one of the big take aways was that staff
> 15 felt that it was very important to have a TCP
> 16 conducted by the tribes.

Id. at p. 2097. *See also* Id. at p. 2062 at lines 17-22 ([CHAIR GIBSON:] "the tribes indicated they were unable to provide the NRC staff with specific feedback about any cultural sites without first doing a TCP survey. Does that sound right to you, sir? MR. GOODMAN: More than sound right, Your Honor. That's right."). This point was also repeatedly expressed in the Dewey-Burdock proceedings hearing. *See, e.g.,* Transcript of Hearing conducted August 19, 2014 (Docket No. 40-9075-MLA)(ML14234A449) at p. 860, lines 1-8; p. 762, line 24 to p. 763, line 6.

With respect to the Dewey-Burdock site, as has been communicated to NRC Staff for several years, the Office asserts that there must be an effort to coordinate the several different

Lakota Sioux Tribes before designing and conducting a cultural resources survey. *See, e.g.*, Transcript of Hearing conducted August 19, 2014 (Docket No. 40-9075-MLA)(ML14234A449) at p. 794. While the Office understands that NRC Staff is under an obligation to conduct consultation meetings with the Oglala Sioux Tribe specifically, and the Office wishes to take part in those, coordination of a cultural resources survey must include the other Lakota Sioux tribal governments at the earliest stages in order to be competent in its analysis of Lakota Sioux cultural resources.

The Office strongly maintains that the best manner to conduct a proper survey is to involve a contractor(s) with the necessary experience, training, and cultural knowledge to carry out and facilitate the survey. This approach was endorsed by NRC Staff's expert in the Crow Butte expansion proceeding hearing:

> DR. NICKENS: Mr. Goodman covered it pretty well in sketchy detail. In my experience, probably the best TPC survey approach is to involve Tribal Elders, wherein if it's one tribe or a group of tribes would supply elders of their choice and then there would be a facilitator, something along the lines of a cultural anthropologist who would accompany the elders and provide logistics support, documentation, recording support, report preparation if that were necessary. That's usually been the best approach that I've seen.

Transcript of Hearing conducted August 27, 2015 (Docket No. 40-8943-OLA) (ML15244B278) at p. 2023. Similarly, in the Dewey-Burdock record, the Tribes repeatedly communicated this need for a contractor/facilitator, which is what gave rise to the Tribes' cultural resources survey proposal presented to, but disregarded, by NRC Staff.

With respect to specific protocols and methodologies that should be incorporated into any competent cultural survey approach, on multiple occasions during his testimony during the Crow Butte expansion proceeding hearing, Mr. Catches Enemy addressed the issue in his testimony:

> [MR. CATCHES-ENEMY]: If the survey was to be done the way the tribes had wanted to, not only would they probably have had the on-the-ground survey cultural resource specialist, they would have conferred with tribal elders, spiritual advisors, spiritual leaders; a lot of people know them as medicine men, medicine women, on the findings that were in the field. A lot of our tribal elders are not able to walk out, you know, in transects to identify some of these special places that haven't -- if you're thinking about any one of these project areas, our people have been displaced from them for a long time, a very long time. So the connection remains regardless of that displacement from having access to these places.
> I think it's mentioned several times in

> some of the testimony from some of the tribes that
> were participating either on the bus tour in June of
> 2011 that a lot of them hadn't ever been to or had
> access to these places before because of probably the
> land ownership or the companies that had taken the
> placement of their companies at these locations.
> So, to be able to have access for the
> period that is required to do a proper identification
> I think was what the tribes were trying to push. And
> I think that proposal was rejected maybe for the
> monetary reasons; I'm not sure, but the know that the
> tribes were really trying to look at including the
> spiritual and cultural significance to do a full
> analysis. So it wasn't just to be limited to the NHPA
> Section 106 requirements, but also the hard look under
> NEPA.

Transcript of August 28, 2015 (Docket No. 40-8943-OLA) (ML15252A189) pp. 2244-2245. Mr. Catches Enemy further testified:

> MR. CATCHES-ENEMY: Again, that discussion
> would have to be reexamined with the other Tribal
> Historic Preservation Offices, their advisory council
> members as well as any of their elders and spiritual
> advisors. So as far as putting a time frame on how
> long a reasonable TCP survey could occur, I wouldn't
> want to lock myself into stating that.

Id. at p. 2274. Mr. Catches Enemy explained:

> MR. CATCHES-ENEMY: Yes, based on
> archeological training and methodologies TCP surveys
> have a different aspect which don't typically follow
> those same guidelines, still trying to perform under
> NHPA, Section 106 parameters, however there's a huge
> cultural component that I mentioned before that we
> keep in mind with NEPA, the hard look with NEPA, that
> involves a broader context than just maybe material
> items or tangible items that are identified or that
> can be touched.
> When we start talking about the spiritual
> components, that's something that an archeologist
> would never document. They will not document
> something that's intangible, something that's specific
> to practices, beliefs, mores of a tribe or an
> indigenous group. So a TCP survey is quite extensive,
> and that's why I didn't want to limit to maybe even
> just one year. I would say a couple years.
> When you're talking about that large of an

> audience, as far as that many tribes to be involved, to get a good feel for the area, maybe in different seasons -- maybe they want to be out there during different seasons, maybe they want to be out there when the ground visibility is the best, or maybe there are ceremonies to be performed during that time at the elders' discretion. That's something you'll never see with an archeological survey.
>
> CHAIR GIBSON: Yes, sir.
>
> MR. CATCHES-ENEMY: You're going to get out and do the transects, do the recording, the reporting and it'll be a final product made on -- based on a different cultural mind set.

Id. at p. 2275-2276. This same basic premise of the need to carry out a cultural resources survey in a fashion consistent with the Lakota Sioux cultural values was discussed and elaborated on in the Dewey-Burdock licensing hearing as well. *See* August 19, 2014 Transcript (Docket No. 40-9075-MLA) (ML14234A449) at p. 800-801.

Chairman Gibson in the Crow Butte expansion proceeding turned to the NRC Staff's expert, who affirmed the points Mr. Catches Enemy expounded upon:

> CHAIR GIBSON: Okay. Dr. Nickens, do you think Mr. Catches-Enemy is being overly conservative or overly aggressive in how long he believes this would take to do a realistic TCP survey involving all these tribes?
>
> DR. NICKENS: It's difficult to respond to that, Your Honor.
>
> CHAIR GIBSON: Yes, sir.
>
> DR. NICKENS: It totally depends on the scope of work as Mr. Catches-Enemy has just mentioned, the involvement of elders, which based on my reading of the proposals leading up to this point that have been offered, I don't see elder involvement in any of those. So it's kind of apple and oranges here as to what Mr. Catches-Enemy is talking about.
>
> He is absolutely correct in the way that the tribal people, particularly the elders and religious leaders, would look at the resource compared to the way I as an archeologist would. We can identify the tangible resource on the ground. If we used the Crow Butte butte as an example, I can document it, I can record it, I can do a literature search, but in no way could I ascribe the cultural meaning to that that the Lakota people would.
>
> Now back to the basic question, in my experience with various project areas in the Western United States and the involvement of tribal elders and

groups and the entire process, taking the elders to the field as possible, identifying resources, documenting those resources, recording and then transcribing in to a report that would be used by the parties in the long run, I would guess -- and I would put it in a matter of months. Maybe in this case; and this is just a wild stab, I'd say eight to nine months.

CHAIR GIBSON: Okay. Very well. Thank you.

MR. YELLOW THUNDER: Your Honor, if I may add a little bit to –

CHAIR GIBSON: Oh, yes, Mr. Yellow Thunder.

MR. YELLOW THUNDER: -- what my colleague Mr. Catches-Enemy has previously discussed. I'd just like to put it on the record that throughout this entire process from beginning to end to this point the staff, the Applicant, consultants have used different tactics, ploys and maneuverings in which there's almost a total disregard for our customs, our beliefs and our way of life. Often we have been pushed into a corner. An example is we want this scope of work tomorrow. Another example is we want this survey TCP completed yesterday. And if you don't, we're going to go ahead and do it our way.

So in regards to the timeline, time frame in which this work is conducted in our way, we always have deferred to our elders because they have the wealth of knowledge that we do not possess, and we would not dishonor them in any way. So we have always taken the time to be certain that what we are looking at is what we are looking at, because what is out there and the things that have been uncovered by the consultants and archeologists that they have found is often -- the numbers are often very different. They have discovered 20 sites. We have gone out and discovered 200 sites. And in that time period we have allowed prayer and ceremony and spirituality to guide us. So it is very important that we don't rush into these things.

CHAIR GIBSON: Yes, sir.

MR. YELLOW THUNDER: And we often will take the time to, like I was saying, defer to our elders. We didn't get to where we are today by rushing into things.

CHAIR GIBSON: Yes.

MR. YELLOW THUNDER: But thank you. I just wanted to add that.

23 CHAIR GIBSON: Thank you, sir. We will
24 stand in recess for 10 minutes. Thank you.

Id. at p. 2276-2279.

Dr. Nickens later clarified that his estimate of 8-9 months included not just the field work, but also the additional work of preparing reports, and other non-field work. However, the point remains that an "open-site" approach as proposed by NRC Staff, with no coordination amongst the Tribes or protocols or approaches identified for making or documenting observations, is not suitable for satisfying the requirements of NEPA and the NHPA. As far as timelines, the "open-site" proposal from NRC Staff asks the Office to identify a two-week period to conduct all field work. This directly contradicts the Oglala Sioux Tribe's testimony in both proceedings identified above and ignores Mr. Yellow Thunder's request that NRC staff avoid pushing the Tribe into a corner.

In order to address the issues the Office identified at the in-person meeting with NRC Staff, the Office respectfully requests NRC Staff re-evaluate and come back to the table for discussion. The Office asserts, as presented in the testimony copied above, that the methodologies, protocols, and timing need to account for the cultural needs of the Lakota Sioux – including the ability to use tribal elders and other experts as resources in a coordinated fashion with other tribal historic preservation offices. The Tribe wishes to engage NRC Staff in a much more detailed discussion of how these components can be incorporated into a cultural resources survey approach. The Office understands that NRC Staff and the applicant were not ready to accept the September 27, 2012 Makoche Wowapi proposal that the various Lakota Sioux tribes had generated through significant effort. ML15222B282. However, the failure of one attempt in 2012 should not eliminate the possibility of using a contractor for such important work.

Recognizing the progress made at the May 19, 2016 in-person meeting between the Office and NRC Staff, the Office re-asserts its strong preference for face-to-face meetings to discuss these matters, elaborate positions, and come to agreement on details. The importance of face-to-face communication over these cultural resources issues has been reiterated repeatedly during both the Dewey-Burdock proceedings and the Crow Butte expansion proceedings. *See, e.g.*, Transcript of Hearing conducted August 27, 2015 (Docket No. 40-8943-OLA) (ML15244B278) at 2171, line 24 to p. 2172, line 3 ("MR. YELLOW THUNDER: We would rather have face to face dialogue. That was not just the view of our tribe, but a view of Cheyenne River Tribe and Rosebud and all of the other tribes that were involved in this."); Transcript of Hearing conducted August 19, 2014 (Docket No. 40-9075-MLA) (ML14234A449) at p. 826 ("MR. CATCHESENEMY: Throughout the whole process I can say that the tribes, especially the Oglala Sioux Tribe, have always advocated for the face-to-face."). Consistent with the approach, the Office specifically requests that significant further discussion take place on a face-to-face basis. As a start, the Office requests that NRC Staff come to the Pine Ridge Reservation to discuss the contents of this letter, the NRC Staff's April 14, 2017 letter, as well as the other relevant issues such as the Tribes' detailed critique of the Programmatic Agreement. *See* Letter dated February 5, 2014 from Oglala Sioux Tribe President Bryan V. Brewer to Haimanot Yilma, NRC Staff, with accompanying email and line-by-line PA comments dated February 20, 2014 from Wašté Wiŋ Young, Standing Rock Sioux Tribe Historic Preservation Officer to NRC Staff (ML14241A448) at pp. 132-159.

Further, in his testimony during both proceedings, Mr. Catches Enemy explained the importance of involving the elected members of the Oglala Sioux Tribal Council in order to ensure the proper level of Section 106 NHPA government-to-government consultation and communication. Transcript of Hearing conducted August 27, 2015 (Docket No. 40-8943-OLA) (ML15244B278) at pp. 2050-2051; pp. 2124-2125. This is also consistent with Ordinance No. 11-10 of the Oglala Sioux Tribal Council of the Oglala Sioux Tribe which mandates that while technical staff may engage in discussions and deliberations with federal governmental agencies, the Oglala Sioux Tribal Council must be included in government-to-government consultation.

With respect to the participation by NRC Staff, testimony from NRC Staff experts indicates a practice of designating one "decision maker":

> MR. GOODMAN: The designated agency
> decision maker under the National Historic
> Preservation Act. Each agency has to designate a
> decision maker. In that case, it is Larry Camper, Mr.
> Camper, Your Honor.

Id. at p. 2129. The Office requests that NRC Staff specifically confirm the identify this decision maker for how the NHPA consultation process will be conducted, and that this person be directly involved in the discussions, face-to-face and otherwise, including those conducted with the Oglala Sioux Tribal Council representatives.

We look forward to continuing to work with NRC Staff regarding the cultural resources survey for the Dewey-Burdock property. Please inform my office as to your willingness to conduct further discussions. As you note in your letter, July can be a particularly difficult month, but there should be no reason a schedule and plan cannot be established during the month of June to further the discussion and set dates for in person meetings between NRC Staff, Office staff, and the Oglala Sioux Tribal Council representatives.

Because this matter involves ongoing litigation in the D.C. Circuit Court of Appeals, please follow the applicable litigation protocols and please involve the Tribe's attorneys for this matter in all communications.

Sincerely,

Trina Lone Hill
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Cc: Jeffrey C. Parsons, Counsel for the Oglala Sioux Tribe
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Andrew P. Averbach, Solicitor, U.S. NRC
Lane McFadden, U.S. Department of Justice

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket No.: 40-9075-MLA
POWERTECH (USA), INC.	)	
	)	Date: June 20, 2014
(Dewey-Burdock In Situ Uranium Recovery Facility)	)	

POWERTECH (USA), INC. INITIAL STATEMENT OF POSITION

Powertech (USA), Inc. (Powertech) hereby submits its initial statement of position and testimony regarding the grant of License No. SUA-1600 by the United States Nuclear Regulatory Commission (NRC) permitting the construction and operation of the Dewey-Burdock *in situ* leach uranium recovery (ISR) project in the State of South Dakota. The issued license permits Powertech to construct ISR facilities at the Dewey and Burdock sites, including a central processing plant (CPP), ion-exchange (IX) columns, satellite IX facilities, wellfields, and other associated and ancillary structures in accordance with NRC regulations at 10 CFR Part 40 and Appendix A Criteria and other applicable regulations, guidance, and policy.

As will be discussed in greater detail below, a group of individual members of the public (hereinafter "Consolidated Intervenors") and the Oglala Sioux Tribe (hereinafter the "Tribe") requested and were granted an NRC administrative hearing pursuant to 10 CFR Part 2, Subpart L of the Commission's hearing procedures. Over the course of the past four (4) years, the

Licensing Board admitted, amended, and/or migrated two (2) safety and seven (7) environmental contentions.[1]

As set forth in Powertech's Initial Statement of Position, Direct Testimony, and Exhibits, Powertech NRC License No. SUA-1600, its record of decision (ROD) and accompanying decision documents, including but not limited to its Safety Evaluation Report (SER),[2] its Final Supplemental Environmental Impact Statement (NUREG-1910, Supplement 4 or FSEIS), its National Historic Preservation Act (NHPA) Programmatic Agreement (PA) and associated requirements and mitigation measures, and final license conditions (SUA-1600) addressing both safety and environmental-related resource areas, the final decision by NRC Staff to issue SUA-1600 satisfies the Commission's statutory mandate delineated by Congress in the Atomic Energy Act of 1954, as amended by the Uranium Mill Tailings Radiation Control Act of 1978 (collectively the "AEA"), to adequately protect public health and safety and the common defense and security. Accordingly, the safety-related allegations levied by Consolidated Intervenors and/or the Tribe in Contentions 2 and 3 are without merit. Further, as will be shown below, NRC Staff's issuance of SUA-1600 adequately satisfies the requirements of the National Environmental Policy Act of 1969 (NEPA) as interpreted by the Commission in its 10 CFR Part 51 implementing regulations. Thus, the environmental-related allegations levied by Consolidated Intervenors and the Tribe in Contentions 1A/B, 2-4, 6, 9, and 14A/B also are without merit.

I. BACKGROUND AND PROCEDURAL HISTORY

On February 25, 2009, Powertech submitted a license application for a combined source and 11e.(2) byproduct material license to construct and operate its proposed Dewey-Burdock

[1] It should be noted that the two safety contentions are portions of Contentions 2 and 3.
[2] *See* NRC Staff Exhibit NRC-134-135; ML14043A347.

ISR project in South Dakota. After completing its ninety day acceptance review, the NRC Staff determined that Powertech's Dewey-Burdock license application required additional data and information prior to docketing it for detailed technical and environmental review. As a result, on June 19, 2009, Powertech voluntarily withdrew its license application pending re-submission of the required additional data and information. On August 10, 2009, Powertech re-submitted its Dewey-Burdock license application with the additional data and information requested by NRC Staff. Powertech's resubmission of its license application provided additional data and information on some specific items such as breccia pipes, the potential for unplugged or improperly plugged site boreholes, and old mine workings and their potential impacts. After completion of a second acceptance review, NRC Staff determined that Powertech's Dewey-Burdock license application was acceptable for detailed technical and environmental review and it was docketed on October 2, 2009.

After the Dewey-Burdock license application was made publicly available, on January 5, 2010, NRC Staff issued a Federal Register notice providing interested stakeholders and other members of the public with an opportunity to request a hearing on the application and to request access to sensitive unclassified non-safeguards information (SUNSI) associated with such application.[3] On January 15, 2010, counsel for Petitioners submitted a request for access to SUNSI documentation. After reviewing this request, NRC Staff determined that Petitioners were not entitled to access to the SUNSI documentation. On February 26, 2010, Petitioners submitted a motion for a ninety (90) day extension of time to file their Request based on a number of factors including a lack of time to review the Dewey-Burdock license application. On March 3, 2010, both Powertech and NRC Staff filed responses in opposition to Petitioners' motion and, on

[3] *See* 75 Fed. Reg. 467 (January 5, 2010).

March 5, 2010, the Commission determined that Petitioners were not entitled to an extension of time.

On March 12, 2010, the Commission established an Atomic Safety and Licensing Board Panel (Licensing Board). On March 8 and 9, 2010, and April 6, 2010, CI and the Tribe respectively submitted requests for a hearing including proposed contentions for admission to such a hearing. On April 12 and May 3, 2010, Powertech and NRC Staff respectively submitted responses to CI's and the Tribe's requests respectively and argued that most, if not all, of the proffered contentions were not admissible under NRC regulations at 10 CFR Part 2.309. On June 8 and 9, 2010, the Licensing Board conducted oral argument in Custer County, South Dakota, where all parties' arguments on standing and admissible contentions were heard.

In this proceeding, CI's and the Tribe's hearing requests proffered approximately twenty-one (21) contentions that raised a variety of safety and environmental issues of concern regarding Powertech's license application. On August 5, 2010, the Licensing Board issued LBP-10-16 in which CI and the Tribe each were granted standing to intervene and several contentions for both parties were admitted. More specifically, the Licensing Board admitted several contentions related to historic and cultural resources, adequacy of baseline groundwater quality data, hydrogeological confinement in aquifers within which the proposed Dewey-Burdock Project is to occur, and groundwater consumption. After an October, 2012 teleconference, the Licensing Board consolidated these admitted contentions into the following: (1) CI Contention D (groundwater quality), (2) CI Contention E (hydrogeologic information), (3) CI Contention K (historic and cultural resources), (4) Tribe Contention 1 (historic and cultural resources, (5) Tribe Contention 2 (groundwater quality), (6) Tribe Contention 3 (hydrogeologic information), and Tribe Contention 4 (groundwater quantity impacts).

On January 10, 2010, NRC issued a Federal Register notice indicating its Notice of Intent to prepare a supplemental environmental impact statement (SEIS) for the proposed Dewey-Burdock process. As part of the SEIS preparation process, NRC Staff contacted the United States Bureau of Land Management (BLM) and, per letter dated November, 2011, BLM agreed to serve as a cooperating agency for preparation of what would eventually become the Powertech FSEIS. By joining as a cooperating agency, BLM contributed expertise on a variety of resource areas including historic and cultural resources, land use, soils, and endangered species.

On May 28, 2010, and April 14, 2010 respectively, NRC Staff issued requests for additional information (RAI) on its safety review of Powertech's technical report (TR) and its environmental review of Powertech's environmental report (ER), respectively. On June 28, 2011 and August 12, 2010 respectively, Powertech submitted final responses to NRC Staff's RAIs regarding the ongoing safety and environmental reviews. These documents were made publicly available on NRC's ADAMS database on August 29, 2011 (ML112071064) and September 9, 2010 (ML102380530) respectively. Neither CI nor the Tribe filed a request for admission of a new or amended contention on any of Powertech's RAI responses.

On March 18, 2013, NRC Staff issued its Safety Evaluation Report (SER) detailing the analyses and conclusions of its safety review for all resource areas for the Project, including but not limited to groundwater quality and quantity issues. NRC Staff's final conclusion regarding the safety review was that, absent an environmental concern to the contrary, that its recommendation was that Powertech's requested license should be issued as adequately protective of public health and safety. *See* NRC Exhibit NRC-134-135.

On November 26, 2012, NRC Staff issued the DSEIS for the Dewey-Burdock Project for public comment. By rule, CI and the Tribe were entitled to thirty (30) days to file new or amended contentions. In compliance with this opportunity and after receiving an extension from December 31, 2012 to January 25, 2013, both CI and the Tribe filed requests to admit several new or amended contentions. On March 11 and 7, 2013 respectively, both Powertech and NRC Staff submitted responses to these requests opposing the admission, amendment or migration of any new/amended contentions. On March 25, 2013, CI and the Tribe submitted replies to such responses.

On July 22, 2013, the Licensing Board issued an Order granting the admission of three (3) new contentions to the proceeding regarding mitigation measures (Contention 6), connected actions (Contention 9), and Endangered Species Act consultation analysis (Contentions 14A/B). The Licensing Board also rejected several contentions, many of which were brought forward from previous contentions on Powertech's license application.

On January 29, 2014, NRC Staff issued the FSEIS which stated that, absent a safety-related concern to the contrary, its recommendation was that Powertech's requested license should be issued. *See* NRC Staff Exhibit NRC-008A & 008-B. The FSEIS included an assessment of the environmental aspects of groundwater and historic and cultural resources at the Dewey-Burdock site, as well as mitigation measures.[4] Based on the FSEIS, on March 17, 2014, both CI and the Tribe submitted a request to admit new/amended contentions, including migration of existing admitted contentions, to the FSEIS. On April 4, 2014, both Powertech and NRC Staff submitted responses to these requests and, on April 11, 2014, both CI and the Tribe submitted replies to these responses.

On April 28, 2014, the Licensing Board issued an Order allowing the previously admitted contentions to migrate from the DSEIS to the FSEIS with no changes in the substance of such

[4] *See* NRC Staff Exhibit NRC-008-A & 008-B.

contentions. As a result, the complete list of contentions in this proceeding is detailed in the *Table of Admitted Contentions* in LBP-14-5, Appendix A.

On April 8, 2014, NRC Staff issued notice to the Licensing Board that it had issued Powertech NRC License No. SUA-1600 stating that "the Staff finds that the application complies with the Atomic Energy Act and the NRC's regulations….The Staff has considered the safety-related arguments raised by the Intervenors in the hearing, but those arguments do not affect the conclusions in the Safety Evaluation Report."[5] Included in the ROD issued by NRC Staff was the PA which was the culmination of the NHPA Section 106 Tribal Consultation process for which NRC served as the lead agency.

On April 11, 2014, both NRC Staff and the Tribe submitted Motions for Summary Disposition of certain contentions or portions thereof. NRC Staff's summary disposition motion sought disposition of the safety-related components of Contentions 2 and 3 dealing with the adequacy of Powertech's groundwater data and site hydrology, and the Tribe's summary disposition motion sought disposition of Contention 1A related to historic and cultural resources and Contention 6 on mitigation measures. On April 25, 2014, all parties submitted responses to these summary disposition motions with Powertech supporting NRC Staff's motion and opposing the Tribe's, NRC Staff opposing the Tribe's motion, the Tribe opposing NRC Staff's motion, and CI supporting the Tribe's motion and opposing NRC Staff's. On June 2, 2014, the Licensing Board denied both NRC Staff's and the Tribe's motions.

On April 14, 2014, both CI and the Tribe submitted Motions for a Stay of the Effectiveness of Powertech's NRC license citing various claims associated with Powertech's and NRC Staff's review and assessment of historic and cultural resources at the Dewey-Burdock site and other claims. On April 24, 2014, both Powertech and NRC Staff submitted responses to

[5] *See* ML14098A492.

these Motions opposing the grant of a stay of SUA-1600. On April 30, 2014, the Licensing Board issued a temporary stay of SUA-1600 pending oral argument, which was held via teleconference on May 13, 2014. On May 20, 2014, the Licensing Board issued an Order lifting the temporary stay and denying a stay of the effectiveness of License No. SUA-1600.

II. <u>APPLICABLE LEGAL STANDARDS</u>

A. <u>SAFETY CONTENTIONS</u>

1. Regulatory Requirements

For safety contentions in this proceeding (i.e., portions of Contentions 2 and 3 specifically related to baseline groundwater quality adequacy and hydrogeological confinement), NRC Staff evaluates the "safety" portion of a license application with a particular focus on the Commission's 10 CFR Part 40 regulations and accompanying Appendix A Criteria. Safety reviews also extend to additional Commission regulations at 10 CFR Part 20 for radiation protection. However, since no contention admitted to this proceeding implicates potential concerns for radiation safety, these Part 20 regulations are not relevant here.

Powertech's license application was submitted for a new combined source and 11e.(2) byproduct material operating license allowing the construction and operation of the Dewey-Burdock Project. As the license application is for a new operating license to possess and use both source and 11e.(2) byproduct material in conjunction with ISR or "uranium [source material] milling" operations, NRC regulations require that a license applicant comply with appropriate requirements to allow for a complete safety review of the application. *See generally* 10 CFR § 40 & Appendix A. For the safety review, NRC regulations require that a new ISR operating license application include a full TR addressing a wide range of resource areas, including specifically water resource data, information, and analyses. During the course of its safety review, NRC Staff's AEA-based regulatory standard for issuance of an operating license is a demonstration that issuance of said license will result in adequate protection of public health and safety and will not be inimical to the common defense or security. *See* 10 CFR § 40.32. At the completion of its safety review, NRC Staff issues a final SER in which its findings on the aforementioned Part 40.32 standard are documented.

In addition, within the context of 10 CFR Part 40 regulations, new ISR operating license applicants must adhere to the provisions of 10 CFR § 40.32(e) with respect to pre-licensing site construction activities. Independent of its license application, new ISR operating license applicants are permitted to engage in specific site development activities (known as "preconstruction") prior to the receipt of its requested NRC license. Recently, NRC Staff revised Part 40.32(e) to provide interested stakeholders with clarification regarding the Commission's position on what site development activities at Part 40 facilities, such as the Dewey-Burdock Project, that are considered to be preconstruction.

2. NRC Guidance

a. NUREG-1569: Standard Review Plan For Safety/Technical Issues

NRC Staff evaluates new ISR operating license applications in accordance with the aforementioned requirements in 10 CFR Part 40 and Appendix A Criteria, as well as NRC Staff guidance contained in NUREG-1569 entitled *Standard Review Plan for In Situ Leach Uranium Extraction Facilities* (hereinafter "NUREG-1569").[6] NUREG-1569 was issued for public comment in October of 1997 and later in February of 2002 and was finalized in June of 2003, thereby rendering the document Commission-approved guidance created specifically to address ISR licensing decisions.

[6] *See* NRC Exhibit 0013; ML031550272.

NUREG-1569 serves as NRC Staff's interpretation of its 10 CFR Part 40 regulations and Appendix A Criteria for the contents of an ISR license application, specifically with respect to safety/technical issues and TRs. In its Table of Contents, the NUREG-1569 delineates the resource areas covered by NRC Staff for TRs, with the caveat that deviations from the guidance therein are permissible assuming that they are properly justified in the license application and are adequate to protect public health and safety and the environment consistent with the AEA's statutory mission.

NUREG-1569 was developed with a specific eye towards the aforementioned Part 40.32(e) construction rule. Chapter 2 of the ISR SRP entitled *Site Characterization* provides license applicants with guidance on submitting data, information, and analyses for site-specific activities that are permissible prior to the issuance of an NRC operating license. More specifically, Chapter 2 of NUREG-1569 addresses the requirements for *license applications* related to site-specific groundwater conditions, including the development of pre-license issuance, baseline groundwater quality as mandated by 10 CFR Part 40, Appendix A, Criterion 7. Criterion 7 of Appendix A is specifically tailored towards pre-license issuance, baseline characteristics at a proposed project site across a wide range of resource areas, including but not limited to pre-license issuance groundwater conditions. Chapter 5 of the ISR SRP entitled *Operations* represents NRC Staff's requirements for ISR operations, including the development of Criterion 5 Commission-approved background, which is the foundation for development of all other operational and restoration standards for groundwater at a proposed ISR site. It is critical to note that Criterion 5 Commission-approved background cannot be developed without the ability to fully delineate an ISR-amenable ore body and to construct a full wellfield and complete monitor well networks. Per the aforementioned Part 40.32(e) construction rule, an ISR license applicant is not permitted to install a complete wellfield and associated monitor well networks until after a license is issued. Thus, Criterion 5 Commission-approved background cannot be known until after a license is issued. Therefore, the Board should be mindful of this distinction between Criterion 7 (embodied in NUREG-1569, Chapter 2) baseline and Criterion 5 (embodied in NUREG-1569, Chapter 5) Commission-approved background when evaluating groundwater–specific contentions in this proceeding.

B. ENVIRONMENTAL CONTENTIONS

For the remaining contentions in this proceeding (i.e., Contentions 1A/B, portions of Contentions 2 & 3, Contentions 6, 9 and 14A/B), regulatory standards applicable to such Contentions can be found at 10 CFR Part 51. Part 51 was promulgated by the Commission as the implementation of Council on Environmental Quality (CEQ) regulations pursuant to the National Environmental Policy Act of 1969 (NEPA). NEPA is a procedural statute and is not designed to confer any additional substantive jurisdiction beyond that in its empowering statute to a specific agency such as NRC. As an independent regulatory agency, the Commission promulgated Part 51 as its interpretation of CEQ regulations under its AEA statutory mandate of protecting public health and safety and the environment.[7]

1. 10 CFR Part 51 Environmental Review Regulations

To the extent that environmental contentions raised by Intervenors implicate potential deficiencies in NRC Staff's NEPA process, NRC Staff is required to take a "hard look" at the environmental impacts of a proposed action, in this case the Dewey-Burdock Project. This "hard look" is tempered by a "rule of reason" that requires agencies to address only impacts that are

[7] 49 Fed. Reg. 9381 (March 12, 1984).

reasonably foreseeable –not remote or speculative.[8] If an admitted contention alleges that an environmental review document (SEIS) is inadequate, "the 'rule of reason' by which NEPA is to be interpreted provides that agencies need not consider 'remote and speculative' risks or 'events whose probabilities they believe to be inconsequentially small.'"[9] Further, "NEPA gives agencies broad discretion to keep their inquiries within appropriate and manageable boundaries."[10] As stated by the Commission, although "there 'will always be more data that could be gathered,'" agencies 'must have some discretion to draw the line and move forward with decisionmaking.'"[11]

When challenging NRC Staff's environmental review, an intervening party must identify, with some specificity, the alleged deficiencies in its NEPA analysis.[12] An EIS-level document such as the Dewey-Burdock SEIS may have mistakes or errors but so long as they are not significant or material it does not represent an inadequacy in NRC Staff's environmental review.[13] NRC Staff's environmental review is deemed to be adequate unless NRC Staff "has failed to take a 'hard look' at significant environmental questions—i.e., the Staff has unduly ignored or minimized pertinent environmental effects."[14]

For source material milling facilities such as the Dewey-Burdock Project, Part 51 regulations require that a new operating license application's potential environmental impacts be

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[8] *See Long Island Lighting Co.* (Shoreham Nuclear Power Station, Unit 1), ALAB-156, 6 AEC 831, 836 (1973).
[9] *Vermont Yankee Nuclear Power Corp.* (Vermont Yankee Nuclear Power Station, ALAB-919, 30 NRC 29, 44 (1989) (citation omitted).
[10] *Louisiana Energy Servs, L.P.*, CLI-98-3, 47 NRC at 103 (internal citation omitted).
[11] *Entergy Nuclear generation Co.* (Pilgrim Nuclear Power Station), CLI-10-11, 71 NRC 287, 315 (2010) (footnote omitted).
[12] *See Hydro Resources, Inc.* (Crownpoint Uranium Project), CLI-99-22, 50 NRC 3, 13 (1999).
[13] *See Exelon Generation Co.* (Early Site Permit (ESP) for Clinton Site), CLI-05-29, 62 NRC 801, 811 (2005) ("[I]n an NRC adjudication, it is Intervenors' burden to show the 'significance and materiality' of mistakes in the EIS).
[14] *See Duke Energy Corp.* (McGuire Nuclear Station, Units 1 & 2; Catawba Nuclear Station, Units 1 & 2), CLI-03-17, 58 NRC 419, 431 (2003) (discussing what an intervenor must allege, with adequate support, to litigate a NEPA claim).

reviewed using an environmental impact statement (EIS) level document.[15] However, for purposes of new ISR operating license applications, NRC Staff developed a programmatic or generic environmental impact statement (GEIS or "NUREG-1910") due to the largely standardized aspects of ISR projects across the nation. It is NRC's intent that all new ISR operating licenses utilize the programmatic analyses and conclusions in the GEIS to the maximum extent practicable in the development of a site-specific SEIS for each proposed license. In the instant case, NRC Staff developed NUREG-1910, Supplement 4 for the Dewey-Burdock Project which analyzed all resource areas for the Project. The only exception to this statement is the completion of the Section 106 Tribal consultation process, which was severed pursuant to 36 CFR § 800.8 from NRC's Part 51 environmental review.

As a general matter, the Commission is an independent regulatory agency and does not consider itself legally bound by substantive regulations of the CEQ.[16] While the Commission agrees that CEQ's regulations are entitled to substantial deference where appropriate, these regulations apply only to federal actions to which NEPA applies. In developing Part 51 of its regulations, the Commission stated that it is not bound by those portions of the CEQ's NEPA regulations that have some substantive impact on the way in which the Commission performs its regulatory functions.[17]

The SEIS for the Dewey-Burdock Project was prepared in accordance with applicable NRC regulations and was issued in draft form for public comment on November 15, 2012 for a period of forty-five (45) days. NRC Staff responded to relevant public comments, including those submitted by Powertech, and published such responses in the FSEIS on January 29, 2014.

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[15] *See* 10 CFR § 51.20(b)(8) (2014).
[16] *See Vermont Yankee Nuclear Power Corp.* (Vermont Yankee Nuclear Power Station), ALAB-876, 26 NRC 277, 284 n.5 (1987).
[17] *See Long Island Lighting Co.* (Shoreham Nuclear Power Station, Unit 1), CLI-91-02, 33 NRC 61 (1991).

2. NUREG-1748 Environmental Report Guidance

Pursuant to 10 CFR § 51.90 *et seq.*, NRC Staff developed NUREG-1748 entitled *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs*[18] to provide license applicants with its interpretation of Part 51 requirements for ERs for a range of operating licensing actions, including new ISR operating license applications. NUREG-1748 provides license applicants with an acceptable format for these ERs and directs such applicants to provide specific information regarding site-specific conditions at a project site. To the extent necessary and practicable, ISR operating license applicants are encouraged to utilize the analyses and conclusions in the GEIS to further support their site-specific ER. Powertech's license application included an ER modeled on the guidance in NUREG-1748.

3. 36 CFR Part 800 National Historic Preservation Act Regulations

Pursuant to the NHPA, federal agencies are required to assess potential impacts to historic and cultural resources when reviewing new operating license applications. The Advisory Council on Historic Preservation (ACHP) has promulgated regulations to address the agency's role in the conduct of the Section 106 Tribal consultation process and the procedures that should be followed in the development of agreement documents to assist in the protection of historic and cultural sites and resources.

Prior to the initiation of a federal "undertaking" under these regulations, NRC Staff requires that a license applicant provide appropriate, site-specific data and analyses for archaeological and, to the extent practicable, Tribal and other historic properties and resources. For new ISR operating license applications, it is typical practice for an applicant to submit a Level III archaeological study identifying potential historic and cultural properties and resources for review by NRC. After receipt of a license application and identifying the federal

[18] *See* NRC Staff Exhibit NRC-0014; ML032450279.

"undertaking," the lead agency (NRC) initiates the Section 106 process which is comprised of four (4) distinct steps. Step one involves the identification of interested/consulting parties with whom the lead agency will consult during the Section 106 process. These consulting parties typically include other federal agencies such as BLM, the State Historic Preservation Officer (SHPO), and interested Tribes and their Tribal Historic Preservation Officer (THPO). Step two involves the identification of historic properties in consultation with the consulting parties with the lead agency required to exercise a reasonable and good faith effort to identify such properties per 36 CFR § 800.4. This step involves the delineation of the area of potential effect (APE), the review of existing information on properties within the APE, and the identification of properties based on information from the consulting parties. As part of this identification effort and as is the case with ISR projects, ACHP regulations permit this identification effort to be phased as ISR projects are, by their nature, phased projects. The phased identification process for ISRs has been endorsed by the Commission in the *Hydro Resources, Inc.* litigation.[19]

Step three of the process involves determining whether the identified resources are eligible for inclusion on the National Register of Historic Places and identifying potential adverse effects to such resources from the federal "undertaking." 36 CFR § 800.5(a)(2) provides a detailed list of potential adverse effects to historic resources including destruction or damage to the resources, alteration to those resources, and visual or audio impacts to a resource's integrity. The determination of potential adverse effects also is permitted to be conducted in a phased manner. Step four involves the resolution of potential adverse effects in accord with Part 800.6. The lead agency, in consultation with consulting parties, will determine whether adverse effects

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[19] *See e.g., In the Matter of Hydro Resources, Inc.* (Crownpoint Uranium Project), LBP-05-26 (September 16, 2005). It is well-understood that where a matter has been considered by the Commission, it may not be reconsidered by a Board. Commission precedent must be followed. *See e.g., Va. Elec. & Power Co.* (North Anna Nuclear Power Station, Units 1 and 2), ALAB-584, 11 NRC 451, 463-65 (1980).

are present that need to be resolved or, under Part 800.5, render a determination of no adverse effect. In the event that adverse effects are identified, they can be resolved using agreement documents such as memoranda of agreement (MOA) or programmatic agreements (PA). In the instant case, a PA was finalized and signed by mandatory signatories including NRC, BLM, the State of South Dakota SHPO, and the ACHP.

4. Burden of Proof

In a licensing proceeding such as this, an applicant has the burden of proof. However, intervening parties have the initial burden of moving their case (admitted contentions) forward. This burden can only be satisfied by providing sufficient evidence to support their contentions and the allegations levied in such contentions. This burden is applied at hearing, even after a contention is admitted. This burden cannot be satisfied if intervening parties' claims are nothing more than unsupported allegations and mere speculation. Should an intervening party carry their burden, then the applicant and/or NRC Staff has the burden of persuasion to convince a Board to reject the admitted contentions on the merits. The burden to be met by an applicant/licensee and NRC Staff is that their position must be supported by a preponderance of the evidence.

III. POWERTECH EXPERT WITNESSES

While it has submitted Exhibits APP-001-005, 010-014, 037-038, 046-047, and 053-054 as Attachments to this Position Statement, Powertech believes it is important to provide the Board with a brief description of its expert witnesses and their credentials here.

A. DR. LYNNE SEBASTIAN

- Dr. Lynne Sebastian currently serves as a member of the SRI Foundation and the supervising member of the Foundation's continuing professional education and regulatory compliance and technical assistance programs. Dr. Sebastian has more than 30 years of experience in historic preservation issues and is a nationally recognized expert in historic preservation regulatory and legislative issues. She also is a recognized scholar in the archaeology of the American Southwest. Dr. Sebastian has a Ph.D in

Anthropology from the University of New Mexico, a Masters degree in English literature from the University of Utah, and a Bachelors degree in English and Secondary Education from the University of Michigan. Prior to joining the SRI Foundation, Dr. Sebastian was the State Historic Preservation Officer (SHPO) for the State of New Mexico where she administered State and federal historic preservation laws, provided technical assistance to federal, State, and local government agencies, maintained New Mexico's National and State Registers of historic properties, conducted public education and outreach programs, provided technical assistance and preservation incentives for owners of historic prehistoric sites, reviews Section 106 compliance projects and programs, and consulted with federal, State, and local agencies and with Native American Tribes and other traditional communities regarding preservation planning, archaeological research designs, and mitigation plans. Prior to serving as President of the Society for American Archaeology, she was the Chair of SAA's Government Affairs Committee and served a term as Secretary of the Society. Dr. Sebastian also is an Adjunct Professor of Anthropology appointment at the University of New Mexico. Dr. Sebastian also serves as an expert member of the federal Advisory Council on Historic Preservation.

- Dr. Sebastian's testimony is set forth in Exhibit APP-001.

B. <u>DR. ADRIEN HANNUS</u>

- Dr. L. Adrien Hannus currently serves as the Director of the Archaeology Laboratory and a Professor of Anthropology at Augustana College in Sioux Falls, South Dakota and has served in this role since 1982. Dr. Hannus has over forty-five (45) years of archaeological experience with a specialty in prehistoric and historic cultural dynamics. Dr. Hannus received a Ph.D in archaeology from the University of Utah, with an emphasis in archaeology, and a Masters degree in cultural anthropology from Wichita State University. Dr. Hannus has conducted significant cultural and archaeological fieldwork throughout the Great Plains and the Rocky Mountain West, as well as collaborating on projects in Egypt, France, Mexico, and Great Britain. Additional teaching and research interests include early human populations in the New World [specifically Clovis], historic Native American cultures of the Plains, and lithic analysis. Dr. Hannus and his Augustana College team performed the Level III archaeological study submitted by Powertech in support of its license application resulting in issuance of NRC License No. SUA-1600.

- Dr. Hannus' testimony is set forth in Exhibit APP-003.

C. <u>MICHAEL FOSHA</u>

- Michael Fosha currently serves as the Assistant State Archaeologist for the State of South Dakota. Mr. Fosha has a M.A. in Anthropology from the University of Kansas and a B.S. in Anthropology from Kansas State University and has been involved in the discipline of archaeology for approximately 30 years. His work experience includes the migration of complex archaeological sites, National Register evaluation of archaeological sites, survey and geo-archaeological investigation of archaeological sites, analysis of material culture, research, teaching, outreach, public education of the human past, mining archaeologist and chief review of archaeological investigations pertaining to mining activities and those on State land.

- Mr. Fosha's testimony is set forth in Exhibit APP-010.

D. HAL DEMUTH

- Mr. Demuth is a senior engineer/hydrologist and principal of Petrotek Engineering Corporation. He holds an M.S. in Hydrogeology from the University of Idaho a B.S. in Petroleum Engineering from the University of Tulsa. Mr. Demuth is a member of the Association of Ground-Water Scientists and Engineers (NGWA), the Society of Petroleum Engineers (SPE) and the Society of Mining Engineers (SME). He has served as a manger of groundwater projects for ISR operations (permitting, characterization, design, optimization and regulatory compliance). He currently serves as Team Leader at Petrotek for aquifer testing operations throughout the U.S. Mr. Demuth also has served as project manager for groundwater modeling studies related to TDS and radionuclides/metals plume remediation and restoration operations and regulatory compliance for uranium ISR operations.

- Mr. Demuth's testimony is set forth in Exhibit APP-013.

E. ERROL LAWRENCE

- Mr. Errol Lawrence currently serves as a senior hydrologist employed by Petrotek Engineering Corporation. Mr. Lawrence currently holds a Masters degree in Engineering Geology from the Colorado School of Mines and a Bachelors degree from Northern Arizona University. Mr. Lawrence is a registered professional geologist in the States of Wyoming and Texas and a member of the National Ground Water Association, the American Institute of Professional Geologists, and the National Water Well Association. Mr. Lawrence has worked on more than twelve (12) ISR projects in the United States, Paraguay, Turkey, and Kazakhstan. With specific regard to United States-based ISR projects, Mr. Lawrence has worked on nine (9) Wyoming and two (2) Texas ISR projects. Mr. Lawrence also served as a lead groundwater consultant for the Dewey-Burdock Project.

- Mr. Lawrence's testimony is set forth in Exhibit APP-037.

F. DOYL FRITZ

- Mr. Fritz is a senior technical advisor employed by WWC Engineering. He has a B.S. in Civil Engineering from the University of Wyoming and an M.S. in Civil Engineering from Arizona State University. He is a licensed professional engineer in Wyoming and Colorado and a Life Member of the American Society of Civil Engineers. Mr. Fritz has over 40 years' professional experience in civil engineering, hydrologic investigations, hydraulic design, water rights, water supply and wastewater disposal studies, and surface mine permitting and regulation. He has broad experience managing a variety of civil and environmental engineering projects. He co-founded WWC and has helped the firm grow into one of Wyoming's largest consulting engineering firms. He is past president of American Council of Engineering Companies of Wyoming, former National Director of American Council of Engineering Companies, and past president of Wyoming Section American Society of Civil Engineers. Mr. Fritz has served as primary author of numerous NEPA compliance documents (Environmental Impact Statements and Environmental Assessments) working as a third-party contractor for various federal agencies, including the Bureau of Land Management and the Interstate Commerce Commission.

- Mr. Fritz's testimony is set forth in Exhibit APP-046

G. GWYN MCKEE

- Gwyn McKee is the President of and Principal Wildlife Biologist for Thunderbird Wildlife Consulting, Inc. She holds a B.S. in Wildlife Management and an M.S. in Wildlife Management/Ecology, both from the University of Missouri, Columbia. She serves as a primary contact for both the energy industry and regulators (local, state, federal) in the Northern Great Plains regarding project requirements and design, impact assessment, and mitigation strategies. Ms. McKee prepares and/or reviews technical reports and documents used by agencies during the permitting process, including contributing to and/or managing environmental impact statements (EISs) and environmental assessments (EAs). Ms. McKee is considered a Qualified Third Party NEPA Contractor by the BLM, USFS, and USFWS, a Qualified Wildlife Biologist by the USFWS, USFS, BLM, WGFD, SDGFP, and MFWP, and qualified by the USFWS to conduct black-footed ferret surveys. She is a member of the The Wildlife Society & Raptor Research Foundation.

- Ms. McKee's testimony is set forth in Exhibit APP-053.

IV. POWERTECH STATEMENT OF POSITION

A. THE ISR PROCESS

Prior to addressing the specific contentions, it is important that the Board understand information on the ISR process so that the context of the aforementioned ISR regulatory programs also may be understood. As a general proposition, the existence of natural geologic, hydrologic, and geochemical conditions in aquifers amenable to the ISR process, the ISR process itself, and regulatory requirements for ISR operations and restoration taken together provide a significant package of mitigation measures to prevent potential short and long-term impacts to adjacent, non-exempt underground sources of drinking water (USDWs). There are several naturally occurring geologic, hydrologic, and geochemical conditions that, in and of themselves, contribute significantly to the isolation of uranium and its associated heavy metals in a redistributed ore body from other portions of an aquifer that can potentially serve as a USDW and that can serve to complement and enhance the benefits of existing NRC regulatory control requirements for operations and groundwater restoration.

ISR operations were first tried on an experimental basis in the early 1960s with the first commercial facility commencing operations in 1974. ISR processes continuously re-circulate through the ore body native groundwater from the aquifer in which the ore body resides after fortifying it with oxygen and/or carbon dioxide. Uranium deposits amenable to ISR processes occur in permeable sand or sandstones that typically are confined above and below by less permeable strata. Confinement is a natural environmental condition that acts to assist in the creation of isolated deposits of minerals (e.g., uranium) as a natural result of groundwater flow forced by less permeable layers above and below through coarser sands into reducing environments. These deposits can either be tabular or C-shaped deposits formed as “roll-fronts.” These uranium-bearing formations were formed by the lateral movement “downdip” of groundwater bearing minute amounts of oxidized uranium in solution through the aquifer until precipitation of the uranium occurs along the boundary where the oxygenated waters encounter a zone of abundant reductant. Currently, the uranium roll front deposition that has taken place over millions of years is *ongoing on a regional basis every day*. Regional roll fronts require broad areas of upgradient oxidation to keep uranium mobile until the oxygenated water moves downgradient and encounter a zone with sufficient reductant. It is at this regional *redox* *interface* where the oxygenated water is reduced and uranium is deposited in a reduced mineral phase in what is known as a rollfront ore body that ISR operations are conducted.

Uranium mineralization leaves a distinct radiochemical footprint or signature in the host rock and surrounding groundwater—that is, uranium occurs not only upon the rock matrices, but also in the groundwater within the ore body. In other words, given natural dissolution processes, uranium and uranium progeny that accumulate on the host sands also occur naturally in surrounding groundwater media. For a uranium ore body to be amenable to ISR processes using industry standard recovery chemistry, the ore zone must be saturated with relatively fresh water and the rock must have enough transmissivity for water to flow from injection to extraction wells. In other words, for the ISR process to work, the ore must be situated in a saturated, water-bearing interval referred to as an aquifer. *There are no ISR uranium recovery operations in ore bodies that are not in aquifers.*

Techniques for ISR operations, including well construction techniques, regular well testing techniques (i.e., mechanical integrity testing (MIT)), upper control limits (UCL) for highly mobile constituents to provide "early warning" of potential excursions, extensive monitor well systems, and well field balance and "bleed," have evolved to the point where these techniques complement and enhance the above-noted naturally occurring conditions to provide ongoing, iterative mitigation measures with the flexibility to adjust to site-specific conditions in order to protect adjacent USDWs.

After an ore body that is amenable to ISR processes is identified, the licensee develops wellfield designs to progressively remove uranium from the identified ore body. Wellfield design is based on grids with alternating extraction and injection wells, monitor wells above and below the recovery zone, and a ring of monitoring wells surrounding the entire recovery zone to detect any potential *excursions* of solubilized uranium and other minerals from the uranium recovery production zone. Each wellfield is operated at the maximum continuous flow-rate achievable for that particular wellfield pattern area. Injection and extraction/production flow-rates are monitored and adjusted as necessary on a daily basis, so that injection can be balanced with extraction/production across the entire wellfield, with the injection flow smaller than the extraction flow by the amount of the "bleed" rate. The process "bleed" rate varies according to ore body geometry, well pattern and magnitude, and direction of the natural groundwater velocity. Proper wellfield balance, including the process "bleed," maximizes recovery while protecting against recovery solution excursions.

The *sequential* development of ISR wellfields is an example of the iterative, "phased" nature of ISR projects. The development of these well-fields and the accumulation of a complete sampling database cannot take place until a project operator installs baseline, production, and monitor wells. Engineers and geologists continually assess data as it is obtained, applying this new information to the next phase or activity, thus ensuring that subsequent exploration and delineation is based on the most up-to-date information possible to ensure proper well placement. Prior to installing monitor wells, additional exploration and delineation has to be conducted to assure the wells are properly placed. As wellfields are developed, all wells, including monitor wells, are pump tested to assure that they function appropriately prior to being sampled. Water quality sampling establishes water quality within and outside the ore zone (i.e., at the monitor wells) and the aforementioned UCLs enable the licensee to readily determine if an excursion has occurred. A "lessons learned" approach is implemented, as the results in one wellfield may cause the site engineer or geologist to change design in the next. This process is both progressive and iterative, as each wellfield is developed and tested with the mineral being progressively depleted from different parts of the ore body.

During active operations, native groundwater from the recovery zone in the aquifer is pumped to the surface for fortification with oxygen and carbon dioxide. This fortified water, which is similar to soda water (i.e., not water fortified with toxic chemicals), is then returned to the recovery zone through a series of *injection* wells in varying patterns in the well-fields. Water withdrawn from *extraction wells* in these patterns exceeds the water injected into the patterns creating a "cone of depression" that assures a net inflow of water into the recovery zone of the aquifer. This is to ensure no lateral or vertical water movement from the small portion of the aquifer where uranium recovery operations will occur, so that any adjacent, non-exempt USDWs will not be impacted by excursions of recovery solutions. The process also continually flushes fresh water into the recovery zone helping to inhibit the build-up of contaminants that could reduce the efficiency of recovery operations.

The extraction pumping causes the injected lixiviant to move through the uranium ore body oxidizing and solubilizing the uranium present in the host sandstone. The water from the extraction wells is then run through ion-exchange (IX) columns containing synthetic resins, which remove the uranium in a process very similar to that used to remove minerals from "hard" drinking water in a conventional home water softener. The uranium is then stripped from the IX resins using a brine solution (again similar to the backwash that takes place in a home water softener). The uranium in this rich eluate is then precipitated chemically, dewatered, and dried to produce saleable *yellowcake.*

After uranium removal in the IX column, the water in the circuit is re-fortified and re-injected as part of a continuous process until the uranium in the ore zone is exhausted. Since water from the ore body, already containing naturally occurring uranium and its progeny, is continuously refortified with oxygen and re-circulated through the sandstone to enhance uranium values removed in the IX columns, injection is balanced with extraction (i.e., extraction slightly exceeds injection to maintain an inward hydraulic gradient). Injection cannot proceed without an equal or greater amount of extraction; therefore, over-injection across the area cannot take place. To help keep the continuously operating system in balance, the extra water that is extracted is removed from the circuit as a "bleed." The "bleed," which contains elevated levels of radium, can be treated to remove the radium in settlement ponds using a barium-radium sulphate precipitation method. Ultimately, the treated water is discharged to holding ponds or tanks and from there it must be disposed of using deep well injection, solar evaporation, land application or some combination of these methods.

After active ISR operations cease, the groundwater in the recovery zone is restored *consistent with baseline* or other water quality criteria that are approved by NRC prior to the commencement of active production operations. The natural reductive and confining conditions noted above and NRC's requirement that an ISR operator engage in active groundwater restoration in the recovery zone together serve as the primary bases for mitigation of any potential long-term impacts to adjacent, non-exempt USDWs. Restoration efforts are designed to flush recovery solutions from the recovery zone to enhance its natural pre-operational reductant properties. Logic dictates that these reductant properties which created the redistributed ore body in the first place will be more than adequate to retard movement of mobilized constituents (particularly heavy metals such as uranium) over the long-term.

Upon completion of groundwater restoration, wells are sealed or capped below the soil surface using approved plugging methods and the soil surface is restored. Surface process facilities are decontaminated, if necessary, and removed, and any necessary reclamation and re-vegetation of surface soils is completed. As a result, after site closure is completed and approved, there is no visual evidence of an ISR site, and the decommissioned site will be available for unrestricted (i.e., any future) use.

Liquid waste also is generated during groundwater restoration when uranium recovery operations have ceased. Groundwater sweep uses existing production wellfield patterns to flush the recovery zone with natural groundwater from outside of the recovery zone and to extract the flushed water from the ore zone for treatment on the surface. Removed groundwater can be treated using reverse osmosis (RO) to create *de-ionized* water which can be re-injected to accelerate groundwater restoration. In fact, more recent groundwater restoration efforts have often used a combination of these two techniques and, possibly, the injection of a reductant and pH modifier to optimize restoration results. Groundwater restoration returns water within the depleted recovery zone to approved levels determined by NRC to be adequate to minimize or eliminate post-restoration migration of contaminants and any potentially significant, adverse impacts to adjacent, non-exempt USDWs.

In over three decades of operations, there have been *no significant, adverse impacts to adjacent, non-exempt USDWs* outside the recovery zone and into the related area of review (AOR)[20] from ISR operations in the United States.[21] Wellfield balancing, use of the "bleed," and extensive ongoing monitoring and frequent MITs at ISR sites have been highly successful in

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[20] The "area of review" is essentially a "buffer zone" prescribed by the United States Environmental Protection Agency's (EPA) underground injection control (UIC) program to provide additional protection for USDWs during ISR uranium recovery. The regulation also states:

> "In determining the fixed radius, the following factors shall be taken into consideration: Chemistry of injected and formation fluids; hydrogeology; population and ground-water use and dependence; and historical practices in the area."

40 CFR § 146.6.

[21] *See* United States Nuclear Regulatory Commission, *Staff Assessment of Groundwater Impacts from Previously Licensed In-Situ Uranium Recovery Facilities*, (July 10, 2009).

assuring that leach solution is contained within the ore (recovery) zone and to mitigate the impacts of any excursions. Before monitoring ceases, restoration is completed to minimize or eliminate the potential risk of excursion that could result in the migration of contaminants from the exempted recovery zone portion of the aquifer to adjacent, non-exempt portions of the aquifer.

ISR projects can be operated in one of two facility types. First, an ISR project can be operated using a central processing facility and wellfields that are directly adjacent to the processing facility. This allows the operator to license a defined site footprint and to construct adjacent well-fields from which pregnant lixiviant may be directly pumped to the central processing facility. This recovery approach is best utilized when the identified and defined uranium ore body contains enough uranium to make the licensing, construction, and operation of an individual central processing facility economically viable.

In instances where uranium ore bodies do not contain enough uranium to justify the licensing, construction and operation of central processing facilities, ISR operators may use satellite or so-called “remote IX” technology to develop wellfields that can be at considerable distances from a central processing facility. The use of “remote IX” has been utilized to recover uranium in South Texas as early as 1980 and is currently used by various ISR companies in Wyoming and Texas. Each “remote IX” is a self-contained, stand-alone unit that recovers uranium using IX columns and resins. When the IX resins are fully loaded with uranium, they are pumped into transport conveyances, typically tanker trucks. After the uranium-bearing resins are pumped into the transportation conveyance, the resins are transported to a central processing facility where the resins will undergo the same processes described above. The use of remote IX technology has become increasingly popular given that many uranium deposits (e.g., deposits with 2-3 million pounds) cannot justify the cost of licensing and constructing a commercial-scale central processing facility.

B. ADMITTED CONTENTIONS

As stated in Section I, above, the Board admitted a total of seven (7) contentions in this proceeding related to a wide range of resource areas and analytical requirements. In the sections below, Powertech will address each contention with the support of its expert testimony, relevant portions of the ROD for NRC License No. SUA-1600, and identified exhibits. As will be shown below, Powertech's position is that none of CI's or the Tribe's admitted contentions should result in modifications to the ROD and NRC License No. SUA-1600 should be upheld in total.

1. Contention 1A: Alleged Failure to Meet Applicable Legal Requirements Regarding Protection of Historical and Cultural Resources

Contention 1A alleges that Powertech and NRC Staff did not satisfy applicable legal requirements under NEPA, the NHPA, and applicable NRC, ACHP, and CEQ regulations because the ROD for NRC License No. SUA-1600 fails to adequately describe the affected environment and the potential impacts to archaeological, historic, and traditional cultural resources. *See* LBP-13-09 at 12. Based on three (3) Board decisions, Contention 1A has successfully migrated from Powertech's license application to NRC Staff's DSEIS and FSEIS. No additional requests from either CI or the Tribe requested that this Contention migrate to NRC Staff's issuance of a final executed PA or any conditions therein regarding historic and cultural resources. Thus, for purposes of Contention 1A and Contention 1B, the PA and its provisions remain unchallenged.

Initially, Contention 1A contains procedural arguments related to NRC Staff's environmental review of the Dewey-Burdock Project and its assessment of historic and cultural resources under NEPA. More specifically, this Contention alleges that NRC Staff impermissibly severed or “de-coupled” its Section 106 Tribal consultation process from its 10 CFR Part 51 NEPA environmental review (i.e., from the FSEIS development). This allegation is wholly without merit as it is legally flawed.

The NHPA is a separate and distinct federal statute imposing requirements on federal agencies that are outside the scope of NEPA. Pursuant to 36 CFR § 800.8, ACHP regulations for the Section 106 Tribal consultation process allow lead agencies to conduct NHPA-based responsibilities under Section 106 concurrently with and as part of the agency’s NEPA process (e.g., NRC’s 10 CFR Part 51 environmental review). At the beginning of the “undertaking’s” review, the lead agency is permitted to combine these processes, but they are not as a matter of law, mandated to do so. Further, if the lead agency determines during the course of simultaneous conduct of these processes that they should be severed or “de-coupled,” the agency is permitted to do so. *See generally* 36 CFR Part 800.8. Even after NRC Staff engaged in this action, it still completed the Section 106 process in accordance with ACHP regulations culminating in the execution of a PA signed by all mandatory signatories, including the ACHP. NRC Staff’s conduct of the Section 106 process in the instant case is supported by Powertech’s expert testimony from Dr. Lynne Sebastian. *See* Powertech Exhibit APP-001 at ¶¶ A.10 & A.11. Therefore, Contention 1A’s procedural argument on severing the NHPA process from its NEPA process is without merit.

Contention 1A further alleges that the aforementioned PA was not included and analyzed in the FSEIS and resulted in an inadequate assessment of potential impacts to historic and cultural resources and mitigation measures. As stated by Dr. Sebastian in her testimony, ACHP’s 36 CFR Part 800 regulations do not require that a Section 106 document such as a PA be evaluated in a NEPA document. *See id.* at ¶ A.12. The Tribe’s claim that it was not accepted by the Tribe is also refuted by Dr. Sebastian when she states that only an undertaking proposed to be conducted on Tribal land would require acceptance by that particular Tribe. *See id.* at ¶ A.13. The PA is also referenced by Dr. Sebastian as an ongoing responsibility for Powertech and NRC Staff since a PA can be used where "effects on historic properties cannot be fully determined prior to the approval of an undertaking." *See* 36 CFR §800.14(b)(1)(ii). This is consistent with the ACHP's and the Commission's endorsement of phased identification for projects such as the Dewey-Burdock Project. *See* 36 CFR § 800.4(b)(2). Thus, this procedural allegation levied under Contention 1A is without merit.

Contention 1A also alleges that Powertech, as the then-license applicant and now licensee, failed to enter an MOA with the Tribe and did not seek out the Tribe's participation in the development of any assessments of or provisions by which potential impacts to historic and/or cultural resources could be assessed and/or mitigated. It further alleges that Powertech failed to adequately include the Tribe in the evaluation of the Dewey-Burdock Project. These allegations are wholly refuted by Dr. Sebastian who notes in her written testimony that a license applicant or licensee such as Powertech "has no responsibility for or authority to enter into consultations with the federally recognized tribes" within the context of the Section 106 process. *See* Powertech Exhibit APP-001 at ¶ 15. This alleged failure to include the Tribe in the review process, which will be discussed in the Contention 1B argument below, is refuted by Dr. Sebastian's testimony that the current PA addresses all aspects of future consultation regarding mitigation measures and that the Tribes were offered an opportunity to participate in the PA's development, including Dispute Resolution provisions, and some, including the Tribe, *chose not to do so. See id.* at ¶¶ A.15 & A.16. Thus, this allegation must fail as it lacks a proper legal foundation for mandating Powertech to act to gain Tribal participation in the review process and as the Tribe declined to avail itself of the opportunity to participate in the PA's development. Further, the Tribe cannot challenge the final provisions of the PA in this proceeding as they did not request to migrate or amend this Contention to reflect a challenge to the PA itself.

Contention 1A then continues with allegations regarding the adequacy of Powertech's commissioned Level III cultural resources study conducted by the Archaeology Laboratory of Augustana College (ALAC) and NRC Staff's surveys of traditional cultural properties and site-specific survey to assist in identification of historic properties. With respect to the Level III study, Powertech submits the written testimony of Dr. L. Adrien Hannus, the Director of the ALAC. Dr. Hannus' testimony sets forth the state-of-the-art standards followed by the ALAC team when conducting the study of the Dewey-Burdock Project area, including the fact that it complied with ACHP and State SHPO requirements for such studies. *See* Powertech Exhibit APP-003 at A.6. This testimony also provides significant detail as to the procedures and study preparation steps used by the ALAC team when it conducted this study. *See id.* at A.7. Dr. Hannus' conduct of this study is supported by the written testimony of Mr. Michael Fosha, who currently serves as the Assistant State Archaeologist for the South Dakota State Historical Society. Mr. Fosha attests to the credentials of the ALAC team and refers to them by stating, "I find them to have shown the highest standards in Plains and Northern Plains cultural resource management and research." Powertech Exhibit APP-010 at A.3.

With specific respect to the results of the Level III study, Dr. Hannus attests to the fact that the study was conducted as a one-hundred (100) percent pedestrian survey of the APE using appropriate steps to ensure identification of properties in landscape settings with higher site potential. *See id.* at A.7. According to Dr. Hannus, at all times the study team ranged from four to eleven people with a professional archaeologist as crew chief and that the Tribe's allegations that “students” conducted the study is a “blatant falsehood.” This response is supplemented by a listing of the team’s credentials through Dr. Hannus’ testimony. *See e.g., id.* at A.10. The conclusions of this report specifically identified several sites whose eligibility had not yet been determined and recommended a phased identification approach to their eligibility evaluations; all of which is supported by ACHP regulations and Commission precedent. *See id.* at A.14. Mr. Fosha’s testimony also supports Dr. Hannus’ study and conclusions. Mr. Fosha references a February 11, 2013 letter to the State of South Dakota Department of Environment and Natural Resources (SDDENR) which, paraphrased, states that his office has no reservation for the issuance of a large-scale mine permit, because the Dewey-Burdock Project lands have been fully inventoried from a cultural resource perspective. *See* Powertech Exhibit APP-010.

Dr. Hannus’ testimony also speaks to a Contention 1A allegation that no subsurface testing was conducted at the Dewey-Burdock site during the ALAC study. Table 1 of Dr. Hannus’ testimony specifically refutes the claims rendered by Dr. Redmond regarding subsurface testing by showing the extensive conduct of subsurface testing during the ALAC study. The level of subsurface testing required at a particular site depends greatly on the site-specific soil strata present during the study. For the Dewey-Burdock Project, Dr. Hannus specifically notes that the soil strata at the site is so severely eroded that “a very limited number of tests reveals that there is virtually no intact soil and, therefore, the site has no integrity and is not eligible.” Powertech Exhibit APP-003 at A.16. Further subsurface testing may be implicated and that process is addressed in the PA as part of the ACHP and Commission-endorsed phased identification. *See id.* at A.17. Thus, Contention 1A’s allegations regarding subsurface testing and the adequacy of the Level III study should be dismissed as they are without merit.

Subsurface testing or a lack thereof is also alleged in Contention 1A with respect to bulldozer operations during site development and potential impacts to unidentified and/or unevaluated cultural resources. Initially, nowhere in the ROD has NRC Staff or Powertech identified that further subsurface testing will not be required and/or conducted. But rather, the PA provides for the development of evaluation plans, including subsurface testing, in the event that it is necessary and for Tribal monitors during site development. This PA provision requires consultation with consulting parties. Further protection of such properties is accomplished pursuant to the PA without the need for divulging confidential information regarding the significance of these cultural sites. *See* Powertech Exhibit APP-001 at ¶ A.31. Additional protective measures may be used such as temporary or long-term fencing. *See id.* at ¶ A.32.

Dr. Hannus also addresses several individual Contention 1A allegations which will be addressed here. Contention 1A alleges that areas near surface waters were not adequately surveyed. Dr. Hannus specifically states that it is standard practice in archaeology that land areas near water sources have a high potential for identifiable sites. *See id.* at A.18. As stated previously, Dr. Hannus attests that the ALAC study was a 100 percent pedestrian survey and that all water sources within the Dewey-Burdock project area were examined. *See id.* The ALAC survey also addressed areas such as terraces and hilltops near water sources using appropriate procedures. *See* Powertech Exhibit APP-003 at A.18. Thus, this allegation must fail as the ALAC study adequately addressed this allegation.

Contention 1A also alleges that the ALAC study did not properly account for past use of the Project area by a variety of Tribes. Dr. Hannus refutes this allegation in his written testimony as he states that ALAC reviewed the evidence available for the Project site and provides that some of the limited identified physical portions of the archaeological record were evaluated in the study. *See id.* at A.19. Additionally, some physical portions of the archaeological record cannot be linked to any particular Tribe. *See id.* Thus, the ALAC study did indeed address the physical portions of the archaeological record that could be identified and linked or not linked to particular past usage by Tribes. Therefore, this Contention 1A allegation should fail.

Lastly, Contention 1A alleges that the ALAC study did not adequately address all cultural sites, including burial sites. As a general matter, a Level III study is intended to assess the Project area for *all* cultural sites, including burial sites; but, such a study does, in fact, specifically include burial sites. Specific to the ALAC study, it utilized standard archaeological practices to identify specific burial sites and, during the course of the study, ALAC recommended that "cairns and three additional areas of possible EuroAmerican graves be avoided." *See* Powertech Exhibit APP-009 at 7.16. As shown in Dr. Hannus' testimony, these practices were followed and sites were accurately identified, including but not limited to one (1) site that was suspected to be a burial site but, in fact was not, and ten (10) sites containing cairns.

With specific respect to traditional cultural properties (TCP) and site-specific Tribal surveys, Dr. Sebastian addresses these matters in her written testimony on Contention 1A. Initially, Contention 1A alleges that a competent survey with scientific expertise and participation from Tribal representatives was not developed and conducted by NRC Staff; but rather NRC Staff invited Tribes to visit the Dewey-Burdock site and proceed with surveys without a scope or methodology. This allegation goes on to claim that accepting site-specific evaluation information from some Tribes that elected to participate was impermissible.

As stated by Dr. Sebastian in her written testimony, these allegations are wholly without merit. First, Dr. Sebastian attests that the idea that "proper scientific expertise" in the context of identifying TCPs and other traditional properties is "puzzling." Powertech Exhibit APP-001 at ¶ A.17. Dr. Sebastian states further that identifying religious or culturally significant properties in a project area is entirely reliant on the Tribes themselves and the special expertise of the Tribal cultural practitioners. *See id.* Simply put, entities such as NRC or Powertech are not equipped with the Tribe-specific knowledge and traditions to adequately instruct a specific Tribe using "proper scientific expertise" on this subject. Similar to this, Dr. Sebastian also opines on the "proper methodology" for conducting the identification of religious or cultural significant properties. *See id*. In ¶ A.17 of her testimony, Dr. Sebastian states that there is no "right" way for Tribes to identify such properties. The Tribe, which declined to participate in these surveys,[22] has utterly failed to offer any "right" way to do this, nor have they attempted to contradict Dr. Sebastian's statements. Due to this, NRC Staff's approach of allowing the interested Tribes the opportunity to visit the Dewey-Burdock Project site and to investigate the Project area for such properties with funding from Powertech satisfied the NHPA's "reasonable and good faith effort" standard. The determination of whether this standard was satisfied is, as stated by Dr. Sebastian, NRC's "prerogative." Powertech Exhibit APP-001 at ¶ A.17. More specifically to this point, Dr. Sebastian states:

> "The Programmatic Agreement has been signed by all signatories and the invited signatory. Execution by the ACHP, which is authorized in law to promulgate the regulations for Section 106, also indicates that NRC has met the regulatory requirements for compliance with Section 106."

See id. at ¶ A.43.

Contention 1A also alleges that the Dewey-Burdock Project site has not been adequately surveyed due to the fact that several identified historic and/or cultural sites have not been fully

[22] Dr. Sebastian also notes in ¶ A.22 of her testimony that the Tribe's failure to participate in the opportunity to visit the Dewey-Burdock Project site and investigate the Project area for religious or culturally significant properties negates Contention 1A'a allegation that the Tribe cannot verify that a comprehensive study on cultural resources has been conducted at the Project site.

evaluated for registration on the NRHP. However, this allegation ignores a large component of the ACHP's 36 CFR Part 800 regulations and the steps for completion of the Section 106 process embodied therein. As stated by Dr. Sebastian, the allegation improperly confuses and combines two (2) separate steps which are the identification step (Step 2 above) and the evaluation step (Step 3 above). *See id.* at ¶ A.21. Contention 1A's failure to identify the differences between these two steps of the Section 106 process demonstrates a clear misunderstanding of the law applicable to this process.

This failure to properly understand the 36 CFR Part 800 regulations for the Section 106 process also migrates to the Contention's inability to note that the identification step has been completed and that the evaluation step may be handled under the ACHP and Commission-endorsed phased identification approach to historic and cultural resources. This is supported by Dr. Sebastian's testimony at ¶¶ A.21 where she notes that the PA establishes the process by which these identified but yet unevaluated properties will be protected prior to evaluation and how they will be evaluated in consultation with the appropriate parties. Indeed, the level of consultation in this phased identification process includes Tribal consultation in evaluation plan development and NRHP eligibility. *See id.* at ¶ A.21.

Contention 1A also alleges that the TCP survey was required to assess both direct and indirect effects on the entire 10,580 acre area. Tribes were invited to participate in the identification effort, including investigation of all areas within the APE. As stated by Dr. Sebastian, Table 1 of the PA, which has not been and cannot be challenged in this proceeding, shows that NRC Staff did indeed evaluate direct and indirect effects for all identified historic properties. *See* Powertech Exhibit APP-001 at ¶ A.20. As a result, based on the preceding argument, it is Powertech's position that the entirety of Contention 1A should be dismissed.

Contention 1A further alleges that the Tribe was excluded from the Section 106 process until after the DSEIS was issued and that this exclusion prevented the Tribe from being able to participate in initial identification efforts and harms the Tribe in its ability to participate in later adverse impact determinations. The Board should look to Appendix B, Section 4 of the PA, which the Tribe has not and cannot now challenge, for a detailed timeline of NRC Staff's Section 106 process actions. NRC Staff commenced the process of contacting consulting parties on March 19, 2010, when initial contact with twenty Tribes was made. Four (4) additional Tribes were added to this list in April of 2010. The Tribe accepted NRC Staff offer to consult on the Dewey-Burdock Project on January 31, 2011. As discussed in Dr. Sebastian's testimony, several additional consulting actions, including a June 8, 2011 information gathering meeting, an initial site visit the next day, and a February 14-15, 2012 session to hear Tribal input on how to appropriately identify religious and culturally significant properties. *See id.* at ¶ A.24. All of these activities occurred prior to the issuance of the DSEIS in November of 2012. Consultation continued up to the issuance of the FSEIS and NRC License No SUA-1600 with the issuance of the PA. Tribal consultation also will continue under the PA's provisions. Thus, the Tribe has not been affected adversely in any way by NRC Staff's conduct of the Section 106 process, and this allegation should be dismissed.

Another Contention 1A allegation focuses on the number and density of cultural resources at the Dewey-Burdock project site and the potential likelihood of adverse impacts to such resources from the licensed operation. Again, this allegation demonstrates a fundamental lack of understanding of the Section 106 process and the current ROD. As part of the Section 106 process, the lead agency (NRC) is required to conduct an assessment of potential adverse effect (step 3 above) and determine whether such effects will actually occur from the "undertaking." As noted in the record and by Dr. Sebastian in ¶ A.27 of her testimony, NRC Staff already determined that the Dewey-Burdock Project will have adverse effects on cultural resources and, as part of its mitigation efforts, it has developed and executed a PA (with ACHP as a signatory) addressing mitigation of these effects. The PA's provisions on these matters are not and cannot be challenged by CI or the Tribe in this proceeding for the reasons noted above. Further, as stated by Dr. Sebastian in ¶ A.42 of her testimony, execution of the PA by ACHP demonstrates that it has determined that NRC has satisfactorily completed its Section 106 requirements and ACHP's 36 CFR Part 800 regulations.

2. Contention 1B: Alleged Failure to Involve or Consult All Interested Tribes as Required by Federal Law

Contention 1B submits several allegations that scrutinize NRC Staff's conduct of the Section 106 process, including consultation efforts with Tribes. First, Contention 1B alleges that NRC Staff failed to execute its legally mandated "reasonable and good faith effort" to consult with appropriate Tribes, including specific Tribes identified such as the Omaha, Skidi, and Southern Cheyenne Tribes. These allegations are offered in concert with additional allegations that NRC Staff did not satisfy the legal mandate of the NHPA imposed through ACHP regulations at 36 CFR Part 800 *et seq.* Contention 1B has migrated throughout this proceeding pursuant to three (3) Board Orders from Powertech's license application to NRC Staff's DSEIS and FSEIS. This Contention, however, has not migrated to or been amended to reflect a direct challenge to the PA and its provisions.

As a general matter, it is the lead agency's responsibility to identify and consult with potentially affected Tribes; but however, as stated by Dr. Sebastian in ¶ A.33 of her testimony, "it is not a clear-cut process to identify which tribes might be interested in a particular undertaking." Powertech Exhibit APP-001 at ¶ A.33. As part of a typical process, NRC Staff sought assistance from the South Dakota SHPO and, as stated above, was provided with approximately twenty (20) Tribes to contact as potential consulting parties. This list of Tribes was supplemented using additional resources and suggestions from the already-contacted Tribes. Further, in February of 2013, NRC Staff identified additional Tribes and, as noted by Dr. Sebastian, "NRC contacted and began consultations with the Omaha tribe, the Pawnee Nation of Oklahoma (of which the Skidi are one of the four confederated bands), and the Cheyenne and Arapaho Tribes of Oklahoma (Southern Cheyenne)." *See id.* at ¶ A.36. On this matter and the other procedural allegations in Contention 1B, Tribes will continue to have consultation roles in the future for site development pursuant to the PA, the provisions of which are not and cannot now be challenged. NRC Staff determined that it engaged in a "reasonable and good faith effort" with the provision of funds from Powertech to investigate potential religious or culturally significant properties and the development and execution of the PA to complete the Section 106 process. Since there are only two statutory requirements under Section 106, taking into account the effects on historic properties and affording the ACHP the ability to comment on NRC (and BLM) efforts to account for the effects of the undertaking, the execution of the PA by all mandatory and the one invited signatories represents satisfactory completion of the Section 106 process. Thus, the entirety of Contention 1B should be dismissed.

3. Contention 2: Alleged Failure to Include All Necessary Information for Adequate Determination of Baseline Groundwater Quality

Contention 2 involves a series of allegations regarding baseline groundwater quality data and information presented by Powertech in its license application and used by NRC Staff to issue NRC License No. SUA-1600. This Contention also alleges that Powertech did not comply with certain provisions of NUREG-1569 regarding gathering and submission of baseline groundwater quality data and that NRC Staff's conclusions in the FSEIS that Powertech's proposed ISR operation and commitments in its license are adequate to comply with NRC regulations for baseline groundwater quality are incorrect. Contention 2 is both a safety and an environmental contention in this proceeding. As the argument and testimony offered below will show, Contention 2 should not result in any modification to Powertech's NRC License No. SUA-1600.

Initially, Contention 2's allegations should be put in the proper context so that an evaluation of compliance with applicable NRC regulations for "baseline" groundwater quality can be properly understood. For ISR operations, the gathering and analysis of groundwater quality at a project site is contingent on specific NRC regulatory requirements. 10 CFR Part 40, Appendix A, Criterion 7 requires that a license applicant conduct a minimum of twelve months of pre-operational monitoring to provide "complete baseline" data for a number of resource areas including site groundwater quality. However, as noted in NUREG-1569, Chapter 2, a license applicant is not required to gather *complete* site groundwater quality data in order to support an ISR operating license application. As stated on Page 2-2 of NUREG-1569, NRC's guidance states:

> "Reviewers should keep in mind that the development and initial licensing of an in situ leach facility is not based on comprehensive information. This is because in situ leach facilities obtain enough information *to generally locate the ore body and understand the natural systems involved.* More detailed information is developed as each area is brought into production….[R]eviewers should ensure that sufficient information is presented to reach only the conclusion necessary for initial licensing."

See also Powertech Exhibit APP-037 at ¶ A.26.

As stated previously, this is NRC Staff's interpretation of Commission regulations and is supported by the Part 40.32(e) construction rule which prohibits the installation of an entire wellfield, including monitor well networks.

In addition, this regulatory system is further supported by 10 CFR Part 40, Appendix A, Criterion 5(B)(5) which establishes groundwater quality standards for operating uranium recovery facilities. Unlike the required "baseline" groundwater quality data under Criterion 7 for *license applications*, Criterion 5(B)(5)'s operations groundwater quality standard is termed "Commission-approved background" and is the primary groundwater protection standard for operational uranium recovery facilities. In the context of ISR facilities and in accordance with Chapter 5 of NUREG-1569, the final determination of "Commission-approved background" requires the installation of a complete wellfield, including monitor well networks above, below, and around the wellfield, and an analysis of all groundwater quality data within that wellfield to determine a number of groundwater protection limits such as UCLs. This is the control system for ISR operations to operate efficiently at these sites to monitor for, detect, and remediate potential excursions and be prepared to perform restoration after exhaustion of the ore body. This control system allows pump testing to determine confinement and serves as an early warning system for excursions from wellfields to assure that adjacent, non-exempt USDWs will be protected. As will be shown below, the control system based on well-accepted industry experience that is embodied in license conditions and standard operating procedures assures effective groundwater data gathering, monitoring, and protection.

Powertech's groundwater expert, Mr. Hal Demuth, specifically addresses NRC's regulatory scheme for groundwater at ISR facilities. His testimony focuses directly on the fact that the gathering of baseline and, later, the determination of Commission-approved background is a phased process over the course of pre and post-license, pre-operational reviews and procedures. *See* Powertech Exhibit APP-013 at ¶ A.13-23. His testimony also uses this Commission-approved regulatory scheme to justify NRC Staff's approval of Powertech's pre-license baseline groundwater data and analyses pursuant to Criterion 7 and its *procedures* for gathering and analyzing sufficient groundwater data to establish Criterion 5 Commission-approved background. *See id.* at A.13. He describes in detail how NRC Staff complied with the Commission's requirements under these Criteria and reviewed all aspects of these data and analyses in both the SER and FSEIS. *See id.* at A.19 & A.21. Further, he specifically notes that Powertech is precluded from attempting to gather all required data for a determination of Criterion 5 Commission-approved background by the provisions of the Part 40.32(e) construction rule. *See id.* at A.22. Mr. Demuth also confirms that the phased approach to acquire Criterion 7 baseline and Criterion 5 Commission-approved background is commonly used at NRC-licensed ISR facilities. *See* Powertech Exhibit APP-013 at ¶ A.23. It is Powertech's position that this argument and testimony accurately embodies NRC's regulatory approach to groundwater at ISR facilities and the adequacy of the ROD's supporting issuance of NRC License No. SUA-1600.

Specific to Contention 2, the initial allegation is that Powertech's license application and NRC Staff's FSEIS do not contain and adequately analyze baseline groundwater quality data. Contention 2 is rife with allegations that Powertech did not comply with identified acceptance criteria in NUREG-1569 and that NRC Staff's safety and environmental reviews culminating in the development and finalization of the SER and FSEIS do not adequately assess baseline groundwater quality.

In response to these allegations, Powertech relies upon the testimony of Mr. Demuth and Errol Lawrence. As will be shown in their testimony, Powertech's license application and NRC Staff's decision documents adequately evaluate and approve baseline groundwater quality data and license commitments. Initially, Mr. Demuth's testimony properly summarizes NRC regulations for baseline groundwater quality *data* and Commission-approved background groundwater data *procedures* as embodied in the ROD. Contention 2 alleges that Powertech's license application and the FSEIS do not comply with NUREG-1569, Section 2.7.1(4). Compliance with sections of NUREG-1569 is the responsibility of the license applicant and not NRC Staff and, thus, any challenges to the SER or FSEIS based on NUREG-1569 provisions is without merit. Further, both Powertech's license application, including RAI responses, and NRC Staff's decision documents repeatedly address the groundwater quality necessary for a license application. Mr. Lawrence's testimony provides multiple references to these documents and their adequacy. *See* Powertech Exhibit APP-037 at ¶ A.8-A.15.

Contention 2 also alleges that Powertech's license application and NRC Staff's decision documents violate NUREG-1569, Section 2.7.3(4) regarding "reasonably comprehensive" baseline groundwater quality data. Mr. Lawrence discusses the term "reasonably comprehensive" in his testimony and notes that NRC guidance identifies approximately 34 constituents that should be included in the groundwater monitoring/sampling data. *See id.* at ¶ A.18. In each portion of his testimony regarding this specific allegation, Mr. Lawrence identifies locations in the record, including Powertech's license application and NRC Staff's decision documents, where this requirement is satisfied. *See id.* at A.20. His testimony also identifies a commonly used American Society for Testing and Materials (ASTM) standard used by Powertech for sampling procedures that has been used by other NRC-licensed ISR operators. *See id.* at A.24. Based on this, Contention 2's allegation on this portion of NUREG-1569 should be dismissed.

Mr. Lawrence also provides supporting testimony for Powertech's and NRC Staff's conclusion that the groundwater data gathered, submitted, and approved in the record complies with Criterion 7's requirement for "baseline" groundwater quality, including guidance-derived parameters for their analyses. Powertech's "baseline" groundwater quality data utilized NRC

Staff regulatory guides and other guidance (including NUREG-1569) to determine the proper radius for groundwater sampling, as approved in the SER, as well as the fact that certain guidance, while developed for conventional mills, can properly be used for ISR facilities where relevant. *See* Powertech Exhibit APP-037 at ¶¶ A.26-A.32. Further support for these conclusions also was derived from a comparison to past TVA data over a 30 year period, which Mr. Lawrence attests to in his testimony. *See id.* at A.33. He also states that evaluation of the submitted data was done without such data being biased as alleged by opposition declarations and that groundwater in the proposed ore zone needs to be exempted by EPA in order to conduct recovery operations. *See id.* at A.34-A.36. Additionally, the duration of groundwater quality sampling was for a period of approximately eighteen (18) months rather than just the mandatory 12 months in Criterion 7. In short, the totality of Mr. Demuth's and Mr. Lawrence's testimony demonstrate that the conclusions reached by NRC Staff in its decision documents and its review of Powertech's license application are based on adequate "baseline" water quality data to satisfy Criterion 7 requirements that was submitted and approved.

4. Contention 3: Alleged Failure to Include Adequate Hydrogeological Information to Demonstrate Ability to Contain Fluid Migration and Assess Potential Impacts to Groundwater

Contention 3 consists of a series of allegations regarding the adequacy of hydrogeological data and analyses submitted, reviewed, and approved demonstrating Powertech's ability to contain recovery solution migration during operations and restoration at the Dewey-Burdock Project site. In response to this Contention, Powertech will rely on the testimony of Mr. Lawrence and Mr. Demuth. Powertech emphasizes here that the entirety of its written expert testimony addresses each allegation levied in this Contention, but its written position statement addresses the primary allegations related to potential hydrogeologic data and confinement of recovery solutions at the Project site.

As a general proposition and as stated in the Contention 2 argument, the gathering of site-specific hydrogeologic data and information is a phased process. As stated by Mr. Demuth, the initial acquisition of such information is to satisfy the requirements of Criterion 7 for baseline groundwater quality data. Powertech can only gather information permitted under the Part 40.32(e) construction rule, which is consistent with Chapter 2 requirements in NUREG-1569 and then post-license issuance, pursuant to Chapter 5 of NUREG-1569, Powertech will gather additional detailed information on hydrogeologic conditions, including that from pump tests to identify and justify the location of a wellfield's monitor well network and hydrogeologic confinement. *See* Powertech Exhibit APP-013 at ¶¶ A.27-A.30. None of these Chapter 5-related activities are permitted without a license. Mr. Lawrence's testimony further supports this when addressing compliance with specific NUREG-1569, Chapter 2 criteria, including those related to baseline data demonstrating excursion control and characterizing hydraulic properties such as porosity, conductivity, and gradient. *See* Powertech Exhibit APP-037 at ¶¶ A.38-A.43. Compliance with NUREG-1569 criteria also implicates Powertech's 2012 Numerical Groundwater Model, which offered sufficient information for NRC Staff to complete its DSEIS/FSEIS analyses of subsurface hydraulic conditions prior to the issuance of a license. *See id.* at A.41. NRC Staff reviewed this groundwater model and, to the extent necessary, used that model to finalize its conclusions on site-specific hydraulic properties in the FSEIS. *See id.* at ¶ A.42.

With respect to Contention 3's allegations on adequate confinement at the Dewey-Burdock Project site, Powertech's position is that the Fall River and Chilson aquifers are isolated sufficiently for the safe conduct of ISR operations. Sections of the FSEIS and Powertech's license application are cited by Mr. Demuth in his testimony such as the information supporting their isolation due to the presence of the Fuson Shale and the cross sections that show the locations of three (3) major confining units across the Project site. *See id.* at A.31. The multitude of data and analyses present in the ROD also demonstrate that the Project is aimed at recovery operations in fluvial sandstones similar to those at ISR facilities that have operated safely for decades. *See* Powertech Exhibit APP-037 at ¶ A.44-A.46. The suitable confinement for operations similarly can be projected to the formation proposed for use of Powertech's proposed Class V wells (i.e., the Minnesula and Deadwood formations) and the Madison formation which is the proposed source of supplemental water for the Project. Mr. Lawrence's testimony also notes that sufficient controls will be put in place to prevent a lack of confinement due to unplugged or improperly plugged exploration holes and have been used at other licensed ISR facilities due to the fact that "most historic drill holes were plugged and abandoned using techniques sufficient to prevent vertical migration of wellfield solutions, natural processes seal open drill holes, and adequate procedures are in place to locate unplugged or improperly plugged holes during wellfield delineation and testing to prevent potential impacts." *See id.* at ¶ A.56

Subsurface features alleged in Contention 3 to be a potential cause of migration of recovery solutions during operations or restoration is discounted by the testimony of Mr. Lawrence and the FSEIS and SER. Using USGS subsurface mapping, there is no evidence of faults or fractures in the Project area and, on the contrary, the record evidence supports the likelihood that no such structures exist with the potential to substantially impact groundwater flow. *See id.* at ¶ A.47. The FSEIS' and SER's conclusions support this premise and also utilize substantial record evidence in their formulation. *See id.* at ¶¶ A.49-A.50. Additionally, the evidence in Powertech's license application, including RAI responses, and in NRC Staff's decision documents support the premise that there are no breccia pipes in the Project area that could cause issues with hydraulic confinement and fluid control. *See* Powertech Exhibit APP-037 at ¶¶ A.52-A.55. Moreover, as is the case with groundwater quality data, Powertech is required to acquire and analyze more information post-license issuance pursuant to license condition and other record requirements. *See id.* at ¶ A.51. Based on these arguments and the written testimony presented herein, it is Powertech's position that Contention 3 should be dismissed and should not result in any modification to the ROD.

5. Contention 4: Alleged Failure to Adequately Analyze Groundwater Quantity Impacts

Contention 4 consists of a series of allegations regarding Powertech's and NRC Staff's alleged failure to adequately analyze potential groundwater quantity impacts for the Dewey-Burdock Project. This Contention's allegation specifically attempts to invalidate a variety of aspects of the Dewey-Burdock operational approach including items such as water balance, pumping rates, and potential impacts to local wells from the licensed operation. Contention 4 is an environmental contention that has migrated from Powertech's license application to NRC Staff's DSEIS/FSEIS. While this Contention is focused on NRC Staff's analysis of groundwater quantity impacts, Powertech deems it appropriate to provide supporting argument and testimony regarding the licensee's analysis of these potential impacts and the validation of NRC Staff's analysis. In this response, Powertech will be relying on the written testimony of Mr. Demuth, Mr. Lawrence, and Mr. Fritz. Powertech emphasizes here that the entirety of their written expert testimony addresses each allegation levied in this Contention, but its written position statement addresses the primary allegations related to potential groundwater quantity impacts.

Contention 4 levies allegations related to potential impacts to local wells in the Dewey-Burdock project area due to volume of water used during operations and restoration. The estimated sustainable pumping rate and quantity for the Inyan Kara at the Project was finalized in the FSEIS based on the submission of Powertech's 2012 Numerical Groundwater Model (Powertech Exhibit APP-025). This specifically contradicts Contention 4's allegation that the pumping rates for the Project are inconsistent with the record. *See* Powertech Exhibit APP-037 at ¶ A.106. The record further indicates that both the DSEIS and the FSEIS adequately address potential impacts to local wells from the Project's water use. Mr. Demuth's written testimony specifically identifies sections of the DSEIS and FSEIS that address this issue and how Powertech's groundwater model provided adequate information to substantiate these conclusions. *See* Powertech Exhibit APP-013 at ¶¶ A.46-A.47. Powertech also provided adequate water balance in its license application, which was reviewed, approved, and documented in the FSEIS. *See* NRC Staff Exhibit NRC-008A-008B.

Contention 4 contains an allegation that the lifecycle of the Dewey-Burdock Project will result in the consumption of billions of gallons of water is misguided. As stated in the testimony of Mr. Doyl Fritz, SDDENR approved water rights applications from Powertech based on assumptions related to not exceeding the average annual recharge of the Inyan Kara and Madison aquifers. *See* Powertech Exhibit APP-046 at ¶ A.12. Mr. Fritz also compares the Project groundwater consumption rate in the Inyan Kara to a member of CI (Dayton Hyde) who requested a water right for irrigation purposes using a center pivot system. *See id.* at ¶ A.12. Mr. Fritz concludes that this water right request projected over the Project lifecycle and in accord with this allegation puts Mr. Hyde's consumption at 90.6 million gallons per year or more than what has been requested by Powertech. *See id.* Mr. Fritz's testimony also offers an analysis of

Powertech's proposed groundwater consumption for the Madison aquifer and concludes that the statement that the Project's groundwater consumption would be "massive" is incorrect. *See id.* at ¶ A.13

Contention 4 also alleges that there is no information on baseline water levels and pumping rates for domestic and stock wells surrounding the Project site. Mr. Demuth's testimony specifically addresses the fact that existing pre-license issuance data on these wells is present in Powertech license application, including its RAI responses and was used in the groundwater model. *See* Powertech Exhibit APP-013 at ¶ A.48. His testimony also reiterates the responsibility of a licensee to gather post-license issuance groundwater quality data on these wells pursuant to license condition, and the requirement that Powertech protect such wells within the Project area such as removing all domestic wells within the license area from private use prior to operations and all stock wells within ¼ mile of wellfield from private use prior to operating those wellfields and during operation of the Project. *See id.* at ¶ A.49. These preventative measures also contribute to mitigation measures discussed in Section 6 on Contention 6. Based on the argument and testimony on this Contention, Powertech's position is that Contention 4 should be dismissed and should not result in a modification to the ROD.

6. Contention 6: Alleged Failure to Describe or Analyze Proposed Mitigation Measures

Contention 6 is an environmental contention offered in this proceeding as a challenge to the mitigation measures offered by Powertech and NRC Staff in the ROD. More specifically, Contention 6 is an attempt to challenge various aspects of the record with incomplete information or a complete misunderstanding of the analyses offered in NRC Staff's decision documents.

Generally speaking, an evaluation of mitigation measures is a standard component of new ISR operating license applications and is submitted as part of the application's ER pursuant to NUREG-1748. Typically, a mitigation measure analysis in a license application is nothing more than a preliminary offering of data and other information to assess potential, reasonably foreseeable actions within a given review area (e.g., 50 mile/80 kilometer radius from the project area). Over the course of a license application review, NRC Staff will submit RAIs to the license applicant requesting any additional specific data and information regarding a variety of resource areas, including but not limited to mitigation measures for the Proposed Action. In the instant case, Powertech's license application describes a variety of mitigation measures, including the development of mitigation measures prior to operations but post-license issuance. These items were contained in both the TR and ER, as well as relevant RAI responses and are discussed in ¶ A.23 of Mr. Doyl Fritz's written testimony. *See* Powertech Exhibit APP-046.

However, the license application and RAI responses are merely a small portion of the ROD for all resource areas including mitigation measures. As discussed in his response to Contention 6's allegation that NRC Staff's FSEIS' assessment of mitigation measures merely consists of a multi-page chart, Mr. Fritz states that "[t]he allegation seems to reflect either a lack of understanding or an incomplete reading of what is contained in the FSEIS." Powertech Exhibit APP-046 at ¶ A.6. This multi-page chart is a summary table and does not, in any way, purport to describe the complete scope of planned mitigation measures, their development and implementation or their effectiveness. *See id.* These proposed mitigation measures are described in additional areas such as FSEIS Sections 2 and 4.

Contention 6's allegation regarding mitigation measures consisting of nothing more than plans to be developed later after license issuance (post-NEPA process) also ignores the

Commission's endorsement of performance-based licensing, including the development of wellfield packages, post-license issuance. *See Hydro Resources, Inc.* (Crownpoint Uranium Project), CLI-99-22 (July 23, 1999). Further, specifically with respect to wellfield packages and mitigation measures for managing drilling fluid during well drilling operations as stated above, 10 CFR Part 40.32(e) ("construction rule") prohibits full wellfield development prior to the issuance of a license. Thus, Contention 6 cannot claim that these mitigation measures should have been implemented during the NEPA process, pre-license issuance.

With respect to specific resource areas covered under Contention 6 regarding mitigation measures, Powertech will attempt to address these items here. Contention 6 alleges that mitigation measures with respect to groundwater are inadequate and that NRC Staff's FSEIS fails to adequately address such measures. Generally speaking, groundwater restoration imposed by NRC through Powertech's license serves as the ultimate mitigation measure. By law, companies such as Powertech are not permitted to engage in ISR operators in an aquifer or a portion thereof without an aquifer exemption from EPA or a primacy State (which South Dakota is not for ISR-specific wells) under the SDWA. This aquifer exemption, by definition, labels an ISR amenable aquifer or portion thereof not suitable for drinking purposes now or at any point in the future. *See* 40 CFR § 146.4. Thus, restoration of an exempted aquifer post-ISR operations typically does not make any legal or practical sense for water quality purposes in that aquifer. Due to this, groundwater restoration in such aquifers or portions thereof can only be as a mitigation measure to re-establish the natural geochemical conditions in the ore zone aquifer in order to prevent or minimize migration of recovery solutions post-restoration to adjacent, non-exempt aquifers.

Contention 6-specific allegations on mitigation measures for groundwater at the Dewey-Burdock Project are addressed by Powertech's groundwater expert Mr. Demuth in his written testimony. Contention 6's broad allegation that NRC Staff's FSEIS does not adequately address mitigation measures for groundwater ignores two fundamental facts. First, the allegation merely focuses on the FSEIS' mitigation measures and not the discussions and analyses in NRC's SER. As stated by Mr. Demuth, the mitigation measures discussed in the FSEIS are the same as those evaluated by NRC Staff during the course of its safety review and memorialized in the SER. *See* Powertech Exhibit APP-013 at ¶ A.51. Indeed, the FSEIS provides frequent references to the SER and the license conditions imposed as a result of the safety review. The SER's finding that Powertech's proposed ISR operations (including restoration) will adequately protect public health and safety on its face assures significant mitigation of any potential environmental. *See id.* at A.52. Thus, the entirety of the ROD, and not just the FSEIS must be taken into consideration by the Board when ruling on Contention 6's groundwater allegations.

Second, Contention 6's groundwater allegation does not account for the wide range of groundwater-related mitigation measures identified in FSEIS, Section 6. As is the case with other resource areas, Section 6 of the FSEIS provides a summary chart of groundwater-related mitigation measures with supporting analyses of such measures and their acceptability are found throughout the FSEIS, particularly in Sections 2 and 4. Mr. Demuth's testimony also specifically references mitigation measures for controlling pipeline leaks and identifies various references to discussions in both the FSEIS and the SER demonstrating that NRC Staff properly analyzed this particular mitigation measure. *See id.* at A.52.

Next, Mr. Demuth also discusses mitigation measures associated with minimizing potential impacts from historical mine pits. Contention 6 alleges that the FSEIS does not have sufficient detail to address mitigation on this issue and only requires future plans for monitor well networks in the eastern portion of the Project area where the Chilson aquifer is the production zone. Initially, Mr. Demuth points to NRC Staff's response to comments in the FSEIS which specifically state the variety of mitigation measures approved for recovery operations near historic mine pits, including the need to demonstrate through typically, post-license issuance, pre-operational ore body delineation drilling, wellfield installation, and the development of a monitor well network where the Chilson is the production zone. *See id.* at A.55. Mr. Demuth specifically notes that in the allegation regarding potential impacts from historic mine pits, "there is no mention of the first four…mitigation measures….Instead the intervenors claim that since the Fall River aquifer monitoring well network is 'unsubmitted' and 'unreviewed' that the FSEIS conclusion of small impacts is 'unsubstantiated.'"[23] *See id*. This allegation once again fundamentally ignores the Part 40.32(e) construction rule prohibition on full wellfield, including monitor well network, installation prior to license issuance and the Commission-endorsed policy on performance-based licensing for ISR as approved in the *Hydro Resources* litigation.

The remainder of Mr. Demuth's testimony on groundwater-related mitigation measures can adequately be summarized as Contention 6 ignores typical, NRC-approved post-license issuance techniques for wellfield development and uranium recovery. For example, Contention 6 alleges that the FSEIS does not adequately address potential impacts from exploration or abandoned boreholes. But, this allegation ignores how the ISR process works and how the wellfield's development contributes as a mitigation measure. When developing an ISR wellfield, a licensee must first delineate the full extent of the ore body it seeks to recover so that it will

[23] Mr. Demuth's testimony also provided a detailed discussion of the specific mitigation measures related to this allegation. *See id.* at ¶ Section 5.

fully understand subsurface conditions to a greater extent than is permitted by NRC regulations under Part 40.32(e) and Chapter 2 of NUREG-1569. After this is complete, pump tests are necessary to determine the nature of the subsurface systems and the responses received by the licensee to recovery technique. As part of this process, a licensee is then able to identify whether abandoned boreholes are present and if they would contribute negatively to the recovery process. This process then allows the licensee to properly plug and abandon such boreholes to ensure no impacts are experienced during operations or restoration. As stated by Mr. Demuth, the FSEIS specifically addresses how the development of wellfield hydrologic packages, including pump tests, will include the utilization of approved South Dakota regulations and procedures to properly plug and abandon these boreholes. *See* Powertech Exhibit APP-013 at ¶ A.59. Mr. Demuth cites to both the FSEIS and the SER as sources of NRC Staff's review and evaluation of wellfield development, identification of abandoned or exploration boreholes, and their plugging and abandonment. *See id*. Specifics of pumping tests and their effectiveness are discussed by Mr. Demuth in his written testimony as well. *See id.* at ¶ A.60.

Mr. Demuth also discusses the plans for Powertech to restore groundwater and conduct stabilization monitoring in accordance with the ROD. The FSEIS addresses several allegations levied under Contention 6 with respect to groundwater restoration beginning with the appropriate standard for restoration cited at FSEIS page 2-40. Contention 6 alleges that Powertech committed to restoring site groundwater to pre-mining conditions, which is incorrect. FSEIS page 2-40 references a commitment by Powertech to restore site groundwater to 10 CFR Part 40, Appendix A, Criterion 5(B)(5) standards, which is Commission-approved background or an MCL, whichever is higher, or an ACL. Thus, this allegation in Contention 6 represents a complete misrepresentation of the ROD.

Contention 6 also alleges that the procedures for groundwater restoration are not identified in the ROD, including NRC Staff's decision documents. According to Mr. Demuth, Powertech's license application, including RAI responses, and the FSEIS and SER identify, analyze, and approve groundwater restoration procedures for the Dewey-Burdock Project. These approvals also are supported by analyses of at least three (3) different past or current ISR projects and historical evidence provided by the International Atomic Energy Agency (IAEA). *See* Powertech Exhibit APP-013 at ¶ A.64. Mr. Demuth also states that it is incorrect to state that restoration methods approved for the Dewey-Burdock Project consist only of "proposals" to restore. *See id.* at ¶ A.65.

Mr. Demuth's testimony also addresses Contention 6's allegations regarding stabilization monitoring post-restoration. Contention 6 alleges that there is no support for a plan to conduct stabilization monitoring for twelve months. NRC Staff's analysis on stabilization monitoring is centered on a license condition requiring a *minimum* of four quarters of monitoring and also requires that specific restoration standards for water quality parameters must be met for the "most recent four quarters" of sampling. The FSEIS, page E-54 specifically states NRC Staff must review and approve groundwater restoration data and make the final determination that restoration is complete. *See id.* at ¶ A.66. As stated by Mr. Demuth, Powertech's proposed monitoring procedures have been reviewed and approved by NRC Staff in the SER and are consistent with past approved practices at other ISR facilities. *See id.* at ¶ A.68. These factors demonstrate that the portions of Contention 6 related to groundwater mitigation should be dismissed.

Contention 6 allegations regarding mitigation measures for air quality and emissions are addressed by Mr. Fritz by noting in his testimony that they are summarized in FSEIS Tables 6.2-

1 and 6.3-1 and are fully described throughout the FSEIS' impact analysis in Section 4. Allegations regarding on-site disposal of radioactive waste are unfounded because ISR sites do not dispose of 11e.(2) byproduct material on-site. Commission policy implementing the requirements of 10 CFR Part 40, Appendix A, Criterion 2 specifically does not allow on-site disposal of such material; but rather imposes a license condition on ISR operators requiring that such material be disposed of at an NRC or Agreement State licensed 11e.(2) disposal facility. This license condition is further enforced by NRC with a requirement that the ISR operator have an off-site disposal contract with such a facility in place prior to the commencement of licensed operations. This is common sense because an ISR operator does not generate 11e.(2) byproduct material until licensed source material (uranium) milling commences. *Compare* 10 CFR Part 40.4 definition of "uranium milling."

With respect to land application, NRC Staff's FSEIS provides for a wide range of mitigation measures, including water treatment methodology, sampling, and reporting.[24] These mitigation measures all are designed to be implemented during operations and restoration, while further procedures for soil sampling and, if necessary, remediation is required for decommissioning and surface reclamation. These measures are all discussed in the FSEIS, Section 6 and referenced in Mr. Fritz's testimony.[25] *See* Powertech Exhibit APP-046 at ¶ A.25.

Further mitigation measures are present for protecting wildlife in contravention of the Contention 6's allegation of inadequate protection of wildlife. NRC's FSEIS proposes more than adequate mitigation measures for protecting wildlife, which are summarized in FSEIS Section 6, including limiting noise and vehicular traffic and wildlife access to wastewater ponds, adherence

[24] Powertech also has received a recommendation for approval of a groundwater discharge plan from SDDENR, which further augments mitigation measures for water quality.

[25] Mr. Fritz's testimony also reflects the fact that several mitigation measures approved for use by Powertech in NRC Staff's FSEIS already have been reviewed and approved by SDDENR. *See* Powertech Exhibit APP-046 at ¶¶ A.25 & A.28.

to timing and distance restrictions from appropriate agencies to protect active raptor nests during breeding seasons, and following appropriate land application requirements. Further protective measures are referenced by Powertech's expert Ms. Gwyn McKee in her written testimony. *See* Powertech Exhibit APP-053 at ¶ A.8. Ms. McKee also determines that the effectiveness of these mitigation measures is evidenced by being in line with current recommendations by regional experts such as those in South Dakota's Greater Sage-Grouse management plan (Powertech Exhibit APP-055), the Sage-Grouse National Technical Team (Powertech Exhibit APP-056), and the FWS' Greater Sage-Grouse Conservation Objectives (Powertech Exhibit APP-057), even though there are no sage grouse in the Project area. *See id.* at ¶ A.9. Other mitigation measures that match established expert recommendations are discussed in Ms. McKee's written testimony. *See id*.

Ms. McKee's testimony also addresses mitigation measures associated with the Avian Monitoring and Mitigation plan. As a general matter, an avian plan is a requirement imposed on Powertech prior to construction by South Dakota and not by NRC. NRC's FSEIS merely accounts for the implementation of such a plan and references that it is an acceptable mitigation measure in FSEIS Section 6. Ms. McKee specifically references materials provided in Powertech's license application and the FSEIS regarding compliance with NUREG-1569, Acceptance Criteria 2.8.3(4). This Criteria merely requires that a license applicant provides materials regarding steps to be taken to mitigate impacts to an identified species and its environment, *but does not require the submission and completion of an actual avian plan. See id.* at ¶ A.10. The proposals and their parameters for the avian plan are based on well-understood monitoring and mitigation measures used at Wyoming surface coal mines which, as stated by Ms. McKee, incur much more substantial impacts to avian species than the Dewey-Burdock

Project. Therefore, since these materials were provided in Powertech's license application and assessed in the FSEIS and they are based on well-understood and accepted parameters, Contention 6's allegation on the avian plan must fail.[26]

In summary, "NEPA does not require 'a fully developed plan that will mitigate environmental harm before an agency can act,' rather, NEPA requires only that 'mitigation be discussed in sufficient detail to ensure that environmental consequences have been evaluated,'" which the NRC ROD more than satisfied.[27]

7. Contention 9: Alleged Failure to Consider Connected Actions

Contention 9 is an environmental contention alleging that the ROD fail to consider connected actions in association with NRC Staff's review of the Dewey-Burdock Project license application and the development of NRC's decision documents (i.e., FSEIS, license conditions, SER, and PA). More specifically, this Contention alleges that NRC Staff failed to appropriately engage other federal agencies in their review process and document preparation. Contention 9 is an environmental contention that has migrated through this proceeding from Powertech's license application to NRC Staff's decision documents, including the DSEIS and FSEIS. However, since no amended contentions or requests to migrate were submitted and approved for the final license and the PA, this contention does not apply to these parts of the record. Further, while this Contention appears to be levied specifically at NRC Staff conduct of its review, Powertech deems it appropriate to offer expert testimony and argument in support of NRC's review.

Initially, Contention 9 alleges that NRC did not fully engage other federal agencies in the review process. As stated in the testimony of Mr. Fritz, the FSEIS and other components of the

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[26] It is important to note that Ms. McKee's testimony also references and describes the process by which the avian plan is being developed, its timing, and the mitigation measures it seeks to impose. *See id.* at A.11-A.12.

[27] *Holy Cross Wilderness Fund v. Madigan*, 960 F.2d. 1515, 1522 (10th Cir. 1992), *quoting Methow Valley*, 490 U.S. at 352-53.

ROD are rife with references to NRC's engagement with other federal agencies. First, the BLM was brought in by NRC Staff as a cooperating agency on the development of the FSEIS, which is expressly permitted (but is not mandatory), under CEQ regulations. To be a cooperating agency on the FSEIS, NRC Staff and BLM engaged in joint development of the FSEIS, and BLM will be utilizing the FSEIS to develop its supplement for Powertech's requested Plan of Operations (POO). Further, as stated by Mr. Fritz, NRC Staff's FSEIS cites to numerous examples of how BLM participated in the license application review, including several sections where NRC Staff specifically consulted with BLM on a variety of issues. *See* Powertech Exhibit APP-046 at A.26. Thus, Contention 9 is not supported by any lack of BLM involvement.

With respect to EPA, the agency that is responsible for issuance of Powertech's requested aquifer exemption(s) and UIC permits for Class III and V wells, Mr. Fritz's testimony specifically identifies the locations in the FSEIS where EPA's involvement in the license application review process is identified and/or described. In addition to the FSEIS descriptions of EPA's involvement, Contention 9 also ignores that EPA was integrally involved in the FSEIS' development, including receiving multiple preliminary drafts of the DSEIS and commenting in writing on both the DSEIS during the public comment period and the FSEIS during its thirty day post-issuance concurrence period. *See id.* at A.26.

EPA regulatory authority for SDWA aquifer exemptions and UIC permits in South Dakota also are specifically identified in the FSEIS. As a regulatory matter, 40 CFR Part 124.9(b)(6) prohibits the preparation of an EIS in conjunction with a UIC permit. But, throughout the FSEIS, NRC Staff provided comprehensive evaluations of the potential impacts of Class III wells associated with their construction and use and Class V wells for wastewater disposal also were discussed along with other wastewater disposal options. As noted by Mr.

Fritz, there are numerous references to these analyses throughout the FSEIS' Chapter 4 impact analysis. *See id.* at A.27. This impact analysis also addresses the false presumption levied in Contention 9 that radioactive wastewater from the Dewey-Burdock Project will be disposed of either in a Class I well, which is not permitted in South Dakota, or in a Class V well. As stated by Mr. Demuth, both allegations are false because Powertech applied for a Class V permit from EPA, which has the regulatory authority to issue such permits and "radioactive waste" is not injected into Class V wells. *See* Powertech Exhibit APP-013 at ¶¶ A.69-A.71The latter reason is supported by NRC requirements in Powertech's license that wastewater must be treated to meet 10 CFR Part 20, Appendix B, Table 2, Column 2 limits and EPA regulations cited at FSEIS page 2-22, which states that liquid waste injected into a Class V well cannot qualify as hazardous material.[28] *See* 40 CFR Part 144.3.

Lastly, Mr. Fritz's testimony addresses the Contention 9 allegation that NRC Staff did not conduct an independent analysis of potential environmental impacts associated with the Dewey-Burdock Project. Specifically, Contention 9 alleges that NRC Staff relied solely on other agencies such as SDDENR and EPA for environmental analyses. Initially, this allegation represents a complete misunderstanding of how NRC Staff "signs-off" on the use of other agency procedures or approvals. When NRC Staff agrees with the use of other agency procedures that are not necessarily within the Commission's federal, preemptive AEA jurisdiction, it evaluates the characteristics and protective nature of these procedures to determine if they are adequate to satisfy NRC's AEA mission of adequately protecting public health and safety. A good example of this is well plugging and abandoning which is typically conducted by NRC-licensed ISR operators in accordance with relevant State Engineers Office

[28] Mr. Demuth also notes that there is no regulatory requirement that Class V wells must be above or below a USDW in response to a Contention 9 allegation to the contrary. *See* Powertech Exhibit APP-013 at ¶ A.71

procedures. Further, as noted by Mr. Fritz, while certain agencies may have regulatory jurisdiction over the issuance of specific permits or authorizations, such as EPA over UIC permits or South Dakota over NPDES permits, NRC Staff still conducted its own evaluation of the potential impacts associated with such permits and authorizations in the FSEIS. For example, while South Dakota will assess the potential impacts associated with and issue a NPDES permit, NRC Staff still assessed its potential impacts and mitigation measures for protecting surface waters. *See* Powertech Exhibit APP-046 at A.28. Thus, based on the argument and testimony noted above and the written testimony submitted by its experts, Powertech's position is the Contention 9 should be dismissed and should not result in a modification to the ROD.

8. Contention 14A: Alleged Failure to Conduct Appropriate Consultation Under the Endangered Species Act and Implementing Regulations

Contention 14 consists of a series of allegations regarding NRC Staff's consultation with the United States Fish and Wildlife Service (FWS) regarding potential environmental impacts to identified species in the Dewey-Burdock Project area. Powertech's responses to this Contention and the expert testimony of Ms. McKee are limited to addressing the FSEIS' provisions noting that the Section 7 ESA consultation was conducted properly for threatened and endangered (T&E) species, correcting misinterpretations and misstatements in the scope of this Contention, summarizing FSEIS data and analyses and updating recent Project data. Contention 14A is an environmental contention that has migrated from Powertech's license application to NRC Staff's decision documents. As is the case with Contention 9, while Contention 14A appears on its face to be an attack on NRC Staff's conduct of its environmental review, Powertech deems it appropriate to offer supporting argument and testimony here.

Contention 14A alleges that the ESA Section 7 consultation was not adequately completed and has resulted in a significant threat to T&E species. This allegation is not supported by the record in that NRC Staff's FSEIS specifically notes that it considered federal T&E species and determined they have not been documented in the Dewey-Burdock Project area and that they were not expected to occur in the area. Based on these factors, it determined that the Project will not affect such species. *See* Powertech Exhibit APP-053 at A.15. Then, the FSEIS documents that the FWS consulted with NRC Staff and determined that further consultation was not needed. *See id.* at A.16. The FWS' written confirmation that further consultation was not necessary are based on both NRC Staff's determination and FWS records of no federal T&E species in the Project area. Ms. McKee summarizes her conclusions in ¶ A.17 confirming that the process was conducted correctly. Thus, this Contention 14A allegation is without merit.

Contention 14A also alleges that NRC Staff was required to "conference" with FWS pursuant to 50 CFR § 402.10(a). Ms. McKee points out in her testimony that the Tribe's citation of this regulation is incorrect and does not support their allegation. *See id.* at ¶ A.18. The citation to this regulation by the Tribe is not consistent with the actual intent of its language. As stated by Ms. McKee, the "confer" requirement in this regulation is not to be confused with "consult" and the former deals with conferences between FWS and other agencies regarding species not yet listed as T&E or habitats not yet designated as critical. *See id*. For additional understanding on this incorrect reference, Ms. McKee refers the Board to FWS' ESA Section 7 Handbook (Powertech Exhibit APP-058) and FWS' website (Powertech Exhibit APP-059). This fundamental mischaracterization of the regulation's meaning renders this Contention 14A allegation inapplicable to this proceeding and, thus, should be dismissed.

Lastly, Contention 14A alleges that the DSEIS does not document any attempt to consult on black-footed ferrets and whooping cranes with FWS to obtain concurrence. However, this allegation does not, and cannot, challenge the findings on this issue in the FSEIS as the Contention did not migrate to the FSEIS. As stated by Ms. McKee, NRC Staff addressed this issue in its response to comments at E-156, which states that FSEIS Section 1.7.1 describes FWS/NRC correspondence confirming that the whooping crane and black-footed ferret, while federal T&E species that could occur in Custer and Fall River counties, neither has ever been documented at the Project site. *See id.* at ¶ A.20.

9. Contention 14B: Alleged Adequacy of Impact Analysis to the Greater Sage Grouse, the Whooping Crane, and the Black-Footed Ferret

Contention 14B consists of a series of allegations regarding the adequacy of NRC Staff's actions within the scope of its license application review and development of the ROD with respect to three species: (1) the Greater Sage-Grouse; (2) the whooping crane; and (3) the black-footed ferret. Powertech's responses to these allegations will rely on specific argument and the expert testimony of Ms. McKee. Again, while this Contention appears on its face to be an attack on NRC Staff's conduct of its environmental review, Powertech deems it appropriate to offer supporting argument and expert testimony here.

First, with respect to the Greater Sage-Grouse, Contention 14B alleges that there is no documentation regarding NRC Staff's assessment of this species in the Dewey-Burdock Project area in the DSEIS. As stated in Contention 14A above, NRC Staff consulted with FWS on the Greater Sage-Grouse and documented its analysis in the DSEIS, which later appeared in the FSEIS. Despite the FWS sage-grouse conservation objectives not being finalized when the DSEIS was issued for public comment, the document did indeed address those objectives and noted that they could be implemented for the Project when finalized. *See* Powertech Exhibit

APP-053 at ¶ A.22. The DSEIS, and then the FSEIS, also analyze the potential impacts to the sage-grouse in general and documented such findings. As stated in the Contention 6 argument above, these documents also addressed mitigation measures associated with protecting the sage-grouse. Thus, this portion of Contention 14B must fail.

Second, with respect to the whooping crane, Ms. McKee's testimony directly challenges the Tribe's allegation and references multiple areas of the ROD where NRC Staff documented the assessment of this species and its consultation with FWS. Ms. McKee specifically states that the Contention's allegation on the whooping crane fails to appropriately identify the area of review for FWS consultation, noting that the proper area of review is the Project area and not Custer or Fall River counties as a whole. *See id.* at ¶ A.23. Based on previous information noted above, this species is not documented as appearing in the Project area and this fact is documented in NRC Staff in the DSEIS and FSEIS. *See id.*

Lastly, with respect to the black-footed ferret, Contention 14B alleges that there is no FWS concurrence present in the record; no evidence is present that the prairie dog colony at the Dewey-Burdock Project site is likely too small to support and sustain a breeding population of black-footed ferrets; and no evidence that NRC's "no jeopardy" determination is based on necessary expertise and investigation. Section A.24 directly address these allegations and she further attests to the fact that FWS' confirmation that the black-footed ferret will not be affected by the Project was an indirect confirmation that the prairie dog population would be too small to sustain a breeding population. *See id.* at A.24. The FSEIS at page 3-61 also provides additional information that a comparison of Powertech's preliminary monitoring information on prairie dog colonies in the Project area to the FWS' current recovery plan for the black-footed ferret demonstrates that NRC's conclusion is correct. *See id*. In addition, Ms. McKee confirms that

Powertech also has committed to several monitoring measures during the Project's lifecycle to assure that prairie dog populations are tracked adequately.

V. CONCLUSION

Based on the argument and expert testimony discussed above and in concurrence with the arguments and expert testimony offered by NRC Staff, Powertech's position is that each of the Contentions offered by both CI and the Tribe should be dismissed and should not result in a modification to the ROD representing and supporting Powertech's NRC License No. SUA-1600.

Respectfully Submitted,

/Executed (electronically) by and in accord with 10 C.F.R. § 2.304(d)/
Christopher S. Pugsley, Esq.

____

Anthony J. Thompson, Esq.
Christopher S. Pugsley, Esq.
Thompson & Pugsley, PLLC
1225 19th Street, NW
Suite 300
Washington, DC 20036
COUNSEL TO POWERTECH

Dated: June 20, 2014

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No.: 40-9075-MLA
POWERTECH (USA), INC.	)	Date: June 20, 2014
(Dewey-Burdock In Situ Uranium Recovery Facility)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **"POWERTECH (USA), INC.'S STATEMENT OF POSITION"** in the above captioned proceeding have been served via the Electronic Information Exchange (EIE) this 20th day of June 2014, which to the best of my knowledge resulted in transmittal of the foregoing to those on the EIE Service List for the above captioned proceeding.

Respectfully Submitted,

/Executed (electronically) by and in accord with 10 C.F.R. § 2.304(d)/
Christopher S. Pugsley, Esq.

Anthony J. Thompson, Esq.
Christopher S. Pugsley, Esq.
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1225 19th Street, NW
Suite 300
Washington, DC 20036
COUNSEL TO POWERTECH

Dated: June 20, 2014

In-situ recovery uranium mining in the United States: Overview of production and remediation issues

J.K. Otton, S. Hall

U.S. Geological Survey, Lakewood, Colorado, United States of America

E-mail address of main author: jkotton@usgs.gov

In 2007, in-situ recovery (ISR) methods produced about 95% of U.S. production of 4.53 million pounds. Eleven new and five expansion ISR applications or letters of intent were filed with the U.S. Nuclear Regulatory Commission for the period from 2007-2009. ISR mining can be conducted in water-saturated, permeable, hydrologically confined sandstone beds where the uranium is soluble. Contamination of ground water during and after ISR operations has become a major issue for nearby residents, and for local, county and state governments. Colorado has raised ISR mining requirements and established a burden of proof that operations can return water quality to baseline conditions. Similar concerns are affecting mining plans in Wyoming, Texas, New Mexico, South Dakota, and Nebraska. Major issues affecting restoration at ISR mining operations include the following:

- Baseline water quality: Is the water presently potable or suitable for livestock or irrigation? What parts of the local aquifer should be sampled to establish baseline? What sampling methods are required to establish water quality conditions?
- Control of fluid flow during operations: How much hydrologic understanding of the ore zone is necessary to avoid flow problems?
- Ground-water restoration: To what standard should the ground water be restored? How long should monitoring occur after mining is completed?
- Ground-water restoration:What technologies work or might work?

To date, no remediation of an ISR operation in the United States has successfully returned the aquifer to baseline conditions. Often at the end of monitoring, contaminants continue to increase by reoxidation and resolubilization of species reduced during remediation; slow contaminant movement from low to high permeability zones; and slow desorption of contaminants adsorbed to various mineral phases. New remediation technologies are being examined, including bioremediation and monitored natural attenuation. Bioremediation can occur through addition of a carbon source such as acetate or molasses to augment the natural bacterial population which can induce simultaneous reduction and precipitation of uranium in solution. Bioremediation experiments are presently being conducted at U.S. Department of Energy sites in western states. Monitored natural attenuation suggest that ground-water flow that created the deposit moved from an oxidized zone through the orebody to a reduced zone. Re-establishment of ground-water flow after mining should move contaminants from the mined orebody into the reduced zone where natural processes can reduce the contaminants and remove them from the ground water. Questions: 1) Is current ground-water hydrology suitable? 2) What is the reducing capacity of the reduced zone? 3) Do kinetics of reduction reactions in the reducing zone vs. speed of ground water flow? 4) Effects of heterogeneity in mining zone and reducing zone? 5) Can all analytes of concern be attenuated? 6) Monitored attenuation- can the limited time frame preferred by operators be achieved?

From:	Jeffery C. Parsons
To:	Shea, Valois
Cc:	"Roger Flynn"
Subject:	RE: Oglala Sioux Tribe Comment Attachments #2
Date:	Monday, June 19, 2017 3:39:07 PM
Attachments:	INT-15f - Gott faults Map from ML14171A818.pdf

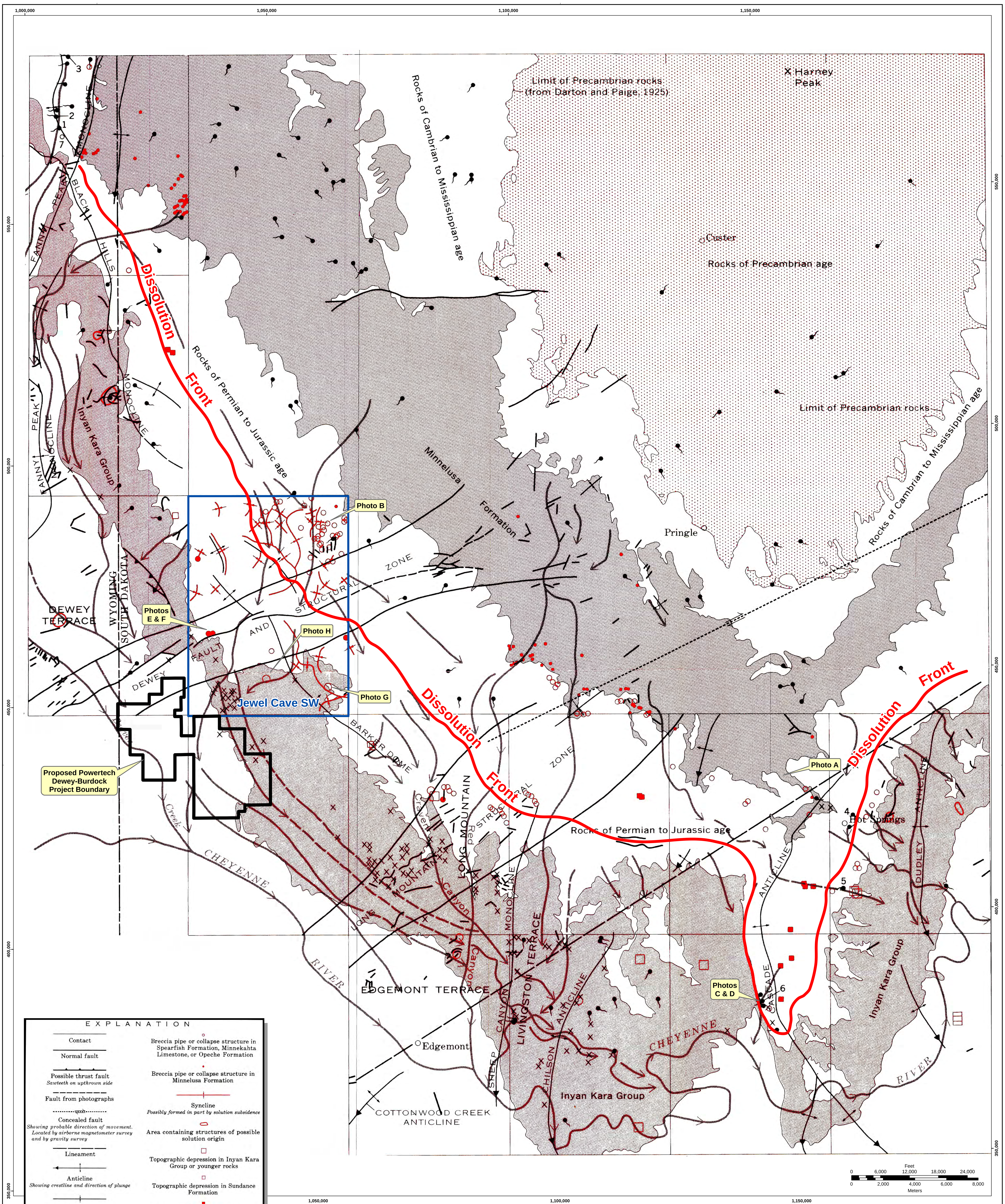
Email #2

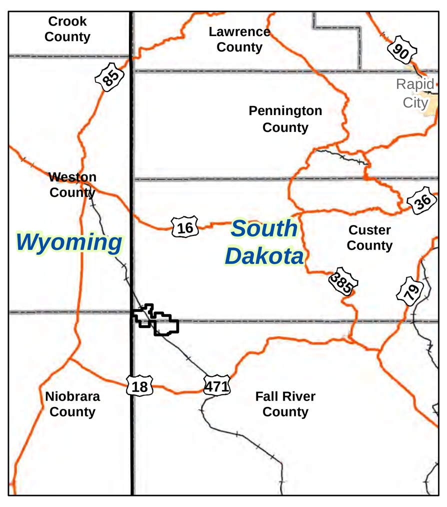
****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:36 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: Oglala Sioux Tribe Comment Attachments

Ms. Shea – in support of the comments submitted this day (June 19, 2017) by the Oglala Sioux Tribe, attached are supplemental documents. As there are several such documents, there are likely to be a series of emails to follow. Thank you.

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****





Base map and legend shows scanned images taken from:

Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits, Southern Black Hills, South Dakota and Wyoming, Geological Survey Professional Paper 763, prepared by Garland B. Gott, Don E. Wolcott and C. Gilbert Bowles, US Government Printing Office, 1974, Plate 4, Map Showing Major Tectonic Elements, Minor Fault and Solution Collapse Structures, Springs, Paleostreams, and Uranium Deposits in the Southern Black Hills, South Dakota and Wyoming.

CONSULTANT

REF 978

CHECK SCALES

If this bar does not measure 1 inch this map is not at its original scale

Arch E 36" x 48"

REVISIONS				
#	DRAWN	CHECKED	APPROVED	DATE

PLOT DATE 26-Jun-2013 | DATE 26-Jun-2013

DRAWN S. Hetrick | PDF FILE R978_BrecciaPipeUSGS763.pdf | COORDS NAD 27, South Dakota State Plane South (feet)

CHECKED James A. Bonner | CAD FILE P:\Dewey-Burdock\Submittals\Technical Report (TR)\June 2013 Revisions\BrecciaPipeUSGS763.mxd

POWERTECH (USA) INC.

Plate 2.6-15
Location of Breccia Pipes Proposed by USGS Professional Paper 763
Dewey-Burdock Project

089293

From:	Jeffery C. Parsons
To:	Shea, Valois
Cc:	"Roger Flynn"
Subject:	RE: Oglala Sioux Tribe Comment Attachments #3?
Date:	Monday, June 19, 2017 3:39:30 PM
Attachments:	NRC-016 letters from OST and SRST Feb 2014.pdf NRC-081 USGS report ML14172A086.pdf

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:37 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

Email #2

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:36 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: Oglala Sioux Tribe Comment Attachments

Ms. Shea – in support of the comments submitted this day (June 19, 2017) by the Oglala Sioux Tribe, attached are supplemental documents. As there are several such documents, there are likely to be a series of emails to follow. Thank you.

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
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****

Oglala Sioux Tribe

Office of the President

Pine Ridge Indian Reservation
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Pine Ridge, South Dakota 57770
Phone: 605.867.8420
Fax 605.867.6076
bryan@oglala.org

February 5, 2014

Haimanot Yilma
Project Manager
FSME/DWMEP/EPPAD/ERB
U.S Nuclear Regulatory Commission
Mail Stop: T8F05
(via email)

RE: Submittal of comments on draft Programmatic Agreement for the proposed Dewey-Burdock ISR uranium mining project

Dear Ms. Yilma,

This is in response to the NRC's request for comment on the draft Programmatic Agreement (PA) for the proposed Powertech Dewey-Burdock in situ leach (ISL) uranium mine. As you know, the Oglala Sioux Tribe has attempted to maintain a high level of involvement in the National Historic Preservation Act (NPHA) Section 106 consultation process through our Tribal Historic Preservation Office (OSTHPO), as well as the preparation of the National Environmental Policy Act (NEPA) environmental impact statement. Unfortunately, these processes have not been conducted in a manner that complies with the letter or spirit of either the NHPA or NEPA, resulting in the effective exclusion of several of the most impacted Tribes to which ascribe this proposed project area as traditional homelands. As such, the Oglala Sioux Tribe, as part of the Great Sioux Nation, continues to have serious unresolved concerns with the proposed project, and cannot concur in the Programmatic Agreement as drafted.

We request that NRC revisit its NEPA and NHPA compliance on this proposed project in order to fulfill its prior commitments, and legal obligations, to provide meaningful opportunities for the OSTHPO participation within both the NHPA consultation and NEPA review. Principal among the Tribe's concerns are those raised previously regarding the lack of a credible cultural resources survey that includes the entire project area of 10,580 acres. As repeatedly communicated in prior correspondence by the Oglala Sioux Tribe and others, while the Tribe remains willing and able to participate in such a process, it must be done in a credible manner, using proper methodologies and expertise. In addition, it states on page 3 of the draft PA indicates that the Tribe has "participated in the preparation of this PA", which is incorrect. On the contrary, representatives of the Tribe were merely on a November 15, 2013 webinar hosted by NRC for interested parties to review the draft PA prepared by the NRC, not with the OST. This is very misleading to anyone who reads this PA.

To date these cultural resources surveys, as well as the ones completed prior by archaeologists are not complete and the NRC and Powertech efforts to date have not provided sufficient resources nor incorporated sufficient THPO involvement to result in a credible product. The PA's repeated strong reliance on a prior "Class III" cultural survey is misleading at best, as that survey was conducted by Powertech consultants in 2008 and has been repeatedly criticized by the Tribe as incomplete, and even recognized by NRC Staff as insufficient. As the Staff explained when it issued the DSEIS, "it is working to facilitate a field survey of the Dewey-Burdock site in order to obtain additional information on historic properties. When the survey is complete, the Staff will supplement its analysis in the DSEIS and circulate the new analysis for public comment." NRC Staff's Answer to Contentions on Draft Supplemental Environmental Impact Statement, at 13. Indicative of the process thus far, this supplement to the draft SEIS never occurred. Instead, NRC Staff simply published a Final SEIS, with a selection of a proposed action and a purportedly complete cultural resource impact analysis, without providing the promised draft analysis in a NEPA context. It is a poor excuse for NRC to provide the Tribes and public an after-the-fact opportunity to comment on any cultural reviews outside of the NEPA process. NRC should rescind its statements in the PA that all effect determinations are considered "final" until all necessary information is collected and meaningfully reviewed within both the NEPA and NHPA processes.

In addition, the cultural resources survey findings conducted by the seven (7) participating Tribes have not been afforded to our Tribe for review. As we are to understand, only three (3) Tribes (Northern Arapaho Tribe, Northern Cheyenne Tribe, Cheyenne and Arapaho Tribes of Oklahoma) submitted their findings; however we have not seen those results for review. Additionally, there is a "Table. 1 Summary of Tribal Cultural Survey Activity and Participation during April-May 2013" received as an attachment that the field survey participating Tribes "examined approximately 95 percent of the entire project area within the license boundary". This brings to question how that claim can be true when only certain days were surveyed by those Tribes, and some for only three (3) days for the entire 10,580 acres.

Further compounding these problems is the PA's reliance on future analysis of the project area for cultural resources impacts and potential mitigation measures. Indeed, even the methodologies to be used for these future surveys and mitigation measure development are left without any specificity or clarification. Unspecified promises for Powertech to "provide funding to tribal representatives" to participate in future surveys is precisely the type of tactic that is partly to blame for the current problems with NRC's NHPA and NEPA processes. While some NHPA processes may be staged under certain circumstances, there is no compelling need to do so here, where proper surveys and analyses could be conducted and completed, albeit probably not on the applicant's preferred accelerated schedule. The applicant's preferred timeline for license approval should not supplant the need to ensure all data collection and analysis at the earliest possible time, as contemplated and required by both NEPA and the NHPA. The PA should not be finalized absent agreement with the Tribe on the methods and practices to be employed, and only those matters that truly cannot be accomplished beforehand should be left for the staged, future study and analysis.

We also remind you that there are two pending applications to the Environmental Protection Agency for underground injection control and plan for disposal of treated ISR processed fluids. Overall, the PA is not a document that the Tribe is comfortable signing at this stage. It fails to take account of the lack of a complete cultural resource survey to date and improperly and needlessly leaves significant data collection and analysis to future unspecified efforts, outside of the NEPA process. We continue to express our interest in fully engaging in the cultural resource analysis and protection processes related to this Project, and ask that NRC Staff abandon its current approach of prematurely finalizing its NEPA and NHPA documents until the proper steps can be taken to ensure a competent cultural resource impact review, as well as consideration for environmental concerns are met.

Sincerely,

Bryan V. Brewer/mrb

Bryan V. Brewer
President, Oglala Sioux Tribe

From:	Waste"Win Young
To:	Caverly, Jill; Yilma, Haimanot; Moore, Johari; Hsueh, Kevin; Goodman, Nathan; Melissa.Ryan@nrc.gove; Magwood, William; Mark.Sartorius@nrc.gov; Jamerson, Kellee; hluhman@louisberger.gov
Cc:	Russell Eagle Bear (reaglebear@yahoo.com); Ben Rhodd (brhodd1@yahoo.com); oglalathpo@goldenwest.net; Joyce Whiting (ostnrrapro@gwtc.net); Dennis Yellow Thunder (ostnrrafd@gwtc.net); Bryan@oglala.org; Steve Vance (stevev.crstpres@outlook.com); dianned@swo-nsn.gov; James Whitted (jmswhitted@yahoo.com); Tamara St John (tamara_stjohn@yahoo.com); jeddins@achp.gov; vhauser@achp.gov; Terence Clouthier
Subject:	SRST Comments
Date:	Thursday, February 20, 2014 12:27:38 PM
Attachments:	Final draft PA Dewey-Burdock SRST-THPO comments.doc

Good Morning,

It has come to my attention reading through the proposed programmatic agreements for Ross and Dewey Burdock how much tribal information, suggestions and critical issues raised by the tribes are purposefully being ignored and omitted. Initially, I did not want to bother you guys again because you are all aware of my sentiments but the gnawing disappointment of how you all have handled the Section 106 process under the NHPA is too overwhelming. (On another note, I seen a job opening for a Native American specialist to assist the NRC with Section 106 NHPA. That's such great news! I mean… In the meantime, 3 areas of historical, cultural and spiritual significance to our tribe will have been destroyed by NRC projects, but hey! At least you guys will get some guidance:)

I have attached comments for the proposed Dewey-Burdock PA to this email.

I am cautious to submit these knowing full well that the NRC has repeatedly ignored tribes who have historic, cultural and spiritual properties in proposed project areas.

Yesterday our office was told by Haimanot that other tribes are too scared to speak up in meetings or feel that their voice is not heard when Sioux tribes are present. I do not know which Sioux tribes she is referring to but I work for the Standing Rock Sioux Tribe—THPO. We will continue to hold federal agencies and call them out—including other tribes who attempt to bypass the federal regulations and smooth things over with false promises. For us, this is not about a ten thousand dollar pay check for three, five or ten days of work as what overwhelmingly happened on Dewey Burdock.

Another troubling incident is that the SD SHPO already received the letter to *concur* on eligibility determinations for Dewy Burdock in December 2013. In the meantime, tribes were sent a letter seeking comments on eligibility determination at that same time and tribal comments were due January 7, 2014. The SD SHPO issued their concurrence on Jan 14 2014. This was all done without tribe's knowledge. When SD state legislators hosted a meeting in Rapid City two weeks ago staff from the Oglala Sioux Tribe said that tribes were still involved in the Section 106 process. A SD legislator said that SD had already signed off on it, tribal concerns were fixed and that the NRC was issuing their permit for Dewey Burdock shortly.

This timeline was confirmed yesterday with the SD SHPO via telephone. If Section 106 is a federal process between agencies and tribes—why was the SD SHPO given a concurrence letter on eligibility determinations the same date that tribes were asked for comments on those determinations? Why would the NRC issue a permit for an incomplete process based on incomplete Section 106 identification results? Why would it base those results off of 3 reports issued from tribes out of 23 the NRC claims to consult with—although only 7 tribes went out? This is not majority rules. It does not take an environmental or cultural resource manager to see that this is wrong. This also needs to be clarified in the PA.

Yesterday Haimanot told our staff that there will be no new identification efforts for Dewey Burdock—which is contrary to what Commissioner Bill Magwood told the Oglala Sioux Tribe and the SRST last summer in Kyle, SD. [I have the exact date. Our legal department and a Tribal councilperson was present].

The PA for Dewey Burdock needs to be accurate. It needs to document tribal concerns. It needs to detail the unbalanced, unfair process that the tribes were up against. It needs to detail the incestuous relationship between the NRC and applicant Powertech. Powertech is calling the shots and because the NRC does not know how to implement Section 106 or has no clue how to work with tribes, it is responsible for the destruction of this spiritual, cultural and historical landscape.

It has been made very clear to us that the NRC wants these projects over and done with. They will continue to operate haphazardly to accomplish this.

YOUR PA NEEDS TO TELL THE TRUTH. The NRC did not consult with 23 tribes. That is like me saying that I sat down and met with the 500 NRC employees in Rockville last January when actually I sat in a room with 7 of you. Why would you willfully lie?

Just to make your PA and efforts look good and faithful? Dewey Burdock is an incomplete catastrophe that has an incomplete Section 106 process. Your sentiments are, “ Why are you guys the only tribe speaking up?” We have a spiritual, cultural and historical tie to this area. We are not one to take the money and move onto the next project. The SRST THPO tried to meet with the NRC in good faith and offer our comments. Yet you decided to listen to the applicant and offer $10,000.00 per tribe because the applicant didn’t like the idea of paying over $100,00.00 for the tribal identification survey. Our suggestions were ignored and instead, we were given pacifying promises of future collaboration.

The SRST is not your trustee. The tribal THPO’s are the Section 106 experts, more so than the applicants and their cultural resource contractors who are hired to write documents that you think fulfills your regulatory responsibility.

If you think we were going to take your $10,000.00 for an inept survey tantamount to a payoff and not fight for what is right and what is ours then I guess what you have heard from other tribes is true. We are overbearing when it comes to protecting our future generations’ land and water.

Thank you for your invitation to the Standing Rock Sioux Tribe inviting us to participate in Section 106 Consultation under the NHPA for Reno Creek. Due to the complete lack of confidence, bad faith and ill will that the Nuclear Regulatory Commission has shown towards the SRST as well as other tribes we will have to decline to participate in this consultation.

Please see our attached comments for the Dewey Burdock PA.

Wašté Wiŋ Young
Standing Rock Sioux Tribe
Tribal Historic Preservation Officer
(701)-854-8645 work
(701)-854-2138 fax

Final DRAFT

PROGRAMMATIC AGREEMENT
AMONG
U.S. NUCLEAR REGULATORY COMMISSION
U.S. BUREAU OF LAND MANAGEMENT
SOUTH DAKOTA STATE HISTORIC PRESERVATION OFFICE
POWERTECH (USA), INC.
AND
ADVISORY COUNCIL ON HISTORIC PRESERVATION
REGARDING THE
DEWEY-BURDOCK IN SITU RECOVERY PROJECT
LOCATED IN CUSTER AND FALL RIVER COUNTIES
SOUTH DAKOTA

Date 02-14-14

WHEREAS, the U.S. Nuclear Regulatory Commission (NRC) received an application from Powertech (USA), Inc. (Powertech or applicant) for a new radioactive source materials license to develop and operate the Dewey-Burdock Project (the undertaking) located near Edgemont, South Dakota in Fall River and Custer counties (Project) pursuant to the NRC licensing authority under the Atomic Energy Act of 1954 (AEA), 42 U.S.C. §§ 2011 *et seq.*; and

WHEREAS, NRC is considering issuance of a license for the Dewey-Burdock In Situ Recovery [ISR] Project pursuant to its authority under the Atomic Energy Act of 1954 (AEA), 42 U.S.C. §§ 2011 *et seq.* which makes the project an undertaking requiring compliance by NRC with Section 106 of the National Historic Preservation Act (NHPA), 16 U.S.C. § 470, and its implementing regulations (36 CFR § 800 (2004)); and

WHEREAS, if licensed, the proposed project will use an In Situ Recovery (ISR) methodology to extract uranium and process it into yellowcake at the Dewey-Burdock site; and

WHEREAS, the proposed project area consists of approximately 10,580 acres (4,282 ha) located on both sides of Dewey Road (County Road 6463) and includes portions of Sections 1-5, 10-12, 14, and 15, in Township 7 South, Range 1 East and portions of Sections 20, 21, 27, 28, 29, and 30-35 in Township 6 South, Range 1 East, Black Hill Meridian, (see Appendix A and Figure 1.0, for fuller description and a map of the project area); and

Comment [TC1]: This "project area" conflicts with statements made throughout the consultation process that the project area would be confined to the area of direct impacts (2k acres). The tribes were specifically told they could not survey the license boundary (10k acres) during meetings between June 2011 and August 2012 even though this was what the tribes felt was the proper area of potential effects (APE). Why is the project area now suddenly the entire license boundary when that was a major stumbling block during consultation for over one year? The NRC switched gears at the last moment and allowed for the tribes to access the entire 10,000+ acres with the caveat that they only had 10k dollars to work with and a restricted timeline of 1 month. There is no way a proper tribal survey could be conducted with those caveats but this is the ultimatum that was forced upon the tribes.

WHEREAS, under the terms of the General Mining Act of 1872 Powertech has filed Federal Lode mining claims and secured mineral rights on 240 acres [97 ha] of public lands open to mineral entry and administered by the U.S. Department of the Interior, Bureau of Land Management (BLM), and has the right to develop the mining claims as long as this can be accomplished without causing unnecessary or undue degradation to public lands and in accordance with pertinent laws and regulations under 43 CFR Subpart 3809; and

WHEREAS, review and approval of a Plan of Operations (POO) for the project that meets the requirements of 43 CFR Subpart 3809 by the BLM-South Dakota Field Office makes the project an undertaking requiring compliance by BLM with Section 106 of the NHPA, 16 U.S.C. § 470 and 36 CFR Part 800; and

WHEREAS, the BLM, by letter dated April 7, 2011, has designated the NRC as the lead agency for compliance with requirements of Section 106 of the NHPA regarding the Dewey-Burdock Project (ADAMS Accession No. ML11116A091) pursuant to 36 CFR § 800.2(a)(2) of the Section 106 regulations; and

WHEREAS, under the terms of the Safe Drinking Water Act, Powertech has submitted to the Environmental Protection Agency (EPA) two Underground Injection Control (UIC) Permit Applications for ISR uranium recovery and the disposal of treated ISR process fluids at the Dewey-Burdock site; the EPA will issue draft permit decisions that meet the requirements of UIC regulations found at 40 CFR Parts 124, 144, 146 and 147; and

WHEREAS, the NRC determined a phased process for compliance with Section 106 of the NHPA is appropriate for this undertaking, as specifically permitted under 36 CFR § 800.4(b)(2), such that completion of the evaluation of historic properties, determinations of effect on historic properties, and consultation concerning measures to avoid, minimize, or mitigate any adverse effects will be carried out in phases, as set forth in this Programmatic Agreement (PA) (see Appendix A for details); and

WHEREAS, the area of potential effects (APE) for the undertaking is the area at the Dewey-Burdock Project site and its immediate environs, which may be directly or indirectly impacted by construction and operation activities associated with the proposed project, as described in Appendix A; and

WHEREAS, Project activities may occur on lands outside the license boundary for the installation of electrical transmission lines, and will be addressed in accordance with Stipulations 3 and 4 of this PA; and

WHEREAS, in accordance with 36 CFR § 800.6(a)(1)(i)(C), the NRC, by letter dated April 24, 2013, notified the Advisory Council on Historic Preservation (ACHP) of the potential for adverse effects to historic properties from the undertaking and invited the ACHP to participate in Section 106 consultation and in the preparation of this PA; and

WHEREAS, the ACHP, by letter, dated October 28, 2013, formally entered the consultation; and

WHEREAS, the NRC initiated consultation with the South Dakota State Historic Preservation Officer (SD SHPO) on December 2, 2009 during a face-to-face meeting held in Pierre, South Dakota; and

WHEREAS, the NRC invited Powertech to participate in Section 106 consultation and preparation of this PA; and

WHEREAS, by letters dated March 19, 2010 (ML100331999) and September 8, 2010 (ML102450647), the NRC invited 23 federally-recognized Indian Tribes who may ascribe religious and cultural significance to historic properties that may be affected by the undertaking, including the Cheyenne and Arapaho Tribes of Oklahoma, the Cheyenne River Sioux Tribe, the Crow Nation, the Crow Creek Sioux Tribe, the Eastern Shoshone Tribe, the Flandreau Santee Sioux Tribe, the Fort Peck Assiniboine and Sioux Tribes, the Lower Brule Sioux Tribe, the Lower Sioux Indian Community, the Northern Arapaho Tribe, the Northern Cheyenne Tribe, the Oglala Sioux Tribe, the Omaha Tribe of Nebraska, the Pawnee Nation of Oklahoma, the Ponca Tribe of Nebraska, the Rosebud Sioux Tribe, the Santee Sioux Tribe of Nebraska, the Sisseton-Wahpeton Oyate, the Spirit Lake Sioux Tribe, the Standing Rock Sioux Tribe, the Three Affiliated Tribes (Mandan, Hidatsa & Arikara Nations), the Turtle Mountain Band of Chippewa Indians, and the Yankton Sioux Tribe (collectively referred to as Tribes), to each be a consulting party in the Section 106 process; and

Comment [HXY12]: EPA to revise this Whereas clasue later.

Comment [TC3]: Has the disposal method been determined? This was also a matter of contention in determining the APE for this project based on only surveying the direct effects.

Comment [TC4]: 36CFR800.14 (a) (1) requires the federal agency to consult with the public in the development of alternate procedures for Section 106 compliance. This allows for the public to have their input into the development of alternate procedures. Where is the documentation that this was ever conducted? 36CFR800.4 (2) also requires the federal agency to take into account the views of the tribes for a phased approach. The SRST-THPO has disagreed with the actions of the NRC since September of 2012. We disagree with the determinations of non-eligibility (TABLE 1) for any sites containing stone features. How is the NRC accounting for this in this PA and in their phased approach?

Comment [TC5]: Appendix A is not attached to any email for this PA. The SRST-THPO would like copies off all appendixes for this PA. It is impossible to make fully informed comments without the proper information being given to the tribes.

Comment [TC6]: This conflicts with the project area being licensed as pointed out in TC1 comment. Why is the NRC not considering the entire license boundary as the APE?

Comment [TC7]: A proper survey of the entire license boundary as the APE would have eliminated the need to develop this PA. The tribes pushed for this throughout 2011 and 2012 and were denied. The identification effort that was forced upon the tribes to accept could in no way properly document the sites given the time and money that was forced upon the tribe.

WHEREAS, the following 23 Tribes participated in consultation at varying levels with the NRC and BLM regarding the proposed Dewey-Burdock Project: the Cheyenne and Arapaho Tribes of Oklahoma, the Cheyenne River Sioux Tribe, the Crow Nation, the Crow Creek Sioux Tribe, the Eastern Shoshone Tribe, the Flandreau Santee Sioux Tribe, the Fort Peck Assiniboine and Sioux Tribes, the Lower Brule Sioux Tribe, the Lower Sioux Indian Community, the Northern Arapaho Tribe, the Northern Cheyenne Tribe, the Oglala Sioux Tribe, the Omaha Tribe of Nebraska, the Pawnee Nation of Oklahoma, the Ponca Tribe of Nebraska, the Rosebud Sioux Tribe, the Santee Sioux Tribe of Nebraska, the Sisseton-Wahpeton Oyate, the Spirit Lake Sioux Tribe, the Standing Rock Sioux Tribe, the Three Affiliated Tribes (Mandan, Hidatsa & Arikara Nations), the Turtle Mountain Band of Chippewa Indians, and the Yankton Sioux Tribe; and

WHEREAS, the NRC worked with consulting Tribes between November 2011 and October 2012 to develop an approach for identifying historic properties of cultural and religious significance to Tribes; the NRC conducted a face-to-face consultation focused on the identification of these properties in February 2012. Although several work plans for a Tribal survey were prepared and discussed by the consulting parties throughout 2012, the parties were unable to reach agreement on the scope and the cost of the Tribal survey (see Appendix B for details); and

WHEREAS, in October 2012, the NRC requested alternative approaches to conduct a field survey by a group representing all consulting Tribes and subsequently proposed opening the project area to all interested Tribes to complete the survey according to needs and interests, and with payments made to participating Tribes (see Appendix B for details); and

WHEREAS, the NRC offered all 23 consulting Tribes the opportunity to participate in a tribal field survey to identify properties of religious and cultural significance to them for the proposed Dewey-Burdock project ISR facility by letter dated February 8, 2013; and

WHEREAS, the following seven Tribes participated in the tribal field survey: the Northern Arapaho Tribe, the Northern Cheyenne Tribe, the Cheyenne and Arapaho Tribes of Oklahoma, the Crow Nation, the Santee Sioux Tribe, the Crow Creek Sioux Tribe, and the Turtle Mountain Band of Chippewa Indians as discussed in details in Appendix A; and

WHEREAS, surveys to identify historic properties have been completed for the project including Class III Archeological Surveys and tribal surveys to identify properties of religious and cultural significance; and

WHEREAS, the NRC received tribal survey reports with eligibility recommendations from the Northern Arapaho Tribe, the Northern Cheyenne Tribe, and the Cheyenne and Arapaho Tribes of Oklahoma, as well as field notes from the Crow Nation as discussed in Appendix A; and

WHEREAS, the NRC staff has reviewed and evaluated the results of the applicant's Class III archaeological surveys and tribal surveys in the development of its initial recommendations concerning eligibility of properties identified within the APE for the undertaking for inclusion on the National Register of Historic Places (NRHP) as presented in Appendix B; and

WHEREAS, the NRC has received concurrence from the SD SHPO on these eligibility determinations as discussed in Appendix B, eligibility determinations were also sent to the Tribes and requested a 30-day review and comment period; and

WHEREAS, the NRC invited each of the 23 consulting Tribes to participate in the development of this PA; and

Comment [TC8]: The applicant and their third-party consultant decided not to continue the discussions with the tribes by stating that further discussions would not be fruitful in an erroneous attempt to "move the project forward" in the 106 process. The applicant was unwilling to fund the project to a level that would have been acceptable to the tribes for proper identification efforts yet they funded all of the archaeological survey and evaluative testing with apparently no complaints. One of the main stumbling blocks was the definition of the APE between the tribes and federal agency and applicant.

Comment [TC9]: This request only came to the tribes due to the tribes not being intimidated by the NRC and their ultimatums. The NRC stated in September that if the tribes did not respond by a specified date that they would just move the process forward – echoing the words of the applicant and their third party consultant. The tribes pointed out that there is no provision for this within the regulation during the identification phase and that precipitated the "alternative approach" comments.

Comment [TC10]: The tribes were offered an ultimatum to either accept the proposal that would in no way properly identify sites of significance to them or be left out of the identification process. This is not a good faith effort to identify sites of significance to tribes. The proposal ignored the information gathered under 36CFR800.4 as to what is actually required to identify and instead the proposal amounted to just saying go drive around ... [1]

Comment [TC11]: This statement alone indicates that the identification process is incomplete for this project. The SRST-THPO objected to the approach adopted by the NRC as it in no way would properly document the sites in the license boundary in a manner consistent with Section 106.

Comment [TC12]: The SRST-THPO and other tribes have never been given the opportunity to identify sites of significance for their tribes in a manner consistent with their tribal identification efforts.

Comment [TC13]: 4 tribes providing comments on survey work somehow meets the standards of good faith effort? Almost three times that many were actively consulting since 2011 and their concerns for their sites are continuing to be ignored.

Comment [TC14]: The SRST-THPO disagrees with the recommendations made for the sites listed in Table 1. How will the NRC address our concerns as they are currently being ignored.

Comment [TC15]: The SRST-THPO is aware that the NRC submitted their eligibility determinations to the SD SHPO for concurrence on the same day that the tribes were asked to provide comments on eligibility in the 30 day window. How can the NRC imply that this was conducted in good faith? The SD SHPO issued their concurrence on Jan 14th, 2014.The ... [2]

WHEREAS, the following Tribes participated at varying levels in webinars and/or provided written comments during the preparation of this PA: Northern Cheyenne, Cheyenne River Sioux, Oglala Sioux, Standing Rock Sioux, Fort Peck Assiniboine and Sioux, and Cheyenne and Arapaho Tribes; (see Appendix B for list of participants) [TBD-include other tribes as necessary]; and

WHEREAS, each of the 23 consulting tribes will be invited to sign the PA as a Concurring Party; and

WHEREAS, the BLM, as a federal agency with a federal action related to this undertaking has participated in the Section 106 consultation and development of this agreement and will be a signatory; and

WHEREAS, the EPA has participated in discussions of this agreement; and

WHEREAS, the PA will be entered as a condition on the NRC license, if granted; and

WHEREAS, the PA will be entered as a condition of Powertech Inc.'s POO, if approved by the BLM; and

WHEREAS, Powertech, as the applicant for federal approvals has been invited to execute this agreement as an invited signatory in recognition of the responsibilities assigned to the applicant under the terms of this agreement;

NOW, THEREFORE, the NRC, BLM, SD SHPO, Powertech, and the ACHP agree that the undertaking will be implemented in accordance with the following stipulations in order to take into account the effects of the undertaking on historic properties.

STIPULATIONS:

NRC shall ensure that the following measures are carried out:

1) **Conditions for Federal Approval:**

~~i.~~a) The NRC will require that Powertech comply with all applicable stipulations and provisions of this PA, as a condition of the Powertech license for the Project.

~~ii.~~b) The BLM will ensure that a Record of Decision on an acceptable POO will not be signed until this PA has been executed by all required signatories.

~~iii.~~c) The NRC shall not grant a license to Powertech until all required signatories have executed this PA. Upon receipt of a fully executed PA, the NRC will issue the license provided that all other requirements for the license have been met.

2) **Identification and Evaluation of Historic Properties within the License Boundary:**

a) Appendix B provides information on the archaeological and Tribal cultural resource surveys and describes the historic properties identified within and adjacent to the boundary of the 10,580 acre project site. More than 300 cultural resources were identified.

Comment [TC16]: Why are the tribes not signatory parties?

Comment [TC17]: Please provide the non-acronym definition.

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Comment [TC18]: This whole PA appears to be developed for this entire purpose. The NRC is well beyond its stated timelines for issuance of the Dewey-Burdock license. This is documented by the fact that they stripped their Section 106 compliance out of their NEPA process due to not being able to conduct both within their stated timelines.

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Comment [TC19]: The SRST-THPO has not been provided with this information. Once again, the definition of the APE has changed from the direct effects to the licensed boundary.

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b) In consultation with SD SHPO and the Tribes, the NRC and BLM determined approximately 14 percent of identified sites are eligible for listing on the National Register of Historic Places (NRHP), 58 percent are not eligible, and 26 percent remain unevaluated.

*move oldstipulation 3(Future identification of Cultural Resources for Transmission Lines) to after Stipulation 6

3) Protection and Evaluation of Unevaluated Properties within the APE

a) Powertech will protect all unevaluated properties until an NHPA-eligibility determination is completed, in accordance with 36 CFR § 800.4(c)

b) If changes in the design or operation of the Project, including wellfield configurations, result in ground disturbance that could affect unevaluated properties, Powertech shall sponsor necessary supplemental research and/or field investigations prior to commencing any ground-disturbance activities. The additional studies will provide information to enable NRC, BLM, consulting Tribes, and the SD SHPO to make NRHP-eligibility determinations for unevaluated historic properties.

c) Powertech must provide a written plan of its investigation methodology at least four months prior to commencement of work, to enable the NRC and BLM to allocate staff resources for Section 106 reviews; additional review time may be necessary if NRC and BLM staff resources are limited or due to conditions beyond the staff's control.

d) The NRC will distribute the proposed investigation plan to the 23 consulting Tribes soon after it is received from Powertech.

e) Upon receipt of the Powertech investigation plan, the NRC, the BLM, consulting Tribes and the SD SHPO will have 30 days to review the proposed plan. If revisions to the plan are necessary, Powertech will circulate the revised investigation plan to the NRC, the BLM, consulting Tribes and the SD SHPO.

f) Upon approval of the investigation plan, Powertech will conduct supplemental research and/or field investigations to evaluate determine NRHP-eligibility of unevaluated cultural resources for NRC consideration. Testing will be conducted under the supervision of individuals meeting the Secretary of the Interior's Professional Qualifications Standards. The report shall follow documentation standards outlined in 36 CFR § 800.11

g) After the completion of any additional studies, the NRC will submit the findings of NRHP-eligibility evaluation to BLM, SD SHPO, and consulting Tribes, with a 45 day period of review and comment.

h) The NRC may request revisions to the reports or additional investigations after consideration of comments received from BLM, SD SHPO, and consulting Tribes. The NRC will provide revisions to BLM, SD SHPO, and consulting Tribes, with a 30 day period for a second review and comments.

i) The NRC will submit final determinations of NRHP-eligibility and effects to SD SHPO for review and concurrence; this review will be completed by the SD SHPO within 30 days.

Comment [TC20]: Which tribes were consulted?

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Comment [TC21]: How will Powertech be conducting this? Who will be conducting this evaluation. In particular, if the site is a site of significance to the tribes what assurances do the tribes have that they will be consulted for their expertise on their sites? The SRST-THPO is unagreeable with a private entity protecting our sites.

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Comment [TC22]: Who exactly will participate in this additional survey work? Will it just be the seven tribes who accepted the NRC forced identification requirements while ignoring the other 16 tribes who disagreed with this process.

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Comment [TC23]: This PA will take the tribes completely out of the consultation process according to this statement. Tribes have a right to comment on identification efforts per 36CFR800.2 yet this PA will take that right out of the tribes hands and put it squarely in the applicants hands. This was attempted by the applicant in the initial identification effort in August of 2011 when the NRC asked them to develop a plan for identification. That plan was unanimously disagreed to by every tribe ... [3]

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Comment [TC24]: This didn't work the last time this was planned and once again it is being proposed. It resulted in the NRC dividing ... [6]

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Comment [TC25]: The SRST-THPO is opposed to any testing of our sites of significance. We have stated this multiple ... [8]

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j) When the NRC, BLM, and SD SHPO agree evaluated properties are NRHP-eligible, avoidance of the properties will be the preferred option. Avoidance measures may include, but are not limited to the relocation of pipelines, roads, facilities, monitoring wells, and other disturbances. When avoidance is unavoidable and adverse effects will result, adverse effects will be resolved in accordance with Stipulation 6.

k) If the NRC, BLM, and SD SHPO make the determination that identified historic properties are not eligible for listing on the NRHP, no further review or consideration of the properties will be required under this PA.

l) When the NRC and the SD SHPO disagree on NRHP-eligibility for a cultural resource, the cultural resource cannot be avoided, or the disagreement is not resolved by further consultation, the NRC will refer the issue to the Keeper of the National Register (Keeper) and request a formal determination of eligibility, in accordance with 36 CFR § 800.4(c)(2). The ACHP may also request referral of an NRHP-eligibility determination to the Keeper.

4) **Assessment of Effects:**

a) As part of its consideration of the effects of construction and operations on the landscape, the NRC conducted a line-of-sight analysis to assess the potential for adverse visual effects on all known historic properties located within three miles of the tallest buildings on both the Dewey and Burdock facilities.

b) The NRC and BLM consulted with SD SHPO and consulting Tribes in making its determination that eligible or unevaluated archaeological sites and properties of religious and cultural significance will be adversely affected by the undertaking. The effects determination is presented in Appendix B Table 1.

c) The NRC and BLM will consult with signatories to this agreement and consulting Tribes to develop proposals to resolve these adverse effects (as summarized in Appendix B Table 2) in accordance with the process set forth in Stipulation 6.

5) **Resolution of Adverse Effects:**

a) The NRC will solicit suggestions from consulting parties concerning potential measures to avoid, minimize, or mitigate adverse effects on historic properties described in Appendix B after the PA is executed.

b) The NRC and BLM, in consultation with consulting parties, will determine what treatment measures are appropriate to each adversely affected historic property.

c) Treatment measures can include, but are not limited to the following:

i. For archaeological historic properties that are significant for their research data potential (Eligibility Criterion D, National Register of Historic Places), the treatment measures may follow standard mitigation through data recovery. Treatment plan(s) for data recovery shall include, at a minimum, a research design with provisions for data recovery and recordation, analysis, reporting, and curation of resulting collection and records, and shall be consistent with the *Secretary of Interior's Standards and Guidelines* (48 FR 44734-44737). Treatment plan(s) must be consistent with easement and permit requirements of other agencies, when applicable. To the extent

Comment [TC26]: Include "in consultation with the tribes" as the SRST-THPO currently disagrees with the eligibility determinations made thus far and since the PA is made to supplant the requirements of Section B of 36CFR800.

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Comment [TC27]: Include "in consultation with the tribes" as the SRST-THPO currently disagrees with the eligibility determinations made thus far and since the PA is made to supplant the requirements of Section B of 36CFR800.

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Comment [TC28]: What provisions exist within this document if the tribes disagree with the determinations? This is never addressed throughout the entire document and since the PA will fulfil the NRC responsibilities for Section 106 compliance, the SRST-THPO would like this explained further.

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Comment [TC29]: Please provide the details of how this will be conducted. The tribes ... [12]

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Comment [TC30]: Please provide the documentation for this statement.

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Comment [TC31]: This will require an amendment to the PA. The SRST-THPO ... [17]

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Comment [TC32]: This should be developed currently within this PA and not at some ... [19]

Comment [TC33]: These treatment plans do not take into account any specialized ex ... [21]

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possible, treatment plan(s) should group related sites and areas, so related resources can be considered in context, and to minimize the burden of review and approval by agencies.

ii. Treatment plan(s) for properties eligible under Criteria A, B and C, or significant for values other than their potential research value, if warranted, shall specify approaches for treatment or mitigation of the property in accordance with the principles, standards, and guidelines appropriate to the resource. This may include, but not be limited to, use of such approaches as relocating the historic property, re-landscaping to reduce effects, public interpretation, ethnographic recordation, oral history, archival research, or prescribing use of a component or activity of this undertaking in such a way as to minimize effects to historic properties. Methods of recordation and documentation described in the treatment plan(s) shall conform to the *Secretary of the Interior's Standards for Architectural and Engineering Documentation* (48 FR 44730-44734) or other standards specified by NRC.

iii. In lieu of standard mitigation approaches described above, treatment plan(s) may adopt other alternative approaches to avoid, minimize or mitigate effects to historic properties, including, but not limited to, assisting in the development of Tribal historic preservation plans, developing detailed historic contexts for the region, developing educational materials, purchasing properties containing historic resources, or developing historic property management plans.

d) Following the development of potential treatment measures by consulting parties, to avoid, minimize, or mitigate adverse effects, Powertech shall prepare a treatment plan for each affected historic property.

e) In conjunction with the submission of their Plan of Activities, which detail construction and operations activities, for each year, Powertech will submit one or more draft treatment plans. A draft plan will identify properties that will be affected that year and measures that will be taken to avoid, minimize, or mitigate those effects. A draft treatment plan will be submitted for NRC and BLM review and approval four months prior to construction, so the NRC and BLM can appropriately allocate staff resources to the extent possible; additional time may be necessary in the event that NRC and BLM staff resources are limited due to conditions beyond the staff's control.

i. The treatment plan shall contain a description of the effects on each adversely affected historic property and a description of the proposed treatment for each of those historic properties.

ii. If any of the affected properties are unevaluated for NRHP eligibility, the treatment plan shall include provisions for evaluation, consistent with Stipulation 4.

iii. If monitoring by a qualified archaeologist and/or Tribal monitor is part of the strategy for resolving or preventing adverse effects, the treatment plan shall include a Monitoring Plan. The objective of monitoring is to protect known sites from construction impacts, identify at the time of discovery any archaeological materials exposed during ground disturbance, and protect such resources from damage until the procedures for discoveries per Stipulation 9 are implemented.

iv. If data recovery is part of the strategy for resolving adverse effects, the treatment plan shall specify all details of the research design, field and laboratory work methodology

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Comment [TC34]: Why is Powertech developing this for the Federal agency? This was attempted before and it failed to address tribal concerns. Why does the NRC keep relying on applicants to fulfil their Section 106 responsibilities?

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Comment [TC35]: This statement contradicts the statements concerning avoidance previously in the document. It doesn't sound like avoidance is the preferred option with such a statement.

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Comment [TC36]: Who decides when a tribal monitor is necessary? Powertech does according to this document. Once again the NRC is letting the applicant call the shots for Section 106 compliance for this project.

Comment [TC37]: The SRST-THPO will reiterate that testing should not occur on any stone feature site.

(including mapping, geomorphological or other specialized studies, controlled scientific excavation methods, analyses of data recovered, and photographic documentation as appropriate), and report preparation.

f) Upon receipt of a draft treatment plan, the NRC will submit the draft treatment plan to all signatories and consulting Tribes for a 45 day review and comment period. The NRC will consider any comments received in writing from consulting parties within the specified review period.

g) The NRC may ask Powertech to revise the draft treatment plan based on comments received from the consulting parties. The NRC will forward revisions to the draft treatment plan with a request for a second review by all signatories and consulting Tribes within a 30 day period.

h) The NRC will then distribute the final treatment plan to SD SHPO for a 30 day review period, and copies of the plan will be distributed to consulting parties.

i) Upon concurrence by the SD SHPO, or if the SD SHPO does not respond in writing within 30 days, the NRC shall direct Powertech to implement the treatment plan.

j) If, after consultation, the NRC and the SD SHPO cannot agree on appropriate terms for the treatment plan, the NRC will refer the matter to the ACHP for comment pursuant to Stipulation 14. The NRC will consider ACHP comments in making its final decision on measures to resolve the adverse effects.

6) Future Identification of Cultural Resources for Installation of Power Transmission Lines in Areas to be Determined:

a) Powertech will notify the NRC and BLM in writing, if it determines that ground-disturbing activities will be required for the installation of electrical transmission lines outside the license boundary. Powertech must provide written notification at least four months prior to commencement of work, to enable the NRC and BLM to allocate staff resources for Section 106 reviews; additional review time may be necessary if NRC and BLM staff resources are limited or due to conditions beyond the staff's control.

b) Powertech must provide the NRC, the BLM, and the SD SHPO a proposed work plan for an archaeological survey as part of the written notification. The plan will include methods for identification of all kinds of cultural properties within the transmission line corridor, including identification of properties of religious and cultural significance with the involvement of the Tribes. The proposed plan should also include report preparation requirements and schedules for the identification efforts.

c) The NRC will distribute the proposed work plan to the 23 consulting Tribes soon after it is received from Powertech.

d) Upon receipt of the Powertech work plan, the NRC, the BLM, consulting Tribes and the SD SHPO will review and provide comments on the plan within 30 days. If necessary, Powertech will revise work plan according to the instructions of the consulting parties.

e) Upon NRC approval of the work plan, Powertech will conduct surveys to identify cultural resources along the transmission corridor within an appropriate APE. Powertech will also

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Comment [TC38]: The SRST-THPO has submitted numerous comments to the NRC that were subsequently ignored. Other tribes have also submitted comments that were ignored by the federal agency. The fact that only 7 of 23 tribes participated in the NRC ultimatum for identification is proof of this. What assurances do the tribes have that their comments v ... [23]

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Comment [TC39]: These surveys should be conducted now so that a federal tie is maintained to the project. The SRST-THPO is more than a little concerned that the apr ... [24]

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Comment [TC40]: The tribes did not accept the Powertech proposal for the initial survey at Dewey-Burdock yet this PA puts the onus on them again to develop this portion of it. ... [25]

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Formatted: Outline numbered + Level: 2 + Numbering Style: a, b, c, … + Start at: 1 + Alignment: Left + Aligned at: 0.31" + Indent at: 0.56" undertake necessary testing to determine NRHP-eligibility of newly identified properties for NRC consideration. Survey and testing will be conducted under the supervision of individuals meeting the Secretary of the Interior's Professional Qualifications Standards. The report shall follow documentation standards outlined in 36 CFR § 800.11.

f) Powertech shall offer to provide financial compensation to Tribal Representatives for the work on the identification of properties of religious and cultural significance. The identification of properties of religious and cultural significance will occur at the same time or prior to identification of archaeological properties.

g) The NRC will consult with the 23 consulting Tribes on identification of properties of religious and cultural significance. This consultation could include using an open site approach to identify and evaluate places of religious and cultural significance to the Tribes.

h) Upon receipt of Powertech's completed survey report, the NRC will submit the findings to the BLM, SD SHPO, and the Tribes for a review and comment period of 45 days.

i) The NRC may request revisions to survey reports or additional investigations, after consideration of comments made by BLM, SD SHPO, and Tribes. The NRC will provide revised documents to BLM, SD SHPO, and Tribes. A second review period of 30 days may be requested.

j) The NRC will submit final determinations of NRHP-eligibility and effects to the SD SHPO for review and concurrence; this review will be completed within 30 days of the SD SHPO receiving complete information. The NRC will circulate copies of this correspondence to the other consulting parties. NRC will consider any comments received within the 30 day time period.

k) When the NRC, BLM, and SD SHPO agree evaluated properties are NRHP-eligible, avoidance of the properties will be the preferred option. When avoidance is unavoidable and adverse effects will result, adverse effects will be resolved in accordance with Stipulation 6.

l) If the NRC, BLM, and SD SHPO make the determination that identified historic properties are not eligible for listing on the NRHP, no further review or consideration of the properties will be required under this PA.

m) When the NRC and the SD SHPO disagree on NRHP-eligibility of cultural resource and the cultural resource cannot be avoided, and the disagreement cannot not be resolved by further consultation, the NRC will refer the issue to the Keeper of the National Register (Keeper) and request a formal determination of eligibility, in accordance with 36 CFR § 800.4(c)(2). The ACHP may also request referral of an NRHP-eligibility determination to the Keeper. The decision of the Keeper is final.

7) Coordination with Other Federal Reviews:

In the event that the Powertech applies for additional approvals or other assistance from federal agencies for the undertaking and the undertaking remains unchanged, the approving agency may comply with Section 106 by agreeing in writing to the terms of this PA and notifying and consulting with SHPO and ACHP. Any necessary modifications to this PA will be in accordance with the amendment process in Stipulation 15

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Comment [TC41]: The SRST-THPO and other tribes opposed this approach and continue to do so. It should not be acceptable as the preferred option as will be the case. It has been demonstrated by the NRC that they will use it regardless of the protestations by the tribes furthering the disharmony among the tribes and the federal agency. The NRC used this approach for the Crow Butte facility without consulting the tribes for their feedback on such an approach. The disharmony created by the NRC in dividing the tribes continues to be felt accross the Indian Country today but the NRC does not care about the results of their actions as long as they can issue their permit ar ... [26]

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Comment [TC42]: Will the process be the same flawed process that involved submitting the eligibility for sites for concurrence to the SD SHPO on the same day as the request f ... [27]

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Comment [TC43]: What provisions will be in place if the tribes disagree on the eligibility?

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Comment [TC44]: This is highly subjective as the impacts from a new federal undertaking might be taken. A blanket statement such as this is inappropriate.

8) Confidentiality:

The NRC, BLM, and other parties to this agreement acknowledge the need for confidentiality concerning tribal spiritual and cultural information, which was or may be provided to the NRC and BLM during the consultation process. Information provided by consulted tribal representatives, which has been identified as sensitive and was accompanied by a request for confidentiality, will remain confidential to the extent permitted by state and federal laws.

All consulting parties shall restrict disclosure of information concerning the location or other characteristics of historic properties, including properties of religious and cultural significance to Tribes, to the fullest extent permitted by law in conformance with Section 304 of the NHPA, South Dakota Codified Laws (SDCL), § 1-20-21.2, Section 9 of the ARPA, and Executive Order on Indian Sacred Sites 13007 (61 FR 26771; May 29, 1996).

9) Unanticipated Discoveries:

In the event a previously unknown cultural resource is discovered during the implementation of the Dewey-Burdock Project, all ground disturbance activities shall halt within 150 feet of the area of discovery to avoid or minimize impacts until the property is evaluated for listing on the NRHP by qualified personnel. The following additional steps shall be taken:

a) Powertech will notify the NRC, the BLM (if the site is on BLM land), and the SD SHPO of the discovery within 48 hours. Unanticipated discoveries may include artifacts, bone, features, or concentrations of these materials outside previously identified sites or in and adjacent to previously identified eligible and not eligible sites. Discoveries may also include stones and groups of stones that are out of place in their sedimentary contexts and may be parts of stone features. A "discovery" may also include changes in soil color and texture, or content suspected to be man-made, such as burned soil, ash, or charcoal fragments.

b) The NRC and BLM (as appropriate) will contact the THPO and/or the Tribal Cultural Resource Office to notify them of an unanticipated discovery soon after notification from Powertech is received.

c) Powertech will have the discovery evaluated for NRHP eligibility by a professional who meets the Secretary of the Interior's Professional Qualifications Standards in Archaeology (36 CFR § 61).

d) Powertech will provide results of evaluation and initial eligibility recommendation to the NRC and BLM within ten business days of the discovery.

e) The NRC and/or BLM, in consultation with signatories and consulting Tribes, shall evaluate the cultural resources to determine whether they meet the NRHP criteria and request concurrence of the SD SHPO. Evaluation will be carried out as expeditiously as possible in accordance with 36 CFR § 800.13(b).

f) When the NRC, BLM, and SD SHPO agree evaluated properties are NRHP-eligible, avoidance of the properties will be the preferred option. When avoidance is unavoidable and adverse effects will result, adverse effects will be resolved in accordance with Stipulation 6.

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Comment [TC45]: Include" but are not limited to,"

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Comment [TC46]: What provisions will be included in this evaluation for sites of significance to tribes? The SRST-THPO has repeatedly commented about not testing sites of significance to the tribes.

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Comment [TC47]: What provisions will be put in place for the tribes to properly identify these properties that might have significance to the them to ensure that we can make informed decisions regarding the properties eligibility? Currently this PA process cuts the tribes from the process which has been the intent of the NRC and the applicant since September of 2012.

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Comment [TC48]: The statement is redundant. Change the first avoidance to property or change unavoidable to not an option. The SRST-THPO believes that sites will not be avoided as the preferred option as the applicant is once again calling the shots as it were for the federal agency.

g) If the NRC, BLM, and SD SHPO make the determination that identified cultural resources are not eligible for listing on the NRHP, no further review or consideration of the properties will be required under this PA.

h) Human remains identified during ground disturbance activities will be treated in accordance with Stipulation 10 and Appendix D.

i) In the event of unanticipated discovery, Powertech may continue to work in other areas of the site; however, ground disturbance activities shall not resume in the area of discovery until the NRC and BLM have issued a written notice to proceed.

10) Human Remains:

a) The NRC, BLM, and Powertech recognize human remains, funerary objects, sacred objects, and items of cultural patrimony encountered during ground disturbance activities should be treated with dignity and respect.

b) Native American human remains, funerary objects, sacred objects, or items of cultural patrimony found on BLM land will be handled according to Section 3 of the Native American Graves Protection and Repatriation Act (NAGPRA) and its implementing regulations (43 CFR §10). BLM will be responsible for compliance with the provisions of NAGPRA on Federal land.

c) Native American human remains, funerary objects, sacred objects, or items of cultural patrimony found on state or private land will be handled in accordance with applicable law as described in Appendix D – Treatment of Human Remains.

d) Non-Native American human remains found on federal, state, or private land will also be treated in accordance with applicable state law.

11) Disposition of Archaeological Collections:

a) BLM will curate artifacts, materials or records resulting from archaeological identification and mitigation conducted on BLM land at the Billings Curation Center, in accordance with the Billings Curation Center Packaging Requirements in accordance with 36 CFR § 79, "Curation of Federally-Owned and Administered Archaeological Collections." BLM will consult with Indian Tribes as required in 36 CFR § 79.

b) Where testing or excavation is conducted on private land, any recovered artifacts remain the property of the landowner. Powertech will return the artifacts to landowners. Powertech will encourage landowners to donate the artifacts to the SD Archaeological Research Center or a Tribal entity, in coordination with the NRC, SHPO, and participating Tribes. Where a property owner declines to accept responsibility for the artifacts and agrees to transfer ownership of the artifacts to SD Archaeological Research Center or Tribal entity, Powertech will assume the cost for curating the artifacts in a facility meeting the requirements of 36 CFR § 79, "Curation of Federally-Owned and Administered Archaeological Collections."

Comment [TC49]: Include "in consultation with the tribes" as we are being ignored throughout this PA.

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Comment [TC50]: What provisions will be in place if the tribes disagree with the agencies and SHPO determinations? None currently.

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Comment [TC51]: Please forward this appendix to the SRST-THPO. This document should not be signed until such time as all appendixes are attached.

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Comment [TC52]: Who will be making the determination that remains are non-native? All remains should be considered to be Native American until such time as they are proven otherwise.

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12) Qualifications:

All historic property identification, evaluation, and mitigation carried out pursuant to this PA shall be performed by or under the direct supervision of qualified individuals in the appropriate historic preservation discipline meeting, at a minimum, the appropriate standards set forth in 36 CFR § 61.

In recognition of the special expertise Tribal experts have concerning properties of religious and cultural significance, the standards of 36 CFR § 61 will not apply to knowledgeable, designated tribal representatives carrying out identification and evaluation efforts for properties of religious and cultural significance to Tribes.

13) Compliance Monitoring:

NRC affirms avoidance of adverse effects to historic properties remains the preferred course of action.

a) Powertech will ensure employees and/or contractors involved in all phases of the Project are aware of and comply with the requirements of the PA. Powertech may use measures such as initial orientation training, as well as pre-job briefings to inform employees and contractors of their responsibilities under the PA. Compliance with this PA is a condition of the NRC license and a condition of the BLM POO.

b) Prior to initiating construction activities, Powertech will develop a Monitoring Plan specific to the project, identifying specific areas, activities, and if appropriate, historic properties that require monitoring during development of the Project, ensuring the requirements of this PA and the treatment plans developed under the provisions of Stipulation 6 are met. The monitoring plan will include provisions for annual reporting of the results of the monitoring program to the signatories and the consulting Tribes to this PA.

i) Powertech will provide the Monitoring Plan to the NRC, which will distribute it to the signatories and consulting Tribes to this agreement for a 30 day review and comment period.

ii) The NRC will request that Powertech make any necessary revisions to the plan, and the revised Monitoring Plan will remain in effect for all covered ground-disturbing activities during the license period.

c) Powertech will engage the services of a Monitor with specific responsibilities to coordinate the requirements of the monitoring plan, the treatment plans, and this agreement during project construction.

i) The Monitor will meet the Secretary of the Interior's Professional Qualifications for Archaeology. Preference will be given to individuals meeting those qualifications who are employed by tribal enterprises, especially during phases of the monitoring program where sites with religious and cultural significance to the Tribes might be affected. In the case of an unanticipated discovery or imminent threat to an avoided historic property, the Monitor shall have authority to stop certain construction activities.

ii) The Monitor will coordinate with Powertech and its contractors during the construction phases of the Project.

d) Powertech will provide periodic updates to all consulting parties on the status of the monitoring program as specified in Appendix C.

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Comment [TC53]: Include "and eligibility determinations"

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Comment [TC54]: The plans developed thus far by Powertech have not been acceptable to the consulting tribes. Why does the NRC allow them to essentially make their decisions for them? This further enforces the widely held belief that Powertech is deciding the 106 process and not the federal agency.

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Comment [TC55]: This statement allows for the applicant to decide which areas need monitoring for the tribes. I'm unaware of any action from our chairman which allows Powertech to decide for the Standing Rock Sioux Tribe which sites we require monitoring on. Please provide this documentation to the SRST-THPO so that we may discuss the issue with our chairman. This statement alone demonstrates the lack of good faith consultation which the NRC has embarked upon with this and all of their projects. The SRST-THPO and all tribes should be involved in this process as our concerns for our sites are certainly different than that of an applicant who refused to negotiate with the tribes after August of 2012.

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Comment [TC56]: So Powertech is once again deciding who can monitor sites of significance to the Standing Rock Sioux Tribe. By tribal resolution that decision rests so ... [30]

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Comment [TC57]: Currently, there are very few archaeologists in the Great Plains who would meet those criteria and short of Powertech hiring Ben Rhodd there is no ... [32]

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14) Dispute Resolution: *formatting

Should any signatory to this PA object in writing to any actions proposed or to the manner in which terms of the PA are implemented, the NRC shall consult with the party to resolve the objection. When the NRC determines an objection cannot be resolved, the NRC will:

a) Forward all documentation relevant to the dispute, including the NRC proposed resolution, to the ACHP and send a copy to all other consulting parties. The ACHP shall provide NRC with its advice on the resolution of the objection within 30 days of receiving adequate documentation.

b) Within 30 days after receipt of all pertinent documentation, the ACHP shall exercise one of the following options:

   i. Advise the NRC that the ACHP concurs in the NRC proposed final decision, whereupon the NRC shall respond accordingly;

   ii. Provide the NRC with recommendations, which the NRC will consider in reaching a final decision on the objection;

   iii. Notify the NRC that the objection will be referred to the ACHP membership for formal comment and refer the objection to the ACHP membership for comment within 30 days. The NRC will consider comments in accordance with 36 CFR §800.7(c)(4);

   iv. Should the ACHP not exercise one of the above options within 30 days after receipt of all pertinent documentation, the NRC may proceed with its proposed response.

c) Prior to making a final decision on the dispute, the NRC will prepare a written response that addresses timely comments from signatories and consulting Tribes to the PA. The NRC will provide signatories, consulting Tribes, and the ACHP with a copy of its written response. The NRC may implement its final decision.

d) The NRC will consider recommendations and comments made by the ACHP that are related to the objection. NRC responsibilities under this Agreement, which are not the subject of the objection, shall remain unchanged

15) Amendment:

A signatory to this agreement may request that it be amended, whereupon the signatory parties will consult to reach a consensus on the proposed amendment. Concurring parties will be provided an opportunity to consult and comment on the proposed amendment. An amendment will be effective on the date the amended PA is signed by all of the signatories to this PA. If a required signatory does not sign the amended PA, the amendment will be void. The amendment shall be appended to this PA as an Appendix.

Any federal agency, including the EPA, may in the future decide to rely on this agreement in connection with satisfying its Section 106 responsibilities and, may join the agreement by adding its signature and circulating the amended agreement to the appropriate parties.

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Comment [TC58]: Will this be the same timely comments that were utilized in the eligibility determinations in which the tribes were given the information on the sites on the same day that the SD SHPO was asked to concur on the eligibility determination by the NRC?

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Comment [TC59]: Will the NRC be considering any comments made by the tribes in any disputes according to section 14?

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Comment [TC60]: So basically, if one signatory decides the amendment does not fit into their plans they can refuse to sign it and the amendment is voided. Who wrote this statement? This greatly favors the applicant in all amendment decisions. If they disagree with a proposed amendment that would impac ... [35]

Comment [TC61]: The SRST-THPO opposes this statement being included as each undertaking must follow through its own Section 106 process and not adopt the incorrect ... [36]

16) Termination:

a) Any Signatory to this PA may initiate termination by providing written notice to the other signatories of their intent. After notification by the signatory initiating termination, the remaining signatories shall have 30 days to consult to seek agreement on amendments or other actions that could address objections and avoid termination. If consultation fails, the termination will be effective after 30 days, unless all signatories agree to a longer period.

b) In the event the PA is terminated, the signatories will comply with any applicable requirements of 36 CFR § 800.4 through 800.7 with regard to the original undertaking covered by this PA.

17) Duration:

Implementation of the stipulations in this agreement must begin within five years from the date of its execution. During that time, the NRC may consult with the signatories and concurring parties to amend the agreement in accordance with Stipulation 16. The agreement will be in place until ten years from the day of execution or the termination of the license.

18) Anti-Deficiency Act:

The stipulations of this Agreement are subject to the provisions of the Anti-Deficiency Act (Pub.L. 97–258, 96 Stat. 923; 31 U.S.C. §1341, Limitations on expending and obligating amounts). If compliance with the Anti-Deficiency Act alters or impairs the ability of the NRC to implement this Agreement, the NRC will consult in accordance with the amendment and termination procedures in this Agreement.

Execution of this PA by the NRC, BLM, SD SHPO, ACHP, and Powertech and the implementation of its terms is evidence the NRC and BLM have taken into account the effects of this undertaking on historic properties and afforded the ACHP an opportunity to comment.

Signatories:

United States Nuclear Regulatory Commission

By:_______________________________ Date:______________
Title: Larry W. Camper, Director
Division of Waste Management and Environmental Protection

United States Bureau of Land Management

By:_______________________________ Date:______________
Title: Marian M. Atkins, South Dakota Field Manager

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Comment [TC62]: These sections were not followed in the original undertaking. What provisions will be in place to ensure that the same bad policies initiated by the NRC which resulted in division amongst the tribes which continues to this day will not just continue?

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Comment [TC63]: So what exactly will be followed during the intervening 5 years? There is no mention of what stipulation will be issued between the time the NRC licensed this project which will be the very same day they get this PA signed and 5 years from now when it must be enforced. Once again who wrote this section? It heavily leans in the favor of the applicant.

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Comment [TC64]: This statement is an outright fallacy and insulting to all of the tribes who participated in consultation with this project. In particular, with the tribes who objected to the ultimatum enforced identification effort endorsed by the NRC at the urging of third party consultants. The tribes who did not accept the forced ultimatum approach have never been afforded the opportunity to address our sites of significance within the license boundary in a manner consistent with the needs of our acceptable identification efforts even though Commissioner Magwood assured the SRST-THPO officer that they would be. PA's should not be used to circumvent responsibilities within the Section 106 process as they are being used in this project. It is extremely premature of the NRC and the ACHP to embark upon execution of a PA when there are still so many questions surrounding the original identification effort and eligibility determinations. The NRC has and continues to ignore the tribes by stating they will not reopen identification under any circumstances. We had our chance according to them. That chance would not have resulted in a meaningful identification process being employed. The consulting tribes sent their objections to the NRC. The NRC chose to adopt it as the only solution anyway further enforcing the view that this project is run by the ap ... [37]

South Dakota State Historic Preservation Office

By:___________________________________ Date:_______________
Title: Jay Vogt, State Historic Preservation Officer

Advisory Council on Historic Preservation

By:__ _______________________ Date:_______________
Title: John Fowler, Executive Director

Invited Signatories:

Powertech USA, Inc.

By:___________________________________ Date:_______________
Title:

Concurring Parties:

Cheyenne and Arapaho Tribes

By:___________________________________ Date:_______________
Title:

Cheyenne River Sioux Tribe

By: __________________________________ Date:_______________
Title:

Apsaalooke (Crow) Nation

By:___________________________________ Date:_______________
Title:

Crow Creek Sioux Tribe

By: __________________________________ Date:_______________
Title:

Eastern Shoshone Tribe

By:_________________________________ Date:_______________
Title:

Flandreau-Santee Sioux Tribe

By: _________________________________ Date:_______________
Title:

Fort Peck Assiniboine/Sioux

By:_________________________________ Date:_______________
Title:
Lower Brule Sioux Tribe

By:_________________________________ Date:_______________
Title:

Lower Sioux Tribe

By:_________________________________ Date:_______________
Title:

Northern Arapaho Tribe

By: _________________________________ Date:_______________
Title:

Northern Cheyenne Tribe

By:_________________________________ Date:_______________
Title:

Oglala Sioux Tribe

By: _________________________________ Date:_______________
Title:

Omaha Tribe of Nebraska

By:___________________________________ Date:________________
Title:

Pawnee Nation of Oklahoma

By: ___________________________________ Date:________________
Title:

Ponca Tribe of Nebraska

By:___________________________________ Date:________________
Title:

Rosebud Sioux Tribe

By: ___________________________________ Date:________________
Title:

Santee Sioux Tribe of Nebraska

By:___________________________________ Date:________________
Title:

Sisseton-Wahpeton Oyate Tribes

By: ___________________________________ Date:________________
Title:

Spirit Lake Tribe

By:___________________________________ Date:________________
Title:

Standing Rock Sioux Tribe

By: ___________________________________ Date:________________
Title:

Mandan, Hidatsa & Arikara Nation
Three Affiliated Tribes

By:___________________________________ Date:_______________
Title:

Turtle Mountain Band of Chippewa

By: __________________________________ Date:_______________
Title:

Yankton Sioux Tribe

By:___________________________________ Date:_______________
Title:

Page 3: [1] Comment [TC10]	Terence Clouthier	02/19/2014 12:37:00 PM

The tribes were offered an ultimatum to either accept the proposal that would in no way properly identify sites of significance to them or be left out of the identification process. This is not a good faith effort to identify sites of significance to tribes. The proposal ignored the information gathered under 36CFR800.4 as to what is actually required to identify and instead the proposal amounted to just saying go drive around where you want – stay for up to one month or leave after three days. That was essentially the proposal put before the tribes.

Page 3: [2] Comment [TC15]	Terence Clouthier	02/19/2014 4:16:00 PM

The SRST-THPO is aware that the NRC submitted their eligibility determinations to the SD SHPO for concurrence on the same day that the tribes were asked to provide comments on eligibility in the 30 day window. How can the NRC imply that this was conducted in good faith? The SD SHPO issued their concurrence on Jan 14th, 2014.The SRST-THPO did not even receive the documents until January 7th, 2014 and the comment review period was barely a week old. This rush to complete the PA and SEIS to issue a licence is not being conducted in good faith. The SRST-THPO has no confidence that our concerns would have been addressed by the NRC as they did not even wait to recieve any comments from tribes before asking for concurrence from SD SHPO. This amounts to token checkmarks by the federal agency and not good faith consultation. The SRST-THPO would require field visits to the sites to propoerly assess their eligibility per our tribal expertise.

Page 5: [3] Comment [TC23]	Terence Clouthier	02/20/2014 11:07:00 AM

This PA will take the tribes completely out of the consultation process according to this statement. Tribes have a right to comment on identification efforts per 36CFR800.2 yet this PA will take that right out of the tribes hands and put it squarely in the applicants hands. This was attempted by the applicant in the initial identification effort in August of 2011 when the NRC asked them to develop a plan for identification. That plan was unanimously disagreed to by every tribe who was consulting at that time for this project. Yet, the NRC is once again trying to limit the participation of tribes.

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Page 5: [6] Comment [TC24]	Terence Clouthier	02/18/2014 3:39:00 PM

This didn't work the last time this was planned and once again it is being proposed. It resulted in the NRC dividing the tribes against each other and this will be the case again for this project. The NRC attempted to mislead some tribes into accepting their proposal by misconstruing the participation level of other tribes. There has been no good faith effort for identification on this project for the tribes who did not accept the powertech handout forced upon them by the NRC. An ultimatum is not good faith.

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Page 5: [8] Comment [TC25]	Terence Clouthier	02/18/2014 3:42:00 PM

The SRST-THPO is opposed to any testing of our sites of significance. We have stated this multiple times in consultation yet our expertise for evaluating our sites is being ignored by this PA.

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Page 6: [12] Comment [TC29]	Terence Clouthier	02/19/2014 4:27:00 PM

Please provide the details of how this will be conducted. The tribes might have concerns not addressed by non-tribal personnel.

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Page 6: [17] Comment [TC31]	Terence Clouthier	02/18/2014 3:51:00 PM

This will require an amendment to the PA. The SRST-THPO is concerned that an agreement is not binding if it is not included in this PA. The NRC should resubmit the PA with the proposals included so that no additional ammendments or agreements are neccessary. This further enforces the view that this PA is not a good faith effort but is rather a rush to issue the license.

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Page 6: [19] Comment [TC32]	Terence Clouthier	02/20/2014 11:09:00 AM

This should be developed currently within this PA and not at some future date. Concerns for this are outlined in TC 27.

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Page 6: [21] Comment [TC33]	Terence Clouthier	02/19/2014 12:23:00 PM

These treatment plans do not take into account any specialized expertise of the tribes for evaluating our sites of significance which can also be eligible under Criteria A-D. The SRST-THPO objects to this treatment plan as currently planned as it over emphasizes the use of archaeologists and not tribal expertise.

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Page 8: [23] Comment [TC38]	Terence Clouthier	02/18/2014 4:02:00 PM

The SRST-THPO has submitted numerous comments to the NRC that were subsequently ignored. Other tribes have also submitted comments that were ignored by the federal agency. The fact that only 7 of 23 tribes participated in the NRC ultimatum for identification is proof of this. What assurances do the tribes have that their comments won't just be used to document " good faith " consultation without addressing them as is currently the case with the NRC for all of their projects

Page 8: [24] Comment [TC39]	Terence Clouthier	02/20/2014 10:38:00 AM

These surveys should be conducted now so that a federal tie is maintained to the project. The SRST-THPO is more than a little concerned that the applicant will argue against having to involve the federal agency if their is no demonstrable tie to the transmission lines for the issuance of the NRC permit or no BLM involved land and therefore no tribal involvement due to no Section 106 tie. Keystone XL utilized this same mauneuver. This represents a complete lack of understanding of the definition of APE according to the 36CFR800.16 (d) and was a huge stumbling block in the scope of work process throughout 2011 and 2012. The NRC's own failures at properly defining the APE helped to create the impasse so that they would attempt to move the process forward in their own words.

Page 8: [25] Comment [TC40]	Terence Clouthier	02/20/2014 11:13:00 AM

The tribes did not accept the Powertech proposal for the initial survey at Dewey-Burdock yet this PA puts the onus on them again to develop this portion of it. This will result in the same failures occuring once again with the vast majority of the tribes unable to participate in the identification efforts because it will not meet our required standards for identification efforts. Should a PA really be used to circumvent the 106 process with a flawed methodology that did not already work and enforce it? The SRST-THPO submits that it should not.

Page 9: [26] Comment [TC41]	Terence Clouthier	02/20/2014 11:14:00 AM

The SRST-THPO and other tribes opposed this approach and continue to do so. It should not be acceptable as the preferred option as will be the case. It has been demonstrated by the NRC that they will use it regardless of the protestations by the tribes furthering the disharmony among the tribes and the federal agency. The NRC used this approach for the Crow Butte facility without consulting the tribes for their feedback on such an approach. The disharmony created by the NRC in dividing the tribes continues to be felt accross the Indian Country today but the NRC does not care about the results of their actions as long as they can issue their permit and be done with the tribes they are happy to create this disharmony. Other federal agencies have followed this practice as well now that the NRC has created it.

Page 9: [27] Comment [TC42]	Terence Clouthier	02/19/2014 4:32:00 PM

Will the process be the same flawed process that involved submitting the eligibility for sites for concurrence to the SD SHPO on the same day as the request for comments on eligibility determinations to the tribes?

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Page 12: [30] Comment [TC56]	Terence Clouthier	02/20/2014 11:17:00 AM

So Powertech is once again deciding who can monitor sites of significance to the Standing Rock Sioux Tribe. By tribal resolution that decision rests solely with the SRST-THPO office and not with an outside agency or entity. We can provide this resolution.

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Page 12: [32] Comment [TC57]	Terence Clouthier	02/20/2014 11:18:00 AM

Currently, there are very few archaeologists in the Great Plains who would meet those criteria and short of Powertech hiring Ben Rhodd there is not a single one that can properly address Standing Rock Sioux Tribe concerns for our sites of significance. The SRST-THPO would have no confidence in any other archaeologist currently working on the Great Plains. Tribal monitors utilizing our specialized expertise must be employed in addition to any Secretary of the Interior Standards qualified personnel. We will accept monitors from the following tribes to address our concerns in addition to our own: Oglala Sioux Tribe, Cheyenne River, Rosebud Sioux Tribe, and Sisseton Wahpeton Oyate.

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Page 13: [35] Comment [TC60]	Terence Clouthier	02/20/2014 9:51:00 AM

So basically, if one signatory decides the amendment does not fit into their plans they can refuse to sign it and the amendment is voided. Who wrote this statement? This greatly favors the applicant in all amendment decisions. If they disagree with a proposed amendment that would impact their practices all they have to do is not sign it and it doesn't pass. This does not surprise the SRST-THPO as the NRC has been favoring the applicant and their timeleine since the inception of this project

Page 13: [36] Comment [TC61]	Terence Clouthier	02/20/2014 10:26:00 AM

The SRST-THPO opposes this statement being included as each undertaking must follow through its own Section 106 process and not adopt the incorrect and consitently terrible policies of the NRC to complete their Section 106 process. I'm surprised the ACHP would even consider this!

Page 14: [37] Comment [TC64]	Terence Clouthier	02/20/2014 11:24:00 AM

This statement is an outright fallacy and insulting to all of the tribes who participated in consultation with this project. In particular, with the tribes who objected to the ultimatum enforced identification effort endorsed by the NRC at the urging of third party consultants. The tribes who did not accept the forced ultimatum approach have never been afforded the opportunity to address our sites of significance within the license boundary in a manner consistent with the needs of our acceptable identification efforts even though Commissioner Magwood assured the SRST-THPO officer that they would be. PA's should not be used to circumvent responsibilities within the Section 106 process as they are being used in this project. It is extremely premature of the NRC and the ACHP to embark upon execution of a PA when there are still so many questions surrounding the original identification effort and eligibility determinations. The NRC has and continues to ignore the tribes by stating they will not reopen identification under any circumstances. We had our chance according to them. That chance would not have resulted in a meaningful identification process being employed. The consulting tribes sent their objections to the NRC. The NRC chose to adopt it as the only solution anyway further enforcing the view that this project is run by the applicants timeline and not any meaningful good faith effort. By endorsing this PA ; the ACHP is agreeing that a process whereby 4 tribes totalling 8 people were given two weeks to survey over 10,000 acres is a process that is acceptable under Section 106. This is unacceptable and unconscionable of the ACHP to agree to the execution of this PA knowing full well the issues that the tribes continue to have for this project and its identification and eligibility determination process.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
POWERTECH (USA) INC.	)	Docket No. 40-9075-MLA
(Dewey-Burdock In Situ Recovery Facility	)	
Source Materials License Application)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **Email of the Standing Rock Sioux Tribe Sent to Commissioner William Magwood and Others** have been served upon the following persons by Electronic Information Exchange, and by electronic mail as indicated by an asterisk*****.

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[Original signed by Clara Sola]
Office of the Secretary of the Commission

Dated at Rockville, Maryland,
this 28th day of February 2014.

Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits, Southern Black Hills, South Dakota and Wyoming

GEOLOGICAL SURVEY PROFESSIONAL PAPER 763

Prepared on behalf of the
U.S. Atomic Energy Commission

Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits, Southern Black Hills, South Dakota and Wyoming

By GARLAND B. GOTT, DON E. WOLCOTT, *and* C. GILBERT BOWLES

GEOLOGICAL SURVEY PROFESSIONAL PAPER 763

Prepared on behalf of the
U.S. Atomic Energy Commission

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1974

UNITED STATES DEPARTMENT OF THE INTERIOR

ROGERS C. B. MORTON, *Secretary*

GEOLOGICAL SURVEY

V. E. McKelvey, *Director*

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ILLUSTRATIONS

[Plates are in pocket]

TABLES

STRATIGRAPHY OF THE INYAN KARA GROUP AND LOCALIZATION OF URANIUM DEPOSITS, SOUTHERN BLACK HILLS, SOUTH DAKOTA AND WYOMING

By Garland B. Gott, Don E. Wolcott, and C. Gilbert Bowles

ABSTRACT

The Inyan Kara Group in the southern Black Hills consists of the Lakota and Fall River Formations of Early Cretaceous age. The Lakota Formation constitutes approximately the lower two-thirds of the Inyan Kara Group, and the Fall River Formation constitutes approximately the upper one-third. The rocks are of continental origin and were deposited under variable depositional environments, resulting in a sequence of many rock units, each composed of several facies.

The Lakota Formation is composed of the Chilson, Minnewaste Limestone, and Fuson Members and ranges in thickness from 200 to 500 feet. The Chilson Member is composed largely of fluvial deposits that can be divided into two major units, which have been designated fluvial units 1 and 2.

The Minnewaste Limestone Member locally overlies the Chilson Member in the southern Black Hills but is not known to exist elsewhere.

From east to west the Fuson Member successively overlaps the Minnewaste Limestone Member and both units of the Chilson Member. At places this overlap brings the Fuson Member in contact with the Morrison Formation. The member is composed of red, green, and gray siltstone and mudstone that locally interfingers with a sandstone designated as fluvial unit 3. After deposition of the fine-grained siltstone and mudstone, deep channels were eroded and then filled with a fluvial sandstone, designated fluvial unit 4.

The Fall River Formation is composed of a heterogeneous group of rocks that ranges in thickness from 100 to 160 feet. Laminated carbonaceous siltstones and fine-grained sandstones are abundant in the lower part of the formation. These siltstones and sandstones are truncated by a thick crossbedded fluvial sandstone, designated fluvial unit 5. Fluvial unit 5 grades laterally into a fine-grained facies composed of tabular beds of alternating sandstone, siltstone, and mudstone. The upper part of the Fall River Formation is composed of a variegated mudstone 20–25 feet thick overlain by a sandstone similar to that in fluvial unit 5. This sandstone also grades laterally into a fine-grained facies.

Petrographic studies indicate that the Unkpapa Sandstone of Jurassic age and sandstones in the overlying Inyan Kara Group are orthoquartzites and feldspathic orthoquartzites derived mainly from preexisting sedimentary rocks. Sandstones of each fluvial unit of the Inyan Kara are identifiable by a characteristic mineral assemblage. Mineral assemblages of fluvial units 1 and 2 of the Chilson Member of the Lakota Formation are derived primarily from older sedimentary rocks and contain relatively little angular detrital material from igneous and metamorphic rocks which cropped out east and southeast, whereas the mineral assemblage of fluvial unit 5 of the Fall River Formation contains a significantly larger proportion of this material. Mineral assemblages of fluvial units 3 and 4 of the Fuson Member represent transitional assemblages having a smaller proportion of rounded grains from sedimentary rocks than the Chilson Member but a larger proportion than the Fall River Formation. The shape and orientation of the fluvial units and the direction of dip of the crossbeds within the sandstones indicate that the sandstones were deposited principally by streams flowing northwestward. It seems likely that most of the detritus that composes the Inyan Kara rocks was derived from areas southeast and southwest of the Black Hills.

The Black Hills uplift of Laramide age is an elongate northwest-trending dome about 125 miles long and 60 miles wide. Precambrian igneous and metamorphic rocks are exposed in the central part of the uplift, and outward-dipping Paleozoic and Mesozoic rocks form cuestas and hogbacks around the central core. Folds constitute the major structural features, and faults, which generally have less than 100 feet of displacement, are secondary features. In Early Cretaceous time minor deformation along concealed northeast-trending structures of Precambrian age affected the courses of the northwest-flowing consequent streams and their tributaries, thereby influencing the location of the fluvial sandstone deposits of the Inyan Kara Group. The recurrent deformation along the northeast-trending structures, both during and after the Early Cretaceous, also fractured the Paleozoic and Mesozoic rocks and indirectly contributed to the formation of collapse structures and breccia pipes of Tertiary to Holocene age.

The Laramide uplift of the Black Hills caused the dome to be breached by erosion, resulting in ground-water recharge of the Englewood, Pahasapa, and Minnelusa Formations of Devonian to Permian age and ground-water movement down the flanks of the dome. Artesian water ascended along fractures in these aquifers and dissolved evaporites in the Minnelusa Formation. Collapse of beds overlying the evaporite zone resulted in subsidence breccias and breccia pipes that extend upward to the Inyan Kara Group. This same process continues today at the margin of the Black Hills. The breccia pipes constitute part of a "plumbing" system through which artesian waters transported low concentrations of uranium into formations of the Inyan Kara where sandstone-uranium deposits were formed.

Uranium is introduced into the Inyan Kara with the artesian recharge of calcium sulfate type water from the Minnelusa. As this water migrates downdip, it is modified by ion exchange and sulfate reduction to either a sodium sulfate or a sodium bicarbonate type water, causing an increase in

pH values and a decrease in Eh values. Reduction of sulfate ions in the ground water was a major factor in creating a favorable environment for the precipitation of uranium.

Other factors that affect localization of the uranium deposits pertain to the concentration of metals in the ground water and to the rate of ground-water flow. Oxidation of uranium deposits near the Inyan Kara outcrop may locally increase the concentration of uranium in the ground water and thereby increase the volume of uranium transported to the site of deposition. The distribution of the fluvial sandstones directly affects the rate of ground-water flow and, therefore, the volume of transported uranium.

INTRODUCTION

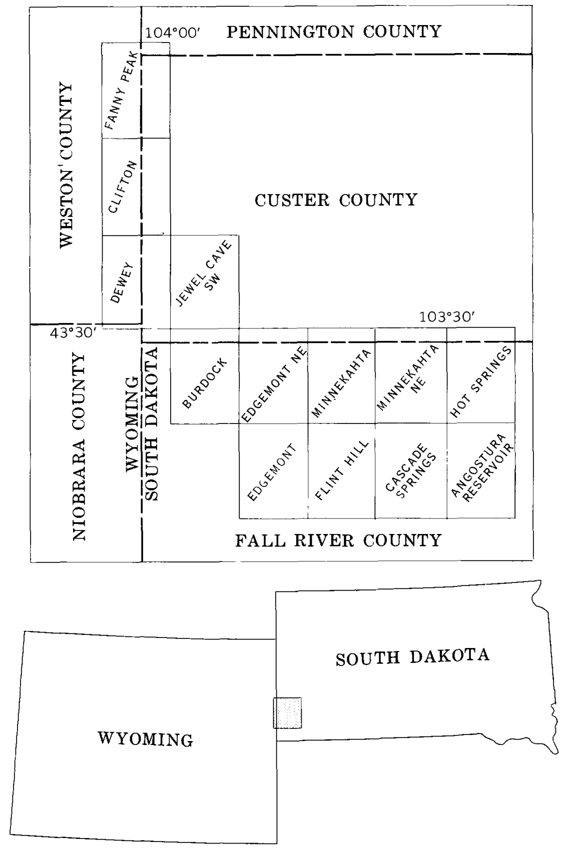
In 1951 uranium was discovered in the southern Black Hills by Jerry G. Brennan of Rapid City, S. Dak. (Page and Redden, 1952). This discovery caused an influx of prospectors and mining companies into the area, resulting in the rapid discovery of many small carnotite-type uranium deposits.

Although the reconnaissance geology had been mapped by N. H. Darton and published in several reports during the first decade of this century, more detailed geology was needed as an aid in prospecting for the uranium deposits. For this reason a program of detailed geologic investigations was carried out from 1954 through 1958 by the U.S. Geological Survey on behalf of the Division of Raw Materials of the U.S. Atomic Energy Commission. The principal objectives of the investigations were to determine the relation of the deposits to their geologic and geochemical environments and to determine criteria that would be useful in the exploration for concealed deposits.

As a result of these investigations thirteen 7½-minute quadrangles, as shown in figure 1, were mapped and described in detail by Wilmarth and Smith (1957a–d), Brobst (1961), Wolcott, Bowles, Brobst, and Post (1962), Brobst and Epstein (1963), Connor (1963), Gott and Schnabel (1963), Schnabel (1963), Braddock (1963), Cuppels (1963), Ryan (1964), Wolcott (1967), Post (1967), and Bell and Post (1971).

This report summarizes information about the stratigraphy, petrography, and factors affecting localization of ore deposits in the formations of the Inyan Kara Group discussed in detail in the reports listed in the preceding paragraph. In addition, unpublished information about the stratigraphy of the Minnekahta quadrangle and unpublished maps of the Runge mine by V. R. Wilmarth, formerly with the U.S. Geological Survey, were utilized.

The quadrangle geologic maps have been recompiled at a reduced scale on plate 1, which represents an area extending from Hot Springs, S. Dak., northwestward around the periphery of the Black Hills



Quadrangle	*Reference*
Fanny Peak	Brobst and Epstein (1963).
Clifton	Cuppels (1963).
Dewey	Brobst (1961).
Jewel Cave SW	Braddock (1963).
Burdock	Schnabel (1963).
Edgemont NE	Gott and Schnabel (1963).
Minnekahta:	
West-central part	Wilmarth and Smith (1957a).
East-central part	Wilmarth and Smith (1957b).
Southeast part	Wilmarth and Smith (1957c).
Southwest part	Wilmarth and Smith (1957d).
Minnekahta NE	Wolcott, Bowles, Brobst, and Post (1962).
Hot Springs	Wolcott (1967).
Edgemont	Ryan (1964).
Flint Hill	Bell and Post (1971).
Cascade Springs	Post (1967).
Angostura Reservoir	Connor (1963).

FIGURE 1.—Index map showing 7½-minute quadrangles mapped that contain rocks of the Inyan Kara Group in the southern Black Hills.

nearly to Newcastle, Wyo. A restored cross section (pl. 1, north half), constructed from the detailed maps and from many measured sections in the 13 quadrangles, summarizes the stratigraphic relations published elsewhere.

The Inyan Kara rocks of Early Cretaceous age are the ore-bearing formations. These rocks were deposited in varying continental environments, resulting in a sequence of diverse rock units, each composed of several facies. The stratigraphic complexities are such that it was necessary to map the beds in considerable detail before the sedimentary history could be determined. Other detailed studies were required to evaluate the effects of the Inyan Kara stratigraphy and structure on the problems of ore localization.

STRATIGRAPHY OF THE INYAN KARA GROUP

The Inyan Kara Group of Early Cretaceous age is composed of the Lakota and Fall River Formations. The Lakota Formation is 200–500 feet thick and makes up about the lower two-thirds of the group. The formation is composed of a diverse sequence of deposits laid down in streams, flood plains, lakes, and swamps. The Fall River Formation is 100–160 feet thick and makes up the upper one-third of the group. It is largely composed of a heterogeneous sequence of fluvial sandstones, siltstones, and mudstones. In the western part of the mapped area the Lakota Formation is underlain by the Morrison Formation of Jurassic age, but in the eastern part of the area it is underlain by the Unkpapa Sandstone, a formation thought to be equivalent in age to the Morrison (Imlay, 1947). The Fall River Formation is overlain by the Lower Cretaceous Skull Creek Shale.

Darton (1901) established, in ascending order, the names Lakota Formation, Minnewaste Limestone, Fuson Shale, and Dakota Sandstone for the sequence of rocks here referred to as the Inyan Kara Group. Later, Russell (1928) discovered that Darton's Dakota Sandstone was older than the type Dakota, and he changed the name from Dakota Sandstone to Fall River Formation. Rubey (1931) later assigned the Lakota Formation, the Fuson Shale, and the Fall River Formation to the Inyan Kara Group. As a result of a recent study of the Inyan Kara stratigraphy in the Black Hills, Waagé (1959) proposed that a twofold division of the Inyan Kara Group be established, with the lower part called the Lakota Formation and the upper part called the Fall River Formation. He further proposed that the boundary between the Fall River and the Lakota Formations be placed at a transgressive disconformity that can be recognized throughout the Black Hills region. He reduced the Fuson Shale and the Minnewaste Limestone to member status within the Lakota.

Detailed mapping subsequent to Waagé's (1959) regional stratigraphic studies has indicated that the pre-Fuson Lakota rocks, or the pre-Minnewaste rocks where the Minnewaste is present, are composed of two complex fluvial units, each predominantly composed of channel and flood-plain facies. These two units were called the Chilson Member by Post and Bell (1961). In some places in the Elk Mountains in the Clifton quadrangle, the Chilson Member is absent, and rocks of Fuson age apparently rest on the Morrison Formation (pl. 1, north half). Thus the Fuson Member rests on progressively older rocks from east to west, and its lower contact must locally represent a major hiatus.

While mapping in the southern Black Hills, we found the following informal terminology for the major fluvial units within the Inyan Kara Group to be useful. This terminology includes fluvial units 1 and 2 in the Chilson Member, 3 and 4 in the Fuson Member, and 5 and 6 in the Fall River Formation. Because of the interest in the uranium deposits in the area, many of the maps were published in preliminary form soon after their completion. Later it was found that some of the numbered units on these maps were of no regional significance and that the implied age relations of others were incorrect. These discrepancies and the current designation of the various numbered units are shown in table 1.

LAKOTA FORMATION

The lower part of the Lakota Formation is composed largely of fluvial deposits. These can be divided into two major units, designated fluvial units 1 and 2 (pl. 1, north half), which together are equivalent to the Lakota Sandstone of Darton and Paige (1925) and which Post and Bell (1961) included within the redefined Lakota Formation as the Chilson Member. Unit 1, the oldest, is present throughout most of the area between lower Chilson Canyon and the Elk Mountains (pl. 1). Unit 2, which overlaps unit 1, is present in the area between Hot Springs and Craven Canyon and in the southern part of the mapped area. It is thickest in the vicinity of Cascade Springs.

In the vicinity of Hot Springs and Cascade Springs, the Minnewaste Limestone Member, of lacustrine origin, overlies the Chilson Member (pl. 1). Between the Cascade Springs area and the northern part of the Burdock quadrangle, the limestone is present as small isolated patches, but it has not been found farther to the northwest.

Three units within the Fuson Member are shown on the geologic map (pl. 1). The most widespread unit is composed of red, green, and gray siltstone and mudstone, probably of lacustrine origin. Highly polished chert and quartzite pebbles, some of which contain Paleozoic fossils, are sparsely distributed throughout this unit. In the Pass Creek and Elk

TABLE 1. — *Unit designations*

[Lithologies of units are described on map explanations of previously published unit designations does not necessarily imply correlation between

AREA ---		FANNY PEAK QUADRANGLE	CLIFTON QUADRANGLE	DEWEY QUADRANGLE			JEWEL CAVE SW QUADRANGLE	BURDOCK QUADRANGLE			EDGEMONT NE QUADRANGLE			EDGEMONT QUADRANGLE	MINNEKAHTA QUADRANGLE	
Source of data ---		1	2	3		4	5	6		7	8		9	10	11	
Fall River Formation	Upper unit	Kfums	Kfums		ms	Kfums	Kfums		sm m$_6$	Kfusm Kfum		sm s$_6$,s m$_5$	Kfusm Kfus Kfum	Kfusm Kfus$_6$ Kfum		
	Middle unit	Kfml Kfms$_5$	Kfms$_5$ Kfmsm Kfmm	Kfr	s$_5$	Kfms$_5$	Kfms$_5$ Kfmsm Kfmm	Kfr	s$_5$ sm	Kfms$_5$ Kfmsm	Kfr	s,s$_6$ sm ss	Kfms$_5$ Kfmsm Kfmss	Kfms$_5$ Kfmsm	Kfr	sm s$_5$,s
	Lower unit	Kflss	Kflss		st	Kflst	Kflst		ss s	Kflss Kfls		ss	Kflss	Kflss		m
Lakota Formation	Fuson Member	Klfm Klfs$_3$	Klfm Klfs Klfs$_3$		s ms s,sm s$_1$	Klfs$_4$ Klfm Klfs Klfs$_3$	Klfs$_4$ Klfm Klfs Klfd Klfs$_3$		m s$_4$ m s$_3$ 2a	Klfm$_4$ Klfs$_4$ Klfm Klfs Klfs$_3$		m s$_4$ m s$_3$	Klfm$_4$ Klfs$_4$ Klfm Klfs	Klfs$_4$ Klfm Klfs		s$_4$ ss,s
	Minnewaste Limestone Member			Kfl				Kfml	l	Klm	Kfml	l	Klm		Kfml	
	Chilson Member	Klcs$_1$ Klcst	Klcs$_1$ Klcst		s$_1$ m	Klcs$_1$ Klcm	Klcsm$_1$ Klcms$_1$ Klcs$_1$ Klcst$_1$		s$_1$ sm	Klcs$_1$ Klcsm$_1$		m s m s$_1$ sm,m sm	Klcs$_2$ Klcm$_2$ Klcm Klcs$_1$ Klcsm$_1$ Klcsh	Klcs$_2$ Klcm Not exposed		s,s$_1$ m,sm,ss sm,m s$_1$,s sm

SOURCE OF DATA

1. Brobst and Epstein (1963, pl. 25).
2. Cuppels (1963, pl. 23).
3. Brobst (1958a, b).
4. Brobst (1961, pl. 5).
5. Braddock (1963, pl. 20).
6. Schnabel (1958); Schnabel and Charlesworth (1958 a, b, c, d).
7. Schnabel (1963, pl. 17).
8. Gott and Schnabel (1956a, b, c, d, e, f).
9. Gott and Schnabel (1963, pl. 12).
10. Ryan (1964, pl. 27).
11. Wilmarth and Smith (1957a, b, c, d).
12. Bell and Post (1957a, b, c, d, e, f).
13. Bell and Post (1971, pl. 32)
14. Wolcott, Bowles, Brobst, and Post (1962).
15. Post and Cuppels (1959a, b); Post and Lane (1959a, b); Post (1959a, b).
16. Post (1967, pl. 29).
17. Connor (1963, pl. 11).
18. Wolcott (1967, pl. 28).
19. Mapel and Gott (1959).

Mountains area a conglomeratic sandstone designated as fluvial unit 3 interfingers with the basal Fuson mudstones, and is included within the Fuson Member. This sandstone rests successively on fluvial unit 1, on the Morrison Formation, and locally on the Redwater Shale Member of the Sundance Formation. After the variegated mudstones of the Fuson were deposited, they were locally dissected by pre-Fall River erosion, and the channels were filled with a medium- to coarse-grained sandstone. This sandstone has been included within the Fuson Member and designated as fluvial unit 4.

In addition to the three units just mentioned, other sandstones occur locally. The scale of the geologic map is so small that these units cannot be shown; their presence is indicated only on the cross section (pl. 1).

Several erosional unconformities extend throughout the southern Black Hills. (1) The sandstone facies of fluvial unit 1 seems to be unconformable with the underlying black fissile Lakota shale, mapped as part of fluvial unit 1, or with the underlying Morrison Formation. (2) The contact between fluvial units 1 and 2 is almost everywhere within the *of the Inyan Kara Group*

U.S. Geol. Survey reports and on plate 1 of the present report. Position of quadrangles. Crosshatch pattern indicates rock unit is absent]

FLINT HILL QUADRANGLE			MINNEKAHTA NE QUADRANGLE	CASCADE SPRINGS QUADRANGLE			ANGOSTURA RESERVOIR QUADRANGLE		HOT SPRINGS QUADRANGLE	SOUTHERN BLACK HILLS	SOUTHERN BLACK HILLS				
12		13	14	15		16	17		18	19	Present report (pl. 1)				
Kfr	sm	Kfust		Kfr		Kfuss	Kfsm		Kfus	Siltstone, sandstone, mudstone, and shale	Kfus$_6$	Fluvial unit 6	Upper unit		Fall River Formation
	s_6	Kfus$_6$			s_5,s	Kfus$_6$			Kfusm	Sandstone	Kfusm				
	m	Kfum			m,st,sst	Kfum			Kfum	Red and gray mudstone	Kfum				
	sm	Kfmsm Kfmm Kfmst Kfms$_5$	Kf middle and lower undivided		m	Kfmm Kfmss		Kfs$_5$		s_5 Thin-bedded sandstone and siltstone		Fluvial unit 5	Middle unit		
	s_6				s_5,s	Kfms$_5$			Kfms$_5$		Kfms$_5$				
	m				m	Kfmsm			Kfmsm		Kfmsm				
	st	Kflst			sst	Kflss Kflst	Kfss		Kflss	Carbonaceous shale, siltstone, mudstone, or sandstone	Kflss		Lower unit		
Kfml	st	Klfm$_4$		Klf			Klfm				Klfm$_4$	Fluvial unit 4	Fuson Member		Lakota Formation
	s_4,s	Klfs$_4$			s_4	Klfs$_4$			Klfs$_4$	s_4 Variegated mudstone, siltstone, sandstone	Klfs$_4$				
	m	Klfm	Klf		m	Klf			Klf		Klfm				
		Klfs						Klfs			Kflss				
										s_2,s_3(?)	Klfs$_3$	Fluvial unit 3			
	l	Klm		Klm		Klm	Klm		Klm	Minnewaste Limestone Member	Klm			Minnewaste Limestone Member	
	m			Klu						s_3 Siltstone, claystone, mudstone, some interbedded sandstone		Fluvial unit 2	Chilson Member		
	s_2	Klcs$_2$	Klcs$_2$		s_2	Klcs$_2$	Klcs$_2$		Klcs$_2$		Klcs$_2$				
	sm,m,s	Klcsm$_2$			m,sm	Klcm$_2$ Klcsm$_2$	Klcm$_2$			Interbedded mudstone, siltstone, and sandstone	Klcu$_2$				
	sm,st											Fluvial unit 1			
	s_1	Klcs$_1$ Klcm Klcst								s_1 Carbonaceous shale, siltstone, mudstone, or sandstone	Klcs$_1$				
											Klcu$_1$				

fine-grained poorly exposed flood-plain facies of the two units. The contact relations, therefore, can rarely be observed. The regional relations, however, suggest that unit 1 originally may have extended farther eastward than it now does. Black fissile carbonaceous shale similar to that which occurs below the sandstone facies of fluvial unit 1 is present several miles east of the main body of sandstone in this unit. One such area is near the mouth of Fall River canyon (W½ sec. 30, T. 7 S., R. 6 E.), where the carbonaceous shale underlies fluvial unit 2. We observed similar shale in the Angostura Reservoir quadrangle. Inasmuch as the carbonaceous shale is known to occur only as part of, or underneath, unit 1, these isolated patches of shale are probably erosional remnants of unit 1. If they are, an unconformity must exist between units 1 and 2. (3) The Fuson Member overlaps successively the Minnewaste Limestone Member and both units of the Chilson Member. At places this overlap brings the Fuson Member in contact with the Morrison Formation and indicates an unconformity of regional magnitude. (4) Fluvial unit 4, at the top of the Fuson Member, fills deep erosional irregularities in the Fuson variegated mudstones, particularly in the Cascade Springs, Flint Hill, Edgemont, and Edgemont NE quadrangles.

CHILSON MEMBER

FLUVIAL UNIT 1

Fluvial unit 1 is present in the region northwest of the eastern part of the Flint Hill quadrangle and is composed of sandstone, shale, siltstone, and mudstone. Locally, black fissile shale has been mapped as the basal part of this unit. The unit consists of a complex of channel sandstone deposits and their fine-grained equivalents and apparently was deposited under predominantly fluvial conditions. The unit is an elongate body whose long axis is oriented northwestward (pl. 1). Generally, the central part of the unit is a series of light-brownish-gray fine to very fine grained channel sandstones. The sandstones grade laterally into other fine-grained deposits composed of thin alternating fine-grained sandstones, siltstones, and mudstones. This unit is one of the four uranium-producing units in the Inyan Kara Group of the southern Black Hills.

The channel-type sandstone facies of unit 1 has been described by Bell and Post (1971), Braddock (1963), Brobst (1961), Brobst and Epstein (1963), Cuppels (1963), Gott and Schnabel (1963), and Schnabel (1963). The sandstone is exposed throughout much of the area between the Cheyenne River canyon in the southern part of the Flint Hill quadrangle and the south end of the Elk Mountains in the Dewey quadrangle. It is best exposed in Cheyenne, Chilson, and Craven Canyons, where it forms massive nearly vertical cliffs 75–100 feet high. It is composed of numerous discrete filled channels resulting in a complex sequence of scour and fill structures.

The sandstone is light brownish gray or yellowish gray and is fine to very fine grained, except for a few medium- to coarse-grained lenses. The sand grains are well sorted and consist mostly of quartz, but on an average include about 5 percent feldspar, a few percent each of detrital chert and white detrital clay grains, and less than 1 percent heavy minerals. Carbonized plant remains are randomly distributed throughout the sandstone. As discussed more fully later, the sandstone is, in places, cemented tightly by carbonate.

Along and marginal to an axial line, the sandstone is thickest and rests unconformably on the Morrison Formation; but in some places laterally from the axial line, the sandstone rests on black carbonaceous fissile shales of the Lakota. This black fissile shale is the oldest known Cretaceous rock in the southern Black Hills and appears to have been laid down as a blanket-type deposit and to have been subsequently dissected during early unit 1 time. The shale is exposed in only a few places throughout the area in which the basal Lakota rocks crop out. For this reason it has been mapped as part of unit 1. It is best exposed in several places along each side of Red Canyon in the vicinity of the Fay Ranch, along Pass Creek, and along the east side of the Elk Mountains, in sec. 16, T. 5 S., R. 1 E. In these areas it is 10–50 feet thick, but where it has been penetrated by drill holes in and adjacent to sec. 1, T. 8 S., R. 2 E., it is as much as 75 feet thick.

The direction of dip of crossbeds indicates that the sand was deposited in streams flowing northwestward. The sandstone thins in the downstream direction along the channel axes from a maximum of 300 feet in Chilson Canyon to 250 feet in Craven Canyon, and it further thins to 200 feet in the vicinity of the south end of the Elk Mountains. The sandstone also thins rapidly and grades into fine-grained deposits to the northeast at right angles to the direction of streamflow. Little is known of its extent southwest of the main channel, but presumably it likewise grades into fine-grained deposits in that direction.

The fine-grained flood-plain facies of unit 1 is composed of thin alternating beds of very fine grained sandstone, siltstone, and mudstone in variable proportions. Limestone beds as much as 1 foot thick occur locally. A few thin coal beds are present. Streaks, pods, and fragments of carbonaceous material are sparse to abundant. The thickness of the flood-plain facies of unit 1 is greatest, as much as 150 feet, northeast of the margin of the sandstone facies in the eastern part of the Edgemont NE quadrangle, in the southern part of the Minnekahta quadrangle, and in the north-central part of the Flint Hill quadrangle.

A varied assemblage of fossils was found in moderate abundance during this investigation. In some places the siltstone and mudstone beds contain abundant ostracodes. Estella Leopold and Helen Penn of the U.S. Geological Survey have recognized spores related to the tropical fern genus *Anemia*. Numerous cycads also indicative of a tropical to subtropical climate have been collected from this unit. The abundant carbonaceous material, including coal beds, indicates a humid, warm climate that supported a luxurious growth of vegetation.

FLUVIAL UNIT 2

Throughout a considerable part of the southeastern Black Hills, unit 1 is overlain unconformably by a sequence of younger rocks that has been designated as fluvial unit 2. This unit extends from the Inyan Kara hogback in the vicinity of Hot Springs and Cascade Springs westward to the central part of the Edgemont NE quadrangle. The thickness of the unit averages about 250 feet east of the central part of the Flint Hill quadrangle; it gradually thins to zero west of the central part of the Flint Hill quadrangle. The unit, like fluvial unit 1, is a fluvial complex composed of stream and flood-plain deposits designated as sandstone and mudstone facies, and it locally includes rocks of possible lacustrine origin.

The unit is lens shaped and elongate to the northwest. Structural depression of the Cascade Springs area caused the axial line of unit 2 to shift to that area, about 6 miles east of the axial line of unit 1 (pl. 1, north half, restored cross section). Sandstone, which predominates near the axial line, grades laterally into interbedded claystone, siltstone, and silty very fine grained sandstone. The sandstone facies generally is light yellowish gray and is fine to very fine grained. It is composed predominantly of quartz but contains a small amount of feldspar and clay. In general, the sand is well sorted.

Several subtle differences are useful in distinguishing unit 1 from unit 2. Unit 2 is more oxidized, probably as a result of climatic changes after the deposition of unit 1, as shown by its lack of carbon and its greater abundance of red, brown, and yellow colors in contrast to the presence of carbon and the less vivid colors in unit 1. The mudstones of unit 2 are shades of red, green, and gray; those in unit 1 are predominantly gray, although a few are green and red. Fissile shales are absent from unit 2 but are commonly present in the basal part of unit 1. Many of the sandstones in unit 2 contain abundant pink calcite cement, whereas those in unit 1 contain less abundant and characteristically gray calcite cement.

The contact relations between the two units are variable. Throughout most of the area northwest of Craven Canyon where unit 2 is absent, unit 1 rocks are directly overlain by the Fuson Member. Unit 1 is absent eastward from the northeastern part of the Flint Hill quadrangle, and there, unit 2 lies directly on the Unkpapa Sandstone of Jurassic age. Where the two units are present in the same area, the fine-grained flood-plain deposits of each are generally in contact. This distribution of rock types occurs near the northeastern boundary of unit 1 in the south-central part of the Minnekahta quadrangle and throughout the east-central part of the Flint Hill quadrangle. Farther west, in the eastern part of the Edgemont NE quadrangle, the sandstone facies of unit 2 apparently rests on the fine-grained facies of unit 1, although unit 2 fine-grained facies may be present in some places in this area.

Where the boundary between the two units is within nonresistant fine-grained rocks, it is rarely exposed, and the contact relations cannot be observed in detail. In the S½ sec. 18, T. 9 S., R. 4 E., and at other places along the Cheyenne River, the sandstone facies of the two units are in contact. The magnitude of the hiatus cannot be determined from the exposures in this area, but sufficient time may have elapsed to allow the removal of 300–400 feet of rock before the deposition of unit 2.

MINNEWASTE LIMESTONE MEMBER

The Minnewaste Limestone Member is restricted to the southern part of the Black Hills. It is continuous east, northeast, and southeast of Cascade Springs and is discontinuous from Cascade Springs west to the northeastern part of the Burdock quadrangle (pl. 1). It has not been recognized in the western, the northern, and much of the eastern part of the Black Hills.

The Minnewaste Member in its thickest part is almost pure limestone, but it grades outward to sandy limestone and, toward the margins, to calcareous sandstone. It ranges in thickness from a few inches to 80 feet. East of Cascade Springs it has an average thickness of about 20 feet, but where it occurs in the Flint Hill, Edgemont NE, and Burdock quadrangles, it generally has a thickness of less than 10 feet. The limestone generally is structureless and weathers to a hackly surface. It strongly resists weathering and forms a vertical cliff where it is exposed in the canyons. In some places, notably in the eastern part of the Angostura Reservoir quadrangle, the limestone contains thin lenses of carbonaceous siltstone and structureless sandstone.

Commonly the limestone is highly brecciated and recemented with calcite. Baker (1947) reported that in the Amerada Petroleum Corp., South Dakota Agricultural College well 1, SW¼SE¼ sec. 27, T. 8 S., R. 7 E., just east of the mapped area, the Minnewaste includes 30 feet of anhydrite interbedded with limestone, dolomite, sandstone, and shale. Solution of the soluble calcium sulfate and subsequent collapse of the overlying beds, therefore, seem to be the most reasonable causes of brecciation.

In the Flint Hill quadrangle and eastward, the limestone commonly rests on red sandstone at the top of fluvial unit 2. Locally, however, gray mudstone separates the red sandstone from the limestone, and in places where fluvial unit 2 is represented by fine-grained flood-plain facies, the limestone also rests on mudstones. Westward the Minnewaste overlaps fluvial unit 2 and occurs as isolated patches resting on sandstones and mudstones of fluvial unit 1 (pl. 1, south half).

Fresh-water sponge spicules have been found in a few places within the limestone. These fossils, together with the limited distribution of the limestone, suggest that the limestone is lacustrine in origin.

FUSON MEMBER

The Fuson Member was evidently deposited in most of the southern Black Hills as gray to variegated mudstone containing variable amounts of fine-grained sandstone. In the vicinity of Pass Creek and the Elk Mountains, however, the lower part of the mudstone interfingers with conglomeratic sandstone that has been designated as fluvial unit 3 (pl. 1). In numerous places between the Elk Mountains and Hot Springs, particularly in the Edgemont area, the top of the Fuson mudstone has been channeled during pre-Fall River erosion. The sandstone that fills these erosional irregularities has been designated as fluvial unit 4 (pl. 1). The Fuson member, therefore, is composed of a variety of rock types including fluvial unit 3, the variegated mudstone, which locally contains fine-grained sandstones, and fluvial unit 4.

After the nomenclature of the formations now included within the Inyan Kara Group was established by Darton (1901), difficulty was encountered in recognizing the base of the Fuson beyond the limits of the Minnewaste Limestone Member. The reason for this difficulty apparently was the variation in facies in both the Fuson and Chilson Members. After these facies were mapped in the area between Hot Springs, S. Dak., and Newcastle, Wyo., however, it became apparent that the Fuson could be traced by detailed mapping beyond the limits of the Minnewaste Limestone Member.

For several miles west of Cascade Springs the Fuson Member rests on an easily identified reddish-brown sandstone in the sandstone and mudstone facies of fluvial unit 2 of the Chilson Member. In some places, however, particularly in the northern part of the Flint Hill quadrangle and the southern part of the Minnekahta quadrangle, variegated mudstone of the Fuson locally rests on similar mudstones of fluvial unit 2. There the Fuson-Chilson contact has been arbitrarily mapped within the mudstone sequence.

Beyond the western limits of fluvial unit 2, the Fuson Member rests on rocks of fluvial unit 1 (pl. 1, north half). The rocks of these two units are generally easily distinguished because of the contrast between carbonaceous sandy beds in the underlying Chilson Member and noncarbonaceous variegated mudstone or white massive sandstone in the Fuson Member. Along the east side of the Elk Mountains in the Dewey quadrangle, where the basal part of the Fuson Member is the conglomeratic sandstone of fluvial unit 3, all the rocks that contain carbonaceous material are placed in the Chilson Member, and all the conglomeratic sandstone is placed in the Fuson Member.

FLUVIAL UNIT 3

Fluvial unit 3 is a conglomeratic crossbedded white to yellowish-brown noncarbonaceous sandstone. It crops out in parts of the Jewel Cave SW, Dewey, Clifton, and Fanny Peak quadrangles. It consists of many intertonguing well-sorted lenses that vary in texture from fine grained to conglomeratic with pebbles locally greater than 3 inches in diameter. Quartz comprises 90 percent of the rock; and chert, feldspar, clay grains, magnetite, zircon, tourmaline, and rutile are minor constituents. Carnotite in uneconomic concentrations has been found in the lower part of the sandstone in the SE¼SW¼ sec. 21, T. 5 S., R. 1 E., Custer County, S. Dak.

The conglomeratic sandstone was deposited on the dissected surface of fluvial unit 1 and, in places, on Jurassic rocks. At the boundary between the Clifton and Dewey quadrangles, the sandstone is in direct contact with either the lower part of the Morrison Formation or the upper part of the Redwater Shale Member of the Sundance Formation of Jurassic age (pl. 1). Crossbeds in the sandstone indicate that the streams that deposited it flowed in a northerly direction. The sandstone interfingers with the variegated mudstone.

Fluvial unit 3 is generally 20–30 feet thick where it is present in the Jewel Cave SW quadrangle. Along the west flank of the Black Hills through parts of the Dewey, Clifton, and Fanny Peak quadrangles the unit ranges in thickness from about 20 to 120 feet and perhaps has an average thickness of about 70 feet.

VARIEGATED MUDSTONE

The variegated mudstone of the Fuson Member was partly or completely removed in many places by widespread erosion prior to deposition of fluvial unit 4. Where it is present the mudstone is as much as 180 feet thick and averages about 100 feet thick. It is nonfissile and noncarbonaceous and is characterized by gray, maroon, and green claystone and siltstone enclosing thin beds of fine-grained sandstone. Silicified logs have been found in the unit, notably in the northeastern part of the Hot Springs quadrangle and the northwestern part of the Edgemont NE quadrangle. Green sandstone float is distinctive, yet the source of this material is rarely exposed. The claystone and siltstone beds generally weather to steep grass-covered slopes. Highly polished subspherical quartzite and chert pebbles and cobbles also characterize this unit and help distinguish the Fuson Member from the Chilson Member. These pebbles and cobbles have been found embedded in the Fuson mudstone in many places, but most are seen littering the mudstone surface. Similar polished pebbles, probably from equivalents of the Fuson Member, around the periphery of the Black Hills have been described by Mapel, Chisholm, and Bergenback (1964, p. C25–C26), Waagé (1959), and many other writers.

Commonly structureless and poorly bedded highly argillaceous silty sandstone that is white or is mottled and streaked with red, pink, and yellow iron oxide stains and cement is characteristic of the unit. The sandstone is lenticular, fine to very fine grained, and noncarbonaceous, and it is as much as 100 feet thick. The most conspicuous exposures of the white structureless sandstone are in the Coal, Craven, and Red Canyons areas, in the Edgemont NE quadrangle. This sandstone is not shown on the geologic map but is shown on the restored cross section.

FLUVIAL UNIT 4

Fluvial unit 4, the youngest rock unit in the Fuson Member, was deposited in channels eroded by northwest-flowing streams during partial dissection of the underlying variegated mudstone. The streams in places incised as much as 150 feet below the surface and cut completely through the variegated mudstone and into units 2 and 1 of the Chilson Member. Subsequently, these valleys were filled with the channel sandstone complex that comprises fluvial unit 4. The sandstone is extensively cemented with calcium carbonate.

The complex is composed predominantly of sandstone; but red or red and gray mudstone is locally present at the top of the unit, and in places along the margins gray mudstone lenses are present. The sand grains are rounded to subrounded and on an average are composed of about 90 percent quartz; chert, kaolinite, illite, feldspar, and sparse mica constitute most of the remaining part. Unit 4 contains almost no organic carbon. The sandstone is resistant to erosion and forms yellowish-gray to light-gray vertical cliffs along the canyons. The basal part locally is conglomeratic, particularly on the crest of the Chilson anticline in the southern part of the Minnekahta quadrangle, but generally the sandstone is fine to medium grained and, except for local clay lenses, is only slightly argillaceous.

The sandstone is intermittently exposed from the Cheyenne River in the southern part of the Flint Hill quadrangle to the southern part of the Clifton quadrangle, a distance of about 35 miles (pl. 1). A tributary channel, in which sandstone was deposited, apparently extended across the western part of the Cascade Springs quadrangle and eastern part of the Hot Springs quadrangle.

Mudstone of variable thickness is locally present in the upper part of fluvial unit 4 west of the Chilson anticline. The mudstone generally forms gentle grass-covered slopes, and little of it can be observed. Where it is exposed it is similar to the red and maroon mudstone in parts of the Fuson variegated mudstone and to varicolored mudstone in the upper part of the Fall River Formation. The maximum thickness of the mudstone, about 50 feet, occurs in the western part of the Edgemont NE quadrangle and the eastern part of the Burdock quadrangle (pl. 1). The mudstone probably was locally derived from the Fuson clays and silts and was deposited on the flanks of the principal channels.

In contrast to the sandstone of other fluvial units, the sandstone of fluvial unit 4 is characterized by many sets of foreset crossbeds, each set ranging in thickness from a few inches near the channel margin to about 4 feet in the central part of the channel. The sets are separated by thin topset beds, none more than 2 inches thick. The crossbeds strike normal to the channel boundaries and dip northwestward. On weathered surfaces many of the individual cross-strata are etched into bold relief, evidently as a result of contrasting textures of adjacent cross-strata. In several places between the southern part of the Flint Hill quadrangle and the southeastern part of the Edgemont NE quadrangle the foreset beds within individual sets are bent downstream in such a manner that a "V" is formed which points upstream. The deformed strata are overlain and underlain by undeformed strata. The deformation of the crossbeds apparently resulted from preconsolidation slumping. According to McKee (1957, p. 132), foreset beds of the type just described result when the base level is raised rapidly, and a series of these sets represents a series of base level rises.

The sandstones of fluvial unit 4 are more extensively cemented with calcite than are the sandstones of the other fluvial units (Gott, 1956; Gott and Schnabel, 1963). Unit 4 sandstones are particularly well cemented along the east side of the Burdock quadrangle, in the southwestern part of the Edgemont NE quadrangle, in the subsurface in the northeastern part of the Edgemont quadrangle, and in various parts of the Flint Hill quadrangle. Most of the calcite contains much manganese and iron, and these metals cause the rock to weather dark gray to black where highly oxidized. The calcite generally is concentrated in spherical nodules, but to a lesser extent it occurs in elongate masses in and marginal to fractures. The nodules are commonly about a half inch in diameter but are locally as much as 4 inches in diameter, and most of them exhibit regularly spaced concentric bands. The cementation apparently grew outward from a nucleus. Where cementation proceeded to completion, the nodules coalesce, and the sandstone in the interstices between the nodules is cemented by calcite; but in many places the internodular sandstone is uncemented.

FALL RIVER FORMATION

The Fall River Formation is composed of sandstone, siltstone, and mudstone. In the southern part of the Black Hills it is 100–160 feet thick. Three units recognized in mapping could be traced over most of the area. (1) Laminated carbonaceous siltstones interbedded with thin sandstones in the basal part of the formation are informally designated as the lower unit. (2) A thick crossbedded fluvial sandstone, which locally truncates the lower unit but which grades laterally into a sequence of alternating thin tabular beds of sandstone, siltstone, and mudstone, is designated as the middle unit. (3) A variegated mudstone 20–25 feet thick and a local overlying sandstone which is similar to the one in the middle unit and which grades laterally into a fine-grained thin-bedded facies are designated as the upper unit.

The lithologic character of the Fall River and Lakota rocks at the formational boundary varies greatly. Because of this, several combinations of lithologic units in each formation are variously present at the formational boundary. Most commonly the lowest part of the Fall River Formation consists of laminated carbonaceous siltstone thinly interbedded with very fine grained sandstone. In most places this unit rests on the variegated mudstone or the white sugary massive sandstone of the Fuson Member. The upper few inches to few feet of the Fuson is bleached, resulting in a strong color contrast between the rocks at the contact. Brownish-red, orange, and yellow siderite spherules commonly occur in the Fuson within 5 feet of the formational contact. These spherules have been discussed by Waagé (1959, p. 55–57) and Gries (1954). In many places, however, the formational contact is much less obvious. In such places the basal Fall River unit was removed by erosion and replaced by sand during middle Fall River time, and in many places this Fall River sandstone, designated fluvial unit 5, rests on the sandstone of fluvial unit 4. At other places the sandstone of fluvial unit 5 is present at the base of the Fall River, but fluvial unit 4 is absent; or fluvial units 4 and 5 are both present but are separated by a thin sequence of the lower unit of the Fall River Formation (pl. 1, north half, restored cross section). The criteria for identifying the contact vary considerably according to which of these combinations is present.

LOWER UNIT

The lower unit of the Fall River Formation is present throughout the southern Black Hills except where it is locally truncated by the sandstone facies of fluvial unit 5. It ranges in thickness from 0 to 50 feet and is composed principally of laminated micaceous carbonaceous siltstone. Interlayered with the siltstone is light-gray very fine grained slightly micaceous sandstone. The sandstone beds are generally less than 1 foot thick and are rarely more than 10 feet thick.

The rock generally contains small ellipsoidal concretionary layers of siltstone or very fine grained sandstone that superficially resemble augen structures of some metamorphic rocks. The unweathered rock contains pyrite nodules a few inches in longest dimension. As a result of oxidation of these nodules and concretions, the weathered sandstone is commonly stained brown or yellowish brown. In general, however, the relatively high carbon content of the siltstones has inhibited oxidation to the extent that they are light or medium gray, particularly on a freshly broken surface.

Some of the thin sandstone beds are covered on the upper surface with ripple marks and a vermiculated pattern of raised ridges that have been interpreted as "worm tracks" (Henry Bell III and E. V. Post, written commun., 1957; Waagé, 1959). Many of the siltstone lenses contain faint low-angle crossbeds that are 1–2 inches in total length, suggesting that the sediment was transported by extremely gentle currents.

Because of the striking contrast between these rocks and those of the underlying Fuson Member of the Lakota Formation, the formational contact where the lower unit is present is easily recognized.

Many small uranium mines have been developed in the lower unit of the Fall River.

MIDDLE UNIT (FLUVIAL UNIT 5)

The middle unit of the Fall River, designated fluvial unit 5, is the fifth of six major fluvial units in the Inyan Kara Group. It comprises a fluvial sandstone and its associated marginal fine-grained deposits. The fluvial sandstone crops out in an irregular band that trends generally northwest throughout most of the southern Black Hills (pl. 1). It is as much as 110 feet thick and is commonly cemented with calcite and silica.

Erosion of part or all of the carbonaceous siltstone in the lower unit locally preceded deposition of fluvial unit 5. In places the lower unit was completely removed, but generally only the upper part was eroded. The fluvial sandstone was then deposited over much of the irregular surface, leaving a plain of low relief. The streams that deposited sand in the principal channelways also deposited extensive overbank flood-plain deposits marginal to the sandstone-filled channels. The irregular lower contact and the relation between the channel and flood-plain facies are shown on plate 1 (north half, restored cross section).

The sandstone is light yellowish gray on freshly broken surfaces, and it weathers to shades of yellow and brown; generally, it is slightly darker than the Lakota sandstones. It forms prominent vertical cliffs along the canyons. The sandstone is composed of about 90 percent subrounded to rounded quartz, less than 5 percent feldspar, and a minor amount of chert. The heavy-mineral content is generally less than 1 percent, and mica is more abundant than in the older, Lakota sandstones. The sandstone is crossbedded, fine to medium grained, and sparsely carbonaceous. Iron sulfide and iron oxide nodules are common, and silicified tree trunks occur in a few places, particularly along the west side of Red Canyon. Calcite cement is abundant in the sandstone near the axis of the Sheep Canyon monocline in the western part of the Flint Hill quadrangle, the eastern part of the Edgemont quadrangle, and the southeastern part of the Edgemont NE quadrangle. It is also abundant in the subsurface in some of the places where fluvial unit 5 is in contact with fluvial unit 4, such as in the southern part of the Edgemont NE quadrangle and the northern part of the Edgemont quadrangle. In other places the sandstone is tightly silicified, particularly on the crest of the Chilson anticline in the southern part of the Minnekahta quadrangle and the northern part of the Flint Hill quadrangle, on Horse Trap Mountain in the southeastern part of the Minnekahta quadrangle, on the Barker dome in the southeastern part of the Jewel Cave SW quadrangle, and at the crest of Battle Mountain in the west-central part of the Hot Springs quadrangle.

The fine-grained facies of the middle unit is composed of alternating thin tabular beds of gray sparsely carbonaceous claystone, light-brownish-gray micaceous very fine grained sandstone, and dark-gray carbonaceous siltstone. This facies is lithologically similar to the underlying carbonaceous siltstone, and thus in places the two are difficult to distinguish. The facies interfingers with the fluvial sandstone and, except for a difference in color, is indistinguishable from the overlying variegated mudstone. The fine-grained facies of the middle unit is 0–50 feet thick.

UPPER UNIT (INCLUDES FLUVIAL UNIT 6)

The upper unit of the Fall River is composed of variegated mudstone at the base overlain by fluvial unit 6, a sequence of fluvial sandstone and fine-grained equivalents of the fluvial sandstone (pl. 1, north half, restored cross section) that is designated the sixth and youngest of the major fluvial units. It crops out in the southeastern part of the southern Black Hills. The thickness of the upper unit ranges from about 40 to 120 feet and averages about 75 feet.

The unit is highly argillaceous and is characteristically mottled red and gray, particularly in the middle part. The top 1–2 feet is normally light gray and locally contains abundant carbonized plant debris.

The mudstone generally is 10–25 feet thick, except in the Angostura Reservoir area, where it includes erratically distributed bodies of sandstone and gray clay and is as much as 60 feet thick. Its lower boundary is gradational with either the fine-grained or the sandstone facies of unit 5. In some places the upper part of the mudstone seems to be gradational with the fine-grained facies of fluvial unit 6; but elsewhere, part or all of the variegated mudstone was removed by erosion prior to deposition of unit 6, and the contact is obviously unconformable.

The mudstone has been recognized and mapped throughout much of the area between Pass Creek, which is in the southwestern part of the Jewel Cave SW quadrangle, and Hot Springs. There is little doubt that equivalents of the mudstone are present to the northwest in the Dewey, Clifton, and Fanny Peak quadrangles, although the unit has lost its easily recognizable color in those areas. Except for patches of variegated mudstone in the vicinity of the Wicker-Baldwin prospect near the north boundary of the Dewey quadrangle and in a few places in the Clifton and Fanny Peak quadrangles, probable equivalents of the variegated unit are various tones of gray ranging from nearly white to dark gray without any of the characteristic red and maroon colors. This makes correlation with the variegated mudstone to the southeast questionable, and for that reason no attempt has been made to map the unit separately in the Dewey, Clifton, and Fanny Peak quadrangles.

Fluvial unit 6 ranges in thickness from about 30 feet in the northwestern part of the Fanny Peak quadrangle to about 100 feet in a few places in the Flint Hill quadrangle. The sandstone facies is most prominent east of the Edgemont NE quadrangle and generally consists of light-gray sandstone that is consistently 10–25 feet thick over large areas. It is generally fine-grained where no more than about 20 feet thick but is crossbedded and medium to coarse grained where very much thicker.

The sandstone grades laterally into a sequence composed of variable proportions of thin alternating tabular beds of fine-grained sandstone, siltstone, and claystone. In general the average grain size of the clastic material increases from predominantly clay in the Fanny Peak, Clifton, and Dewey quadrangles to predominantly silt and sand in the Edgemont NE quadrangle. This sequence, at least in part, appears to represent flood-plain deposits perhaps at the margin of a seaway, as concluded by Waagé (1959).

PETROGRAPHY

A petrographic study was made of sandstones and a few coarse siltstones from fluvial units 1–5 within the Inyan Kara Group and from the underlying Unkpapa Sandstone (fig. 2). Samples from the Unkpapa

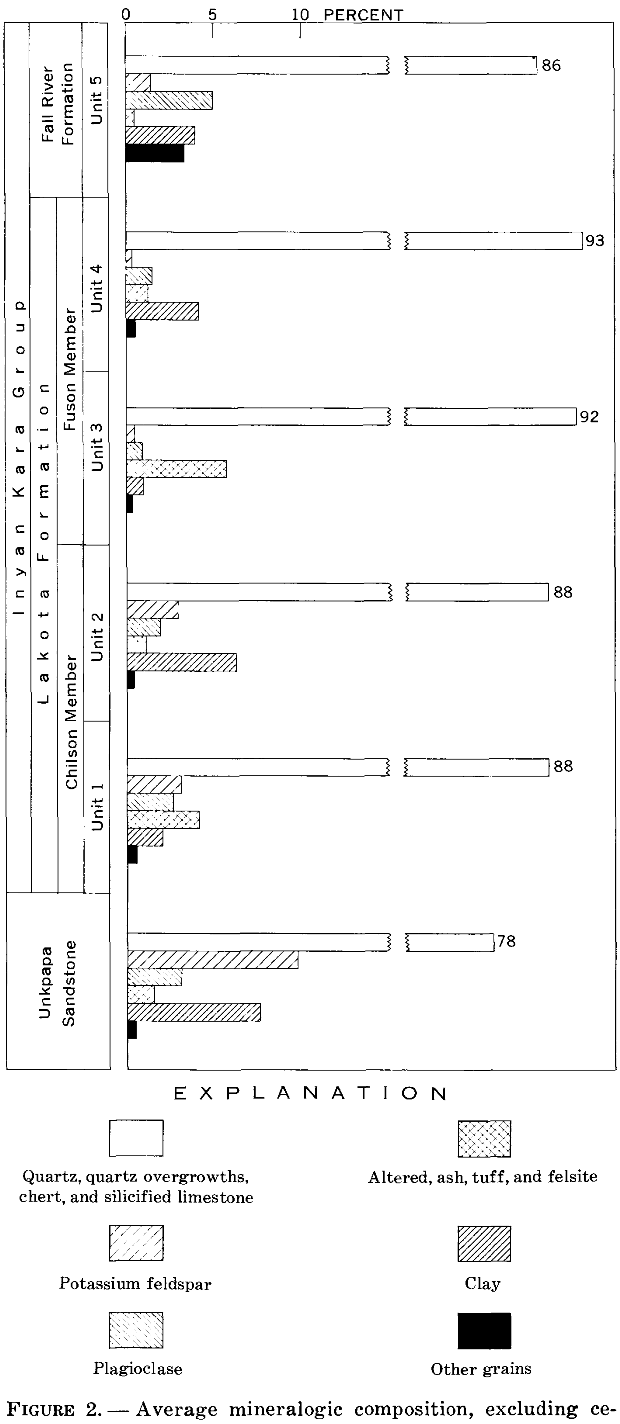


FIGURE 2. — Average mineralogic composition, excluding cement, in percent, of sandstone units in the Inyan Kara Group and the Unkpapa Sandstone.

Sandstone were included because locally the source of some sediments of the Lakota is the Unkpapa. The study was undertaken to determine differences in mineralogy and grain-size distribution for sandstones of each fluvial unit and to provide information for determining the source of sediments and tectonic changes in the source areas and in the Edgemont uranium district.

Chip samples were collected from 84 localities (table 2) for study of the mineralogic composition and texture and for determination of the heavy-mineral content. The thin-section modal analyses and the textural analyses were made by R. A. Cadigan of the U.S. Geological Survey following his reported procedures and classifications (Cadigan, 1959, p. 530, 533, 535). The heavy-mineral studies were done by Wolcott.

In the following sections on composition, grain size, and heavy minerals, the terms "percent by volume," "percent by weight," and "percent of grains counted" are used. The composition was determined by point counts of thin sections which yield the volume of each constituent (Chayes, 1949, 1946). The grain-size-distribution frequencies are based on the weight of each selected size fraction. The heavy-mineral percentages are based on the numbers of each detrital heavy mineral counted.

COMPOSITION

Thin sections of 51 samples were prepared and studied as outlined by Cadigan (1959, p. 533). Potassium feldspars and potassium-bearing clays were stained canary yellow to facilitate their identification. Petrographic modal composition of the rocks was estimated by point-count method using 500 points in each thin section. The composition, in percent by volume of each sample, is shown in table 3, and the average composition of each unit, excluding cement, is shown by histograms in figure 2. On the basis of the average composition, all units of the Inyan Kara Group that were sampled are orthoquartzites (defined as containing more than 60 percent detrital siliceous grains and not more than 25 percent feldspar), and the Unkpapa Sandstone is a feldspathic orthoquartzite. On the basis of mean grain size (table 4), three of the samples (L–3254 in unit 1 of the Lakota Formation and L–3246 and L–3253 of the Unkpapa Sandstone) are coarse siltstones. All the units, as indicated by the presence of chert, quartzite, and silicified limestone grains, were derived in part from preexisting sedimentary rocks.

Some differences in mineral composition among the Inyan Kara sandstones seem to be consistent.

TABLE 2. — *Localities of samples listed in tables 3, 4, and 7*

Field sample (L–)	Section, township, and range[1]	7½-minute quadrangle
	INYAN KARA GROUP	
	Fall River Formation	
	Fluvial unit 5	
3287	NE¼NW¼ sec. 33, T. 7 S., R. 6 E	Hot Springs.
3288	SW¼SE¼ sec. 29, T. 8 S., R. 5 E	Cascade Springs.
3289–3290	SE¼NW¼ sec. 4, T. 9 S., R. 4 E	Flint Hill.
3291–3293	NW¼SE¼ sec. 32, T. 7 S., R. 3 E	Edgemont NE.
3294	NE¼NE¼ sec. 5, T. 42 N., R. 60 W	Clifton.
3379	SW¼NE¼ sec. 27, T. 8 S., R. 3 E	Flint Hill.
3380	NW¼NW¼ sec. 12, T. 9 S., R. 3 E	Do.
3381	NW¼SE¼ sec. 32, T. 8 S., R. 4 E	Do.
3382	W½SE¼ sec. 9, T. 42 N., R. 60 W	Clifton.
3383	SE¼NE¼ sec. 22, T. 6 S., R. 1 E	Jewel Cave SW.
3384	SW¼NE¼ sec. 24, T. 8 S., R. 4 E	Cascade Springs.
3385	SE¼NW¼ sec. 20, T. 8 S., R. 6 E	Angostura Reservoir.
3386	SW¼NE¼ sec. 8, T. 8 S., R. 6 E	Do.
3387	NE¼SE¼ sec. 16, T. 7 S., R. 6 E	Hot Springs.
3388	SW¼SE¼ sec. 16, T. 7 S., R. 6 E	Do.
3389	S½SE¼ sec. 16, T. 7 S., R. 6 E	Do.
3390	SE¼SE¼ sec. 6, T. 8 S., R. 4 E	Minnekahta.
	Lakota Formation	
	FUSON MEMBER	
	Fluvial unit 4	
3279	NE¼NW¼ sec. 33, T. 7 S., R. 6 E	Hot Springs.
3280–3282	SW¼SW¼ sec. 9, T. 8 S., R. 4 E	Flint Hill.
3283	SE¼NW¼ sec. 4, T. 9 S., R. 4 E	Do.
3284–3285	NE¼NE¼ sec. 8, T. 8 S., R. 3 E	Edgemont.
3286	NW¼SW¼ sec. 29, T. 6 S., R. 2 E	Burdock
3295	NW¼ sec. 18, T. 5 S., R. 1 E	Dewey.
3366–3368	NW¼SW¼ sec. 12, T. 8 S., R. 3 E	Flint Hill.
3369	SE¼NE¼ sec. 18, T. 9 S., R. 4 E	Do.
3370	NE¼NW¼ sec. 20, T. 8 S., R. 4 E	Do.
3371	NE¼SE¼ sec. 21, T. 8 S., R. 4 E	Do.
3372	SW¼SW¼ sec. 14, T. 6 S., R. 1 E	Jewel Cave SW.
3373	SE¼SW¼ sec. 4, T. 7 S., R. 2 E	Burdock.
3374–3375	NW¼NE¼ sec. 27, T. 7 S., R. 2 E	Edgemont NE.
3376–3377	SE¼NE¼ sec. 21, T. 7 S., R. 2 E	Burdock.
3378	SW¼SE¼ sec. 16, T. 7 S, R. 6 E	Hot Springs.
	Fluvial unit 3	
3262	NW¼NE¼ sec. 33, T. 44 N., R. 60 W	Fanny Peak.
3263	NW¼NE¼ sec. 7, T. 4 S., R. 1 E	Clifton.
3264	NE¼NW¼ sec. 10, T. 42 N., R. 60 W	Do.
3265	NE¼ sec. 28, T. 5 S., R. 1 E	Dewey.
3331	SE¼SW¼ sec. 29, T. 44 N., R. 60 W	Fanny Peak.
3332–3333	SE¼SE¼ sec. 30, T. 4 S., R. 1 E	Clifton.
3334	NW¼NW¼ sec. 10, T. 6 S., R. 1 E	Jewel Cave SW.
3338	SE¼SW¼ sec. 22, T. 43 N., R. 60 W	Clifton.
3350	NW¼NW¼ sec. 19, T. 6 S., R. 2 E	Jewel Cave SW.
3399	SW¼SW¼ sec. 14, T. 6 S., R. 1 E	Do.
	INYAN KARA GROUP — Continued	
	Lakota Formation — Continued	
	CHILSON MEMBER	
	Fluvial unit 2	
3266–3270	SW¼SW¼ sec. 9, T. 8 S., R. 4 E	Flint Hill.
3271	S½SW¼ sec. 2, T. 8 S., R. 4 E	Minnekahta NE.
3272	NW¼NE¼ sec. 5, T. 8 S., R. 3 E	Edgemont NE.
3273	NE¼NW¼ sec. 3, T. 9 S., R. 5 E	Cascade Springs.
3274–3276	SW¼SW¼ sec. 34, T. 8 S., R. 5 E	Do.
3277–3278	NW¼NE¼ sec. 30, T. 7 S., R. 6 E	Hot Springs.
3339	SW¼NW¼ sec. 3, T. 8 S., R. 3 E	Edgemont NE.
3340	NW¼SE¼ sec. 2, T. 8 S., R. 3 E	Minnekahta.
3341	SW¼SE¼ sec. 18, T. 9 S., R. 4 E	Flint Hill.
3343–3344	NE¼SE¼ sec. 21, T. 8 S., R. 4 E	Do.
3346–3349	S½NW¼ sec. 35, T. 8 S., R. 5 E	Angostura Reservoir.
3352–3353	NE¼SE¼ sec. 1, T. 8 S., R. 3 E	Minnekahta.
3354–3357	NE¼SW¼ sec. 34, T. 7 S., R. 4 E	Do.
3358–3359	SW¼SE¼ sec. 29, T. 8 S., R. 5 E	Cascade Springs.
3360	SW¼SE¼ sec. 4, T. 7 S., R. 6 E	Hot Springs
3361	SE¼NE¼ sec. 9, T. 7 S., R. 6 E	Do.
3362–3365	N½ sec. 4, T. 9 S., R. 4 E	Flint Hill.
3395–3398	NW¼SE¼ sec. 15, T. 8 S., R. 4 E	Do.
	Fluvial unit 1	
3254–3255	SW¼SE¼ sec. 31, T. 8 S., R. 4 E	Flint Hill.
3256–3257	NW¼NW¼ sec. 30, T. 7 S., R. 3 E	Edgemont NE.
3258	SW¼NE¼ sec. 22, T. 7 S., R. 2 E	Do.
3259–3260	NW¼NW¼ sec. 19, T. 6 S., R. 2 E	Jewel Cave SW.
3261	NE¼NW¼ sec. 32, T. 44 N., R. 60 W	Fanny Peak.
3319–3320	NE¼NE¼ sec. 33, T. 7 S., R. 3 E	Edgemont NE.
3321	SW¼SE¼ sec. 18, T. 9 S., R. 4 E	Flint Hill.
3322–3323	SE¼NW¼ sec. 12, T. 8 S., R. 5 E	Angostura Reservoir.
3325	NE¼NW¼ sec. 10, T. 42 N., R. 60 W	Clifton.
3326	NW¼NW¼ sec. 23, T. 6 S., R. 1 E	Jewel Cave SW.
3329	NE¼NE¼ sec. 14, T. 7 S., R. 2 E	Edgemont NE.
3330	NE¼SW¼ sec. 1, T. 8 S., R. 3 E	Minnekahta.
3335	NW¼NW¼ sec. 10, T. 6 S., R. 1 E	Jewel Cave SW.
3336–3337	E½NE¼ sec. 9, T. 6 S., R. 1 E	Do.
3394	NW¼SW¼ sec. 16, T. 8 S., R. 4 E	Flint Hill.
	UNKPAPA SANDSTONE	
3245–3247	SE¼NE¼ sec. 9, T. 7 S. R. 6 E	Hot Springs.
3248	SW¼NW¼ sec. 10, T. 7 S., R. 6 E	Do.
3249–3251	NE¼NW¼ sec. 26, T. 8 S., R. 5 E	Angostura Reservoir.
3252–3253	NE¼NW¼ sec. 3, T. 9 S., R. 5 E	Cascade Springs.
3313	SW¼SW¼ sec. 22, T. 8 S., R. 4 E	Flint Hill.
3314	NW¼SE¼ sec. 15, T. 8 S., R. 4 E	Do.
3315	SE¼NW¼ sec. 12, T. 8 S., R. 5 E	Angostura Reservoir.
3316	NE¼SW¼ sec. 34, T. 7 S., R. 4 E	Minnekahta.
3317–3318	SW¼NE¼ sec. 4, T. 9 S., R. 4 E	Flint Hill.

[1]North townships and west ranges are in Wyoming; south townships and east ranges are in South Dakota.

These differences are (1) a decrease in the ratio of potassium feldspar to plagioclase from older to younger beds in the Lakota Formation (fig. 3, table 6), (2) locally abundant chert and silicified limestone grains in fluvial unit 3 of the Lakota Formation (table 3), (3) the highest percentage of volcanic materials in fluvial units 1 and 3 of the Lakota Formation (table 3), and (4) a significantly greater amount of mica in the Fall River compared with underlying units (table 3, fig. 3). The variation in clay content reported is not significant, because matrix material was lost in preparation of some of the thin sections. As would be expected, the feldspar content in general decreases with increasing grain size (fig. 4).

GRAIN SIZE

Particle-size analyses (table 4) were made of 51 samples to determine the properties of their grain-size distributions. The samples, which had also been used for thin-section analyses, were disaggregated and sieved, with sieve sizes graduated at ½-phi intervals from −3 to 0 phi and at ¼-phi intervals from 0 to 4 phi; grains smaller than 4 phi were analyzed by pipette methods using 1-phi intervals to 10 phi. These data were then used in calculating the grain-size distribution by the method of moments as described by Krumbein and Pettijohn (1938). Parameters derived in this manner are not directly comparable to those derived by the graphic methods of Inman (1952) or Folk (1957). As an example,

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TABLE 3. — *Mineralogic composition (in percent by volume) of samples from the Inyan Kara*

[Sample localities

Field sample (L–)	Grains						
	Quartz and quartz overgrowths[1]	Quartzite	Chert and silicified limestone	Potassium feldspar	Plagioclase	Micaceous and mafic rock	Altered ash, tuff, and felsite
INYAN KARA GROUP							
Fall River Formation							
Fluvial unit 5							
3287	91.0	0.0	0.2	0.0	3.4	0.0	0.2
3288	89.8	.0	1.6	.6	6.8	.0	.0
3289	62.8	.0	.2	1.0	10.6	.2	.4
3290	83.0	.0	.0	2.4	8.4	.0	.6
3291	79.2	.6	.8	.4	1.6	.0	.0
3292	87.4	.4	.8	1.6	2.6	.0	.2
3293	81.2	.6	1.4	2.8	4.0	.6	.4
3294	96.0	.2	.4	1.0	1.6	.0	.4
Lakota Formation							
FUSON MEMBER							
Fluvial unit 4							
3279	89.4	0.0	3.2	0.2	0.6	0.0	2.8
3280	81.0	.8	1.4	.0	.2	.0	.2
3281	81.4	.0	.2	.0	1.0	.0	.2
3282	85.6	.0	.4	.0	2.8	.0	.4
3283	96.4	.2	.4	.0	1.4	.0	.0
3284	93.8	.2	.6	.0	1.2	.0	.6
3285	95.0	.2	.8	.0	1.2	.0	.2
3286	94.8	.0	.0	1.0	1.4	.0	1.0
3295	79.2	.0	13.8	.0	2.0	.0	4.0
Fluvial unit 3							
3262	15.2	0.0	77.2	0.0	0.2	0.0	6.6
3263	74.0	.8	16.8	.0	.8	.0	6.6
3264	89.2	.2	2.4	.8	1.6	.0	4.0
3265	54.4	.0	5.0	.4	.2	.0	3.6
CHILSON MEMBER							
Fluvial unit 2							
3266	81.8	0.0	1.8	2.8	1.4	0.0	1.6
3267	86.0	.0	1.0	3.0	1.8	.0	2.0
3268	90.4	.0	1.0	2.0	1.2	.0	1.4
3269	86.8	.2	4.0	1.0	1.0	.0	2.2
3270	92.0	.0	4.4	1.0	.2	.0	.2
3271	89.4	.0	1.0	3.2	1.6	.0	1.8
3272	89.2	.2	.6	1.8	.6	.0	.2
3273	77.4	.0	.4	7.4	5.2	.0	.4
3274	87.4	.0	.0	7.2	2.2	.0	.2
3275	90.8	.0	2.0	2.6	1.6	.0	.6
3276	89.2	.2	1.0	3.0	2.2	.0	1.2
3277	63.4	.0	.0	.0	1.8	.0	.2
3278	83.6	.0	.4	2.4	1.2	.0	.4
Fluvial unit 1							
3254	79.4	0.0	0.4	7.4	7.6	0.0	3.4
3255	94.8	.0	.2	1.6	2.4	.0	.4
3256	87.8	.0	1.6	.6	.6	.0	8.6
3257	95.2	.0	.4	3.0	.6	.0	.8
3258	88.0	.6	.4	1.8	.4	.0	7.0
3259	83.8	.0	.8	2.0	.8	.0	12.2
3260	78.6	.2	.8	6.4	3.6	.2	3.2
3261	91.4	.2	.0	1.6	2.4	.2	.4
UNKPAPA SANDSTONE							
3245	74.4	0.4	0.0	9.4	2.4	0.0	0.6
3246	61.6	.2	.0	10.6	5.2	.0	1.0
3247	76.8	.2	.0	8.4	3.0	.0	2.6
3248	85.4	.0	.0	.0	1.8	.0	1.2
3249	79.2	.2	.2	12.2	3.2	.0	1.4
3250	85.2	.0	.0	9.6	2.4	.0	.0
3251	82.4	.0	.0	11.8	3.0	.0	1.0
3252	82.0	.0	.2	11.4	.6	.0	3.0
3253	69.2	.0	.2	13.8	5.2	.0	1.8

[1]Quartz overgrowths could not be distinguished from quartz grains in most thin sections.
[2]Includes heavy minerals and indeterminate grains.

Group and the Unkpapa Sandstone as determined by point-count analyses of thin sections are given in table 2]

Grains — Continued		Matrix			Cement			Total grains and matrix	Total cement
Miscellaneous[2]	Mica	Kaolinitic clays	Illite and mica clays	Montmorillonite and related clays	Carbonate and sulfate	Red iron oxide	Silica[3]		
INYAN KARA GROUP — Continued									
Fall River Formation — Continued									
Fluvial unit 5 — Continued									
0.0	0.4	4.4	0.2	0.0	0.2	0.0	0.0	99.8	0.2
.0	.0	.6	.2	.0	.0	.4	.0	99.6	.4
[4]17.6	2.8	4.4	.0	.0	.0	.0	.0	100.0	.0
1.8	.8	2.6	.4	.0	.0	.0	.0	100.0	.0
.0	.0	3.4	4.0	.0	.0	10.0	.0	90.0	10.0
.0	.8	1.2	3.6	.0	.0	1.4	.0	98.6	1.4
.2	.6	.4	5.6	.0	.0	2.2	.0	97.8	2.2
.0	.0	.4	.0	.0	.0	.0	.0	100.0	.0
Lakota Formation — Continued									
FUSON MEMBER — Continued									
Fluvial unit 4 — Continued									
0.2	0.0	2.8	0.2	0.0	0.0	0.6	0.0	99.4	0.6
.0	.0	4.6	.0	.6	.0	4.8	6.4	88.8	11.2
.0	.2	8.2	.0	.4	.0	7.4	1.0	91.6	8.4
.4	.4	6.8	3.0	.2	.0	.0	.0	100.0	.0
.0	.0	1.6	.0	.0	.0	.0	.0	100.0	.0
.4	.4	.0	2.8	.0	.0	.0	.0	100.0	.0
.0	.0	1.6	.6	.0	.4	.0	.0	99.6	.4
.0	.0	.8	1.0	.0	.0	.0	.0	100.0	.0
.0	.0	.2	.0	.0	.0	.2	.6	99.2	.8
Fluvial unit 3 — Continued									
0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.0	99.6	0.4
.0	.2	.0	.8	.0	.0	.0	.0	100.0	.0
.0	.0	.0	1.8	.0	.0	.0	.0	100.0	.0
.2	.0	.0	.0	.0	36.2	.0	.0	63.8	36.2
CHILSON MEMBER — Continued									
Fluvial unit 2 — Continued									
0.0	0.0	1.2	8.0	0.0	0.0	1.2	0.2	98.6	1.4
.2	.0	2.6	3.4	.0	.0	.0	.0	100.0	.0
.4	.0	.0	3.6	.0	.0	.0	.0	100.0	.0
.2	.0	.0	4.6	.0	.0	.0	.0	100.0	.0
.2	.0	1.8	.2	.0	.0	.0	.0	100.0	.0
.0	.0	2.4	.6	.0	.0	.0	.0	100.0	.0
.2	.2	.8	5.2	.0	.0	.8	.2	99.0	1.0
.2	.0	.8	7.8	.0	.0	.4	.0	99.6	.4
.0	.0	.4	1.8	.0	.0	.4	.4	99.2	.8
.0	.0	.2	2.2	.0	.0	.0	.0	100.0	.0
.0	.0	.6	2.6	.0	.0	.0	.0	100.0	.0
.2	.2	2.4	20.8	1.0	.0	10.0	.0	90.0	10.0
.0	.0	1.4	.0	.0	8.4	2.2	.0	89.4	10.6
Fluvial unit 1 — Continued									
0.4	0.0	0.6	0.8	0.0	0.0	0.0	0.0	100.0	0.0
.0	.0	.4	.2	.0	.0	.0	.0	100.0	.0
.0	.0	.0	.6	.0	.0	.2	.0	99.8	.2
.0	.0	.0	.0	.0	.0	.0	.0	100.0	.0
.4	.0	.4	1.0	.0	.0	.0	.0	100.0	.0
.0	.0	.4	.0	.0	.0	.0	.0	100.0	.0
.4	.2	.4	5.6	.2	.0	.0	.2	99.8	.2
.0	.2	.4	3.2	.0	.0	.0	.0	100.0	.0
UNKPAPA SANDSTONE — Continued									
1.2	0.4	0.0	11.2	0.0	0.0	0.0	0.0	100.0	0.0
.4	.0	2.0	18.2	.0	.0	.8	.0	99.2	.8
.4	.0	2.2	6.2	.0	.0	.2	.0	99.8	.2
.0	.0	3.4	7.2	.0	.2	.8	.0	99.0	1.0
.0	.0	1.8	1.4	.0	.0	.4	.0	99.6	.4
.2	.0	2.4	.2	.0	.0	.0	.0	100.0	.0
.0	.0	1.0	.6	.0	.2	.0	.0	99.8	.2
.0	.2	.2	2.4	.0	.0	.0	.0	100.0	.0
.0	.2	5.0	1.8	.0	.0	2.8	.0	97.2	2.8

[3]As authigenic chert.
[4]17.4 percent identified as chlorite.

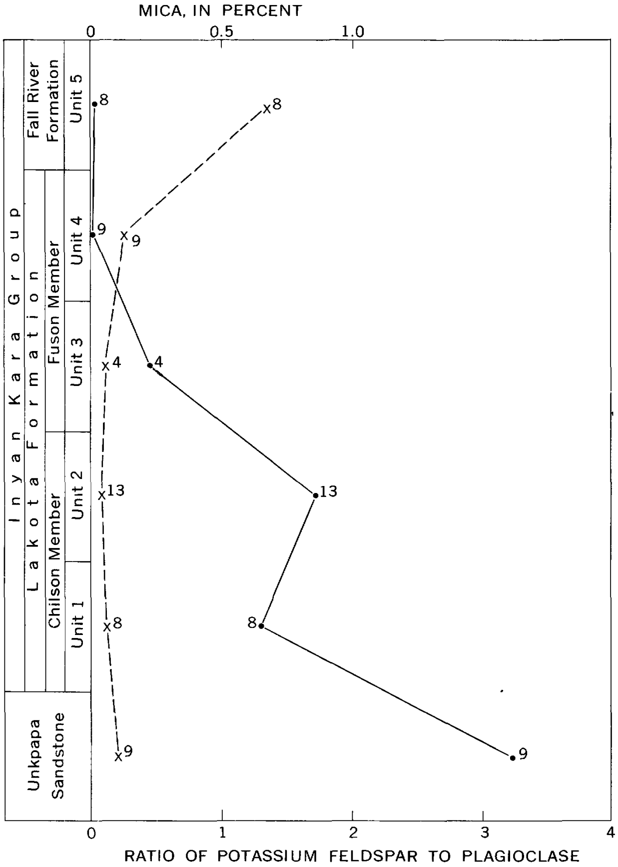

FIGURE 3. — Variation in average mica content (×) and ratio of potassium feldspar to plagioclase (•) by fluvial unit. Number beside symbol indicates number of samples.

table 5 compares mean, standard deviation, and skewness derived by the graphic methods of Inman and Folk with those derived by the method of moments for nine samples of the Unkpapa Sandstone. For all samples shown in table 5, the values of mean grain size are coarsest using Folk's method, intermediate in size using Inman's method, and finest using the method of moments. The standard deviation and skewness for all samples show that Inman's method gives the lowest values, Folk's method gives intermediate values, and the method of moments gives the highest values.

In their study of Jurassic and Cretaceous sandstones, Mapel, Chisholm, and Bergenback (1964) reported the results of grain-size analyses of about 275 samples from 30 localities in the Black Hills; eight of their localities are in the area of this report. They (Mapel and others, 1964, p. C8) used Inman's (1952) method (table 5) for determining standard deviation and skewness and Folk's (written commun., 1955) method (table 5) for determining mean grain size.

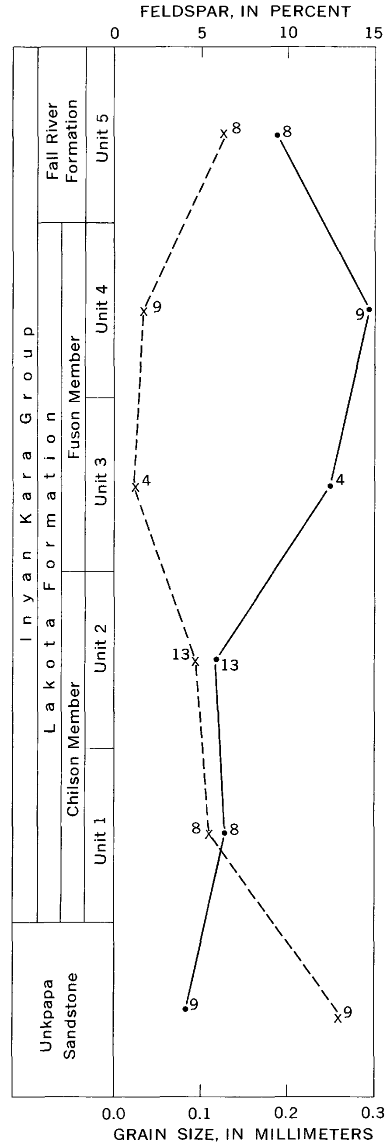

FIGURE 4. — Variation in average percent feldspar (×) and average mean grain size (•) by fluvial unit. Number beside symbol indicates number of samples.

The mean grain sizes of samples used in this report (table 4) range from very coarse sandstone to coarse siltstone; most of them are in the fine to very fine grained sandstone range. The variation in grain size by stratigraphic unit is shown in figure 5. Samples from the Inyan Kara Group are coarser grained than samples from the Unkpapa Sandstone, which are typically very fine grained. Samples from the

TABLE 4. — *Statistical measures of the phi grain-size distribution of samples from the Inyan Kara Group and the Unkpapa Sandstone*

[Sample localities are given in table 2]

Field sample (L–)	Grain size (millimeters)			Standard deviation (phi units)	Skewness (phi units)	Kurtosis (phi units)	Grain-size distribution by percentiles, in ϕ-notation						
	Mean	Mode	Median				P_2	P_5	P_{16}	P_{50}	P_{84}	P_{95}	P_{98}
INYAN KARA GROUP													
Fall River Formation													
Fluvial unit 5													
3287	0.15	0.16	0.18	1.06	2.40	27.15	1.88	1.98	2.17	2.47	2.87	3.81	6.74
3288	.21	.24	.22	.90	2.03	28.59	1.43	1.57	1.77	2.17	2.64	3.20	4.47
3289	.14	.15	.16	1.15	1.80	17.37	1.77	1.92	2.18	2.68	3.25	4.55	6.83
3290	.10	.15	.13	1.29	1.46	10.45	2.18	2.27	2.49	2.92	3.87	5.72	8.07
3291	.29	.49	.46	1.77	1.29	7.90	.22	.55	.72	1.12	2.60	5.43	7.94
3292	.22	.24	.23	.82	2.17	36.36	1.45	1.58	1.79	2.12	2.56	3.40	4.32
3293	.15	.15	.16	.71	2.78	45.50	2.28	2.41	2.51	2.66	3.02	3.69	4.79
3294	.23	.24	.24	.80	1.80	23.82	1.35	1.50	1.71	2.04	2.52	3.15	4.21
Lakota Formation													
FUSON MEMBER													
Fluvial unit 4													
3279	0.24	0.30	0.30	1.49	2.10	20.03	0.85	1.03	1.23	1.76	2.53	3.13	9.49
3280	1.08	.60	.82	2.42	.52	2.82	−8.00	−7.13	−2.63	.28	1.58	2.72	6.52
3281	.25	.30	.29	1.32	1.42	9.42	.15	.34	.96	1.79	2.76	3.39	6.51
3282	.14	.14	.15	1.42	1.20	9.17	1.07	1.23	1.62	2.78	3.66	4.65	7.75
3283	.15	.14	.17	1.18	1.64	16.27	1.45	1.67	1.98	2.54	3.23	4.30	6.49
3284	.13	.15	.16	1.27	2.14	19.75	2.12	2.21	2.35	2.68	3.15	4.87	8.57
3285	.28	.31	.30	.79	1.98	29.98	.93	1.07	1.36	1.74	2.21	2.66	3.86
3286	.19	.26	.22	1.19	1.64	16.57	1.05	1.34	1.68	2.17	2.87	3.90	6.04
3295	.14	.24	.18	1.78	1.39	9.00	1.10	1.33	1.72	2.48	3.55	5.90	10.26
Fluvial unit 3													
3262	0.29	0.23	0.25	1.49	−0.10	3.45	−1.85	−0.57	0.84	1.99	2.67	3.58	4.66
3263	.21	.19	.22	1.32	1.00	10.04	−.04	.45	1.29	2.21	2.90	4.30	4.95
3264	.32	.24	.28	1.61	.31	6.71	−2.22	−1.64	.80	1.81	2.48	3.22	4.81
3265	.16	.17	.19	1.21	2.26	24.17	1.69	1.83	2.07	2.38	2.75	3.86	7.50
CHILSON MEMBER													
Fluvial unit 2													
3266	0.12	0.14	0.15	1.36	2.02	17.82	2.22	2.33	2.53	2.72	3.45	4.64	9.65
3267	.10	.14	.15	1.66	1.40	8.30	1.82	2.06	2.33	2.77	3.95	6.99	10.27
3268	.16	.17	.18	.70	3.25	57.53	1.76	1.92	2.16	2.45	2.82	3.62	4.29
3269	.14	.14	.16	1.33	2.47	24.82	1.97	2.11	2.31	2.62	2.94	3.59	10.08
3270	.12	.14	.14	1.29	1.33	11.37	1.49	1.75	2.19	2.86	3.94	4.77	7.45
3271	.12	.14	.15	1.26	1.84	17.00	1.98	2.19	2.40	2.74	3.78	4.70	7.92
3272	.13	.15	.15	1.10	2.00	21.99	1.80	2.06	2.42	2.76	3.46	4.21	6.55
3273	.08	.08	.09	1.05	2.07	22.80	2.69	2.83	3.03	3.45	3.92	4.74	7.20
3274	.13	.15	.15	1.04	2.06	24.48	1.95	2.08	2.37	2.78	3.54	4.18	5.52
3275	.10	.12	.11	1.06	1.54	17.50	1.87	2.09	2.58	3.20	3.88	4.52	5.50
3276	.12	.15	.15	1.34	1.81	15.66	1.82	2.13	2.46	2.78	3.51	4.67	8.93
3277	.07	.12	.10	1.97	1.11	4.46	2.55	2.67	2.74	3.28	4.74	10.04	10.79
3278	.08	.11	.10	1.59	1.34	8.04	2.33	2.53	2.67	3.27	4.28	7.19	10.20
Fluvial unit 1													
3254	0.06	0.03	0.06	1.29	1.12	8.62	2.61	2.73	3.02	4.04	4.74	5.80	8.77
3255	.10	.11	.10	.76	1.40	21.21	2.38	2.85	2.93	3.30	4.26	4.81	4.98
3256	.14	.14	.15	.84	2.42	35.47	2.02	2.17	2.43	2.76	3.16	3.64	4.43
3257	.09	.08	.09	.72	1.53	23.86	2.60	2.71	2.94	3.45	3.93	4.36	4.75
3258	.15	.16	.17	.97	2.26	29.80	1.72	1.82	2.15	2.54	3.17	3.80	4.80
3259	.18	.18	.20	1.43	1.58	16.74	.87	1.08	1.55	2.29	3.22	4.15	8.25
3260	.10	.05	.10	1.23	1.13	10.45	1.52	1.78	2.15	3.28	4.04	4.79	5.65
3261	.17	.21	.19	1.07	1.88	21.15	1.49	1.65	1.85	2.36	2.97	3.93	5.87
UNKPAPA SANDSTONE													
3245	0.09	0.13	0.12	1.79	1.50	8.16	2.33	2.47	2.60	3.07	3.84	8.63	10.55
3246	.05	.09	.08	1.95	1.13	4.22	2.82	2.97	3.22	3.72	4.97	10.27	10.75
3247	.07	.12	.11	2.23	1.18	4.58	2.54	2.66	2.81	3.22	4.86	10.66	10.95
3248	.08	.12	.12	2.08	1.68	5.85	2.47	2.67	2.74	3.05	3.66	10.55	10.88
3249	.08	.12	.12	1.83	1.52	8.70	2.40	2.59	2.79	3.10	3.73	10.17	10.84
3250	.09	.12	.13	1.96	1.43	7.46	1.93	2.12	2.39	2.99	3.65	10.25	10.81
3251	.08	.13	.13	2.00	1.36	6.56	2.53	2.60	2.68	2.98	3.62	10.30	10.82
3252	.11	.11	.13	1.37	1.97	17.57	2.21	2.49	2.59	2.93	3.44	4.35	10.03
3253	.06	.08	.08	1.79	1.45	7.42	2.78	2.92	3.15	3.56	4.24	10.15	10.75

Chilson Member of the Lakota Formation are generally very fine to fine-grained sandstones, and samples from the Fuson Member are chiefly fine- to medium-grained sandstones. With one exception, all samples from the Fuson are at least as coarse grained as the samples from the Chilson. In fact, pebbles and cobbles are commonly present in the Fuson sandstones but are practically nonexistent in the Chilson sandstones. This provides one criterion for distinguishing between these members. Sandstone samples from the

Fall River Formation are typically fine grained and contain less silt and clay than samples from the Lakota or Unkpapa.

The sorting of sandstones is expressed in terms of phi standard deviations of the grain-size distributions; the higher the values, the poorer the sorting. Cadigan (1959, p. 531) has proposed a classification of sorting in phi units which is as follows: Less than 0.5, very well sorted; 0.5 to 1.0, well sorted; 1.0 to 2.0, moderately well sorted; 2.0 to 4.0, poorly sorted; greater than 4.0, unsorted. According to this scheme, as shown in figure 6 and table 4, all the samples from the Unkpapa Sandstone are moderately well to poorly sorted. Those from the Chilson Member of the Lakota Formation are moderately well to well sorted. Samples from fluvial unit 3 in the Fuson Member of the Lakota are moderately well sorted, and those from fluvial unit 4 are chiefly moderately well sorted. The average sorting in samples from the Lakota Formation (table 6) is best in fluvial unit 1 and becomes progressively poorer in the younger fluvial units. In samples from fluvial unit 5 of the Fall River Formation the average sorting is about equal to that in unit 1.

Skewness is a measure of the asymmetry of the grain-size frequency distribution. It is positive where the particles in the finer half of the distribution are more poorly sorted than particles in the coarser half of the distribution, and it is negative where the coarser half of the grain-size distribution is more poorly sorted than the finer half. All the samples studied have positive skewness except one from fluvial unit 3 of the Fuson Member of the Lakota Formation (table 4), and it has only small negative skewness. The relation between skewness and mean grain size is shown in figure 6.

Kurtosis is a measure of the peakedness of the grain-size distribution. Commonly, high kurtosis values occur in well-sorted distributions, whereas low values occur in the poorly sorted distributions. The grain-size distributions for samples from the Unkpapa Sandstone are only moderately peaked (averaging 7.84), whereas the better sorted grain-size distributions from fluvial units 1 and 2 of the Chilson Member of the Lakota are, respectively, very highly to highly peaked (table 5). Grain-size distributions in the moderately well sorted samples from fluvial units 3 and 4 of the Fuson Member are less peaked than the distributions in samples from the Chilson. As expected, the average grain-size distribution for samples from fluvial unit 5 of the Fall River Formation is very highly peaked (even more highly peaked than the distributions in the Chilson Member).

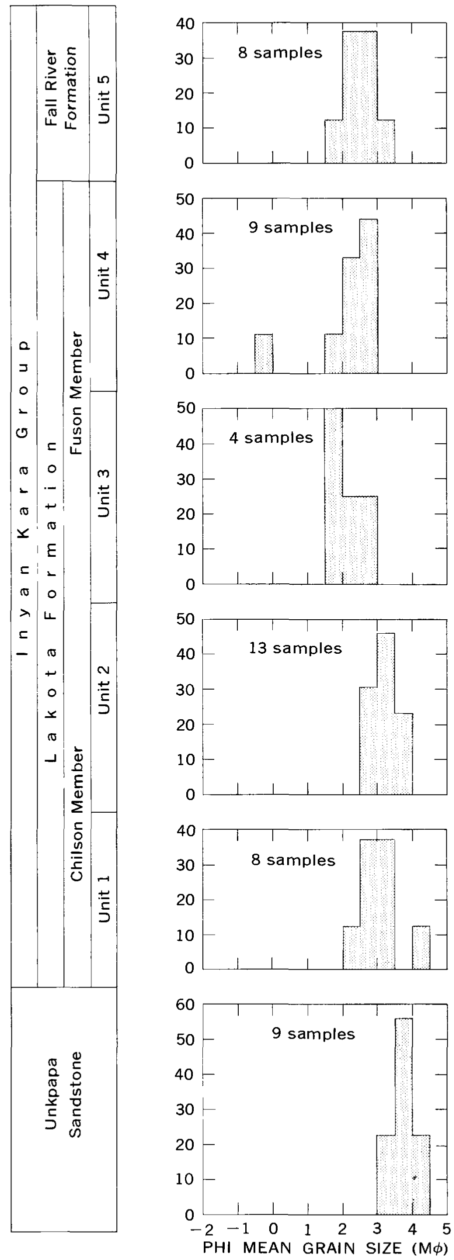

FIGURE 5. — Distributions of phi mean grain sizes of samples from each fluvial unit. The vertical axes represent percent of samples.

The relation of mean grain size to sorting (standard deviation) for each stratigraphic unit reflects the total energy level or tectonic environment of the system and therefore indicates the amount of upwarp of the source area and the amount of subsidence in the area of deposition. This concept, as

TABLE 5. — *Comparison of results of three different methods for determining the phi parameters of the grain-size distribution of samples from the Unkpapa Sandstone*

[All measures are in phi units]

Field sample (L–)	Mean			Standard deviation			Skewness		
	Inman[1]	Folk[2]	Present report[3]	Inman[1]	Folk[2]	Present report[3]	Inman[1]	Folk[2]	Present report[3]
3245	3.22	3.17	3.53	0.62	1.24	1.79	0.24	0.52	1.50
3246	4.10	3.97	4.35	.88	1.55	1.95	.43	.61	1.13
3247	3.84	3.63	3.92	1.02	1.72	2.23	.61	.73	1.18
3248	3.20	3.15	3.63	.46	1.42	2.08	.33	.61	1.68
3249	3.26	3.21	3.55	.47	1.39	1.83	.34	.60	1.52
3250	3.02	3.01	3.48	.63	1.55	1.96	.05	.41	1.43
3251	3.15	3.09	3.55	.47	1.41	2.00	.36	.63	1.36
3252	3.02	2.99	3.15	.42	.49	1.37	.21	.36	1.97
3253	3.70	3.65	4.07	.54	1.37	1.79	.26	.53	1.45

[1]Inman (1952, p. 130) gave the following formulas for determining the phi parameters. The phi values are the grain sizes at the given percentiles:

$$\text{Mean} = \frac{\phi 16 + \phi 84}{2}$$

$$\text{Standard deviation} = \frac{\phi 84 - \phi 16}{2}$$

$$\text{Skewness} = \frac{\phi 16 + \phi 84 - 2\phi 50}{\phi 84 - \phi 16}$$

[2]R. L. Folk (written commun., 1955) gave the following formulas for determining the phi parameters:

$$\text{Mean} = \frac{\phi 16 + \phi 50 + \phi 84}{3}$$

$$\text{Standard deviation} = \frac{\phi 84 - \phi 16}{4} + \frac{\phi 95 - \phi 5}{6.6}$$

$$\text{Skewness} = \frac{\phi 16 + \phi 84 - 2\phi 50}{2(\phi 84 - \phi 16)} + \frac{\phi 5 + \phi 95 - 2\phi 50}{2(\phi 95 - \phi 5)}$$

[3]The phi parameters used in the present report were determined by moment calculations (Krumbein and Pettijohn, 1938; Griffiths, 1967).

TABLE 6. — *Averages of selected properties of sandstones from the Inyan Kara Group and the Unkpapa Sandstone*

ROCK COMPOSITION AND TEXTURE[1]

Stratigraphic unit	Number of samples	Composition[1]					Texture	
		Feldspar (percent)	Potassium feldspar: plagioclase (ratio)	Siliceous grains (percent)	Volcanic grains (percent)	Mica (percent)	Mean grain size (mm)	Sorting ($\sigma\phi$)
Inyan Kara Group:								
Fall River Formation, fluvial unit 5	8	6.1	0.2	86	0.3	0.68	0.19	1.06
Lakota Formation:								
Fuson Member, fluvial unit 4	9	1.4	.1	93	1.0	.12	.29	1.43
fluvial unit 3	4	1.0	.4	92	5.7	.05	.25	1.40
Chilson Member, fluvial unit 2	13	4.6	1.7	88	1.0	.03	.11	1.29
fluvial unit 1	8	5.3	1.3	88	4.0	.05	.12	1.04
Unkpapa Sandstone	9	12.7	3.2	78	1.4	.09	.08	1.89

HEAVY MINERALS[2]

Stratigraphic unit	Number of samples	Zircon plus tourmaline (percent)	Angular zircon plus angular tourmaline (percent)	Garnet (percent)	Anatase plus leucoxene (percent)	Other grains[3] (percent)
Inyan Kara Group:						
Fall River Formation, fluvial unit 5	12	32	11	1	58	2
Lakota Formation:						
Fuson Member, fluvial unit 4	13	34	9	1	57	1
fluvial unit 3	7	41	5	3	50	2
Chilson Member, fluvial unit 2	27	51	3	2	42	2
fluvial unit 1	13	47	8	2	41	5
Unkpapa Sandstone	6	44	4	14	22	15

[1]Based on thin-section modal-composition data.
[2]Based on heavy-mineral grain counts.
[3]Dominantly black opaques.

presented by Cadigan (1961), is the basis for interpretations of tectonic activity during the Early Cretaceous which are given later in this report. Briefly, the tectonic concept recognizes that crustal upwarp provides a stream gradient (that is, energy) for the transport of sediment from the source area to the

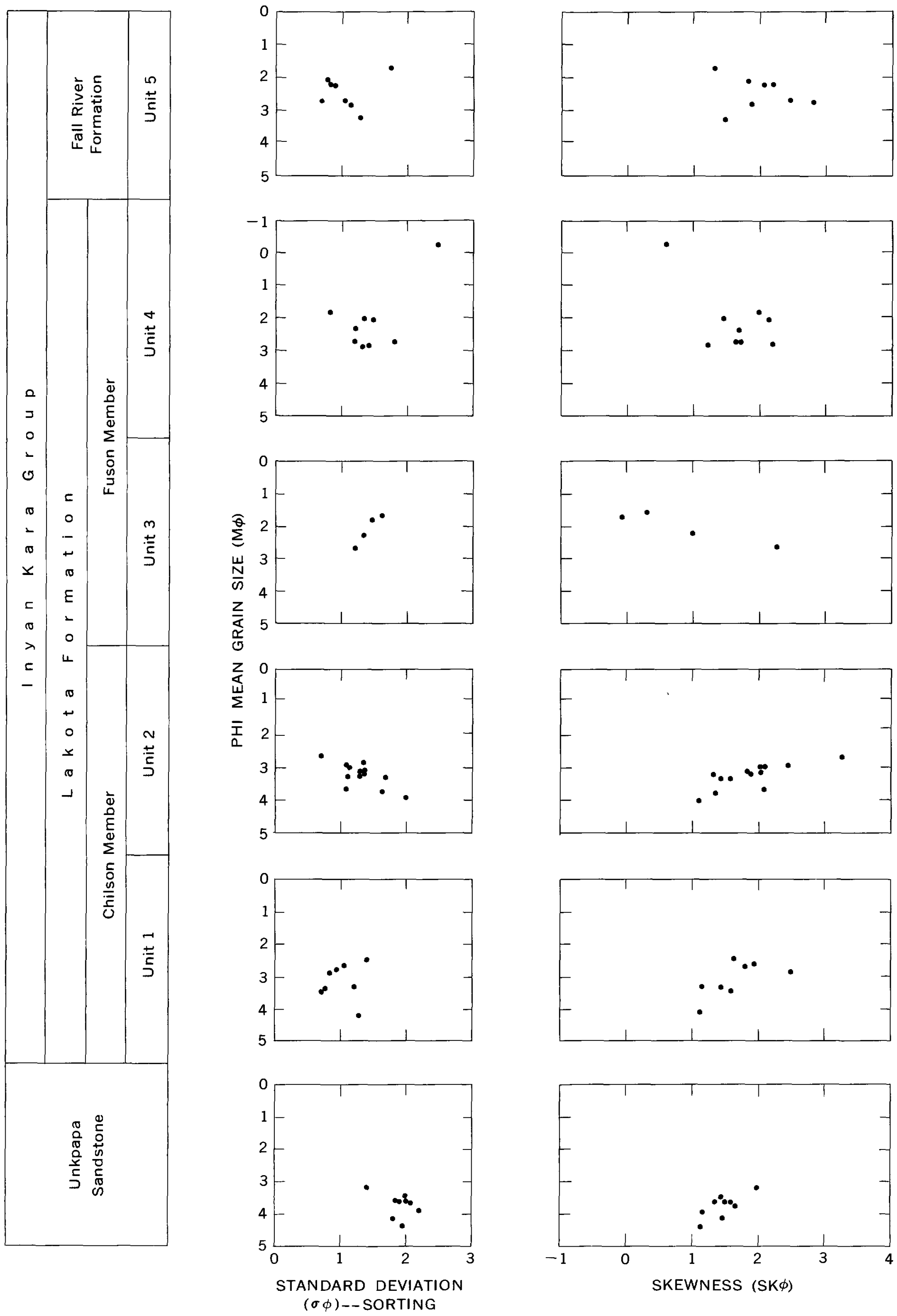

FIGURE 6. — Phi mean grain size measures plotted over phi standard deviation (sorting) measures and over skewness measures of grain-size distributions of samples of sandstone and coarse siltstone from the Inyan Kara Group and the Unkpapa Sandstone.

site of deposition and provides energy for reworking and sorting of the sediment. The grain size of the sediment is limited by the level of available energy. Deposition from streams occurs as the stream gradient (and energy of transport) decreases. Where subsidence is rapid along a stream profile, deposition may be both rapid and permanent, but where subsidence is slow, sedimentary deposits may be exposed to much reworking and sorting.

Values of skewness, kurtosis, and standard deviation are indicators of the amount of reworking and sorting during deposition. According to Cadigan (1961, p. 137), high skewness and kurtosis values indicate

> that a large amount of reworking has taken place in and adjacent to the point of deposition of the sample. High kurtosis values * * * combined with very fine grain size indicate low-energy-level reworking. High kurtosis values * * * combined with fine to medium grain size indicate high-energy-level reworking. Either high- or low-energy-level reworking would be indicative * * * that the supply [of material] is below the transporting capacity of the geologic agent in the area of deposition, and that deposition (and subsidence) is taking place at a slow rate.

Therefore, we conclude that sands of the Unkpapa originated from source areas having low tectonic uplift and that rapid subsidence in the southern Black Hills caused a high rate of deposition and little reworking of the sediment. Low tectonic uplift occurred in source areas contributing sediment for fluvial units 1 and 2, and in the slowly subsiding area of the southern Black Hills a low rate of deposition enabled low-energy-level reworking of these sediments before burial. The source areas of sediment for fluvial units 3 and 4 were moderately uplifted causing some high-energy-level reworking before rapid deposition and burial. Source areas for fluvial unit 5 remained relatively high, and much moderate-energy-level reworking and sorting of sediment occurred before final deposition.

HEAVY MINERALS

Heavy-mineral grain counts were made for 78 samples. Grains were separated from the 0.043- to 0.297-mm size fraction because we thought that this size range would yield the greatest variety of readily identifiable minerals. The heavy-mineral content of the samples studied was commonly a few tenths of 1 percent by weight but ranged from 0.02 to 1.32 percent. Grain mounts were made for each sample, and counts were made by traversing each mount along lines 1–2 mm apart and counting all grains that came under the crosshairs. For nearly all samples a minimum of 100 nonopaque grains were counted and a minimum total of 300 opaque plus nonopaque grains. The percentage composition of the detrital-heavy-mineral suites for all samples is shown in table 7. For purposes of deciding whether authigenic or epigenetic minerals were derived from detrital or secondary minerals, the following arbitrary assumptions were made. Anatase and leucoxene probably formed from detrital titanium heavy minerals and were therefore counted. Many, if not most, hematite grains are pseudomorphous after pyrite and were therefore not counted as detrital components. Authigenic barite and pyrite were also excluded, as they are clearly not detrital.

Zircon, tourmaline, and anatase plus leucoxene form the bulk of detrital or detritally derived heavy minerals in the Inyan Kara Group and the Unkpapa Sandstone. Figure 7 shows the average percentages of the minerals by unit. The suites of heavy minerals from all units are very similar and constitute a chemically stable assemblage.

In the units sampled, the proportions of zircon and tourmaline combined range from 16 to 73 percent of total heavy minerals, but most samples contain 30–50 percent (table 7). Zircon is generally more abundant than tourmaline. In the Inyan Kara Group proportions of anatase plus leucoxene range from 22 to 81 percent of the total heavy minerals, but most samples contain 40–60 percent. In contrast, the Unkpapa samples contain less than 30 percent anatase plus leucoxene and average about 22 percent. Garnet is present in amounts less than 5 percent in most Inyan Kara samples but is more abundant in the Unkpapa, where it averages 14 percent. Rutile and staurolite are minor constituents in samples of all units, but staurolite locally constitutes more than 10 percent in fluvial units 4 and 5. Black opaque minerals and miscellaneous grains compose as much as 5 percent of the heavy minerals in samples from the Inyan Kara but average about 15 percent for the Unkpapa.

In their study, Mapel, Chisholm, and Bergenback (1964, p. C23, C30) recognized three fairly consistent nonopaque heavy-mineral zones in sandstones from Jurassic and Cretaceous formations of the Black Hills. The lower zone includes the Hulett Sandstone and Redwater Shale Members of the Sundance Formation, the lower part of the Morrison Formation, and locally the lower part of the Unkpapa Sandstone, all Late Jurassic age. This zone is characterized by having a garnet content averaging 30 percent of the nonopaque minerals. The middle zone consists of the upper part of the Morrison Formation, most of the Unkpapa Sandstone, and, in the southern Black Hills, all the Lakota Formation. This zone is characterized by the dominance of rounded zircon and tourmaline and by a much lesser amount of garnet, which generally forms less than 5 percent

TABLE 7. — *Percentage composition of the heavy-mineral suite in the 0.043- to 0.297-mm size fraction of samples from the Inyan Kara Group and the Unkpapa Sandstone as determined by mineral grain counts*

[0 indicates mineral not found; X indicates mineral present in amounts less than 1 percent. Sample localities are given in table 2]

Field sample (L–)	Zircon			Tourmaline			Zircon and tourmaline			Garnet	Rutile	Staurolite	Anatase and leucoxene	Other[1]	Grains counted
	Angular grains	Rounded grains	Total	Angular grains	Rounded grains	Total	Angular grains	Rounded grains	Total						
INYAN KARA GROUP															
Fall River Formation															
Fluvial unit 5															
3379	3	10	13	7	8	15	10	18	28	X	2	1	68	X	364
3380	3	6	9	7	10	17	10	16	26	0	2	5	66	X	371
3381	0	9	9	9	0	9	9	9	18	2	0	4	68	7	[2]44
3382	3	15	18	8	6	14	11	21	32	0	2	X	63	2	[2]124
3383	8	24	32	3	6	9	11	30	41	3	5	X	50	1	279
3384	9	14	23	6	3	9	15	17	32	X	2	2	55	8	257
3385	4	8	12	9	17	26	13	25	38	2	3	23	32	2	170
3386	4	12	16	5	12	17	9	24	33	3	4	2	57	X	316
3387	1	11	12	8	8	16	9	19	28	0	3	9	56	4	330
3388	5	19	24	5	8	13	10	27	37	0	5	2	54	2	324
3389	1	21	22	5	6	11	6	27	33	0	5	X	59	3	274
3390	3	4	7	8	10	18	11	14	25	0	2	X	69	1	397
Average	4	13	17	7	8	15	11	21	32	1	3	4	58	2	......
Lakota Formation															
FUSON MEMBER															
Fluvial unit 4															
3366	1	9	10	5	5	10	6	14	20	0	X	2	77	0	461
3367	4	15	19	6	11	17	10	26	36	0	4	X	59	1	301
3368	2	25	27	6	14	20	8	39	47	0	2	9	40	2	251
3369	5	14	19	12	11	23	17	25	42	0	3	3	50	2	252
3370	2	16	18	3	8	11	5	24	29	0	2	10	56	3	241
3371	X	4	4	5	16	21	5	20	25	0	2	31	38	4	299
3372	4	32	36	1	27	28	5	59	64	X	1	X	33	X	302
3373	5	23	28	4	4	8	9	27	36	2	4	X	56	X	237
3374	4	7	11	6	6	12	10	13	23	3	0	5	67	1	265
3375	4	11	15	6	15	21	10	26	36	3	1	1	58	1	306
3376	4	16	20	6	5	11	10	21	31	6	1	2	58	2	341
3377	4	7	11	9	9	18	13	16	29	0	4	X	66	X	334
3378	1	9	10	5	7	12	6	16	22	0	X	2	73	2	478
Average	3	15	18	6	10	16	9	25	34	1	2	5	57	1	......
Fluvial unit 3															
3331	2	10	12	1	3	4	3	13	16	X	X	X	81	1	553
3332	3	32	85	1	8	9	4	40	44	3	1	3	47	2	262
3333	1	17	18	1	8	9	2	25	27	3	1	2	67	X	362
3334	5	32	37	1	13	14	6	45	51	7	3	2	35	2	167
3338	1	20	21	2	8	10	3	28	31	4	X	4	59	X	337
3350	3	23	26	3	25	28	6	48	54	4	3	4	32	3	243
3399	3	40	43	2	14	16	5	54	59	X	3	6	28	4	220
Average	3	25	28	2	11	13	5	36	41	3	1	3	50	2	......
CHILSON MEMBER															
Fluvial unit 2															
3339	3	34	37	0	23	23	3	57	60	2	1	1	34	2	348
3340	3	16	19	0	12	12	3	28	31	1	2	2	61	3	310
3341	6	41	47	2	11	13	8	52	60	10	3	X	26	1	263
3343	2	30	32	1	18	19	3	48	51	3	2	1	41	2	302
3344	1	22	23	1	27	28	2	49	51	2	X	1	45	1	284
3346	1	26	27	4	24	28	5	50	55	2	3	X	39	X	230
3347	0	15	15	2	19	21	2	34	36	3	1	2	58	X	281
3348	1	22	23	2	22	24	3	44	47	2	3	1	45	2	330
3349	3	19	22	2	35	37	5	54	59	4	2	X	33	1	321
3352	2	17	19	2	21	23	4	38	42	2	2	2	48	4	344
3353	2	18	20	1	31	32	3	49	52	2	2	1	41	2	293
3354	4	26	30	0	21	21	4	47	51	X	3	3	42	1	302
3355	2	26	28	0	23	23	2	49	51	X	1	4	38	6	229
3356	1	20	21	1	17	18	2	37	39	X	4	X	54	3	282
3357	3	24	27	0	19	19	3	43	46	5	1	1	45	2	304
3358	2	26	28	1	23	24	3	49	52	4	2	4	34	4	231
3359	4	31	35	X	19	19	4	50	54	3	4	0	34	5	354
3360	2	41	43	1	18	19	3	59	62	0	2	1	23	12	177
3361	3	20	23	1	29	30	4	49	53	2	2	X	42	1	294
3362	X	28	28	0	24	24	X	52	52	1	2	X	41	4	268
3363	3	29	32	0	31	31	3	60	63	0	2	X	32	2	299
3364	4	41	45	1	16	17	5	57	62	0	3	0	31	4	310
3365	2	31	33	2	20	22	4	51	55	4	2	X	37	2	374
3395	2	37	39	3	24	27	5	61	66	0	3	0	31	0	[3]116
3396	1	3	4	1	24	25	2	27	29	X	2	2	66	X	319
3397	0	49	49	0	22	22	0	71	71	0	1	5	23	0	[3]83
3398	1	11	12	2	22	24	3	33	36	X	2	6	55	X	123
Average	2	26	28	1	22	23	3	48	51	2	2	1	42	2	......

TABLE 7. — *Percentage composition of the heavy-mineral suite in the 0.043- to 0.297-mm size fraction of samples from the Inyan Kara Group and the Unkpapa Sandstone as determined by mineral grain counts* — Continued

Field sample (L–)	Zircon			Tourmaline			Zircon and tourmaline			Garnet	Rutile	Staurolite	Anatase and leucoxene	Grains counted	Other[1]
	Angular grains	Rounded grains	Total	Angular grains	Rounded grains	Total	Angular grains	Rounded grains	Total						
INYAN KARA GROUP — Continued															
Lakota Formation — Continued															
CHILSON MEMBER — Continued															
Fluvial unit 1															
3319	2	8	10	5	7	12	7	15	22	0	4	X	68	5	366
3320	6	15	21	6	12	18	12	27	39	8	2	1	27	23	200
3321	5	16	21	1	14	15	6	30	36	X	5	X	54	4	316
3322	2	13	15	0	37	37	2	50	52	4	X	3	40	1	212
3323	5	30	35	X	16	16	5	46	51	X	8	0	36	5	295
3325	5	36	41	1	13	14	6	49	55	5	3	X	31	6	333
3326	4	29	33	2	20	22	6	49	55	4	3	1	35	2	284
3329	2	7	9	4	14	18	6	21	27	0	3	0	65	5	319
3330	7	25	32	4	18	22	11	43	54	6	3	4	30	3	310
3335	10	20	30	8	4	12	18	24	42	0	4	0	45	4	277
3336	3	24	27	6	23	29	9	47	56	0	4	1	36	3	194
3337	4	56	60	2	11	13	6	67	73	X	3	X	22	2	284
3394	1	19	20	4	22	26	5	41	46	2	3	X	46	2	357
Average	4	23	27	4	16	20	8	39	47	2	4	1	41	5	......
UNKPAPA SANDSTONE															
3313	3	15	18	2	12	14	5	27	32	6	1	3	23	35	216
3314	3	18	21	1	29	30	4	47	51	10	2	1	29	7	259
3315	1	22	23	1	30	31	2	52	54	8	1	6	28	3	296
3316	6	35	41	1	9	10	7	44	51	13	5	0	28	3	341
3317	2	16	18	0	10	10	2	26	28	18	1	1	9	43	309
3318	X	21	21	0	25	25	X	46	46	33	X	3	16	X	312
Average	3	21	24	1	19	20	4	40	44	14	2	3	22	15	......

[1]Black opaque minerals, biotite, monazite(?), and spinel(?).
[2]Less than 100 nonopaque grains counted because sample was predominantly iron oxide.
[3]Less than 100 nonopaque grains listed because authigenic barite (counted but not listed) more abundant than total of all other nonopaque minerals.

of the nonopaque suite. The upper zone, in the southern Black Hills, consists of the Fall River Formation and the Newcastle Sandstone. It is characterized by predominantly angular grains of zircon and tourmaline. The results of the present study agree rather well with the conclusions of Mapel, Chisholm, and Bergenback (1964), but the results of the two studies cannot be compared directly. In the present study, detrital opaque heavy minerals as well as nonopaque minerals were included, and the 0.043- to 0.297-mm size fraction was used. Mapel, Chisholm, and Bergenback (1964) confined their study to nonopaque heavy minerals, mostly in the 0.062- to 0.125-mm size fraction. The first factor lowers the percentages of the nonopaque heavy minerals listed in the present report; the second factor, which includes larger grain sizes, probably accounts for the greater percentage of rounded grains of the zircon and tourmaline listed in this report. Mapel, Chisholm, and Bergenback (1964, fig. 12) showed that of the combined zircon and tourmaline grains in the 0.062- to 0.125-mm size fraction, a line drawn at 40 percent angular grains separates 92 percent of the Fall River samples from 91 percent of the Lakota samples, with the Fall River Formation containing the most angular grains. A somewhat similar division can be made in the present study. Figure 8 shows the percentage of angular grains of the zircon and tourmaline. A line drawn at 26 percent angular grains separates 92 percent of the Fall River samples from 82 percent of the Lakota samples. The difference between the 26-percent versus 40-percent division is probably the result of greater rounding of coarser grains and differences in operator judgment. All the samples from the Unkpapa Sandstone contain less than 20 percent angular zircon and tourmaline grains. The samples from fluvial unit 4 in the upper part of the Lakota contain a greater percentage of angular zircon and tourmaline grains than samples from older units in the Lakota and are more similar to the samples from the Fall River Formation. This is in agreement with the findings by Mapel, Chisholm, and Bergenback (1964, fig. 12).

SOURCE OF SAND AND THE INFLUENCE OF TECTONIC ACTIVITY UPON DEPOSITION OF LOWER CRETACEOUS SEDIMENTARY MATERIALS

The sandstones that have been sampled have a considerable variation in the composition of the nonsiliceous fraction, the heavy-mineral fraction, and the mean grain size. In general these variations constitute detrital assemblages that characterize the Unkpapa Sandstone, units 1 and 2, units 3 and 4, and unit 5, but some assemblages overlap these stratigraphic units.

The assemblages of characteristic minerals that have been determined by the petrographic study are

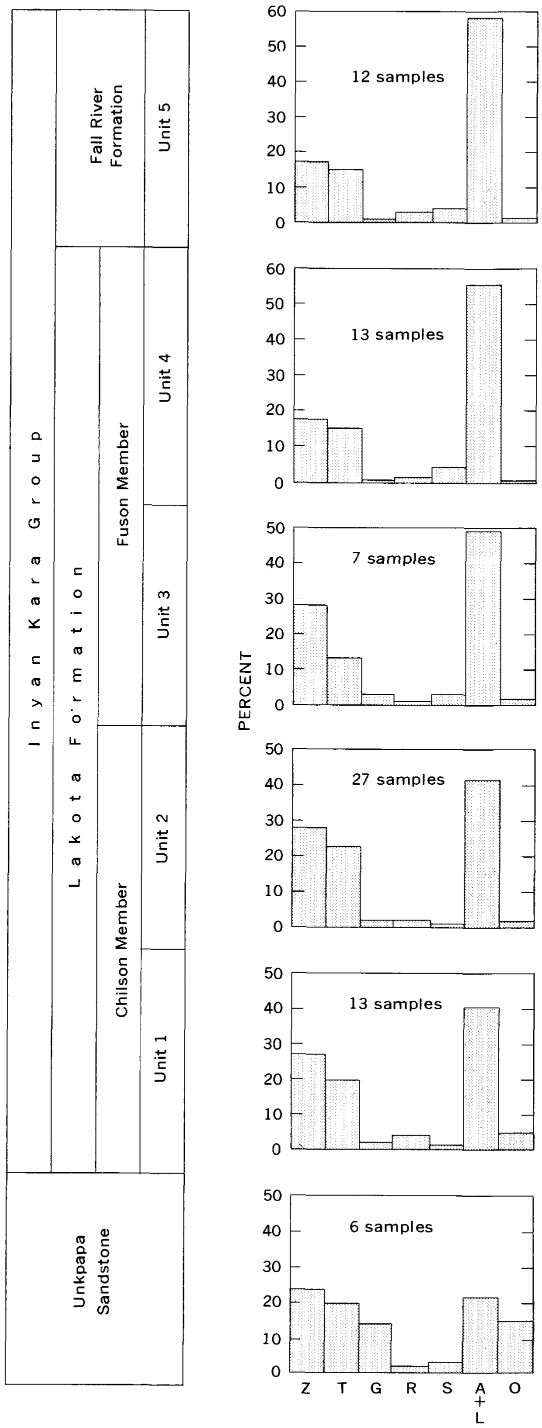

FIGURE 7. — Average percentage composition of heavy-mineral suites in samples from sandstone units in the Inyan Kara Group and the Unkpapa Sandstone. Z, zircon; T, tourmaline; G, garnet; R, rutile; S, staurolite; A + L, anatase plus leucoxene; O, other minerals.

shown in table 8. The data show that the Unkpapa Sandstone is characterized by a very fine grained sandstone and siltstone containing more garnet and feldspar, having a higher potassium-feldspar–plagioclase ratio, and containing less anatase and leucoxene and generally less angular tourmaline than the sandstones of the Inyan Kara Group. Units 1 and 2 contain more rounded and less angular tourmaline and zircon than does unit 5 in the Fall River Formation. Fluvial unit 5 contains much more mica than do the older units, and fluvial unit 3 contains an abnormally high amount of chert and silicified limestone. In general, however, the mineral assemblages of units 3 and 4 of the Fuson Member are transitional in composition between the assemblages of the Chilson Member of the Lakota and those of the Fall River.

All these assemblages are generally similar to assemblages described by Mackenzie and Poole (1962, p. 62–71). From a study of the Dakota Sandstone in the Western Interior, which includes equivalents of the Inyan Kara Group, they found two suites of detrital minerals diagnostic of source areas. (1) The eastern suite, relative to the western suite, contains more feldspar, muscovite, chlorite, chloritoid, angular tourmaline, and heavy minerals in general and contains less chert. They concluded that most of the sandstones were probably derived from the Canadian Shield. (2) The western suite of detrital minerals was derived primarily from pre-Cretaceous sedimentary rocks of the Cordilleran region to the west.

Similar detrital mineral suites are present in the Lakota and Fall River sandstones in the southern Black Hills. By analogy it would appear that these sandstones also were derived from eastern and west-

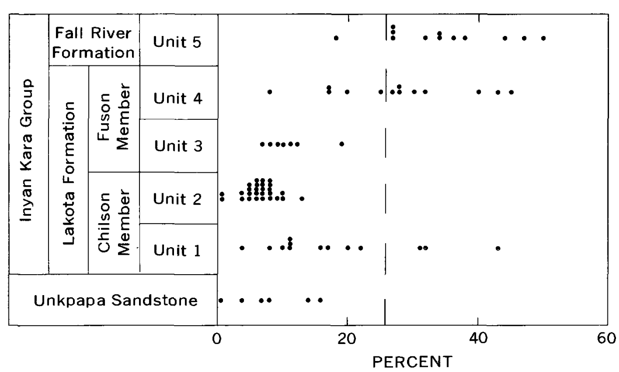

FIGURE 8. — Proportion of angular grains in combined zircon and tourmaline varieties for each of 76 samples (0.043- to 0.297-mm size fraction) from six sandstone units in the Inyan Kara Group and the Unkpapa Sandstone. Each dot represents one sample.

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TABLE 8. — *Average percentage of selected minerals in samples from the Inyan Kara Group and the Unkpapa Sandstone*

[High, intermediate, and low percentages for each column were determined by equal interval grouping of log values for the range in each column]

Formation, member, and group			Fluvial unit	Garnet—Percentage of heavy minerals	Total feldspar	Plagioclase	Potassium feldspar	Rounded tourmaline (Percentage of heavy minerals)	Rounded zircon (Percentage of heavy minerals)	Rounded zircon + rounded tourmaline (Percentage of heavy minerals)	Total zircon + total tourmaline (Percentage of heavy minerals)	Total zircon (Percentage of heavy minerals)	Volcanic grains	Chert and silicified limestone	Anatase + leucoxene (Percentage of heavy minerals)	Angular zircon + angular tourmaline (Percentage of heavy minerals)	Angular tourmaline (Percentage of heavy minerals)	Angular zircon (Percentage of heavy minerals)	Mica	
Inyan Kara Group	Fall River Formation			12 samples	8 samples			12 samples					8 samples		12 samples				8 samples	
			Fluvial unit 5	1 (0-3)	6.1 (2.0-11.6)	4.9 (1.6-10.6)	1.2 (0-2.8)	8 (3-17)	13 (4-24)	21 (9-30)	32 (18-41)	17 (7-32)	0.3 (0-0.6)	0.68 (0-1.6)	58 (32-69)	11 (6-15)	7 (3-9)	4 (0-9)	0.68 (0-2.8)	
	Lakota Formation	Fuson Member		13 samples	9 samples			13 samples					9 samples		13 samples				9 samples	Transitional mineral assemblages
			Fluvial unit 4	1 (0-6)	1 4 (0.2-2.8)	1.3 (0 2-2.8)	0.1 (0-1)	10 (4-27)	15 (4-32)	25 (13-59)	34 (20-64)	18 (4-36)	1 (0-4)	2.3 (0-13.8)	57 (33-77)	9 (5-17)	6 (1-12)	3 (X-5)	0.12 (0-0.4)	
				7 samples	4 samples			7 samples					4 samples		7 samples				4 samples	
			Fluvial unit 3	3 (X-7)	1 (0.2-2.4)	0.7 (0.2-1.6)	0.3 (0-0.8)	11 (3-25)	25 (10-40)	36 (13-54)	41 (16-59)	28 (12-43)	5.7 (3.6-6.6)	22.4 (2.4-77.2)	50 (28-81)	5 (2-6)	2 (1-3)	3 (1-5)	0.05 (0-0.2)	
		Chilson Member		27 samples	13 samples			27 samples					13 samples		27 samples				13 samples	
			Fluvial unit 2	2 (0-10)	4.6 (1.2-12.6)	1.7 (0.2-5.2)	2.9 (0-7.4)	22 (11-35)	26 (3-49)	48 (28-71)	51 (29-71)	28 (4-49)	1 (0.2-2.2)	1.35 (0-4.4)	42 (23-66)	3 (0-8)	1 (0-4)	2 (0-6)	0.03 (0-0.2)	
				13 samples	8 samples			13 samples					8 samples		13 samples				8 samples	
			Fluvial unit 1	2 (0-8)	5 3 (1.2-15)	2.0 (0.4-7.6)	3.1 (0.6-7.4)	16 (4-37)	23 (7-56)	39 (15-67)	47 (22-73)	27 (9-60)	4 (0.4-12.2)	0.55 (0-1.6)	41 (22-68)	8 (2-18)	4 (0-8)	4 (1-10)	0 05 (0-0.2)	
Unkpapa Sandstone				6 samples	9 samples			6 samples					9 samples		6 samples				9 samples	
				14 (6-33)	12.7 (1.8-19)	3 (0.6-5.2)	9.7 (0-13.8)	19 (9-30)	21 5)	40 (26-52)	44 (28-54)	24 (18-41)	1.4 (0-3)	0.066 (0-0.2)	22 (9-29)	4 (X-7)	1 (0-2)	3 (X-6)	0.09 (0-0.4)	

EXPLANATION

- High percentage
- Intermediate percentage
- Low percentage
- 3 — Average mineral percentage for stratigraphic unit
- (9-30) — Range of mineral percentage for each stratigraphic unit
- X — Indicates mineral present in amounts less than 1 percent

ern source areas. The detailed mapping that has been done in the southern Black Hills, however, permits a more detailed account of the stratigraphic distribution of the detrital mineral assemblages than could be given by Mackenzie and Poole.

If we assume that the sandstones making up the Unkpapa Sandstone and the sandstones of the Lakota and Fall River Formations were derived from eastern and western source areas and if we utilize the same criteria to identify the sandstones that were derived from each area, then the depositional history can be surmised.

In Late Jurassic time an eastern source area was subjected to minor tectonic uplift and erosion. Sands with an eastern suite of minerals eroded largely from sedimentary rocks exposed toward the east were redeposited to form the Unkpapa Sandstone of the southeastern Black Hills while finer sedimentary material was being deposited to the west. This material was in part derived from the area east of the zero isopach shown in figure 9.

At the begining of Cretaceous time mild regional uplift accompanied by volcanic activity apparently occurred west of the Black Hills area, possibly to the southwest in central Colorado, and contributed tuff, ash, and felsite to sandstones of fluvial unit 1 of the

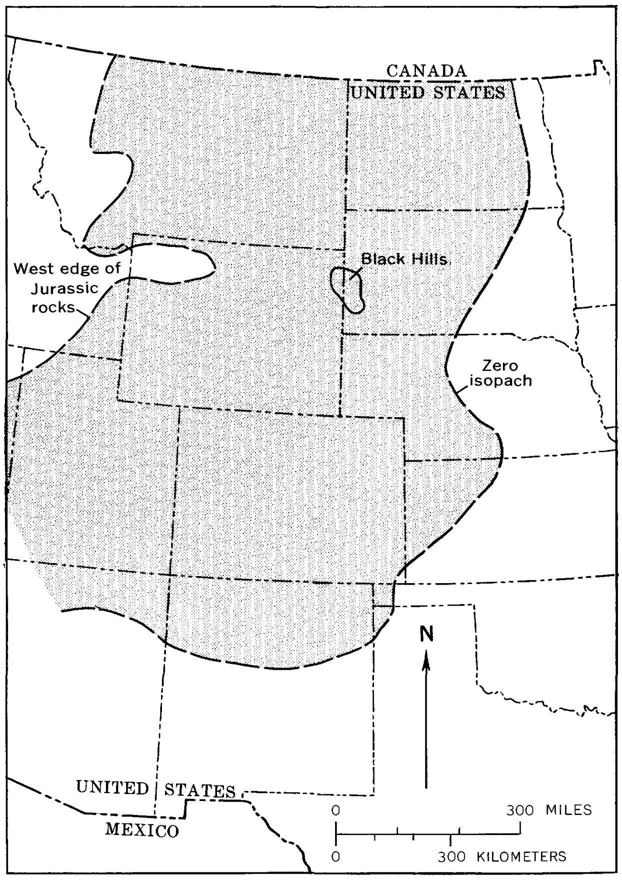

FIGURE 9. — Probable minimum extent of Jurassic rocks (patterned) in the Western Interior region at the end of the Jurassic Period (modified from McKee and others, 1956, pl. 1).

Chilson Member. A contribution from the western source is suggested by the increased chert and decreased mica content of the sandstones. Erosion proceeded simultaneously in eastern South Dakota. Subsidence and deposition by streams along the axis of the Black Hills syncline as described by Bolyard and McGregor (1966) was not as rapid during early Chilson time as during Late Jurassic time; thus, more low-energy reworking and sorting of sediments occurred before burial.

While the sands of fluvial unit 2 were being deposited during late Chilson time, volcanic and tectonic activity was relatively quiescent. This resulted in the deposition of less volcanic material and little change in the grain size of the sand — that is, little change in the energy level of the streams. The proportion of western-suite minerals, including rounded zircon and tourmaline, increased during Chilson time as subsidence shifted the Early Cretaceous syncline eastward and the eastern source areas either were eroded to low topographic relief or were slightly depressed.

At the end of Chilson time renewed tectonic activity caused minor uplift locally along northeast-trending structures (discussed in the structure section). This minor local tectonic adjustment possibly was related to a renewal of uplift to the west, which is indicated by the composition of younger fluvial deposits in the lower part of the Fuson Member. Several lakes were formed, apparently as a result of the tectonic activity, and evaporation of lake waters rich in calcium bicarbonate and calcium sulfate caused precipitation of the Minnewaste Limestone Member of the Lakota.

The Fuson Member is composed mostly of lacustrine mudstones and sandstones, but it also contains the crossbedded sandstones of fluvial units 3 and 4. These sandstones probably were deposited at energy levels generally greater than those at which the other fluvial sandstones of the Inyan Kara were deposited, although the sandstone of fluvial unit 3 locally exhibits foreset bedding suggesting deltaic deposition (Cuppels, 1963). Similarly, the alternating tabular sets of horizontal and cross stratification found in the sandstone of unit 4 (Ryan, 1964) suggest that some of the sandstone was deposited as local deltaic or lacustrine deposits. The paradox of simultaneous high- and low-energy-level deposition probably results indirectly from tectonic activity, which was strongest at the beginning and at the close of Fuson time.

We postulate that, at the end of Minnewaste time, stream erosion or tectonic activity breached natural dams formed by uplift along northeast-trending structures and released large volumes of water stored in the lakes. This release of water, which in some places may have been catastrophic, probably was coupled with relatively high rates of flow. Stream gradients were steepened by local uplift, and channels locally were incised through the Morrison and into the Redwater Shale Member of the Sundance Formation.

The Fuson Member is characterized by mineral assemblages that are transitional in composition between assemblages of the Chilson Member, which contain a large percentage of western-suite minerals, and the assemblage of fluvial unit 5 of the Fall River, which contains an abundance of eastern-suite minerals. This transition is also evident within the Fuson, between the mineral assemblage of fluvial unit 3 in the lower part of the Fuson and the assemblage of fluvial unit 4 in the upper part of the member.

Deposition in fluvial unit 3 is characterized by an abundance of western-suite minerals. Chert commonly ranging in grain size from sand to pebble size is especially abundant. Chert grains may have been derived either from distant sources or from Paleozoic sediments, but the larger chert pebbles probably were derived from local sources including chert lenses in the basal Fuson Member, the Minnewaste Limestone Member, and the Sundance Formation. Other silicified material, consisting of petrified wood and silica-cemented sand and silt from the Lakota, probably is included in the siliceous material of fluvial unit 3. A high percentage of volcanic grains indicates that volcanic activity accompanied a renewed uplift of the western source areas. The limited contribution of sediments of the eastern suite is marked by a low feldspar content and by a clay matrix that contains very little kaolinitic clay but much illitic and mica clay.

Toward the end of Fuson time the eastern source area contributed much sediment to the sandstone of fluvial unit 4. Volcanic material, rounded zircon, and chert are less abundant in this sandstone than in the older fluvial unit 3, whereas the mica content and the proportion of kaolinite to total clay are greater. The uplift of the eastern source areas may have been related to local deformation which shifted the axis of the Black Hills syncline to the west and caused the stream channel of fluvial unit 4 to migrate slightly westward in some areas. This shift of the channel is reflected by the maximum scouring of the channel and the maximum thickness of the fluvial sandstone at the southwest side of the paleodrainage, and by a noticeable thinning of the sandstone at the northeast side of the drainage (Gott and Schnabel, 1963, pl. 13).

By Middle Fall River time the eastern source areas supplied most of the sediment to the southern Black Hills area. Paleocurrent directions in sandstone of fluvial unit 5 in the southeastern Black Hills suggest a streamflow from the east and southeast which deposited much plagioclase feldspar and abundant angular tourmaline and zircon. Corresponding decreases in the abundance of rounded tourmaline and zircon and in the percentage of volcanic grains confirm the decrease in sediment from western source areas. The continued low garnet content in the sediments indicates that significant amounts of garnet were not eroded from the outcrops of Precambrian rocks in the eastern source area at this time.

STRUCTURE

The Black Hills uplift consists of an arcuate north- to northwest-trending dome-shaped anticline that is surrounded by the Missouri Plateau (Fenneman, 1931, p. 79). The mapped area included in the present report has about 6,000 feet of structural relief and lies across the south end of the uplift (pl. 1). The area may be divided into three parts — eastern, central, and western parts — each having a different structural character. (1) The eastern part of the mapped area is folded into three relatively large sinuous south-plunging anticlines and several smaller anticlines (pl. 2) which shape the south end of the uplift. The Black Hills gravity axis coincides with the Chilson anticline 5 miles east of Edgemont, S. Dak. Nearly all the anticlines are asymmetric, having a gentle southeast-dipping flank, a steep west-dipping flank, and a parallel syncline lying about 1 mile west of the crest (pl. 1). The west side of this folded area is bounded by the south-plunging Sheep Canyon monocline along the flank of the Chilson anticline. (2) The central part of the mapped area consists of the southwest-dipping flank of the Black Hills, which is modified by the broad Dewey terrace, by three northwest-trending anticlines, by the northeast-trending normal faults of the Dewey and Long Mountain structural zones (pl. 1, north half), and by smaller normal faults. (3) North of the Dewey terrace, within the western part of the mapped area, major north- and northwest-trending Fanny Peak and Black Hills monoclines form the margin of the Black Hills uplift and the adjoining Powder River basin to the west. These monoclines are transected by small northeast-trending normal faults and by a few northwest-trending faults. In addition, a smaller monocline and two small north-trending anticlines are present. Configuration of the folds in the area is shown on plate 1 by structure contours drawn on the base of the Fall River Formation or on the reconstructed base where the Fall River has been removed by erosion.

FOLDS

The asymmetric, slightly arcuate Dudley anticline, 2 miles east of Hot Springs, S. Dak., can be traced southward for 9 miles along the outcrop of the Inyan Kara Group to the Cheyenne River, 1½ miles north of the Angostura Reservoir. The south-plunging anticline has an amplitude of as much as 600 feet and has about 100 feet of closure (Wolcott, 1967).

The Cascade anticline, 2 miles west of Hot Springs, is the largest fold of the southeastern Black Hills. The anticline has an amplitude of 1,300 feet and has as much as 650 feet of structural closure (Wolcott, 1967). The steep west flank of this asymmetric anticline attains a maximum dip of 70° SW., as contrasted to an average dip of 5° SE. on the east flank. West of Hot Springs the anticline forms a ridge that is held up by dip slopes of the resistant Minnekahta Limestone, and farther south it forms a ridge that is held up by resistant sandstones of the Inyan Kara Group. The south-plunging structure follows a sinuous 17-mile-long course across the area as it trends first to the southwest and then to the south and southeast. The anticlinal axis bifurcates south of Cascade Springs; the main axis continues an additional 8 miles south of the area of this report.

The south-plunging Chilson anticline, 5 miles east of Edgemont, is at least 30 miles long, but only the northern 10 miles of the structure lies within the area discussed here. The asymmetric fold has an amplitude of 800 feet, and its gentle flank dips only 2°–3° SE. Resistant sandstones of the Inyan Kara form a topographic high along the axis of the structure.

The northernmost 3 miles of the gently dipping southwest-trending Cottonwood Creek anticline lies within the mapped area and has little, if any, topographic expression. The fold has an amplitude of only 100 feet, and strata exposed at the surface consist predominantly of easily eroded shales of Cretaceous age.

The south-plunging nose of another asymmetric anticline enters the area 7 miles northwest of Hot Springs and continues southward 4 miles before it terminates. The steep flank dips 10° W. and the gentle flank dips 3° SE., forming a fold with 400 feet of amplitude. Rocks of the anticline exposed at the surface consist of the Minnekahta Limestone, Opeche Formation, and Minnelusa Formation, a stratigraphic sequence of alternating resistant and nonresistant strata that erosion has irregularly dissected to partially mask topographic expression of the fold.

Three southeast-trending anticlines having amplitudes of 100–200 feet are present in the central part of the mapped area. These parallel structural features dip 6°–13° (Braddock, 1963). The longest extends south of the Dewey fault zone for 7 miles and then terminates in a 1½-mile-wide closed structural feature known as the Barker Dome. The two smaller anticlines north of the Dewey fault zone are only 2–3 miles long and less than 1 mile wide.

Two other south-trending anticlines are at the west side of the mapped area, 3 miles northeast of the L A K Ranch and 5 miles south of the ranch. The first-mentioned anticline is at least 5 miles long and has an amplitude of 600 feet. It is bounded on the west side by the Fanny Peak monocline and on the east by an asymmetric syncline. The other anticline, 5 miles south of the L A K Ranch, has an amplitude of 200 feet and is bounded on the west by the Fanny Peak monocline and on the east by a shallow syncline.

A part of the common boundary of the Black Hills uplift and Powder River basin lies within the area and is formed by segments of the intersecting northwest-trending Black Hills monocline and north-northeast-trending Fanny Peak monocline. Northwest of the intersection of these monoclines at the L A K Ranch, 7 miles southeast of Newcastle, Wyo., the basin-uplift boundary is formed by the Black Hills monocline (pl. 1). Sandstones of the Inyan Kara Group crop out on a hogback along the axis of the monocline, and then within a mile they plunge 2,000 feet beneath the shales that underlie the plains. South-southeast of the intersection, the monocline diverges from the margin of the basin and has about 1,000 feet of relief, but within 12 miles the monocline gradually merges into the southwest-dipping flank of the uplift.

The Fanny Peak monocline forms the basin-uplift margin south of the L A K Ranch (pl. 1, north half) and, within the mapped area, has about 2,300 feet of relief. North of the ranch the monocline, exposed lower in the stratigraphic section, is steeper but has only 1,200 feet of relief.

A smaller, unnamed monocline with 800 feet of structural relief lies between the Black Hills and Fanny Peak monoclines north of the L A K Ranch. This monocline trends southward 3 miles from the northern boundary of the area before swinging to the southeast.

About 2½ miles east of Edgemont the west-dipping south-plunging Sheep Canyon monocline at the west margin of the Livingston terrace has 400 feet of relief within a distance of half a mile. The slightly sinuous monocline trends almost due north for 12 miles.

The southwest flank of the Black Hills is modified by the Dewey, Edgemont, and Livingston structural terraces, as well as by several small unnamed terraces indicated by the structure contours on plate 1. The Dewey terrace, bounded by the Fanny Peak monocline on the west and bisected by the Dewey fault zone, covers more than 30 square miles in the Dewey quadrangle and extends south of the mapped area, where it is not as well defined. The Edgemont terrace, which covers about 10 square miles (Ryan, 1964), is present at Edgemont, north of the Cottonwood Creek anticline, and is bounded on the east by the Sheep Canyon monocline. Much of the terrace is overlain by alluvium of Quaternary age, and therefore, details of the structure are not known. The smaller, Livingston terrace, 4 miles northeast of Edgemont, is bounded on the west by the Sheep Canyon monocline and on the east by the Chilson anticline. Rocks of the Inyan Kara Group crop out on the terrace, forming a gentle south-dipping surface. A small unnamed terrace covering 1–2 square miles is adjacent to the northwest side of the Long Mountain structural zone about 8 miles north of Edgemont.

FAULTS

Steeply dipping to vertical northeast-trending normal faults are common in the northwest and central parts of the area but are sparse in the folded eastern part. Generally, the north sides of the faults are upraised, as occurs in the Dewey and Long Mountain structural zones (pl. 2), in the central part of the area.

The Dewey structural zone consists of sinuous en echelon steeply dipping to vertical normal faults that uplift the north side of the zone a total of 500 feet by a combination of fault displacement and drag. The fault zone can be traced for 13 miles northeastward across the Dewey and Jewel Cave SW quadrangles, before the zone bifurcates east of the mapped area (pl. 2). One branch continues east for 6 miles, and the other branch trends an equal distance to the northeast. Although no direct evidence for horizontal movement along the faults is reported, the sinuous en echelon trace of the faults suggests that a minor strike-slip component of movement may possibly exist within the fault zone.

The less well defined Long Mountain structural zone, 7 miles north of Edgemont, consists of small northeast-trending normal faults exposed in rocks of the Inyan Kara Group and Sundance Formation within a zone measuring several miles across. Individual faults within this zone generally have been traced less than a mile, and continuity of the structures is variable. For 2 miles southwest of Long Mountain, where the faults border a structural terrace, the zone is more clearly defined, and the northwest sides of the faults are uplifted. To the north, strata are downdropped toward the center of a wide northeast-trending fault zone. The faults have a displacement of as much as 40 feet, but adjacent to the faults as much as 60 feet of additional structural relief results from folding of the sedimentary strata.

In the Clifton and Dewey quadrangles sinuous and arcuate or ring faults and low-angle faults have been mapped in addition to the usual northeast-trending faults. The sinuous faults are randomly oriented and may be associated with the arcuate faults, such as those 11 miles north of Dewey. There, the faults are present in an area where anomalous gravity measurements indicate high relief on the buried surface of Precambrian rocks. The faults may have resulted from compaction of sediments around the basement high, as was suggested by Cuppels (1963), but they may also have resulted from dissolution and removal of evaporites in the Minnelusa Formation.

Two minor northwest-trending reverse(?) faults in sandstone of fluvial unit 5 of the Fall River Formation 3 miles north of the Dewey fault dip at low angles to the southwest. Dips range from nearly horizontal to 40° SW. and average about 25° SW. Slickensides and breccia along one of the faults were traced about 3 miles. The topography on the exposed fluvial unit 5 sandstone suggests that the southwest side of the faults may have been uplifted as much as 30 feet by reverse movement; however, most of the displacement probably occurred along bedding planes within the sandstone and is not readily discernible.

JOINTS

Joints within the southern Black Hills area are nearly vertical and commonly strike northeast or northwest. The major set of joints within the north and central parts of the area strike northeast, whereas a northwest orientation is dominant in the folded eastern part of the area (fig. 10). The differences in orientation of major joint sets probably reflect divergent stresses that deformed two major basement blocks, as discussed later.

STRUCTURAL INTERPRETATION

Uplift of the Black Hills probably began in Late Cretaceous time and continued until early Eocene time (Bartram, 1940). Chamberlin (1945) suggested that compression in a northeast direction may have produced north and northwest shear zones that determined the outline of the Black Hills; however, Noble (1952) believed that the main structural features of the uplift resulted from vertical forces associated with igneous intrusion. Osterwald and Dean (1961, p. 345–346) noted that structures of Paleozoic and Mesozoic age at the south end of the Black Hills trend parallel to structures of Precambrian age; they suggested that "the original Precambrian structures guided later and recurrent deformation."

PRECAMBRIAN STRUCTURE

The Precambrian structure of a nearby area in the central part of the Black Hills was interpreted by Redden (1968) to have evolved during three periods of deformation. (1) Major north-northwest-trending, west-dipping, isoclinal folds and subparallel faults were formed, and the rocks were metamorphosed. Redden (1968, pl. 34) inferred that displacement along many of the faults resulted in reverse throw. (2) In the metamorphosed rocks, shear deformation, localized along northeast trends, formed

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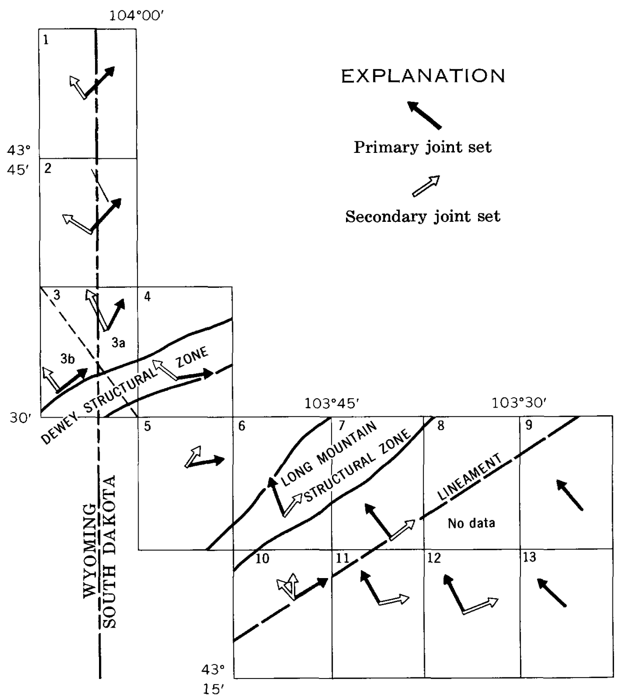


Map No.	Reference	Joint Sets	
		Primary	Secondary
1	Brobst and Epstein (1963)	N. 45° E.	N. 20°–45° W.
2	Cuppels (1963)	N. 40°–50° E.	N. 50°–60° W.
3a	Brobst (1961)	N. 10°–45° E.	N. 10°–40° W.
3b	......do	N. 45°–60° E.	N. 10°–40° W.
4	Braddock (1963)	N. 80° E.	N. 50° W.
5	Schnabel (1963)	N. 75°–85° E.	N. 35°–45° E.
6	Gott and Schnabel (1963)	N. 20° W.	NE.
7	Wilmarth and Smith (1957a, b, c, d)	N. 30°–40° W.	N. 50°–60° E.
8	Wolcott and others (1962)	No data	No data.
9	D. E. Wolcott (unpub. data, 1969)	N. 40° W.	
10	Ryan (1964)	N. 60° E.	N., N. 40° W.
11	Bell and Post (1971)	N. 30° W.	N. 75°–80° E.
12	Post (1967)	N. 20°–40° W.	N. 70° E.
13	J. J. Connor (unpub. data, 1969)	N. 40°–50° W.	

FIGURE 10. — Average orientation of joint sets in the southern Black Hills.

nearly vertical foliation. (3) Intrusion of granite and pegmatite masses domed the rocks. At this time pegmatite dikes were intruded along the northeast-trending shear foliation, as well as along bedding-plane foliation.

RECURRENT DEFORMATION

Sedimentary rocks in the southern Black Hills were repeatedly deformed along northeast trends during the Mesozoic Era and again during the Laramide orogeny. This deformation, which paralleled northeast-trending structures of Precambrian age, is most evident in the Dewey and Long Mountain structural zones, where mild structural adjustments affected deposition of the Inyan Kara Group prior to faulting that displaced the Inyan Kara. Mild structural deformation during the Early Cretaceous diverted the main northwest-flowing consequent streams and affected the courses of their tributaries. Thick fluvial sandstones were deposited where streamflow was restricted to areas of more rapid subsidence, along the axis of a gentle northwest-trending syncline (Bolyard and McGregor, 1966), whereas finer grained and interbedded sediments were deposited on the more stable interstream areas. Locally, sandstone was deposited in small northeast-trending channels where tributaries flowed parallel to the secondary structures.

The Dewey structural zone underwent minor deformation during Middle to Late Jurassic and Early Cretaceous time, prior to the Laramide faulting. Early uplift of the area immediately north of the Dewey fault is indicated by the nearly total absence of the Canyon Springs Sandstone Member in outcrops of the Sundance Formation of Late Jurassic age. At one small outcrop north of the Dewey fault the Canyon Springs rests upon an irregular erosion surface on the Spearfish Formation, but south of the fault the Canyon Springs Member is conformable with the Spearfish (Braddock, 1963). The area north of the fault, therefore, was uplifted or upwarped during Canyon Springs time while sandstones were deposited south of the fault. Later during Early Cretaceous time, mild deformation at the Dewey structural zone affected the course of consequent streams that deposited channel sandstones of the Inyan Kara Group (pl. 1, north half). During deposition of fluvial unit 1 of the Chilson Member, the northwest-flowing stream changed course and flowed westward at the structural zone before resuming its northwest course. Similarly, the stream that deposited fluvial sandstone of unit 4 of the Fuson Member altered course slightly at the structural zone.

Recurrent deformation during Early Cretaceous time also preceded Laramide faulting in the Long Mountain structural zone. Repeatedly, the northwest-flowing streams that deposited fluvial units 1, 2, 5, and 6 were diverted to the northeast at the structural zone as the area north of the zone remained stable or was slightly elevated. Rapid subsidence at the structural zone apparently determined the course of a northeast-flowing tributary during much of Inyan Kara time.

Although direct evidence of Early Cretaceous movement along northeast-trending structures of Precambrian age is lacking, many of these older structures are known. Layered pegmatite dikes of Precambrian age, mapped northwest of Pringle by Redden (1963), mark northeast-trending structures of Precambrian age that are alined with a northern branch of the Dewey structural zone (pl. 2). Similarly, geophysical data indicate a large concealed northeast-trending wrench fault northeast of the Long Mountain structural zone (pl. 2). Another concealed structure of Precambrian age is indicated by the sharp bend in an aeromagnetic anomaly north of Hot Springs (Meuschke and others, 1963). This structure apparently yielded to Laramide deformational stresses and thereby influenced the folding of the asymmetrical anticlines in the eastern part of the area. The concealed structure is coincident with the north end of a lineament that is marked by northeasterly bends and northward terminations of the Dudley, Cascade, Chilson, and Cottonwood Creek anticlines of Laramide age (pl. 2). This lineament trends S. 60° W. for 25 miles to Edgemont, S. Dak.

During the repeated deformation along the structural zones, the Paleozoic rocks probably were badly fractured. Later, when artesian pressures caused ground waters to migrate vertically through the stratigraphic section, these structural zones were especially favorable for the development of solution collapse structures discussed later.

DEFORMATIONAL FORCES

A major vertical force, as proposed by Noble (1952), probably caused the Laramide uplift of the Black Hills, but many structures within the mapped area indicate secondary compressive stresses from a westerly direction. These lateral stresses acted in a northeast to easterly direction and, locally, in a southeasterly direction.

Northeastward compression probably formed the three northwest-trending anticlines in the central part of the area and the low-angle reverse(?) faults north of Dewey. Higher on the flank of the Black Hills, toward the axis of the uplift, the stress was eastward, as indicated by a change of strike of faults in the Dewey structural zone. Similarly, the general northeast strike of major joint sets changes to a more easterly orientation in the Jewel Cave SW quadrangle (fig. 10). The change in stress orientation possibly is related to a buttressing effect by the granitic intrusive at Harney Peak (pl. 2) and to a deflection of the compressive force toward the east.

An eastward compression is also believed to have formed the anticlines in the eastern part of the area. The stress probably was transmitted through a basement block lying north of the lineament previously discussed. The eastward compressive force exerted by the northern block would have imparted both eastward and southward force vectors upon the adjacent southern block, and it would have created a resultant stress acting in an east-southeast direction. This east-southeast force probably caused the eastward deflection of the anticlinal folds along the lineament. The divergent orientation of forces acting upon the two blocks created a different orientation for the major joint sets on each side of the lineament. Although local variations in joint patterns exist, the major joint set on the northern block strikes northeasterly, whereas the major set on the south block strikes northwesterly (fig. 10). To a lesser degree the Dewey and Long Mountain structural zones also appear to have affected the orientation of joint sets.

SUBSIDENCE STRUCTURES

Many structural features consisting of breccia pipes, collapse structures, and, possibly, synclinal folds are solution features formed by dissolution of beds of anhydrite, gypsum, limestone, dolomite, and, perhaps, salt with accompanying collapse or slumping of overlying rocks. Numerous caverns and solution breccias and a few breccia pipes present in the Pahasapa Limestone of Mississippian age locally cause draping and faulting of the overlying lower part of the Minnelusa Formation. More extensive solution has occurred in the upper part of the Minnelusa, where nearly 250 feet of anhydrite and gypsum has been removed, as shown by figure 11 (see also Bowles and Braddock, 1963, p. C93), and subsidence of the interbedded sandstone, siltstone, and dolomite has formed founder breccias (Braddock, 1963).

Most breccia pipes bottom within the founder breccias of the Minnelusa; some pipes are exposed in vertical canyon walls for as much as 200 feet, and a few pipes stope upward as much as 1,300 feet to the Lakota Formation (Bowles and Braddock, 1963). Diameters of the pipes range from tens of feet to several hundred feet. These breccia pipes (fig. 12) consist of disoriented blocks, fragments, and detrital particles of sedimentary rocks which were displaced downward and which later were recemented by calcite deposited from artesian waters. The brecciation and disorientation of displaced blocks within a collapse structure are less intense toward the upper limit of stoping, high above the zone of solution. Where the structure terminates, only minor faulting, slight slumping, or draping may be present near the center of the collapse. Minor collapse at the surface may extend downward into a typical breccia pipe. Similarly, recent sinks within the outcrop of the Lakota Formation (Wolcott, 1967) probably pass downward into cemented or partially cemented breccias.

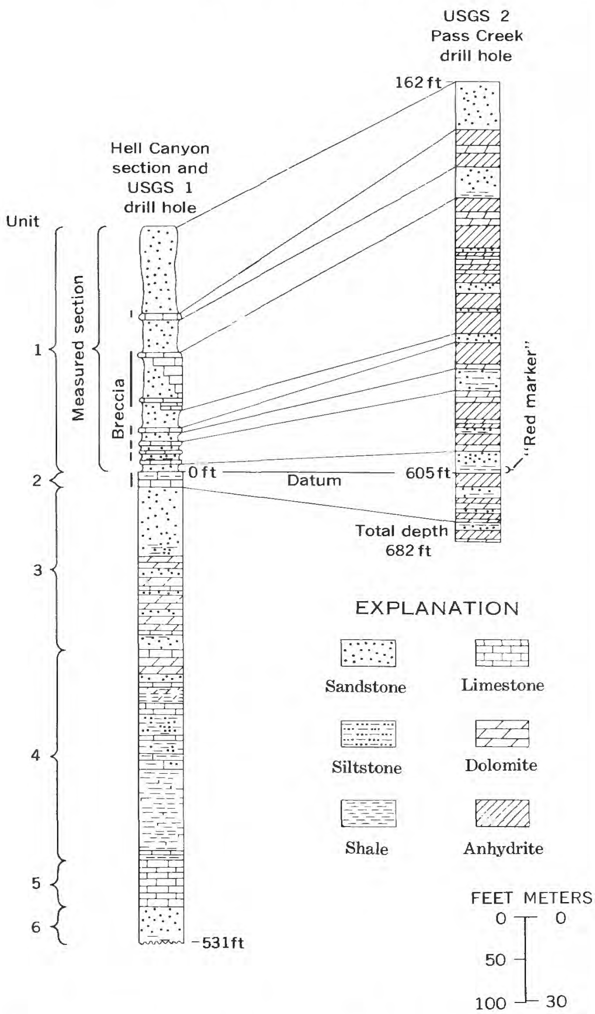


FIGURE 11. — Stratigraphic sections of the Minnelusa Formation, showing correlation of brecciated rocks in outcrop with anhydrite-bearing strata of the subsurface in Custer County, S. Dak. The locations of the stratigraphic sections are: Hell Canyon section, NW¼ sec. 3 and NE¼ sec. 4, T. 5 S., R. 2 E.; USGS 1 Hell Canyon drill hole, sec. 3, T. 5 S., R. 2 E.; USGS 2 Pass Creek drill hole, sec. 1, T. 6 S., R. 1 E. (From Bowles and Braddock, 1963, fig. 83.2.)

Some small synclinal folds in outcrops of Minnekahta Limestone and Spearfish Formation may have been formed in part by solution. Braddock (1963) attributed undulations of the Minnekahta to the solution and extensive removal of underlying anhydrite and gypsum from the Minnelusa, but he believed that the small synclinal folds were formed by gravity sliding during uplift of the Black Hills. Several small east-trending synclines at the center of the Jewel Cave SW quadrangle trend parallel or subparallel to the Dewey structural zone and to the major joint

FIGURE 12. — Breccia pipe (p) in the upper part of the Minnelusa Formation in Gettys Canyon, SE¼ sec. 16, T. 3 S., R. 1 E., Custer County, S. Dak. Photograph by J. B. Epstein. (From Bowles and Braddock, 1963, fig. 83.4.)

set north of the zone. These small synclines are present at steeply dipping parts of the southwest flank of an anticline where artesian movement of ground water toward the surface is likely. Possibly these and other small synclines were formed, in part, by solution of evaporites along fracture zones in advance of the general zone of solution and founder breccias.

Since the Laramide uplift of the Black Hills, breccia pipes and collapses probably have formed under artesian conditions. A similar origin has been proposed for fissure caves and vertical shafts in eastern Missouri (Brod, 1964). It is postulated that the pre-Pennsylvanian karst surface on the Pahasapa Limestone provided high permeability and permitted rapid ground-water recharge at Limestone outcrops high on the flanks of the Black Hills. Limestone solution in the Pahasapa formed collapses that fractured, folded, and faulted strata in the lower part of the Minnelusa, permitting artesian ground water to ascend from the Pahasapa and from sandstones in the lower part of the Minnelusa through the overlying evaporites. These waters were unsaturated with respect to anhydrite and gypsum before encountering the evaporites. This permitted calcium sulfate to be dissolved by ascending waters and caused breccia pipes to form as an initial stage of solution, in advance of the general front of solution activity.

Solution collapse is controlled in part by tectonic structure, in part by sedimentary structure, and in part by topography. All three factors may affect artesian movement of the large volumes of ground water required to dissolve enough rock to cause collapse. Continued solution, both of soluble strata peripheral to the collapse and of soluble breccia fragments within the collapse, enables further stoping. Pipes form prior to the development of founder breccias and may be present several miles downdip in advance of the founder breccias. Initially, solution occurs both along bedding planes and along fractures. Breccia pipes are likely to develop at the intersection of fractures, particularly in zones of intense fracturing and (or) faulting, such as the Dewey and Long Mountain structural zones. In these zones breccia pipes are more common on the uplifted side of the faults, where artesian water has a shorter path to the surface and may encounter less resistance to flow en route to a discharge point. An example of this structural control of pipe formation is present in the Jewel Cave SW quadrangle, where two pipes in the Sundance Formation are on the upthrown fault block, only 200 and 400 feet from the Dewey fault (pl. 1).

GROUND WATER

This ground-water study, which tests the theory that ground water introduced uranium into the Inyan Kara Group to form the uranium deposits, was begun after unpublished analyses of water samples from 32 wells marginal to the southern Black Hills were made available through the courtesy of William Chenoweth of the U.S. Atomic Energy Commission. If this theory of mineralization is valid, studies of ground water at the margin of the Black Hills may provide an opportunity to examine the processes of uranium transportation and deposition. Data presented in the following discussion indicate that in the southern Black Hills, uranium apparently is being introduced into the Inyan Kara Group by artesian water from the Minnelusa Formation. Where a strong reducing environment exists at the locality of artesian recharge, uranium is rapidly precipitated and may form economic deposits; elsewhere, uranium introduced by the ground water is disseminated over a wide area to increase the uranium "background" level within the Inyan Kara Group. As erosion of the Inyan Kara progresses, the leaching of low-grade deposits and disseminated uranium may provide an enriched mineralizing solution and result in secondary-enrichment ore bodies similar to roll-type uranium deposits found in several of the Tertiary basins in Wyoming.

SOURCE OF GROUND WATER IN THE INYAN KARA GROUP

Darton (1896, 1909) believed that ground-water recharge occurred at the exposures of what he called the Dakota Sandstone on the flanks of the Black Hills and that the water then migrated through this aquifer eastward under the plains of North and South Dakota. His view was generally accepted until Swenson (1968a, b) presented evidence indicating that much of the ground water obtained from the Dakota Sandstone in eastern North and South Dakota was derived from recharge of the Englewood Formation and the Pahasapa Limestone on the eastern flank of the Black Hills. This ground water flows eastward through the limestone aquifers until upward leakage into the Dakota Sandstone is made possible by the pre-Dakota erosion of the intervening sedimentary formations in the central and eastern parts of North and South Dakota. We believe that ground-water movement and the recharge of the Inyan Kara Group of the southern Black Hills is best explained by the following modification of the basic Swenson theory.

The Minnelusa Formation, as well as the Englewood and Pahasapa Formations, apparently receives a significant amount of ground-water recharge from precipitation and runoff in the Black Hills, whereas only minor surface recharge enters aquifers of the Inyan Kara Group. Streams gaged by Brown (1944) at the east side of the Black Hills lost water — as much as 54 cubic feet per second — to the three major aquifers of Paleozoic age. In contrast, no measurable stream loss was detected at the Inyan Kara outcrop. In a recent study, Gries and Crooks (1968) reported that water losses to the Pahasapa Limestone for eight streams in the eastern Black Hills are roughly proportional to streamflow and that the losses vary seasonally. The total loss that they observed during the study, which did not include water losses to the Minnelusa, ranged from "2.8 cubic feet per second in December 1967 to 164.5 cubic feet per second in June 1967." The high rate of recharge to the deeper aquifers is possible because solution caverns in the limestones of Mississippian age and extensive solution brecciation in the Minnelusa permit rapid ground-water recharge and enable a swift basinward flow. Locally in the outcrop area, ground water from the Minnelusa probably recharges the underlying cavernous Pahasapa Limestone. As a result of the rapid flow of ground water, productive Minnelusa wells are scarce where the formation crops out, and yet, as reported by Whitcomb, Morris, Gordon, and Robinove (1958), large yields occur from some Minnelusa wells farther downdip at the margin of the Black Hills.

The apparently limited recharge of the Inyan Kara Group by surface water seems incompatible with the large flow of water from wells in the Inyan Kara at the southwest flank of the Black Hills, just as it is incompatible with the amount of water produced from the Dakota Sandstone during the last 80 years, discussed by Swenson (1968a). Davis, Dyer, and Powell (1961) concluded that the water "must have moved into the aquifer by some method other than direct recharge at the outcrop." They suggested that deeper aquifers, having appreciable artesian pressure, provide a part of the recharge to the Inyan Kara, even though relatively impermeable confining material intervenes. They also suggested that, locally, the Inyan Kara may be recharged at a high rate by an artesian flow of ground water from deeper aquifers through uncased and caved or cratered wells. Probably of greater significance, a high rate of artesian recharge may occur through the previously described collapses and breccia pipes, which form natural conduits to the Inyan Kara Group.

The recharge of aquifers of the Inyan Kara Group by waters derived from older formations is strongly indicated by the composition of present-day spring waters emanating from formations older than the Lakota and Fall River Formations. Partial analyses of seven such spring waters are given in table 9 (see also Gott and Schnabel, 1963, p. 135) and show that the waters contain a high concentration of sulfate, bicarbonate, calcium, and magnesium. The equivalents per million of calcium and magnesium nearly perfectly balance the equivalents per million of sulfate and bicarbonate. This balance demonstrates that the material being leached is largely anhydrite but includes lesser amounts of dolomite. The only possible source for the sulfate, bicarbonate, calcium, and magnesium in these proportions is the evaporite zone in the Minnelusa Formation.

Numerous collapse structures that served in the past as conduits for artesian flow of water were located during mapping in the southern Black Hills (pl. 1). Direct artesian recharge of the Inyan Kara was possible where these structures penetrated the Lakota Formation. Elsewhere, pipes penetrated no higher than the Sundance Formation, and ground water may have flowed through the Canyon Springs Sandstone Member or other intermediate aquifers before finally encountering fractures that permitted continued upward migration to the Inyan Kara. Just as the older structures once served as conduits for artesian movement of ground water, recent collapses, such as the "Lost Wells" in the Lakota Formation near Hot Springs, S. Dak. (Wolcott, 1967), probably transmit artesian water at present.

Temperatures recorded in water wells in the vicinity of the Black Hills also suggest not only a rapid surface recharge of the more porous and (or) cavernous formations but also, farther downdip, an artesian flow of some of this water into overlying strata. Where rapid recharge of the deeper aquifers by surface water occurs, heat flow from underlying rocks may be insufficient to warm the ground water to a temperature predicted for an average geothermal gradient; conversely, where rapid artesian recharge of the higher aquifers by heated artesian water occurs, the heat flow to the ground surface may be insufficient to permit cooling of the water to the predicted temperatures. Adolphson and LeRoux (1968) reported an average geothermal gradient of 0.9°C per 100 feet for 42 wells that tap aquifers of pre-Jurassic age in the Black Hills area. The geothermal gradients, averaged for each formation, range from 0.7°C per 100 feet for the Minnelusa and Opeche Formations to 1.3°C per 100 feet for the

TABLE 9. — *Calcium, magnesium, bicarbonate, sulfate, and uranium in water from springs in the Minnelusa Formation*

[epm, equivalents per million (milligram equivalents per kilogram); ppm, parts per million; ppb, parts per billion]

Locality (pl. 4)	Field sample	Calcium + magnesium (epm)	Bicarbonate + sulfate (epm)	Calcium (ppm)	Magnesium (ppm)	Sulfate (ppm)	Bicarbonate (ppm)	Uranium (ppb)
			Weston County, Wyo.					
1	2208	33.38	33.25	532	83	1,420	225	12
2	2209	29.96	29.95	472	78	1,260	227	11
3	2210	24.66	24.76	402	56	1,040	190	4.7
(1)	2211	85.60	80.47	1,310	246	3,680	235	17
			Fall River County, S. Dak.					
4	2247	16.76	17.10	252	51	639	232	7.5
5	2249	34.56	35.36	508	112	1,610	112	6.3
6	2250	35.91	35.91	508	92	1,540	235	5.7

[1]Not shown on plate 4 (outside mapped area).

LOCALITIES SAMPLED

Field sample	*Locality description*
2208	SE¼ sec. 31, T. 45 N., R. 60 W.
2209	NE¼ sec. 31, T. 45 N., R. 60 W.
2210	SW¼ sec. 17, T. 45 N., R. 60 W.
2211	About 7 miles north of Newcastle, Wyo., T. 46 N., R. 61 W.
2247	Evans Plunge, Hot Springs, NW¼ sec. 13, T. 7 S., R. 5 E.
2249	NW¼ sec. 35, T. 7 S., R. 5 E.
2250	Cascade Springs, SW¼ sec. 20, T. 8 S., R. 5 E.

Spearfish Formation. Adolphson and LeRoux suggested that relatively low gradients computed for the Black Hills area may be due, in part, to "rapid downward movement of recharging waters in very porous formations" (such as the Pahasapa Limestone or Minnelusa Formation). In addition, their data indicate a progressive increase in the temperature gradient from the permeable Minnelusa Formation upward through relatively impermeable strata to the Spearfish Formation. The increase in the gradient probably results from an artesian movement of water from the Minnelusa Formation.

Temperatures of water from wells and drill holes along the southwest flank of the Black Hills indicate that the warmer artesian flow progresses upward into the Inyan Kara Group. Geothermal gradients calculated for wells in the southern Black Hills ranged from 0.8°C to 7°C per 100 feet (fig. 13). The average geothermal gradient for 19 wells that are deeper than 200 feet is 1.5°C per 100 feet, in contrast to the average gradient of 0.9°C per 100 feet determined by Adolphson and LeRoux (1968) for pre-Cretaceous rocks in the Black Hills area. The higher gradients calculated for temperatures recorded at the shallower wells (fig. 13) are due, in part, to an artesian flow within the Inyan Kara, but the magnitude of the gradients in some wells indicates that water probably has been heated in deeper aquifers and then has ascended to the Inyan Kara Group at the margin of the Black Hills. This interpretation of artesian recharge is further supported by the distribution and concentration of tritium in waters of the Inyan Kara and will be discussed later.

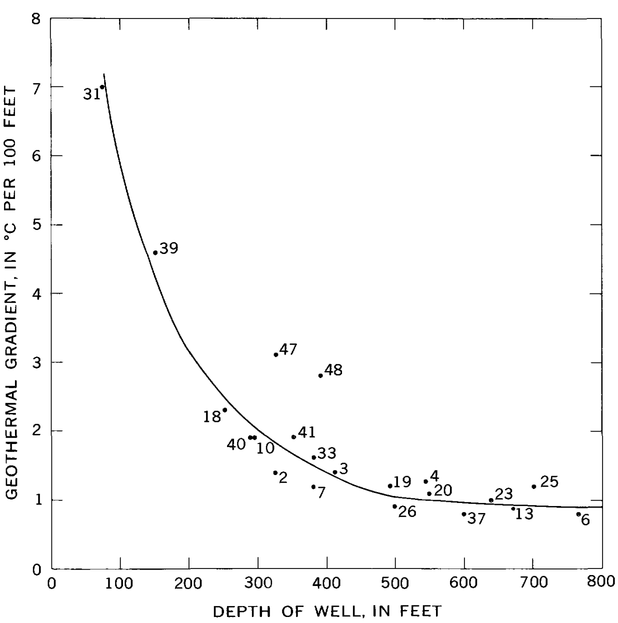


FIGURE 13. — Variation in geothermal gradient with depth of well in the Inyan Kara Group. Numbers indicate selected wells shown on maps and listed in table 10. Temperatures recorded in flow at the surface. Well depths are reported depths.

COMPOSITION

The present composition of the ground waters probably reflects variations in composition that have existed marginal to the Inyan Kara outcrop since the Black Hills were uplifted and artesian circulation was established in the Paleozoic and Mesozoic rocks. Distribution patterns for the variations in ground-water composition have shifted basinward as erosion has progressively stripped the sedimentary rocks from the uplift and lowered the water table. Ground water in the Minnelusa, Lakota, and Fall River Formations is classified into three general water types — calcium sulfate, sodium sulfate, and sodium bicarbonate — according to the most abundant pairs of cations and anions in solution (fig. 14). This system of classification was modified slightly so that ground-water composition could be mapped (pl. 3*A*) in the detail made possible by a plot of water composition on a multiple-trilinear diagram (pl. 3*B*) of the type proposed by Piper (1944). The water types indicated on the combined cation-anion diagram are separated at the 50th percentiles, and the waters are named for the most abundant pair of cations and anions present in water of average composition for each type. Because some ions, such as calcium and magnesium, are grouped together in the plot, water samples plotted near the 50th percentiles may have other ions in greater abundance than the indentifying pair. However, the grouping of these ions does not obscure the important genetic relationships within the ground water; therefore, the convenience of easy referral to three water types and the advantage of more detailed mapping of ground-water composition provided by this system of classification far outweigh the disadvantage of imprecise identification of an individual water sample.

As the ground water migrates upward to the Inyan Kara Group and then basinward within the Lakota and Fall River aquifers, the composition of the water changes from a predominantly calcium sulfate water to a sodium sulfate water and, locally, to a sodium bicarbonate water (pl. 3*C*). The first detectable change in composition of the ground water occurs within ascending waters where a loss of carbon dioxide causes precipitation of calcite which results in a decrease in the proportion of calcium to other cations remaining in the water. A second significant change takes place within the Inyan Kara Group where a further decrease of calcium ions as well as magnesium ions is accompanied by a proportionate increase in sodium ions in the water (fig. 14). This change is interpreted as a natural base-exchange softening of the waters. A third change in composition of the water, occurring locally within the Lakota and Fall River Formations, results in modification of calcium and sodium sulfate water to sodium bicarbonate water (fig. 14).

The change from sulfate water to bicarbonate water in the Inyan Kara is interpreted as the product of several chemical reactions that probably occur simultaneously. Separate grouping of sodium bicarbonate waters plotted on the anion and combined cation-anion diagram of plate 3*B* suggests that these

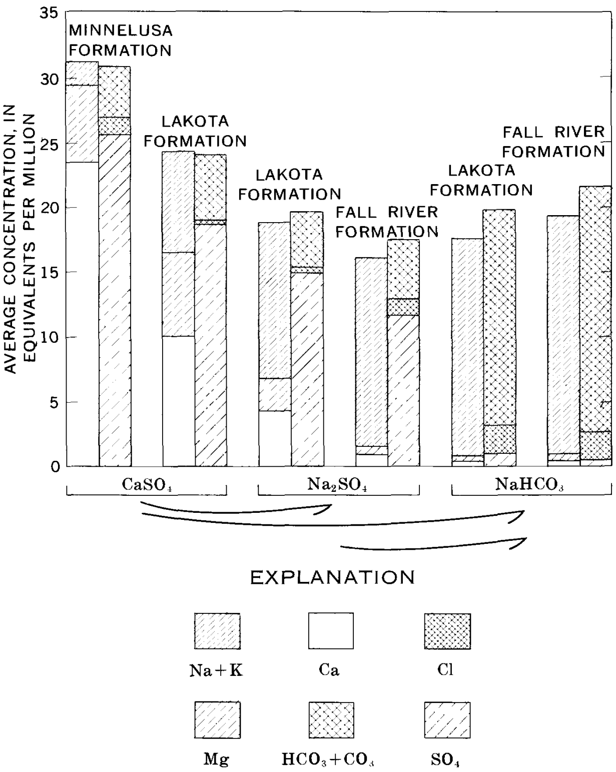


FIGURE 14. — Average composition of calcium sulfate, sodium sulfate, and sodium bicarbonate ground water from the Minnelusa, Lakota, and Fall River Formations. Concentrations are expressed as equivalents per million (epm), that is, the chemical equivalence of a weight concentration (ppm) of ions in solution. Arrows indicate modification of water types. Composition of Minnelusa water is average from water sampled at localities 1–4 (pl. 4). All samples of water from Inyan Kara Group were obtained from wells (pl. 3*A*).

chemical changes take place rapidly to completely transform the water as it flows through a zone less than 1½ miles wide (the minimum spacing between the sampled wells). Chemical reactions yielding high sodium bicarbonate waters were discussed by Foster (1950), who concluded that "carbonaceous material may act as a source of carbon dioxide which, when absorbed by water, enables the water to dissolve more calcium carbonate. If base-exchange materials are also present to replace calcium with sodium, a still greater amount of bicarbonate can be held in solution and high sodium bicarbonate waters * * * result." In the bicarbonate water of the Inyan Kara, a low sulfate content and a concentration of as much as 150 ppm hydrogen sulfide (table 10), together with the isotopic fractionation of the sulfur (T. A. Rafter, 1969, written commun.), suggest that sulfate reduction contributes to the genesis of the high sodium bicarbonate water.

The process of base-exchange softening in the sulfate water and the genesis of bicarbonate water result in two distinct patterns of distribution for the ground-water types in the Inyan Kara Group (pl. 3*A*). The softening of the sulfate water results in a pattern of progressive change from calcium sulfate water near the Inyan Kara outcrop to sodium sulfate water southwestward down the regional dip. Superimposed on this pattern in the vicinity of the Long Mountain structural zone is the distribution pattern for the high sodium bicarbonate water.

The chemical composition of the ground water is influenced by structures that affect the rate and direction of ground-water movement. A higher proportion of calcium may be present in the water where structure favors a rapid flow of artesian water from the Minnelusa. For example, the composition of ground water changes across the Dewey fault, where water on the upthrown, or north, block contains proportionately more calcium and magnesium and less sodium than water on the downdropped, or south, block (pl. 3*A*). Variations in water composition also occur at the southwestward projection of the Long Mountain structural zone (pl. 3*A*).

FLOW (AS INDICATED BY TRITIUM DISTRIBUTION)

The distribution of tritium in ground water at the margin of the Black Hills supports the interpretation of artesian recharge of the Inyan Kara Group and provides a measure of the rate of ground-water flow.

Tritium, a radioactive isotope of hydrogen, has a half life of 12.26 years (Stewart and Hoffman, 1966). It is derived naturally by cosmic radiation in the atmosphere, but the concentrations are low and have been masked by large quantities of synthetic tritium

TABLE 10.—*Analyses of water from wells or drill holes in the Inyan Kara Group*

[Analyses of major ions by Lucius Pitkin, Inc. (unpub. data), prepared for U.S. Atomic Energy Commission; analysis of sample from loc. 19 supplied by Hans Anderson. Analyses by U.S. Geol. Survey analysts: uranium, by V. J. Janzer; tritium, by J. D. Larson, except sample from loc. 33 by L. L. Thatcher; total sulfides reported as H_2S from locs. 22, 35, 44, and 46, by M. J. Fishman. H_2S determined in the field during July–Aug. 1967. Redox potential, pH, and temperature determined in the field during summer and fall of 1968. CO_2 calculated from field measurements of pH and laboratory determinations of HCO_3. Redox potential referred to KCl-saturated calomel electrode. Waters sampled for tritium Aug. 1967 and analyzed Jan.–May 1968. Explanation of abbreviations: ppm, parts per million; epm, equivalents per million (milligram equivalents per liter); mv, millivolts; Tu, tritium unit (tritium atom/10^{18} hydrogen atoms ≅ 3.2 picocuries per liter); ppb, parts per billion. Leaders (......) indicate data not shown or not applicable. Localities for well samples are shown on pl. 3A; localities for well and drill-hole samples are listed by section, township, and range at end of table]

Sample loc.	Date of sample collection	Unit of measurement for ions	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved solids	pH	Redox potential (mv)	Free carbon dioxide (CO_2) (ppm)	Hydrogen sulfide (H_2S) (ppm)	Tritium (Tu)	Uranium (ppb)	Temperature (°F)
							Weston County, Wyo.														
1	Aug. 18, 1965	ppm	9	0.7	28	9	600	4	0	383	1,082	18	0.4	2,134		−293		0.1			55
		epm			1.40	.74	26.10	.10		6.28	22.53	.51									
2															7.1	+45		0			54
3															7.1	+48				1.5	57
4	June 10, 1965	ppm	8	.12	8	4	289	2	0	242	536	15	.6	1,105	8.1	−179	3.1	<.1	247		59
		epm			.40	.33	12.66	.05		3.97	10.76	.42									
5	Oct. 17, 1965	ppm	10	.16	13	3	350	3	0	220	652	15	.8	1,267	8.0	−156	3.5	<.05	248	.07	58
		epm			.65	.25	15.23	.08		3.61	13.57	.42									
6															7.3	+78				.8	57
							Custer County, S. Dak.														
7															7.0	+162					55
8															7.4	−48				4.0	60
9															7.8	−114				1.5	55
10	July 20, 1965	ppm	11	0.05	118	37	108	9	0	213	485	9	0.5	991	7.2	−27	24	0	237	6.4	58
		epm			5.89	3.04	4.73	.23		3.49	10.10	.25									
11	Aug. 19, 1965	ppm	2	.02	8	14	200	6	12	134	391	14	.4	770		−39		.05	<100		55
		epm			.40	1.15	8.70	.15	.40	2.20	8.14	.39									
12															7.2	−78		0		2.0	62.6
13	Oct. 17, 1965	ppm	2	1.4	11	6.1	180	7	12	122	310	12	.9	664							
		epm			.55	.50	7.83	.18	.40	2.00	6.45	.34									
14															8.3	−321		<.1		.3	57
15															7.7	−204					
16	June 10, 1965	ppm	2	.11	56	20	211	9	0	202	428	24	1.0	953	7.7	−204	4.0	.15		1.7	
		epm			2.79	1.64	9.24	.23		3.31	8.60	.68									
							Fall River County, S. Dak.														
17	Oct. 17, 1965	ppm	10	0.92	80	18	170	9	0	207	468	11	0.8	975	7.8	−181	5.2	<0.05	221	0.25	58.7
		epm			4.00	1.48	7.39	.23		3.40	9.74	.31									
18	do	ppm	9	.75	39	10	240	6	0	232	482	14	.9	1,034	7.7	−175	7.4	.05	<100	15	56.5
		epm			1.95	.82	10.44	.15		3.80	10.04	.39									
19		ppm	1.3		50	3.2	143			202	254	13		672	7.8	−245	5.1	.15			57
		epm			2.50	.26	6.21			3.31	4.16	.37									
20	Apr. 29, 1965	ppm	10	.20	72	36	185	12	0	234	524	17	1.1	1,091	7.6	−116	4.2	.05	241	.14	56.6
		epm			3.59	2.98	8.10	.31		3.84	10.91	.48									
21	Oct. 17, 1965	ppm	10	.75	50	13	270	9	0	268	558	11	1.0	1,191	7.8	−213	12	<.05	113	.35	58
		epm			2.50	1.07	11.74	.23		4.39	11.62	.31									
22	Apr. 29, 1965	ppm	10	1.32	260	125	100	20	0	294	1,014	15	.1	1,839	7.3	−147	27	.2	<100	13	56
		epm			12.97	10.28	4.38	.51		4.81	21.11	.42									
23	July 21, 1965	ppm	10	.18	62	22	250	12	0	279	552	11	.4	1,199	7.7		13		257	.26	58
		epm			3.09	1.80	10.95	.31		4.59	11.49	.31									
24	do	ppm	15	.25	26	10	282	8	0	238	500	17	1.3	1,098	8.0	−247	3.8	.05	182	.2	59.5
		epm			1.30	.82	12.35	.20		3.90	10.41	.48									
25	Aug. 19, 1965	ppm	8	1.6	40	13	257	6	0	232	521	15	.3	1,094	8.0	−264	3.7	.4	<100	1.2	60.5
		epm			2.00	1.07	11.18	.15		3.80	10.85	.42									
26	July 21, 1965	ppm	14	.10	152	53	250	20	0	330	852	8	.3	1,679	7.3	−114	26	.05	249	.5	54
		epm			7.58	4.28	10.95	.51		5.41	17.74	.23									
27	Apr. 28, 1965	ppm	7	.17	12	6.8	252	7	0	244	420	15	1.9	966	8.3	−237	2.2			.06	61
		epm			.60	.56	11.04	.18		4.00	8.74	.42									
28	July 21, 1965	ppm	12	2.05	40	15	250	9	0	240	490	13	.5	1,076	8.2	−295	2.4	.15	110	.5	64.4
		epm			2.00	1.23	10.95	.23		3.93	10.20	.37									
29	Oct. 15, 1965	ppm	13	.22	25	7.9	280	7	0	248	483	19	.9	1,084	8.0	−199	4.5	.05	<100	.1	57.5
		epm			1.25	.65	12.17	.18		4.06	10.06	.54									
30															7.8	−60		0			57
31															7.1	−5		0	177	.5	55.5
32	July 21, 1965	ppm	16	.07	206	87	283	20		409	1,140	8	.4	2,169	7.1	−53	52	0	<100	.4	57
		epm			10.28	7.15	12.39	.51		6.70	23.73	.23									

TABLE 10. — *Analyses of water from wells or drill holes in the Inyan Kara Group* — Continued

Sample loc.	Date of sample collection	Unit of measurement for ions	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved solids	pH	Redox potential (mv)	Free carbon dioxide (CO_2) (ppm)	Hydrogen sulfide (H_2S) (ppm)	Tritium (Tu)	Uranium (ppb)	Temperature (°F)
							Fall River County, S. Dak. — Continued														
33	Apr. 28, 1965	ppm	12	.02	11	6.2	325	7	24	706	158	65	.5	1,315	8.2	−306	8.5	>50	14±20+	.04	57
		epm			.55	.51	14.24	.18	.80	11.57	3.30	1.83									
34	Oct. 16, 1965	ppm	12	1.4	9.7	4.7	390	6	70	875	16	91	2.4	1,478	8.3	−408	7		<100	.07	59
		epm			.48	.39	16.95	.15	2.33	14.34	.33	2.57									
35															7.7	−388		120		2.5	55
36															7.6	−50				14	55
37	Apr. 29, 1965	ppm	10	.02	134	80	339	16	0	400	1,102	10	.3	2,091	7.6	−158	16	<.1	<100	.4	55
		epm			6.69	6.58	14.85	.41		6.56	22.94	.28									
38															8.0	−370		>50	240	.07	55
39	Apr. 28, 1965	ppm	11	.21	9	5.3	408	7	57	996	60	82	1.4	1,637	7.9	−407	20		<100	.08	58.5
		epm			.45	.44	17.89	.18	1.90	16.32	1.24	2.34									
40	Oct. 15, 1965	ppm	12	.08	9	6.5	390	6	60	952	11	86	2.2	1,535	8.0	−390	17	>50	114	.06	56
		epm			.45	.53	16.96	.15	2.00	15.60	.23	2.43									
41	do	ppm	14	.24	7	6.0	420	6	96	964	21	77	2.4	1,614	8.0	−402	15	>50			58
		epm			.35	.49	18.26	.15	3.20	15.80	.44	2.17									
42															8.1	−320		>50			
43															8.0	−260				.12	
44	Oct. 17, 1965	ppm	12	.10	8	4.5	380	5	60	952	8	76	2.4	1,508	7.8	−400	24	150	313	.07	56
		epm			.40	.37	16.52	.13	2.00	15.60	.17	2.14									
45															7.8	−42					57
46															7.5	−207		2.8		2.4	60.5
47	Oct. 16, 1965	ppm	12	.07	5.5	3.4	400	4	48	952	28	73	2.3	1,528	7.5	−348	54			.01	64.4
		epm			.27	.28	17.39	.10	1.60	15.60	.58	2.06									
48	do	ppm	10	.13	4.5	2.9	380	3	60	878	41	58	2.0	1,440	7.8	−367	22	>50	128	.03	66
		epm			.23	.24	16.52	.08	2.00	14.39	.85	1.64									
49	do	ppm	11	1.2	5.9	.5	430	2	6	384	503	73	1.2	1,418							
		epm			.29	.04	18.70	.05	.20	6.29	10.47	2.06									
50															7.3	−150				.15	
51	Oct. 16, 1965	ppm	12	.25	37	11	580	4	0	531	822	286	1.0	2,284	7.8	−66	13	.15	154	.1	
		epm			1.85	.90	25.22	.10		8.70	17.11	8.07									

SAMPLE LOCALITIES

Weston County, Wyo.

No.	*Sec.*	*T. N.*	*R. W.*
1	NW¼NE¼ 31	43	60
2	Near E. line, N½ 3	41	60
3	Near E. line, N½ 10	41	60
4	SE¼NW¼ 7	41	60
5	NW¼SE¼ 7	41	60
6	N. ¼ cor. 28	41	60

Custer County, S. Dak.

No.	*Sec.*	*T. S.*	*R. E.*
7	SW¼SW¼ 31	5	1
8	SW¼SW¼ 6	6	1
9	NW¼SE¼ 7	6	1
10	SW¼NE¼ 18	6	1
11	SE¼NE¼ 19	6	1
12	NW¼SW¼ 19	6	1
13	SE¼SE¼ 20	6	1
14	NW¼SW¼ 30	6	1
15	SE¼NW¼ 31	6	1
16	NW¼NW¼ 33	6	1

Fall River County, S. Dak.

No.	*Sec.*	*T. S.*	*R. E.*
17	NW. cor. 3	7	1
18	SW¼NE¼ 5	7	1
19	NW¼SW¼ 9	7	1
20	SE¼NE¼ 9	7	1
21	SE¼SE¼ 9	7	1
22	SW¼SW¼ 11	7	1
23	SE¼SE¼ 16	7	1
24	NW¼SW¼ 17	7	1
25	SW¼NW¼ 19	7	1
26	SW¼SE¼ 23	7	1
27	Center 27	7	1
28	NW¼NW¼ 29	7	1
29	SW¼NE¼ 35	7	1
30	SE¼NW¼ 36	7	1
31	SE¼SE¼ 32	7	2
32	SE¼SE¼ 32	7	2
33	NE¼NE¼ 1	8	1
34	N. ¼ cor. 4	8	1

Fall River County, S. Dak. — Continued

No.	*Sec.*	*T. S.*	*R. E.*
35	SE¼SE¼ 4	8	2
36	SE¼SE¼ 4	8	2
37	NE¼NE¼ 5	8	2
38	NE¼SE¼ 5	8	2
39	NW¼SW¼ 6	8	2
40	NW¼SE¼ 6	8	2
41	SE¼SW¼ 6	8	2
42	Center N½ 7	8	2
43	NE¼NE¼ 8	8	2
44	NE¼NE¼ 8	8	2
45	Center N½ 9	8	2
46	W. ¼ cor. 10	8	2
47	NW¼NE¼ 17	8	2
48	NE¼SW¼ 17	8	2
49	SE¼SE¼ 20	8	2
50	SE¼SW¼ 23	8	2
51	SE¼SE¼ 28	8	2

placed in the atmosphere by thermonuclear explosions. Tritium is dissipated from the atmosphere largely by precipitation, or rain-out, of tritiated water (HTO), which then becomes a part of the surface- and ground-water systems. Since 1952, large quantities of tritium have been added to the atmosphere, and peak concentrations in the water were reported during the winter of 1958–59 and in 1963. In 1963 the average concentration of tritium in rain water in the Black Hills (data reported by Stewart and Hoffman, 1966) was about 3,500 Tu (tritium units)[1] (G. L. Stewart and R. K. Farnsworth, written commun., 1968), or perhaps three times the 1958–59 level of rain-out. During 1964–67, tritium concentration in precipitation steadily declined, and in 1967 the weighted average tritium concentration of precipitation in the southern Black Hills was about 500 Tu (G. L. Stewart and T. A. Wyerman, written commun., 1970). (The average concentration of natural tritium in the water is 2–10 Tu.)

We sampled ground water from 26 wells in the Inyan Kara Group during August 1967 to determine the time in transit and rate of movement of water at the margin of the Black Hills. During January–May 1968, J. D. Larson of the U.S. Geological Survey analyzed the waters by using an analytical method having a minimum detection limit of 100 Tu (table 10).

High concentrations of tritium, ranging from 110 to 313 Tu, were distributed in a lobate pattern, and the southwest, leading edge of the detected tritium concentration was as much as 4 miles downdip from the Inyan Kara outcrop (fig. 15). Ground water containing tritium flowed most rapidly basinward in three areas — one on the Dewey terrace, in the vicinity of Beaver Creek north of the Dewey structural zone, and two in the vicinity of the Cheyenne River, west of Edgemont and southwest of Burdock, S. Dak. High tritium concentrations roughly paralleled the Cheyenne River, and low values (less than 100 Tu) were present southwest of the river. We did not determine whether tritium values decrease to natural background amounts within the area sampled; but L. L. Thatcher (written commun., 1969), by using a more sensitive method than the one used by Larson, analyzed one sample and found a concentration of 14 ± 20 Tu (table 10), apparently slightly more than the natural background level.

The highest tritium values are much lower than peak concentrations in rain-out during the 1958–59 and 1963 periods, indicating a dilution of young, highly tritiated water by an older water containing only natural concentrations of tritium. The amount of dilution can be estimated if the highest measured tritium values are corrected for radioactive decay and the age of the water is assumed. If we assume that the highest tritium concentration was derived from rain-out during 1958–59, then the initial value of the detected tritium, corrected for radioactive decay, was approximately 520 Tu. Similarly, if the highest tritium concentration was derived from rain-out during 1963, then the initial value, corrected for radioactive decay, was about 400 Tu. Both corrected tritium values are much lower than the weighted-average tritium rain-out for either period. The most highly tritiated water sampled in the Inyan Kara must have been diluted by older ground water in the respective proportions of either 1:1, if the tritium is from 1958–59 recharge, or 1:9, if it is from 1963 recharge. The 1:9 dilution ratio best fits the observed data. If the 1:9 ratio of tritiated water to older artesian water is valid, then the tritium concentration in pre-1963 waters is reduced by dilution below the detection level employed in this study, and no lesser tritium pulse is observable. Conversely, if the 1:1 ratio calculated for 1958–59 recharge were valid, then a pulse of approximately 1,500 Tu should be present near the Inyan Kara outcrop. No comparable concentration has been detected.

We concluded, therefore, that the tritiated water recharged the Inyan Kara Group at the outcrop and then was diluted by older artesian water downdip along the margin of the Black Hills. Dilution has apparently occurred in the vicinity of several wells near the Inyan Kara outcrop in the west-central and southeastern parts of the Burdock quadrangle, where less than the detectable amount of tritium (<100 Tu) was present in the water (fig. 15). These older waters are of the calcium sulfate type characteristic of artesian water from the Minnelusa Formation. In the west-central part of the Burdock quadrangle this Minnelusa type water forms the center of a tongue of a rapid basinward flow that apparently mixed with highly tritiated water farther downdip where the tritium content of the water increased to 113 Tu at well 21 and to about 200 Tu at well 24 (fig. 15).

Widely varied rates of ground-water flow in the Inyan Kara are indicated by the tritium distribution. In the west-central part of the Burdock quadrangle, near the confluence of Beaver Creek and the Cheyenne River, a flow of 15 feet per day is required to transmit tritium rain-out of the year 1963 from the recharge area at the Inyan Kara outcrop to the position of the larger tritium concentrations detected by sampling during 1967. To the north, between the

[1]Tu ≅ 1 tritium atom/10^{18} hydrogen atoms ≅ 3.2 picocuries per liter.

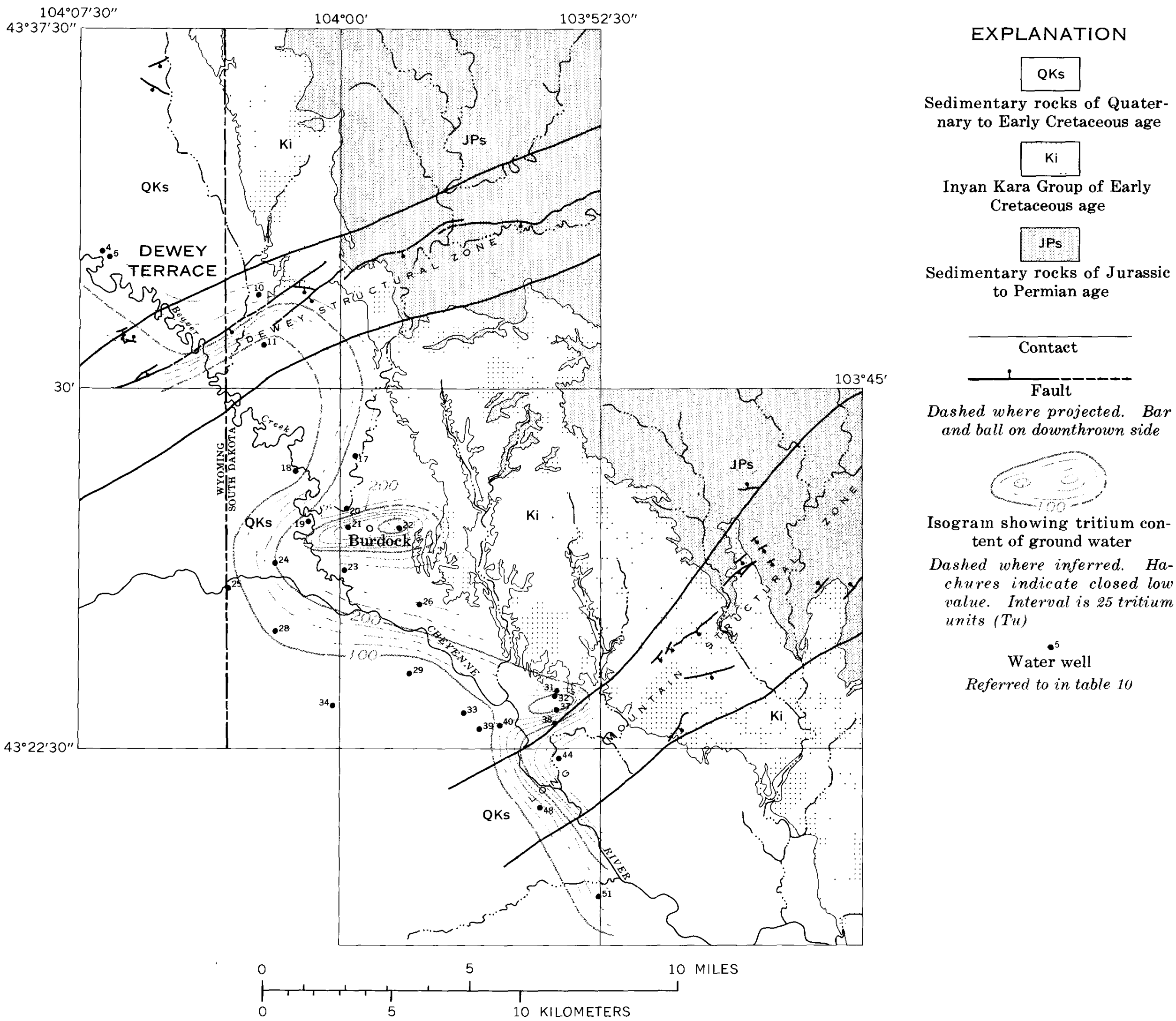


FIGURE 15. — Tritium distribution in ground water of the Inyan Kara Group of the southern Black Hills, August 1967.

Beaver Creek–Cheyenne River area and the Dewey fault, ground water in the Inyan Kara flows less rapidly, but the flow rate cannot be calculated from the available data. The exceedingly rapid flow rate in the Beaver Creek–Cheyenne River area possibly results from artesian discharge of the Inyan Kara water into gravels of the two streams; if so, a high rate of flow would not occur within the Inyan Kara at greater depths in the Powder River basin.

REDUCING ENVIRONMENT

Ground water in the Inyan Kara Group changes from an oxidizing solution near the outcrop to a reducing solution farther downdip. The transition (fig. 16) is very abrupt along the southwest projection of the Long Mountain structural zone, where the water changes from the calcium sulfate type to a very strongly reducing hydrogen sulfide-bearing water of the sodium bicarbonate type. Elsewhere, the reducing environment generally is less intense, and the oxidation-reduction front may be present farther downdip, as along the Dewey structural zone.

HYDROGEN SULFIDE

Hydrogen sulfide in the ground water ranges in content from less than 0.05 ppm in the calcium sulfate water of the Minnelusa Formation to 150 ppm in sodium bicarbonate water in the Inyan Kara Group (table 10). Generally, the sulfate water of the Inyan Kara Group contains a trace of hydrogen sulfide (about 0.05–0.1 ppm H_2S), although none was detected in some water samples.

The presence of hydrogen sulfide in the artesian waters is attributed to bacterial reduction of sulfate within the Inyan Kara. Jensen (1958), Lisitsyn and Kuznetsova (1967), and others have stressed the role of micro-organisms in the reduction of sulfate and the formation of ore deposits. Sulfate may be reduced by several bacteria, including *Desulfovibrio desulfuricans,* to form hydrogen sulfide and other sulfide complexes where sufficient carbonaceous material is available to support the bacteria. Adequate to large flows of calcium magnesium sulfate water transmitted through porous aquifers or collapse structures to highly carbonaceous host rocks support intensive sulfate reduction and the formation of a large quantity of hydrogen sulfide, but sparsely carbonaceous rocks and a flow of ground water that is restricted by low permeability limit the reduction activity. If the supply of carbonaceous material becomes depleted, then reduction activity by the micro-organism is terminated.

The reduction of sulfate is also limited by Eh and pH, as shown by a study of sulfate reduction in soils by Connell and Patrick (1968). They showed that reduction of sulfate in waterlogged soils generally occurs between pH 6.5 and 8.5, and the greatest accumulation of sulfide occurs near pH 7. Reduction occurs at a high rate from pH 7 to 7.8 and then decreases to almost zero at pH 8.5. Their experiments also showed that the reduction of sulfate to sulfide is intense below a threshold Eh of about −150 mv (millivolts) but is very slight at higher Eh values.

OXIDATION-REDUCTION (REDOX) POTENTIAL

The oxidation-reduction (redox) potential of the waters in the Inyan Kara Group was measured (table 10) at the well sites during the summer and fall of 1968 using a portable pH meter with calomel and platinum electrodes. Water was siphoned through an enclosed measuring cell, thus preventing absorption of oxygen from the atmosphere and providing a constant temperature during the measurements. Redox measurements were made 20 minutes after the water was first introduced into the cell, and the values were reported as the potential difference between the saturated calomel reference electrode and the platinum electrode. The redox measurements provide only relative values because equilibration of the platinum electrode was not fully achieved in the more reducing waters. In these waters, redox values, after complete equilibration of the electrodes, may be as much as 50 mv lower than the recorded values. It should be noted, however, that even with complete equilibration, redox (and pH) measurements recorded at the surface in flowing wells cannot exactly duplicate the values present within the aquifer at depth because hydrogen sulfide and carbon dioxide are released from solution as the waters rise to the surface.

At the margin of the Black Hills, redox values (fig. 16) decrease from a high of +162 mv near the Inyan Kara outcrop to less than −200 mv in the sodium sulfate water farther basinward, and within the strongly reducing hydrogen sulfide-bearing sodium bicarbonate water, redox values of −400 mv were recorded. Anomalous redox values are present along both the Dewey structural zone and the projection of the Long Mountain structural zone. A redox value of +78 mv was recorded in well water flowing from a depth of about 700 feet at the Dewey structural zone 3 miles downdip from the Inyan Kara outcrop. Large differences in redox potential probably exist within or marginal to this zone. Within the Long Mountain structural zone, extreme differences in redox potential were measured in waters from closely spaced wells. In part, these differences in oxidation-reduction potential may be related to a separation of waters flowing from different sandstone aquifers; however, some interconnection of the aquifers and mixing of the waters are expected in this area. More likely, the extreme differences in redox potential are caused by the introduction of an artesian calcium sulfate water, having slightly positive to neutral redox potential, into an area where intense reduction of sulfate rapidly lowers the electrode potential.

HYDROGEN-ION CONCENTRATION (pH)

During the summer and fall of 1968 the pH values of the ground water were measured (table 10) at well sites using a portable pH meter. The pH generally increases in a basinward direction from about 7.1 pH in the calcium sulfate water to as much as 8.3 pH in the sodium sulfate water (fig. 17). Values in the hydrogen sulfide-bearing sodium bicarbonate water generally range from 7.5 to 8.0 pH. Release of carbon dioxide and hydrogen sulfide as the water rises to the surface probably causes these pH values to be somewhat higher than true values within the aquifer. However, the release of hydrogen sulfide and carbon dioxide that produces an increase in pH and related chemical reactions is only partially complete at the time the water reaches the surface, because the laboratory determinations of pH average 0.1 pH higher than field determinations for 12 samples of sodium sulfate water, 0.2 pH higher for calcium sulfate water, and 0.8 pH higher for sodium bicarbonate water.

Values of pH, as well as Eh, are affected by differ-

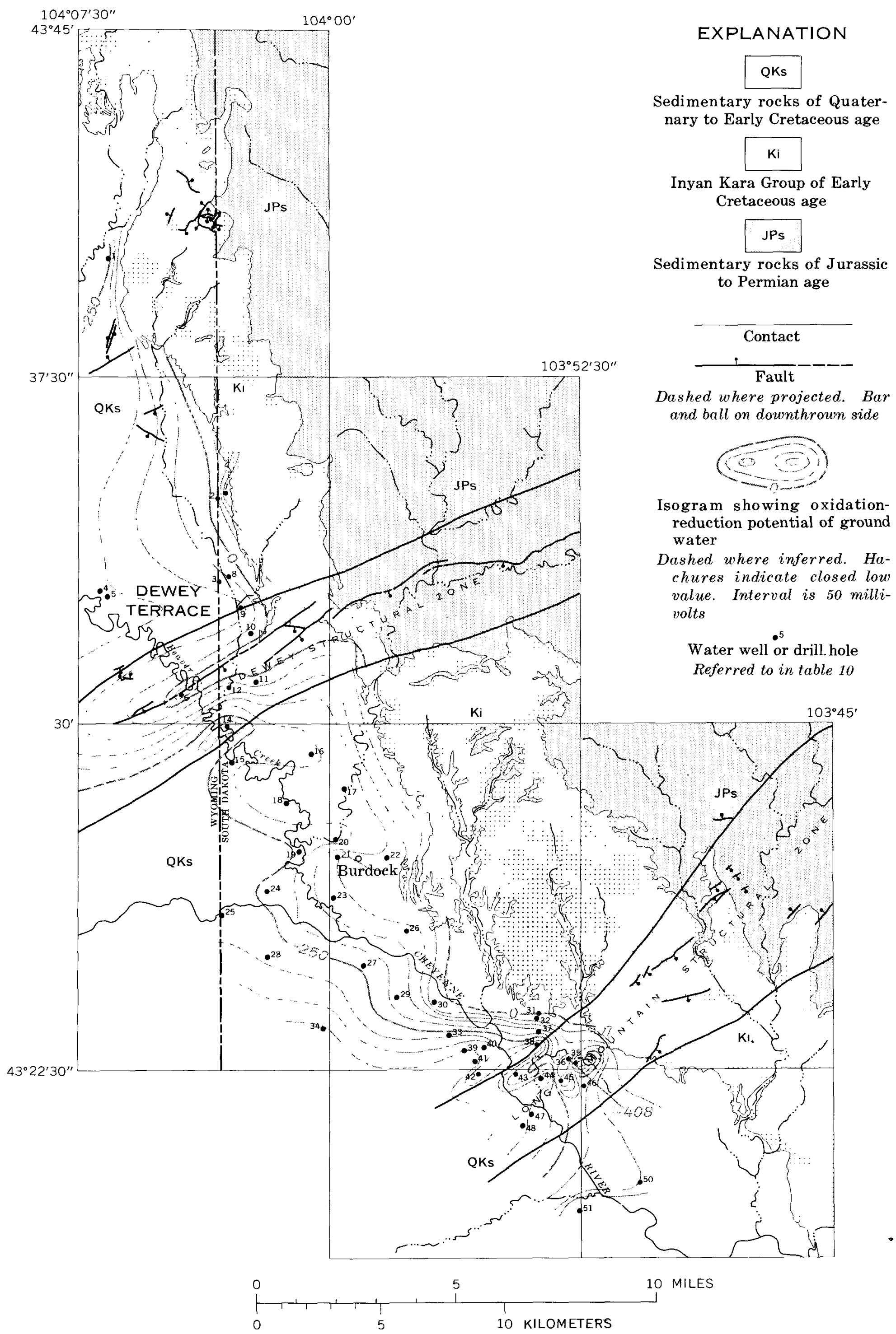


FIGURE 16. — Oxidation-reduction potential (Eh) of ground water in the Inyan Kara Group of the southern Black Hills. Redox potential referred to KCl-saturated calomel electrode.

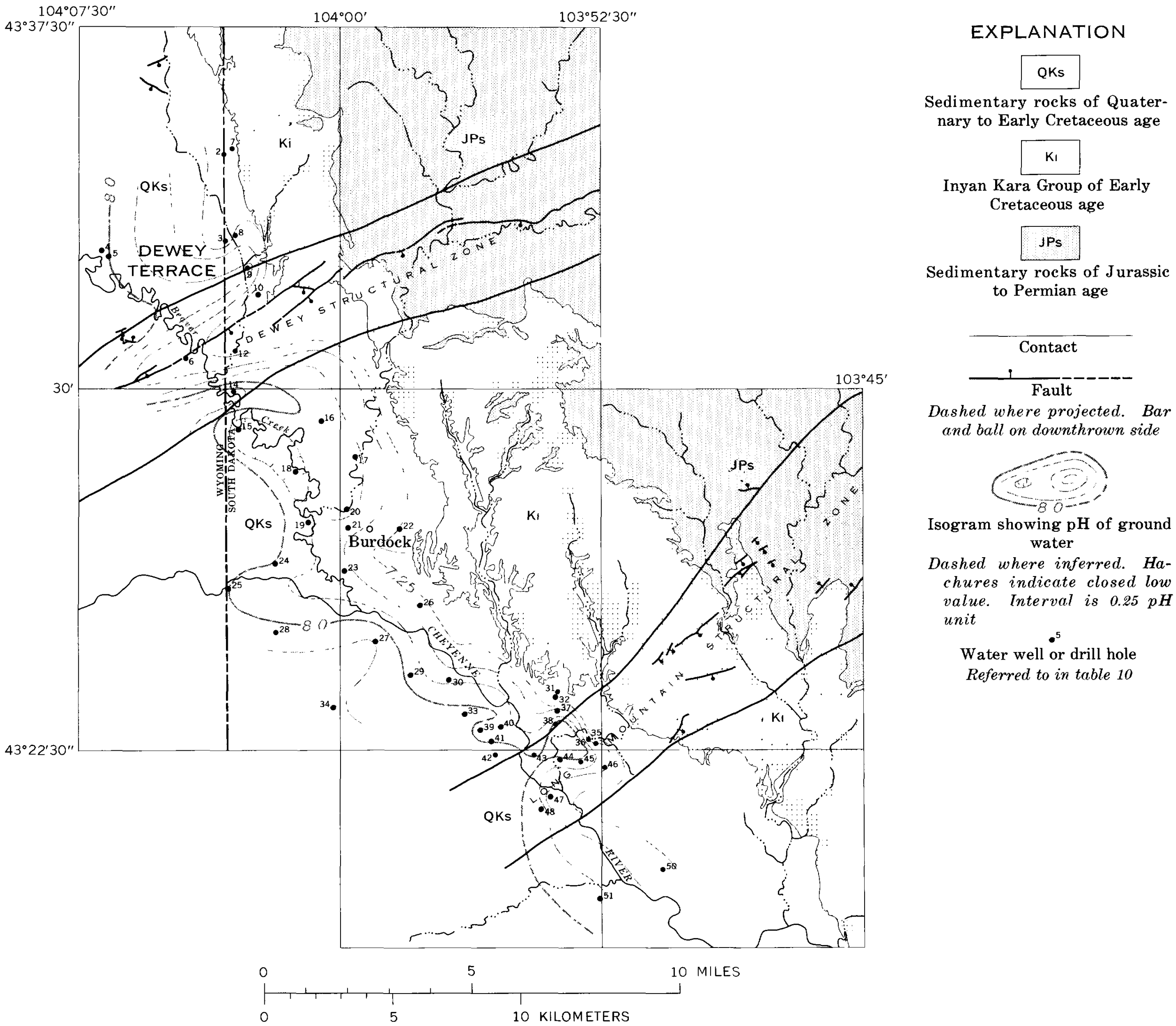


FIGURE 17. — Hydrogen-ion concentration (pH) of ground water in the Inyan Kara Group of the southern Black Hills.

ences in ground-water composition; therefore tectonic, solution, and sedimentary structures that influence the movement of ground water of different compositions also influence the distribution of the pH values. Relatively low pH values are present farther basinward in the vicinity of the Dewey structural zone, where artesian water rises through the section and, at one locality, discharges as a spring. Similarly, along the southwest projection of the Long Mountain structural zone, low pH values are recorded in calcium sulfate water introduced at the margin of an area containing sodium carbonate water of high pH.

CARBON DIOXIDE

The carbon dioxide content of water from 28 wells in the Inyan Kara was calculated from the bicarbonate content and pH of the water (table 10). Field measurements of pH were used in the calculations, rather than laboratory pH determinations made at the same time as the bicarbonate analyses, because pH alters with release of carbon dioxide from the water as the dissolved gases adjust to equilibrium at atmospheric pressure. The pH values changed 0.8 pH in sodium bicarbonate water before the water was analyzed in the laboratory. The calculated carbon dioxide content of these waters is a minimum value, because neither loss of carbon dioxide from the water before it reaches the surface nor precipitation of calcium carbonate prior to analysis is considered in the calculation. The carbon dioxide content of the ground water sampled from the Inyan Kara ranges from 2.2 to 54 ppm CO_2 (table 10). Highest carbon dioxide values are present in samples of calcium sulfate water, which average 32 ppm CO_2. Surprisingly, the carbon dioxide content decreases downdip in samples of sodium sulfate water, which average about 6 ppm CO_2. Samples of sodium bicarbonate water contain intermediate concentrations of carbon dioxide, which average 20 ppm CO_2.

The large concentrations of carbon dioxide in the calcium sulfate waters of the Inyan Kara Group probably are derived chiefly from carbon dioxide species that were present in the water within the Minnelusa Formation. The carbon dioxide content of the calcium sulfate water from the Minnelusa sampled at three springs and one well in the southern Black Hills ranges from 29 to 47 ppm CO_2 and averages 38 ppm (table 11). As the waters rise to the Inyan Kara, some carbon dioxide is immediately released, but more carbon dioxide apparently is released somewhat later as the water migrates downdip within the Inyan Kara and is softened by ion exchange to a sodium sulfate water. The samples of sodium bicarbonate water contain less carbon dioxide than those of calcium sulfate water sampled updip but contain more than the sodium sulfate water. This distribution of carbon dioxide in the sodium bicarbonate water also suggest some loss of carbon dioxide from the artesian water introduced into the Inyan Kara as the water continues to migrate through the group; however, other chemical and biochemical processes probably produce additional carbon dioxide, thereby moderating the effect of this loss of carbon dioxide from bicarbonate ground water.

TABLE 11. — *Carbon dioxide content (calculated) of water from the Minnelusa Formation*

[ppm, parts per million]

Locality (pl. 4)	pH	HCO_3 (ppm)	CO_2 (ppm)
1	7.0	225	36
7	7.0	238	38
6	6.9	235	47
4	7.1	232	29
Average			38

LOCALITIES SAMPLED

No.	*Description*
1	Spring, SE¼ sec. 31, T. 45 N., R. 60 W., Weston County, Wyo.
7	Flowing well, LAK Ranch, center W½NW¼ sec. 5, T. 44 N., R. 60 W., Weston County, Wyo.
6	Spring, Cascade Springs, SW¼ sec. 20, T. 8 S., R. 5 E., Fall River County, S. Dak.
4	Spring, Evans Plunge, Hot Springs, NW¼ sec. 13, T. 7 S., R. 5 E., Fall River County, S. Dak.

URANIUM DEPOSITION

The conditions necessary for uranium deposition probably have persisted intermittently since the establishment of the present pattern of ground-water recharge and artesian flow following Laramide uplift of the Black Hills. The general requirements for the deposition of uranium consist of a source of uranium, a favorable environment for deposition, and a means of transporting an adequate quantity of uranium to this environment. When these three conditions are fulfilled for a sufficient length of time, an ore deposit can be formed.

Changes in the geochemical environment in the Inyan Kara Group occur continuously along the margin of the Black Hills as erosion progressively lowers the surrounding plains. During erosion, the water table declines, and the zone of artesian recharge, as well as the oxidation-reduction front within the Inyan Kara, migrates basinward. Various stages in the evolution of the geochemical environment in which ore deposits are formed can be observed in the ground water along a line running northeasterly updip to the Inyan Kara outcrop.

EFFECT OF REDUCING ENVIRONMENT

Uranium is precipitated from solution by the reduction of the complex uranyl ion U^{+6} to the uranous ion U^{+4}. This reduction can be brought about by several reducing agents, including those derived from organic material and hydrogen sulfide. Considerable evidence indicates that a reducing environment resulting in the formation of uranium deposits in the southern Black Hills was brought about by the presence of hydrogen sulfide.

The ore deposits are restricted to four stratigraphic units, of which only one is highly carbonaceous. These units are (1) the highly carbonaceous sandstones and siltstones of the lower unit of the Fall River Formation, (2) noncarbonaceous fluvial unit 5, also in the Fall River Formation, (3) noncarbonaceous fluvial unit 4, in the Fuson Member of the Lakota Formation, and (4) moderately carbonaceous fluvial unit 1 in the Chilson Member of the Lakota Formation (pl. 1, north half). The lack of a close spatial association between some uranium deposits and the organic carbonaceous material indicates that in these deposits the organic carbon did not directly cause precipitation of the uranium.

As discussed previously, many of the water wells that were drilled into the Inyan Kara rocks along the southwest side of the Black Hills produce water highly charged with hydrogen sulfide. Where the water in the Inyan Kara changes from a predominantly calcium sulfate water to a sodium bicarbonate water (pl. 3), hydrogen sulfide is abundant. Most likely, the hydrogen sulfide resulted from sulfate reduction by bacteria that depend upon carbonaceous material within the Inyan Kara rocks for their life processes. This reduction resulted in the establishment of a geochemical environment favorable for the formation of uranium deposits.

EFFECT OF THE "PLUMBING" SYSTEM AND THE INYAN KARA STRATIGRAPHY ON LOCALIZATION OF URANIUM DEPOSITS

The route of migration and volume of flow of the ground water are major factors that influence the size and location of the uranium deposits. Extensive channel sandstones permit lateral migration of large volumes of aqueous solutions, and the stacking of channels (pl. 1, north half, restored cross section) permits vertical migration within the Inyan Kara Group. As previously discussed, numerous breccia pipes as well as faults and fractures extend from the Lakota Formation downward to sandstone aquifers and solution breccias in the Minnelusa Formation to complete a complex plumbing system that permits vertical migration of solutions between the Minnelusa and favorable host rocks in the Inyan Kara Group (fig. 18).

Channelways provided by the superposition of fluvial sandstones permit circulation of ground water from the base of the Lakota Formation into unit 5 sandstone in the Fall River Formation, and apparently they significantly influenced the location of the ore deposits by directing the mineralizing solutions into favorable host rocks. This is especially true of

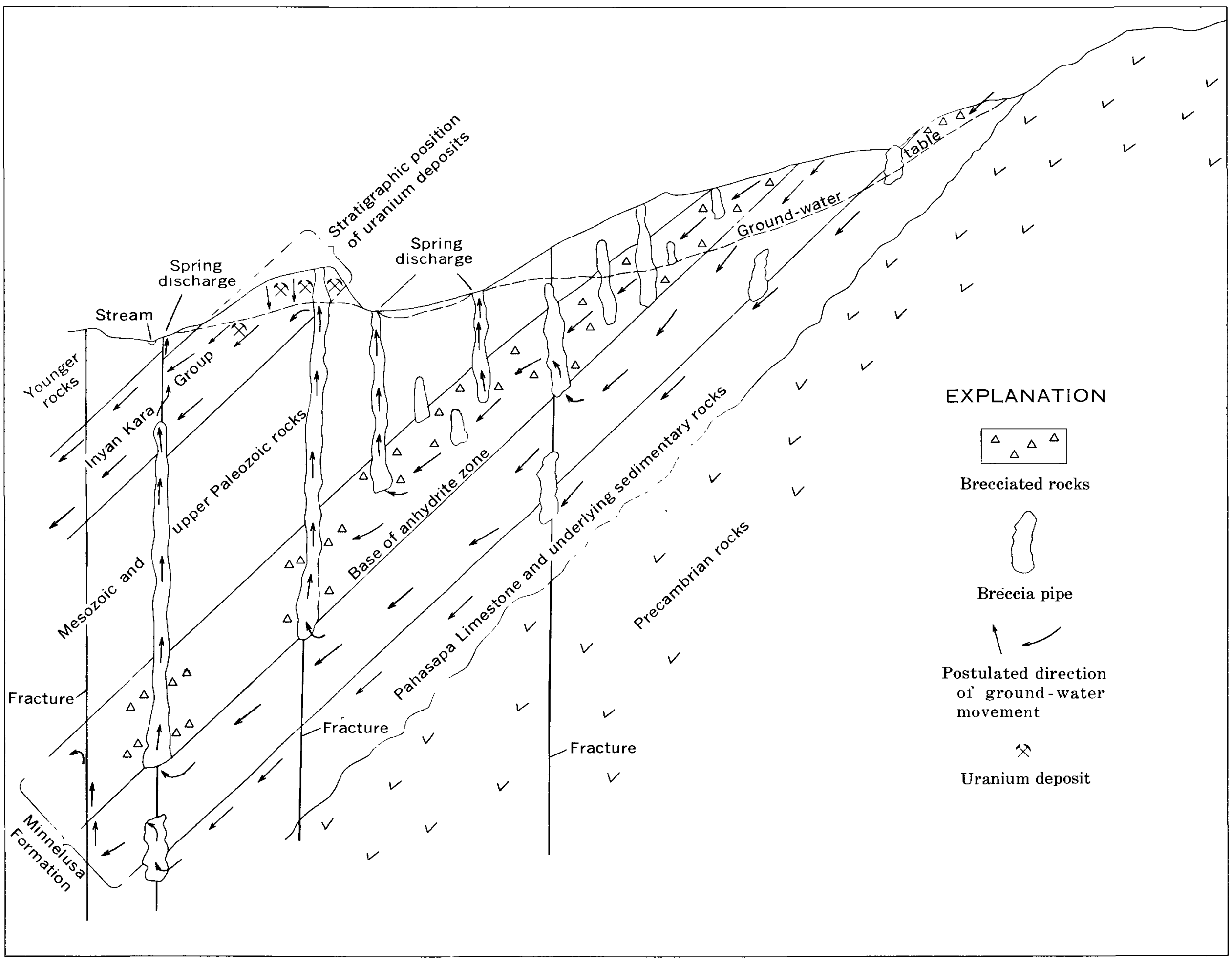


FIGURE 18. — Spatial relation of the uranium deposits to leaching of evaporites, brecciation, and postulated direction of ground-water movement. Diagram not to scale.

fluvial unit 4, which fills irregularities on an erosional surface that partly dissected or completely truncated the Fuson mudstone, an impermeable unit that apparently was laid down as a bed of relatively uniform thickness across units 1 and 2 of the Chilson Member. The Fuson mudstone, therefore, retards or prohibits ground-water circulation between the sandstones of the Chilson Member of the Lakota Formation and the sandstones of the overlying Fall River Formation except where the Fuson mudstone is cut by the channel sandstone of unit 4.

The lower sandstone and siltstone unit in the Fall River similarly retards circulation of ground water from the Lakota Formation into stratigraphically higher units except in those places where the unit is faulted or is cut by the channel sandstone of unit 5.

The "plumbing" system and the Inyan Kara stratigraphy, which control the volume of metals that are transported into favorable host rocks, are influenced indirectly by tectonic deformation. As previously discussed, pipe structures that transmit artesian water to the Inyan Kara are more numerous in the structural zones, where evaporites were fractured by recurrent deformation and thus were more susceptible to dissolution and collapse. In addition to the development of the breccia pipes, the stacking of the channel-fill sandstones of the main streams and their tributaries was influenced by recurrent structural deformation not only along the axis of the regional northwest-trending syncline, but also along secondary northeast-trending basement structures. Therefore, the location of the uranium deposits is indirectly influenced by tectonic structure, which was a factor in the development of the "plumbing" system and also in the location of superposed, or stacked, channel-fill sandstones of the Inyan Kara Group.

MINERALIZING SOLUTIONS

The relations between the reducing environment, the "plumbing" system, and the distribution of the deposits are interpreted to mean that uranium was introduced into the Inyan Kara Group with the calcium sulfate water that flowed from the Minnelusa Formation to recharge the sandstone aquifers of the Lakota. The uranium concentration in water from the Minnelusa sampled at seven springs (table 9) ranges from 4.7 to 17 ppb. Uranium in the water probably was derived from multiple sources, including sedimentary rocks of Paleozoic and Mesozoic age and the exposed granites of Precambrian age in the central part of the Black Hills. During Tertiary time volcanic ash of the White River Group of Oligocene age may have also contributed uranium.

The uranium concentration in ground water of the Inyan Kara Group decreases in a basinward direction (fig. 19) as the calcium sulfate water is modified to a sodium sulfate water (fig. 20) and simultaneously is subjected to minor sulfate reduction. Where intensive reduction of sulfate occurs within the more carbonaceous rocks, and the water is modified to the sodium bicarbonate type, the uranium content decreases very rapidly until less than 0.1 ppb uranium remains in solution.

The decrease in uranium concentration in the basinward-flowing waters is interpreted to be the result of the precipitation of uranium, although possibly absorption and (or) adsorption of uranium by organic matter and by clay minerals may remove some of it from solution. The decrease in uranium concentration does not result from dilution by older, less uraniferous water, because such dilution should everywhere result in the simultaneous dilution of the tritium concentrations in the ground water. Simultaneous dilution of uranium and tritium concentrations does not occur; instead, these concentrations decrease independently.

Values of redox potential and pH recorded in the water flowing from wells (table 10) also indicate the probable precipitation of uranium from the ground water rather than a dilution of the uranium concentration by less uraniferous waters. High uranium values are present in calcium sulfate waters having higher redox and pH values, representing oxidizing conditions. Conversely, low uranium concentrations (less than 0.5 ppb U) are present in sodium sulfate or sodium bicarbonate waters in which low redox and pH values indicate the presence of reducing conditions that could precipitate uraninite.

The primary mineralizing solution appears to be a calcium sulfate type ground water. Where the sulfate water, carrying weak concentrations of uranium, is introduced into highly carbonaceous units of the Inyan Kara, relatively rapid reduction of sulfate and uranium occurs. Rapid precipitation of uranium at the site of modification of the water to the hydrogen sulfide-bearing sodium bicarbonate type follows. Where calcium sulfate water is introduced into sparsely carbonaceous or noncarbonaceous rocks, uranium precipitation may proceed more slowly and occur across a broad zone as the water is modified to the sodium sulfate type; after this modification of water type, most of the uranium has been precipitated. Where ground-water movement is rapid, a low rate of uranium precipitation results in the dissemination of uranium throughout the sandstone of the Inyan Kara, but rapid precipitation results in the formation of higher grade deposits.

Some enrichment-type uranium deposits may have

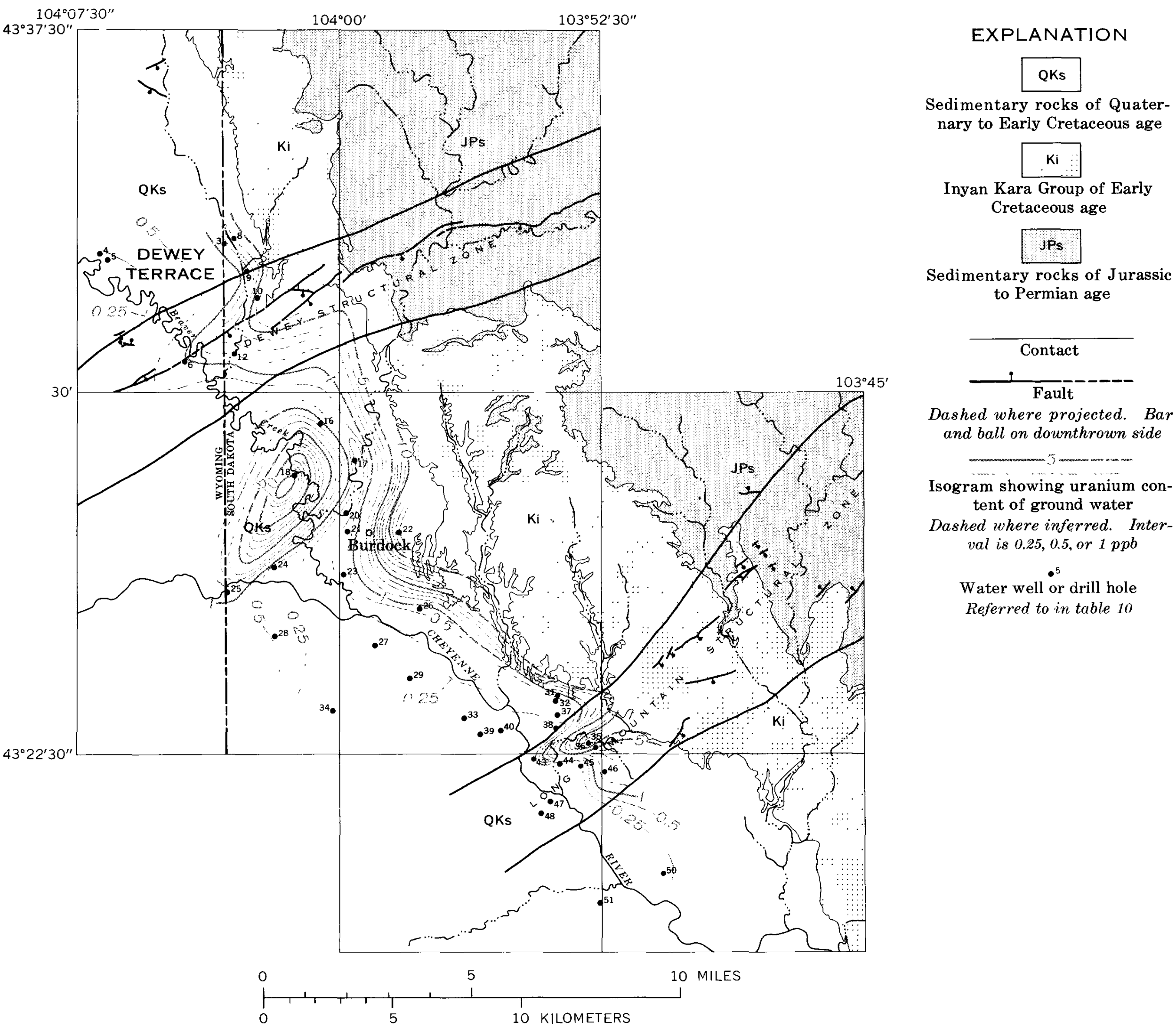


FIGURE 19. — Uranium distribution in ground water of the Inyan Kara Group of the southern Black Hills.

been derived from disseminated uranium and from older deposits in the Inyan Kara at higher elevations. These enrichment- or lateral accretion-type deposits are likely to be along well-defined oxidation-reduction fronts near the Inyan Kara outcrop and may occur as roll-type uranium deposits (Shawe and Granger, 1965). Lateral accretion of uranium can be most rapid where the uranium concentration in the host rocks is highest; therefore, roll-type deposits may lie downdip from areas that, in the past, have had much higher rates of ground-water flow and a significant contribution of uranium derived from artesian recharge. Ground water that forms roll-type deposits probably flows much more slowly than the rate of 15 feet per day calculated for the most rapid flow at the margin of the southern Black Hills; therefore, roll-type deposits are less likely to be present in areas having a high rate of ground-water movement. A low rate of flow, favorable for roll-type deposits, may be indicated by the presence near the Inyan Kara outcrop of sodium sulfate water, softened by ion exchange, as well as by the absence farther downdip of very young water containing high tritium values. The mineralizing solutions for the enrichment-type deposits may contain higher concentrations of uranium than the primary mineralizing solution, thereby permitting uraninite precipitation in a somewhat less reducing environment (a slightly

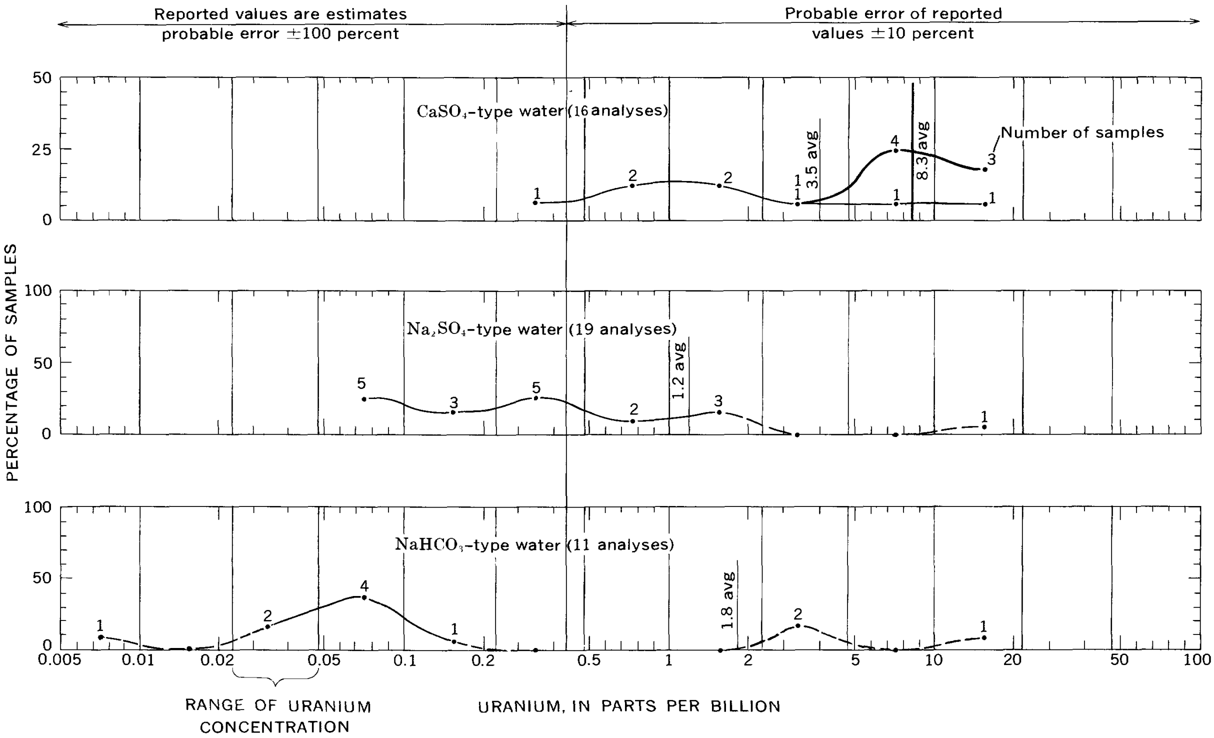


FIGURE 20. — Uranium in samples of three types of ground water from the Inyan Kara Group (light lines) and from the Minnelusa Formation (heavy lines). Points indicate percentage of samples reported for each range of uranium concentration.

higher redox and pH environment) than the environment of primary mineralization. This influence of uranium concentration upon precipitation is indicated by the phase-equilibrium diagrams of Hostetler and Garrels (1962).

ORE DEPOSITS AS RELATED TO THE "PLUMBING" SYSTEM AND THE STRATIGRAPHY

One important factor in the formation of the ore deposits — a "plumbing" system adequate to transmit large volumes of solutions — has already been described. A brief description of representative ore deposits as they are spatially related to this system follows.

In the vicinity of the Runge mine (E½ sec. 1, T. 8 S., R. 2 E.), in the southern part of the Edgemont NE quadrangle, the major sandstones in fluvial units 4 and 5 are in erosional contact (fig. 21). Fluvial unit 5 sandstone cuts through the highly carbonaceous and pyritiferous basal Fall River siltstone and sandstone, thus permitting ground water in fluvial unit 5 access to reducing agents derived from the carbonaceous unit. Ore minerals are extensively disseminated through the two sandstones near the contact.

As shown by figure 22, several metals appear to have a systematic zoning pattern within the Runge mine (V. R. Wilmarth, unpub. data). The zones are identifiable by their mineralogy, color, and grade. They consist of (1) a basal zone which is tightly cemented by calcium carbonate and which contains pods, lenses, nodules, and concretions of unoxidized uranium, vanadium, and iron sulfide-bearing minerals; (2) an unoxidized iron-rich discontinuous zone that overlies zone 1; (3) an oxidized vanadium-rich zone of reddish sandstone, in which iron oxide is concentrated, that overlies both zones 1 and 2; and (4) a discontinuous zone at the top in which arsenic and molybdenum are concentrated. Possibly the molybdenum has been recently redistributed. This zoning pattern suggests that, of all the elements, uranium moved the least distance and arsenic the greatest distance, from the point where waters from the two sandstones intermingled. Iron was present in all zones.

The numerous ore deposits that occur in the basal part of the Fall River Formation in secs. 25 and 26, T. 7 S., R 2 E., could have formed under geochemical conditions similar to the Runge deposit. The deposits

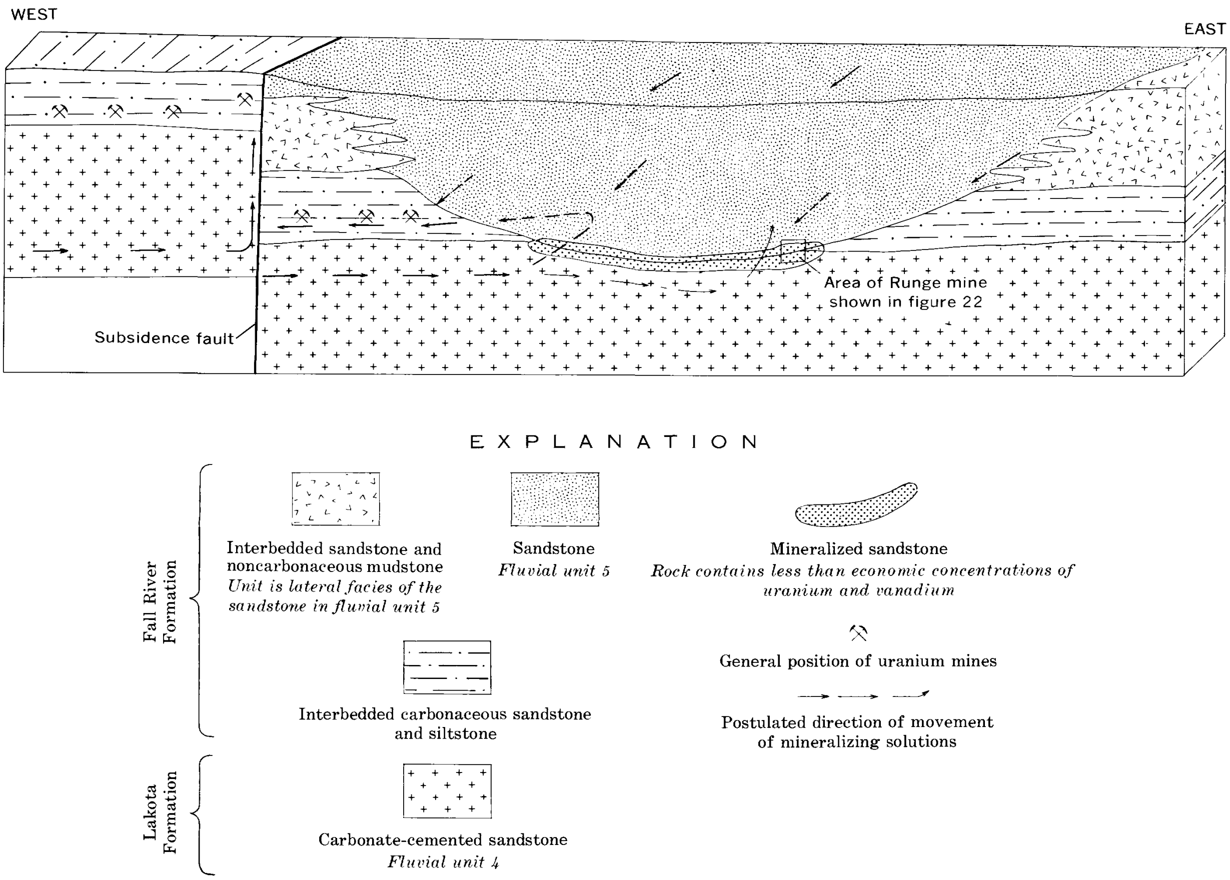


FIGURE 21. — Relation of channel sandstones to uranium deposits, carbonate cement, and postulated direction of movement of mineralizing solutions. Diagram not to scale.

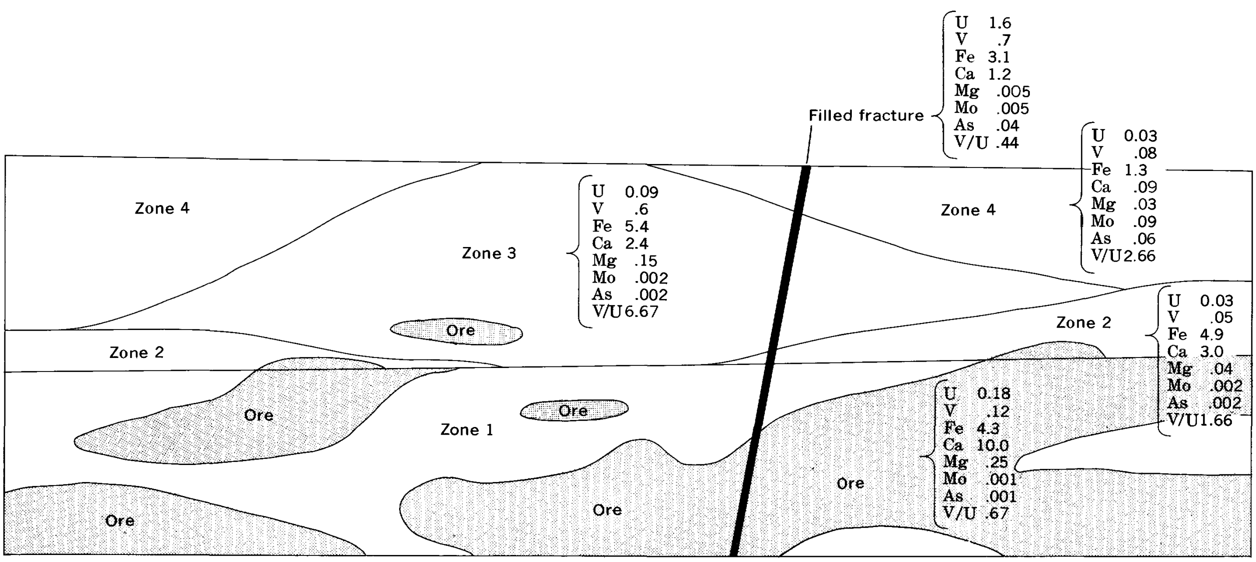


FIGURE 22. — Idealized diagram showing zonal relations of several metals in the Runge mine, Fall River County, S. Dak. Average concentrations of metals in percent. Diagram not to scale.

are partly oxidized and are in a sequence of alternating thin beds of fine-grained sandstone and laminated carbonaceous siltstone. Corvusite, rauvite, carnotite, and tyuyamunite constitute the ore-forming minerals. The deposits occur in the vicinity of several small faults that may be partly of subsidence origin and are also marginal to the western channel boundary of unit 5 sandstone (fig. 21). It seems likely that uranium-bearing solutions migrated upward from unit 4 sandstone into the carbonaceous siltstone-sandstone unit either through the fault zone or by way of unit 5 channel sandstone. Entry of the solutions into the reducing environment of the carbonaceous siltstones and sandstones apparently resulted in precipitation of the uranium and vanadium minerals.

Evidence of vertical migration of mineralizing solutions through collapse structures is seen in the Kellog mine, which is near the center of the Flint Hill quadrangle (pl. 1), and near the northeast margin of fluvial unit 1. The ore minerals occur in a 6- to 8-foot-thick fine-grained sandstone, the basal part of which contains numerous carbonaceous shale and siltstone layers that average about 1 inch in thickness. The sandstone is overlain by a black carbonaceous shale and is underlain by a thin bed of greenish-gray plastic clay that locally contains calcite spherulites. The mine is traversed by numerous small intersecting faults that have displacements of as much as 2.3 feet (fig. 23). In order of decreasing age, they strike north, east, northeast, and northwest. The intersecting faults define numerous relatively small sandstone blocks bounded by the black carbonaceous shale at the top and the greenish-gray plastic clay at the base. Uranium ore occurs in intimate association with carbonaceous material in the lower 2–5 feet of the complexly faulted sandstone, and it also occurs stratigraphically higher along the fault planes. The uranium minerals have not been identified but are assumed to be either uraninite or coffinite or both.

The fault pattern is typical of that formed by subsidence, a pattern similar to that found locally throughout the mining district. The relatively high concentrations of the ore-forming minerals along and marginal to the fault planes indicates that the faults served as pathways of vertical migration for the mineralizing solutions.

Many small oxidized uranium deposits occur along or near the outcrop of the major sandstone in fluvial unit 1. In many of these deposits the uranium minerals are selectively concentrated around carbonized wood fragments and macerated plant remains. In the many other deposits, in which this relation does not exist, the uranium minerals seem to have been precipitated by an ephemeral agent. As discussed previously, there is reason to suspect that biogenically derived hydrogen sulfide has become enriched in the ground water in some areas, and this enrichment probably accounts for those deposits not directly associated with organic material.

It is interesting to speculate about the low vanadium content in these small carnotite deposits. The vanadium-uranium ratio ranges from 0.25 to 0.68 and averages about 0.4 (Gott and Schnabel, 1963, p. 175). This amount of vanadium is barely enough to form the mineral carnotite, and inasmuch as some vanadium is known to be present in the clays, probably all the available vanadium was used in the formation of carnotite. Under such a circumstance uranium may have been lost during oxidation. After all the vanadium had been utilized in the formation of carnotite, excess uranium, if any existed, would have been carried away by ground and surface water. The uranium carried downdip by ground water would have been reprecipitated below the zone of oxidation.

The location of the deposits in fluvial unit 1 may have been influenced by pre-Fall River folding. With few exceptions these deposits as well as those in stratigraphically higher units are restricted to favorable host rocks within a gentle syncline, the center of which trends through the northwestern part of the Flint Hill quadrangle, through the northeastern part of the Edgemont quadrangle, and diagonally northwestward across the Edgemont NE quadrangle (pl. 1; see also Gott and Schnabel, 1963, pl. 14). The syncline apparently was formed by mild structural deformation during Lakota time. The effect of the syncline apparently was to control the position of streams which deposited the thick channel sandstones that constitute the major distributors of migrating solutions.

Calcium carbonate cement seems to be an indicator of the extent and ramifications of the "plumbing" system. The cement impregnating the ore-bearing sandstones is so extensive that it seems evident that the cementing material was imported from an external source, for there is no evidence that an adequate source ever existed within the Inyan Kara rocks. For example, one 10-mile segment of fluvial unit 4 in the southwestern part of the Edgemont NE quadrangle and adjacent areas is estimated to contain more than 1 billion cubic feet of calcite. An extensive segment of the sandstone of fluvial unit 5 is similarly cemented along the axis of the Sheep Canyon monocline along the western part of the Flint Hill, the eastern part of the Edgemont, and the southeastern part of the Edgemont NE quadrangles. Elsewhere, these and other sandstones are cemented with significant volumes of calcite cement. Numerous calcite-cemented breccia pipes extend upward from the evaporite zone in the Minnelusa Formation to the Inyan Kara sandstones, indicating that the source of the calcite was the Minnelusa evaporites. The breccia pipes evidently were the "pipelines" through which large volumes of solutions were supplied to the Lakota Formation, and the calcite-cemented sandstones were the distributors of these solutions through the accessible Inyan Kara rocks.

Polished-section studies show that some of the uraninite is contemporaneous with the calcite cement although in general the calcite is earlier than the uraninite (Gott and Schnabel, 1963). This contemporaneity indicates that the two minerals resulted in part from the same mineralizing process and suggests that uranium, vanadium, calcium, and bicarbonate were transported in a common solution. Solution of evaporites and the formation of breccia pipes to permit circulation of ground water from the Minnelusa Formation to the Inyan Kara Group are, therefore, among the combination of factors that resulted in the localization of the ore deposits.

EFFECT OF THE TERTIARY AND QUATERNARY DRAINAGE SYSTEMS ON LOCALIZATION OF URANIUM DEPOSITS

The Laramide uplift provided the structural and topographic relief necessary for the erosion that exposed Mesozoic and Paleozoic rocks for the recharge of aquifers by surface waters and for the establishment of a pattern of surface- and ground-water flow away from the central part of the Black Hills. Where ground water at the lower flank of the uplift was confined to an aquifer by overlying and underlying impermeable strata, artesian pressure developed that was sufficiently strong to force water up through puncture points or conduits formed by faults, fractures, anastomosing sandstone channels, and solution collapse structures. In places where conduits underlay deeply incised valleys, ground water was forced to the surface to be discharged by springs. At these localities ground-water flow through the Inyan Kara rocks was relatively rapid.

Relocation of drainages occurred as erosion exposed the formations underlying shales of Late Cretaceous age. Structural deformation and the varied resistance to erosion of the older formations resulted in modification of the drainage pattern. The position of Tertiary and Quaternary streams, as indicated by remnant terrace gravels, wind gaps, incised meanders, and shallow upland valleys, is shown on plate 4. Broad gravel terraces along the dip slopes of the Inyan Kara hogback on the southwest flank of the Black Hills indicate a downdip migration of major southeast-flowing streams as erosion progressed. One of the major ancestral drainage courses in the Craven Canyon area is an excellent example of stream relocation. The stream that formed Craven Canyon originally crossed the Chilson anticline and continued southeast through the lower part of Chilson Canyon until it was diverted by stream capture, first into Sheep Canyon and later into the lower part of the present Red Canyon.

The occurrence of uranium deposits near drainages of the Tertiary and Quaternary streams, as well as in the areas of northeast-trending structures (pl. 4), reflects the influence of both vertical and horizontal movement of ground water during formation of the ore deposits. Where artesian water flowed at the maximum rate through the Inyan Kara, proportionately larger amounts of uranium were transported to sites of reduction and precipitation. Continued erosion within the Black Hills and on the adjacent plains, periods of stream aggradation during Tertiary and Quaternary time, and minor structural deformation all contributed to the shifting of the streams, influenced the rate and direction of ground-water movement within the Inyan Kara aquifers, and caused a shifting of the sites of uranium deposition. For example, the upper part of Chilson Canyon, which was deeply eroded prior to the capture of the drainage from Craven and Red Canyons, contains uranium deposits, whereas the lower part of Chilson Canyon, which was eroded by a much smaller discharge of water and which probably has had relatively little effect on ground-water movement, contains no known uranium deposits.

EXPLORATION GUIDES

Exploration for uranium in the Inyan Kara Group of the southern Black Hills can be facilitated by the combined use of stratigraphic, lithologic, structural, and hydrologic guides.

Solution of evaporites in the Minnelusa Formation resulted in subsidence and brecciation of many of the overlying rocks. Of particular significance was the formation of breccia pipes that extend upward from the Minnelusa Formation and permit large volumes of artesian water carrying relatively low concentrations of uranium to ascend into the Lakota and Fall River Formations. Factors within these formations affecting the localization of the uranium deposits pertain mainly to the "plumbing" system, which transmits the mineralizing solutions, and to the geochemical environment in the host rocks. Exploration for concealed uranium deposits, therefore,

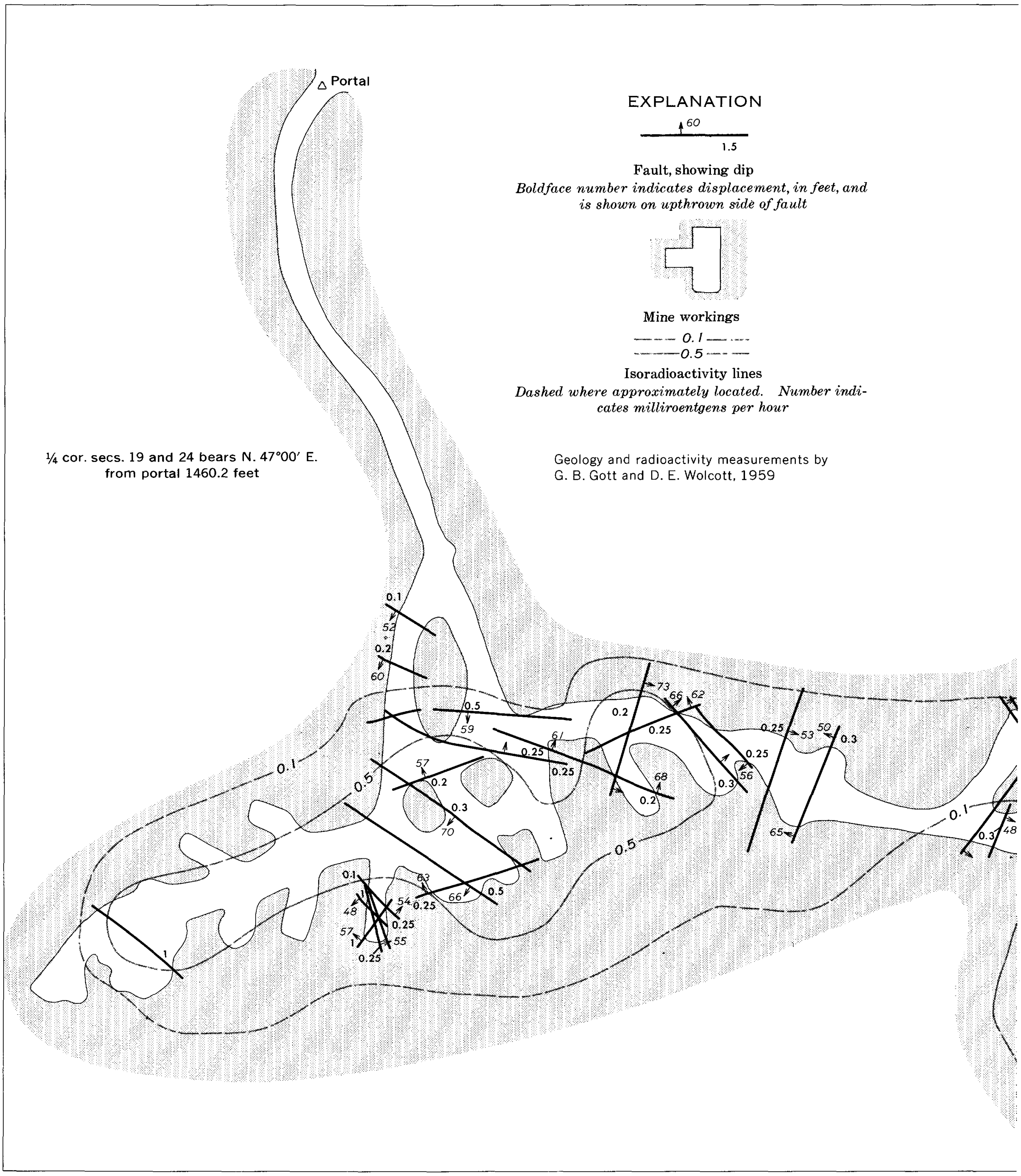
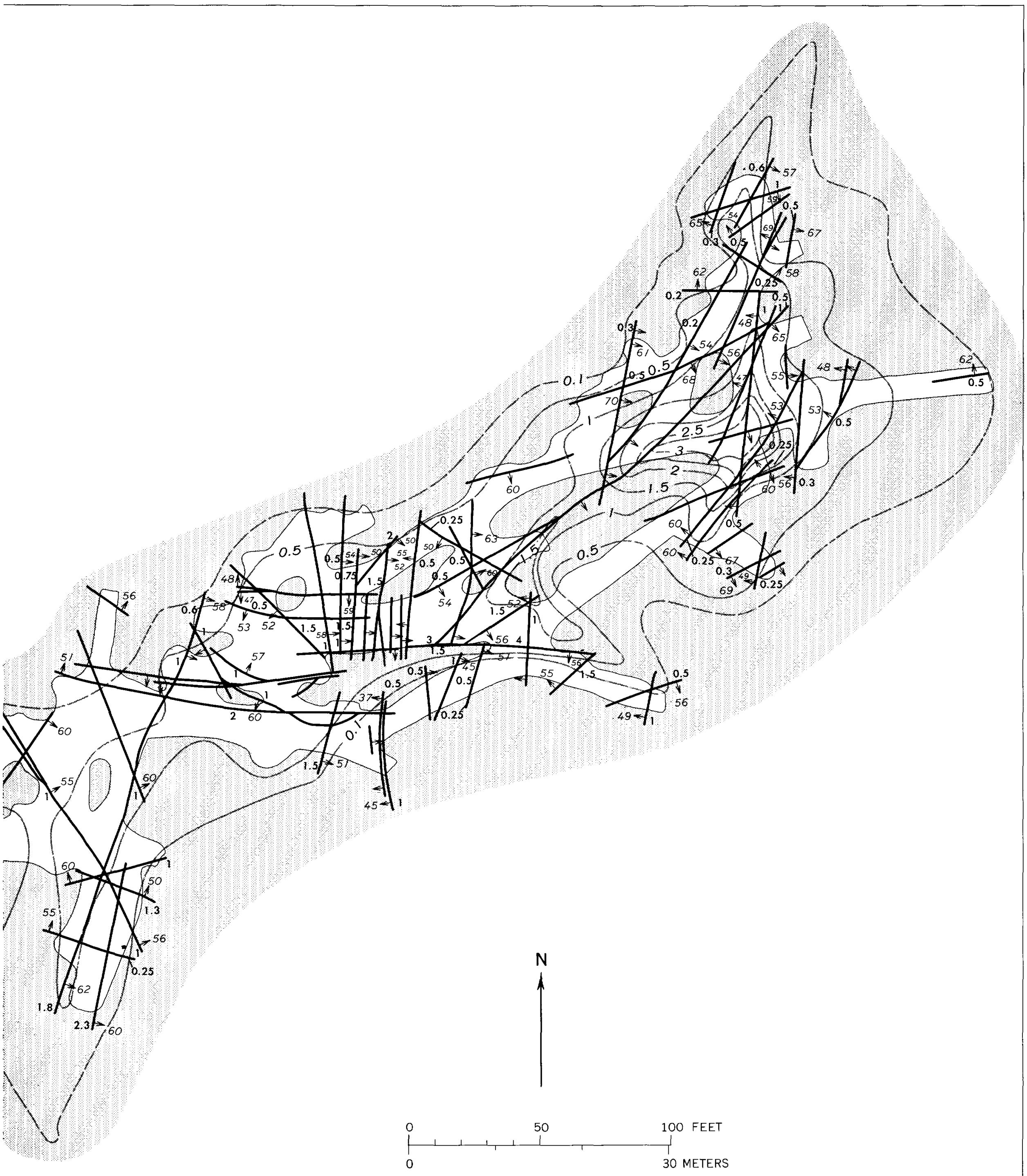


FIGURE 23. — Mine workings, faults, and radioactivity



in the Kellog mine, Fall River County, S. Dak.

should be based on the coincidence of favorable host rocks and vertical conduits caused by the subsidence of rocks overlying the evaporites, particularly in zones of fracturing and faulting.

Many billions of cubic feet of calcium carbonate cement are in the sandstones of the Inyan Kara Group. The cement is continuous from that part of the Minnelusa Formation that has been leached of calcium sulfate, upward through many breccia pipes, and into the Lakota and Fall River Formations. This continuity indicates that the source of the calcite cement is the leached evaporite zone and other carbonate rocks, which were accessible to the ascending solutions, and that the abundance of the cement in the Inyan Kara is evidence that ground water from the Minnelusa has ascended at least as high as these calcite-cemented sandstones. The presence of so much cement would mean that there may have been an adequate volume of solutions to import enough uranium to form an ore deposit, but it would not necessarily mean that a geochemical environment favorable for its precipitation also existed.

Ore deposits are restricted to fluvial units 1, 4, and 5 and to the sandstones and siltstones of the basal Fall River Formation, indicating that sandstones in these units have offered an environment favorable for uranium deposition and therefore favorable for exploration. Conversely, the sandstones of fluvial unit 2 are unfavorable for exploration. Unit 2 is mostly well oxidized and therefore forms an environment in which uranium would tend to be soluble and would not precipitate from solutions migrating through the unit.

One of the requirements for the formation of ore deposits by precipitation of uranium from the ground water is a circulation system within which the circulation is rapid, thereby permitting the influx of a large volume of mineralizing solution. Under ideal conditions, including the flushing of tremendous volumes of ground water through the system, significant amounts of uranium can be derived from minute concentrations of uranium in the ground water.

Both the Lakota and the Fall River Formations normally contain fine-grained, poorly permeable rocks that retard ground-water movement. Examples of these fine-grained rocks are the fissile shales at the base of the Lakota, the Fuson mudstones, and the tabular siltstones interbedded with fine-grained sandstones at the base of the Fall River Formation. Where these fine-grained rocks have been removed by intraformational erosion, the ground water can migrate freely through sandstones of fluvial units 1, 4, and 5, in which the geochemical environment is favorable for precipitation of uranium. The stacking and interconnection of these fluvial sandstones should be considered when planning an exploration program.

Structural deformation has influenced the deposition of the fluvial sandstones, thereby affecting the later flow of ground water through the Inyan Kara Group. The pre-Fall River structural trough shown by Gott and Schnabel (1963, fig. 26) appears to have been a particularly favorable area for the transmission of large volumes of solutions and for the formation of ore deposits. Most uranium deposits within the Edgemont district are in fluvial unit 1, which was deposited along the axis of the structural trough, or in other overlying favorable stratigraphic units to which fluvial unit 1 is connected by superjacent channels. Consideration should be given to exploring this syncline where it extends downdip under the Skull Creek Shale along the toe of the Sheep Canyon monocline and south on the Chilson anticline.

Northeast-trending secondary structures also influenced the position of the main and tributary streams and the deposition of fluvial sandstones that transmit ground water through the Inyan Kara. Within both the Long Mountain and Dewey structural zones, recurrent deformation continually affected sedimentation during Lakota and Fall River time by causing a deflection of the northwest-flowing streams and by defining the courses of tributary streams. Later folding and faulting in these two structural zones also significantly affected ground-water movement. Elsewhere, deformation along northeast-trending structures was more sporadic, but the structural influence on sedimentation, although more limited, does indirectly affect ground-water movement. The effect of these secondary, northeast-trending structures upon ground water movement should be considered when an area is evaluated for possible exploration.

Within the more deeply incised drainages, artesian water from the Inyan Kara Group locally discharges as springs or recharges alluvium and gravel. Near the points of discharge, ground-water flow in the Inyan Kara is accelerated. The possible effect of these high rates of ground-water movement upon mineralization should be considered both for the present drainages and for the ancestral drainages, which are indicated by stream terrace gravels and erosional features.

Ground-water analyses and field measurements of redox potential and pH indicate areas below the Skull Creek Shale where uranium probably is being precipitated now. The analyses suggest that most of the uranium is transported by calcium sulfate water and that it precipitates at the margin of a strong reducing environment, such as the hydrogen sulfide-bearing sodium bicarbonate water. The transition zone between calcium sulfate and sodium bicarbonate waters at the Long Mountain structural zone should therefore be considered as a favorable area for exploration. Conversely, the central part of the area containing hydrogen sulfide-bearing sodium bicarbonate water should be considered unfavorable for exploration unless indications of local recharge of the Inyan Kara by uraniferous water are found.

During the evolution from calcium- and magnesium-rich sulfate water to the sodium-rich sulfate water, uranium is precipitated. Perhaps more rapid precipitation of uranium, and therefore higher grade deposits, occur at the margin of the hydrogen sulfide-bearing sodium bicarbonate water.

Studies of water samples collected from water wells and exploration drill holes should supplement the usual stratigraphic, mineralogic, lithologic, and radiometric studies conducted during exploration, and they probably would aid a systematic search for uranium deposits present below the water table.

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U.S. GOVERNMENT PRINTING OFFICE : 1974—O-537-784

From:	Jeffery C. Parsons
To:	Shea, Valois
Cc:	"Roger Flynn"
Subject:	FW: Oglala Sioux Tribe Comment Attachments #4
Date:	Monday, June 19, 2017 5:36:48 PM
Attachments:	OST-1 Opening Written Testimony of Dr Robert Moran.pdf OST-018 Dr Moran Rebuttal Testimony 7_15_2014.pdf

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Email #4

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From: Jeffery C. Parsons [mailto:wmap@igc.org]
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From: Jeffery C. Parsons [mailto:wmap@igc.org]
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Email #2

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From: Jeffery C. Parsons [mailto:wmap@igc.org]
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Cc: 'Roger Flynn' <wmap@igc.org>
Subject: Oglala Sioux Tribe Comment Attachments

Ms. Shea – in support of the comments submitted this day (June 19, 2017) by the Oglala Sioux Tribe, attached are supplemental documents. As there are several such documents, there are likely to be a series of emails to follow. Thank you.

****
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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
POWERTECH (USA) INC.,	)	Docket No. 40-9075-MLA
	)	ASLBP No. 10-898-02-MLA-BD01
(Dewey-Burdock In Situ Uranium Recovery	)	
Facility)	)	

OPENING WRITTEN TESTIMONY OF DR. ROBERT E. MORAN

I, Dr. Robert E. Moran, do hereby swear that the following written testimony is true to the best of my knowledge:

I. Basis for Testimony as an Expert in Hydrogeology

The opinions below are based on my review of the materials in the hearing record, including those materials referenced in my previous declarations and in the testimony below. My qualifications as an expert in hydrogeology and geochemistry are summarized in this testimony, and are set out more completely in the documents contained in the hearing record that detail my education, training, and experience. My curricula vitae is attached.

By way of summary, I earned my Ph.D. in, Geological Sciences from University of Texas, Austin in 1974 after earning my B.A. in Zoology from San Francisco State College in 1966. I am a hydrogeologist and geochemist with more than 42 years of domestic and international experience in conducting and managing water quality, geochemical and hydrogeologic work for private investors, industrial clients, tribal and citizens groups, NGO's, law firms, and governmental agencies at all levels. Much of my technical expertise involves the quality and geochemistry of natural and contaminated waters and sediments as related to mining, nuclear fuel cycle sites, industrial development, geothermal resources, hazardous wastes, and water supply development. In addition, I have significant experience in the application of remote sensing to natural issues, development of resource policy, and litigation support. I have often taught courses to technical and general audiences, and have given expert testimony on numerous occasions. Countries worked in include: Australia, Greece, Bulgaria, Mali, Senegal, Guinea, Gambia, Ghana, South Africa, Iraqi Kurdistan, Oman, Pakistan, Kazakhstan, Kyrgyzstan, Mongolia, Romania, Russia (Buryatia), Papua New Guinea, Argentina, Bolivia, Chile, Colombia, Guatemala, Honduras, Mexico, Peru, El Salvador, Belgium, France, Canada, Great Britain, United States.

Literature reviewed in preparation of my testimony includes:

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- Technical Report (TR)
- Environmental report (ER)
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II. Contention 2: Baseline Characterizations are Inadequate

A. Past Uranium Mining and Other Contamination.

1. *Expert Opinion*: Analyis of impacts from past mining and other contamination are critical to assessing the baseline water quality and potenential impacts of future mining activity at the proposed site.

2. *Basis for Opinion*: The Dewey-Burdock region has been impacted by past mining and related activities, which were permitted by the AEC / NRC, and which have resulted in negative impacts to the local water resources and environment. Activities at the Black Hills Ordinance Depot (operational from 1942 through1967) have also impacted waters in this region. While limited remediation of surface facilities at portions of these two areas has occurred, no remediation of the historic water contamination has occurred at either site.

B. Inadequate Baseline Concept and Baseline Data.

1. *Expert Opinion*: The Application and Final Supplemental Environmental Impact Statement (FSEIS) are inadequate to establish a hydrogeological baseline for the aquifers that would be impacted by the D-B Project.

2. *Basis for Opinion*: Both documents fail to analyze past uranium exploration and mining activities that have degraded the quality of much of the Dewey-Burdock area ground and surface waters. Neither the Application nor FSEIS presents baseline water quality data obtained prior to past mining activities and the contamination from the Black Hills Ordinance Depot. The Application and FSEIS do not address data from samples collected in the early periods of these mining activities.

Instead, the Powertech and NRC Staff assume that the degraded water quality represents "baseline", against which all proposed activities are to be judged. This approach is not scientifically justified as it improperly presents a degraded picture of the original Dewey-Burdock area water quality as a baseline.

C. Fundamental Hydrogeologic Information is Lacking.

1. *Expert Opinion*: The FSEIS and Application lack necessary scientifically-defensible hydrological and hydrogeological information.

2. *Basis for Opinion*: In addition to using a concept of baseline water quality that starts with a degraded aquifer, neither the FSEIS nor Application provides detailed water-related data and information.

Detailed information necessary to develop reliable and scientifically-defensible baseline analysis is not included in the FSEIS or Application. Additional information needed to demonstrate an adequate baseline methodology includes the following categories of information:

-detailed hydrogeologic testing, including long-term aquifer testing, coupled with simultaneous water-quality sampling;
-*detailed* chemical compositions and volumes of all solid and liquid wastes and operating fluids, such as pregnant lixiviant solutions;
-identification of chemical constituents that will be used for aquifer restoration and clean-up standards /criteria for each constituent);
-List of chemical constituents that are likely to require an ACL based on similar projects;
- actual waste disposal methods to be employed;
-detailed analyses and data relating to the specific Underground Injection Control (UIC) Well studies required by the US EPA. EPA approval of the UIC well permits; and,
-Additional structural geologic information, including faults, breccia pipe info., human-induced connectivity.

The Final SEIS states repeatedly that the NRC will require Powertech to collect such detailed data / information **after** NRC license approval, because the Application lacked such data.

The delayed production of this critical baseline information until after licensing is not scientifically defensible as it prevents establishment of a baseline on which to identify, disclose, and analyze the environmental impacts, alternatives, and mitigation measures involved with the Dewey-Burdock project proposal. A scientifically defensible monitoring and mitigation of an operating project is not possible based on the baseline data and analyses I have reviewed.

D. Data Provided Entirely by the Applicant is not an Accepted or Reliable Basis for Analysis.

1. *Expert Opinion*: Analytical results that rely entirely on data provided by the project proponent are not considered reliable by professional hydrogeologists and other water experts.

2. *Basis of Opinion*: Almost none of the relevant Application data, relied upon in the FSEIS, were collected by financially-independent parties. Preparation of most of the documents was directed and paid for by the applicant. The "independent" federal agency with the most, long-term hydrogeologic experience in this region, the Rapid City USGS staff, have not been included as cooperating agencies in the preparation of the FSEIS. Some relevant data collected by USGS was not included in the FSEIS analysis, as it was considered by NRC Staff to be preliminary. In order for the FSEIS to be scientifically acceptable, the available data should have be provided, interpreted, and included in the analysis, and any questions regarding its finality should be noted. Excluding available USGS data results in an unreliable analysis in the FSEIS.

Some of the recent documents provided to NRC Staff by the applicant are largely authored by the applicant, not their consultants. In my experience, this is a signal of significant conflict of interest and the possibility that the consultants were unwilling and unable to give the applicant the desired answer. Many of the significant conclusions in these filings disregard unfavorable details and lack the analytical methods and rigor used by professional hydrogeologists, geochemists, and other water experts. The employment of self-serving analytical methodology does not stand up to accepted scientific methods.

III. Contention 3: The Targeted Production Zones are Unable to Contain Fluids

A. The Targeted Zones are not Hydraulically Isolated

1. *Expert Opinion*: Dewey-Burdock uranium ore zones are not hydraulically-isolated from other geologic units, other aquifers, or zones outside the project area.

2. *Basis for Opinion*: The NRC Staff has disregarded the conclusions of numerous hydrogeologic experts (both Powertech-funded and independent experts) in stating the following (Final SEIS, Exec. Summary, p. xxxvi): "Alluvial aquifers are separated from production zone and surrounding aquifers by thick aquitards (confining units) and, therefore, are not hydraulically connected to production zone and surrounding aquifers."

This incorrect and overly-simplistic statement clearly contradicts expert opinions which state or infer that, long-term, all of the relevant D-B water-bearing zones are hydrogeologically-interconnected (i.e. Keene 1973; Gott, et. al., 1974; TVA, 1979; Butz, et. al., 1980; Smith, 2005; Boggs & Jenkins, 1980, Boggs, 1983, Bredehoeft et. al., 1983; Knight Piesold, 2008).

Upon conducting extensive pumping tests and monitoring, Boggs (1980) concluded: "The aquifer test results indicate that the Fuson member of the Lakota formation is a **leaky** aquitard separating the Fall River and Lakota aquifers. The hydraulic communication between the two aquifers observed during the tests is believed to be the result of (1) **general leakage through the primary pore space and naturally occurring joints and fractures of the Fuson shall,** and (2) direct connection of aquifers via numerous old unplugged exploratory boreholes." (Emphasis added). *Ibid*, p.31.

After reviewing the relevant data, reports and various combinations of satellite imagery, I also conclude that these relevant Dewey-Burdock water-bearing zones are hydrogeologically-interconnected, especially when subjected to long-term pumping as proposed by the Applicant.

Powertech's management and ground water experts have made inconsistent statements about whether the Dewey-Burdock confining units are leaky or not, varying between individual reports, deposition opinions and public hearing testimony. For example, in the Application and Final SEIS, Powertech and NRC Staff assert that all of the relevant pumping tests indicated that the Dewey-Burdock sandstones behaved as leaky-confined aquifers (SEIS, p. 3-34). The consultants who conducted these pumping tests reported the same conclusions. Nevertheless, the SEIS, p. 3-36, states:

"Based on results of the numerical model, the applicant concluded that vertical leakage through the Fuson Shale is caused by *improperly installed wells or improperly abandoned boreholes."*

It is not unusual for the inter-fingering sands, shales, etc. of sedimentary uranium deposits to be hydrogeologically-interconnected, when pumped, long-term. In fact, it is the norm.

Keene (1973) stated that the existence of improperly plugged uranium test holes has contributed to the drop in yields from flowing wells in the Fall River formation. "This practice is not only wasteful of water, "but will ultimately lead to loss of pressure in the aquifer and possible contamination of the Fall River and Lakota aquifers." Keene, p. 24. Neither the Applicant nor the Final SEIS addressed how the Applicant's proposed ISL mining operation will be affected the 1000s of pre-existing boreholes, many of which have never been plugged correctly.

B. Potential Groundwater-Flow Pathways

1. *Expert Opinion*: Potential groundwater-flow pathways in and near the project area are critical to analyzing the proposal and impacts from operations.

2. *Basis for Opinion*: Dewey-Burdock sediments are hydrogeologically interconnected by several potential pathways, which include:

-inter-fingering sediments;
-fractures and faults;
-breccia pipes and / or collapse structures;
-4000 to 6000 exploration boreholes (Bush, 2010, Update Technical Report, prepared for Powertech, states approximately 6000 drill holes are present at D-B);
-oil test wells.

Drilling of hundreds and thousands of wells since the 1880s has caused a drop in artesian pressure of the various sedimentary aquifers in the southern Black Hills areas (Darton, 1909; Davis, Dyer &Powell, 1961, Keene, 1973). Therefore, many wells and boreholes that formerly flowed to the land surface no longer do so, but still contain water under pressure. Thus, contrary to the FSEIS and Application materials, upward flowing waters in these wells and boreholes can interconnect and mix between the various vertical water-bearing zones without showing any expression at the land surface.

"Interview reports indicate that the yields from the Fall River sands have dropped within recent years. Part of this problem is probably due to incrustation…..However, some of this loss of head may result from the recent uranium exploration program. The author personally saw uranium test holes that were uncased, unplugged, and flowing at the surface. This practice is not only wasteful of water, but will ultimately lead to loss of pressure in the aquifer and possible contamination of the Fall River and Lakota aquifers." Keene (1973) p.24: Re. Fall River Fm:

These inconsistencies make clear that Powertech and NRC Staff have failed to define the detailed, long-term hydrogeologic characteristics and behavior of the relevant Dewey-Burdock aquifers and adjacent sediments. In my opinion, the lack of support for NRC Staff's conclusion renders its conclusion scientifically invalid.

C. Significant Geological Structures Allow Migration

1. *Expert Opinion*: The FSEIS and Application rely on the erroneous claim that no significant geologic structures are present at the D-B Project site that could allow migration of water vertically or horizontally.

2. *Basis for Opinion*: The no-migration premise of the FSEIS and Application is contradicted by numerous published reports, such as: Braddock,1963; Butz, et. al.,1980; Gott, et. al., 1974; Smith, 2005; TVA, 1979. Keene also concluded that the recharge of the Inyan Kara by the Minnelusa formation occurred in part through "fault zones. Keene, 1973, p. 1.

As Keene (1973) noted: "The determination of a recharge rate is extremely important in a study of ground-water conditions of a watershed…" *Ibid*, p.35. While the "usual" methods for obtaining such information "are costly, time consuming and involved extensive pumping tests, infiltration tests and a relatively large amount of instrumentation…only by the determination of a recharge rate for a particular aquifer can realistic withdrawal rates be applied to preclude 'mining' of our groundwater resources…Determination of a recharge rate for the Fall River Formations would be extremely difficult….because of the contribution of water from the Minnelusa Formation along the faults in the area." *Ibid*, p. 35-36.

The existence of a "trench" in the potentiometric surface of the Fall River aquifer "where the Cheyenne River flows through Inyan Kara rocks…suggests that the Inyan Kara strata are contributing some water to the river…Residents living along the Cheyenne River report that the river will flow at Rocky Ford (T9S R4E) when the river at Edgemont and Hat Creek are dry." Keene (1973), p. 36. Rocky Ford (T9S R4E) is down stream from the D-B site. If the ground water in the Inyan Kara becomes contaminated Applicant's proposed ISL mining operation, such contamination could affect the water quality of the Cheyenne River at or around Rocky Ford. Rocky Ford is in the vicinity of the Black Hills Wild Horse Sanctuary. Thus, the surface waters that run through the Sanctuary's property could be directly impacted by the contamination of the Inyan Kara aquifer.

In addition, review of several forms of D-B-area satellite imagery by myself and senior remote-sensing experts at Front Range Natural Resources, Ft. Collins, CO, shows clearly that this area is intersected by numerous faults and fractures. The imagery also shows evidence of circular geologic features at the land surface, indicating the presence of collapse structures.

D. <u>Breccia and Collapse Features are Present</u>

1. *Expert Opinion:* Breccia pipes/solution or collapse features are present in the project area that are critical to analyzing the hydrological baseline and project impacts.

2. *Basis for Opinion*: Numerous authors state that breccia pipes / collapse structures allow upward flow of ground waters from the Paleozoic formations to the Inyan Kara rocks at the southern margins of the Black Hills [Bowles, 1968; Braddock, 1963; Keene, 1973; Gott, et. al., 1974; TVA, 1979; Butz, et. al., 1980. Carter, et. al., 2003; state such recharge to the Inyan Kara may occur via such pathways.] For example:

Keene cited Bowles 1968 "excellent study of groundwater movement within the Inyan Kara Group for southwestern South Dakota. In this study, Bowles suggests that water in the Lakota and Fall River Formations originates in the Minnelusa formation …then moves upward along the breccia pipes…Some pipes have been reported to have stoped upwards as much as 1300 feet into rocks of the Inyan Kara Group (Bowles, 1968). This allows recharge of the Lakota and Fall River Formations from artesian water rising from the Minnelusa Formation. Keene, p. 1, 31.

However, several Powertech reports and the Final SEIS argue that there is no evidence that breccia pipes or related collapse structures exist within the D-B property [i.e. NRC, 2014(Final SEIS); NRC, 2013 (March), Safety Evaluation Report, p.40; Clarification of Breccia Pipes, LSMPA, Append. 3.2-C. [Sept. 2012].

In Appendix 3.2-C of the Large Scale Mine Permit Application [Powertech 2012 (Sept.)] Powertech presents a map, Plate 2, which shows a red line that supposedly represents the area in which evidence of breccia pipes and collapse structures have been reported. This Plate was modified by Powertech from an original oversize plate in Gott, et. al., 1974, [U.S.G.S. Professional Paper 763], Plate 4. However, Powertech has misrepresented the data on the original U.S.G.S. map, neglecting to include several locations within the outcrop areas of the Inyan Kara rocks that were originally described as being "topographic depressions" or "structures of possible solution origin". Clearly the original U.S.G.S. authors mapped these areas within the Inyan Kara rocks—near the D-B project-- as probable locations of solution features, such as breccia pipes.

Similar circular, topographic features can be seen on modern, satellite imagery of the D-B site and surrounding areas. It is my opinion and that of senior remote-sensing experts at Front Range Natural Resources, Ft. Collins, CO, that these features likely represent solution / collapse structures.

Neither Powertech nor the NRC Staff have presented any detailed interpretations of the D-B structural geology using high-quality satellite imagery. Until such studies have been performed, it is reasonable to assume that these circular features are potential pathways for upward migration of ground waters into the Inyan Kara sediments.

E. <u>NRC Staff Deferred Analysis of Difficult Hydrological Controversies</u>

1. *Expert Opinion*: NRC Staff did not meaningfully consider my comments and opinions in preparing the FSEIS and issuing the License.

2. *Basis for Opinion*: Instead of meaningfully addressing my opinions, or the cited literature confirming the complex hydrology of the project area, this FSEIS and license allowed Powertech to delay conducting detailed hydrogeologic testing and determination of detailed aquifer cleanup standards until after the NRC has given project approval. Detailed hydrogeologic and water quality studies identified in my comments must be conducted in order to support scientifically credible identification, disclosure and analysis of the complex hydrogeological impacts and effects of the D-B proposal. By delaying the response to issues I raised until after the FSEIS and License issue, it is not possible for regulators, other hydrogeologists, or the public to reliably evaluate potential impacts and consequences to natural resources and the environment.

Based on my experience, the delayed analysis raises the question as to whether other relevant applicant-generated or contracted water / hydrogeology-related reports exist, besides those listed in the various Applications and the SEIS. I would expect that other reports do exist, as the reports listed in the Application and SEIS do not include the critical analysis and information I would expect to find in a scientifically-defensible inquiry. In my opinion, NRC Staff has delayed a full and credible hydrogeological analysis until after the licensing decision, without providing a credible reason for its incomplete analysis.

F. The Petrotek (2012) Model is Unreliable and Biased

1. *Expert Opinion:* The Petrotek (2012) hydrogeologic model does not consider presence of faults, fractures, breccia pipes, or open boreholes, etc. identified by available data.

2. *Basis for Opinion*: The predictions from the Petrotek (2012) flow models are all based on the improper **simplifications and assumptions entered into the model.** At D-B, detailed, long-term testing has not been performed, so Petrotek lacked the detailed information necessary to reliably define many of the hydrogeologic processes. For example, many of the historic pump test data on hydraulic conductivity (vertical and horizontal) differ greatly from the data generated by lab testing of core. Thus the hydraulic conductivity inputs into this model are questionable, and any conclusions about leakage from one water-bearing unit to another are quite speculative. Also, the model assumes that no water flows vertically through some of the bounding geologic units (e.g. the underlying Morrison), but inadequate testing has been conducted to prove this. Likewise, several independent authors have argued that vertical flow does occur through the Morrison into the Inyan Kara. Inadequate data exist to reliably demonstrate the rates of recharge from the Graneros Group and surficial alluvium into the Inyan Kara, or the extent of other surface water-ground water relationships.

The simulations presented in Petrotek (2012) report are unable to reflect the complex inter-fingering of these sediments (facies changes, laterally and vertically), and assume that the Inyan Kara sediments are homogeneous sediments.

Site boring data were used to calculate the tops and bottoms of formations---which were often inconsistent—but these borehole data failed to indicate whether the holes were functionally plugged or acted as conduits for vertical leakage. The statements (by the applicant and Petrotek) that some of the anomalous results are likely the result of leaking boreholes is simply a supposition, not based on actual data obtained from these wells and boreholes. Also, this explanation fails to explain the percentage of error that might be the result of cross-facies leakage, rather than communication through unplugged boreholes and wells.

It is not reasonable for Petrotek (2012) to assume that where historic boreholes and wells have been functionally-plugged in the past, that these plugs remain stable forever. Numerous studies show this is simply untrue, and the various seals, surface casings, plugs, etc, begin to deteriorate after several years, leading to cross-communication between the water-bearing zones.

This flow model assumes that all ground water flow is via porous media and that no permeable faults, fractures or collapse structures act as flow pathways within the D-B property. In this model, even the Dewey Fault is considered a no-flow boundary (see below), despite the fact that Boggs (1983) presents conflicting statements about the Dewey Fault zone (p.12-13). Boggs states it is a barrier to flow, but also that upward recharge may occur at relatively low rates. Obviously detailed testing is needed to answer this question. More importantly, numerous independent investigators have reported the presence of faults within the D-B area, contrary to the claims of the applicant. Additionally, significant information from independent remote-sensing indicate that faults do exist, and that surficial evidence of multiple, circular collapse structures are visible at the D-B site. Likewise, structural interpretations and production data from Cretaceous oil fields indicate that oil and gas have been generated from fractures within shales in these formations. These same Cretaceous formations exist within the D-B region, and it seems obvious that the entire package of D-B area, Cretaceous sediments are fractured. **The Petrotek model wrongly assumes that none of these secondary geologic features transmit water, thus the flow rates are questionable, as would be the changes to water quality resulting from long-term dewatering of the various sand and shale formations.**

The Petrotek (2012) model includes one simulation assuming the presence of **one** collapse structure at the D-B site, and assuming it transmits water vertically at 200 gpm. Evidence exists that several other vertical collapse structure pathways may exist, thus upward flows may be much greater than 200 gpm. However, throughout the FSEIS, the NRC Staff state that no evidence exists for such collapse structures. Despite all of the evidence to the contrary, p. 4-61 of the SEIS P.4-61 states: "Because there is **no evidence for fast flow paths, such as fractures, in the ore-bearing aquifers,** NRC staff conclude that the cone of depression will be maintained during ISR operations."

Computer simulations only provide rough approximations of quantitative results---(flow volumes, not chemistry) even in simple, homogeneous, porous media. Often, when predicted results are compared to future, actual data, the results may be in error by hundreds of percent. One of the main goals of such model exercises is to promote a belief that someone can predict future impacts with real quantitative accuracy (Pilkey, 2007; Sarewitz, et. al. 2000)—which is often untrue. Where unreasonable assumptions and faulty evidence are used, the model cannot be relied upon to disclose impacts or to design monitoring and mitigation measures. Hydrogeological modelling based on uncertain data and assumptions is only useful when supported by numerous simulations based on a range of data and reasonable assumptions, including data and assumptions unfavorable to the project proponent. However, the modelling in the FSEIS does not consider my comments.

Several examples of sections within Petrotek (2012) support my opinion of the unreasonable assumptions and unreliable conclusions in the hydrogeologic modeling are provided:

-pg 8: “The Morrison Formation beneath the Chilson is considered an aquitard for the region and is represented as a **no flow boundary in the model**. The Graneros Group is also considered an aquitard in the region but was included in the model to provide a reference point for water level elevations within the Fall River and Chilson aquifers relative to ground surface.”

-8: “The data within the Project Area are based on site borings. Outside of the Project area, geologic picks are largely based on available oil and gas well logs. The geologic dips of the surfaces are projected out to the model limits.”

- 8: “Therefore, the assumption used in the development of the model is that there is no flow across the (Dewey) fault in either the Fall River or Chilson aquifers. The model domain north of the Dewey Fault system is simulated using the NFB condition.”

-11: “During model construction, there was difficulty in maintaining integrity between the various layers of the model. Based on projection of the available data, some of the layers intersected each other in space. This occurred primarily because the data sets were not entirely consistent,….”

-11: As previously noted, the Fuson ranges from 20 to 80 feet thick across the Project Area (Dewey- Burdock TR), therefore, **a simulated thickness of 45 feet** is a reasonable approximation for purposes of the model.

-12: “Because of the uncertainty in the discharge rates from the pumping and artesian wells, the calibration is considered to be more of a representative steady state than a true steady state calibration.”

-14: “The model was **unable to replicate drawdown in the Fall River** on the scale of what was observed during the test despite extensive efforts to do so. It is possible that the drawdown observed in the Fall River during the 495 gpm pumping test in the Chilson was the **result of improperly completed wells or exploration boreholes that provided a hydraulic connection between the two units.”**

-17: “In summary, changes to the conductance and head of the GHBs in the vicinity of Pass Creek do not appreciably alter the flux of the Fall River and Chilson aquifers across the Project Area, but do result in significant increases to the RSS, indicating a **generally poorer calibration**. **Increasing the recharge rate also changes the calibration substantially and causes large increases in the flux of both the Fall River and Chilson.** Decreasing the recharge has negligible effect on either flux or calibration.”

-18: “For purposes of this modeling effort, the Fall River and Chilson are not subdivided and are each simulated as a single layer within the model.”

-22: "Use of a numerical model can assist in this effort. However, real time monitoring of water levels during operations and adjustment of flow rates in response to water level changes provides the best engineering control to minimize wellfield interference."

-26: "The calibrated numerical model developed for the Dewey-Burdock ISR Project was used to assess the potential hydraulic impacts of a hypothetical breccia pipe release. **A breccia pipe release into the Fall River and or Chilson was simulated by placing an injection well into the model layers** representing those hydrostratigraphic units and running a steady state simulation. **A value of 200 gpm was selected for the simulations. Much higher flow rates have been documented at known breccia pipe locations.** Discharge rates much lower than 200 gpm would probably have minimal impact on ISR operations and could be controlled using engineering practices."

-26: "Because of the large change in the potentiometric surface, the occurrence of discharge from a breccia pipe into either the Fall River or Chilson should be observable with the existing monitor well network and **would definitely be noticed once a monitor ring has been installed around a proposed production unit**."

IV. <u>Contention 4 –Failure to Adequately Analyze Ground Water Quantity Impacts</u>

A. <u>Water Consumption</u>

1. *Expert Opinion*: The applicant will use and contaminate tremendous quantities of ground water, thereby preventing / restricting the use of these waters by others.

2. *Basis of Opinion*: Because differing water use volumes are presented in different sections of the FSEIS, and because of the numerous operational uncertainties, reliable estimates of D-B water use volumes are unclear. The FSEIS confirms that there are known volumes of water the applicant has applied for from the State of South Dakota [SEIS, p. 4-54 & 4-55 (360-361)]:

Powertech has applied for water from the Inyan Kara: 274.2 ac-ft of water **annually** at a rate of 8500 gpm = 12,240,000 gpd (gallons per day) = **4.5 Billion gallons per year = 89.4 Billion gallons over 20 years.**

Powertech has applied for water from the Madison: 888.8 ac-ft water annually at a maximum rate of 551 gpm = 793,440 gpd = 289,605,600 gallons per year **(289.6 Million gallons per year)** = **5.8 Billion gallons over 20 years**.

If deep disposal wells prove feasible, up to about 160 gpm will be required from the Madison. At 160 gpm = 84 Million gallons per year for 20 years = 1.7 Billion gallons over 20 years.

Referring to the Inyan Kara waters, the FSEIS states that consumptive use will be relatively small as only 2 percent of the water will be disposed of as liquid waste (assuming UIC option is accepted). However, this estimate clearly neglects the fact that much of the water from either aquifer will have been contaminated, and that the water undergoing land application will be lost via evaporation / evapotranspiration. In either case, this water is no longer available for present or future uses within the exempted aquifer zone. Clearly, the SEIS under-estimates the volumes of water that are lost or contaminated through these processes.

Because disclosure and analysis of detailed hydrogeologic evaluations have been delayed until after NRC permit approval, it is untenable to state that approval of the application "will not result in average annual withdrawals from the Inyan Kara aquifer that exceed the average annual recharge to the aquifer." Likewise, using such limited testing data and modeling results, any estimates of long-term water level drawdown in either the Madison or Inyan Kara are semi-quantitative, at best.

B. Water Balance

1. *Expert Opinion*: The FSEIS relied on an inadequate and unreliable analysis of water use, and failed to provide a water balance.

2. *Basis for Opinion*: In order to evaluate the adequacy of mine water-related data and water management practices, it is standard practice for EISs and similar mine environmental reports to include a detailed water balance. Such a balance includes measured data for all water inputs and outputs related to all mine operations and all sources of water that might influence these operations. Essentially, any detailed ground water textbook describes the workings of such water balances. Freeze & Cherry (1979) and ICMM (2012) and Golder Assoc. (2011) represent two industry-sponsored studies that describe how water balances should be applied at mine operations.

The water balance in the FSEIS did not follow these accepted methodologies. On page 2-36 the FSEIS (see Fig. 2.1-14) contains what the authors claim is a water balance, but it clearly is not. In fact, it is also labeled as "Typical Project-Wide Flow Rates," which more accurately describes what is contained in the FSEIS. The flow rates calculation is not a water balance for the D-B site or D-B operations. It lacks basic components of a water balance, including detailed, measured data for volumes of water entering the system and losses (e.g. volumes of ground water available in the various aquifers, evaporation from land-application facilities, volumes under-going UIC injection, etc.), and *fails to calculate an actual balance.* In my opinion, a reliable water balance was not prepared and moreover, could not be prepared until the detailed testing described in my testimony has been completed.

Apparently, this misleading water balance figure was added to the FSEIS to deflect comments noting the lack of water balance in the Draft SEIS. However, NRC has not cured the deficiency by including a flow rate figure, which lacks the basic components of a water balance.

Pursuant to 10 C.F. R. §22.304(d) and 28 U.S.C. §1746, I declare under penalty of perjury, that the foregoing is true and correct to the best of my knowledge and belief.

Signed on the 20th day of June, 2014

Robert E. Moran

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EDUCATION
University of Texas, Austin: Ph.D., Geological Sciences, 1974
San Francisco State College: B.A., Zoology, 1966

PROFESSIONAL HISTORY
Michael-Moran Associates, LLC, Partner, 2003 to present
Woodward-Clyde Consultants, Senior Consulting Geochemist, 1992 to 1996
Moran and Associates, President, 1983 to 1992; 1996 to 2003
Gibbs and Hill, Inc., Senior Hydrogeologist, 1981 to 1983
Envirologic Systems, Inc., Senior Hydrogeologist / Geochemist, 1980 to 1981
Tetra Tech Intl./ Sultanate of Oman, Senior Hydrogeologist, 1979 to 1980
Science Applications, Inc., Geochemist / Hydrologist, 1978 to 1979
U.S. Geological Survey, Water Resources Div., Hydrologist / Geochemist, 1972 to 1978
Texas Bureau of Economic Geology, Research Scientist Assistant, summers:1970 & 1971

REPRESENTATIVE EXPERIENCE
Dr. Moran has more than 42 years of domestic and international experience in conducting and managing water quality, geochemical and hydrogeologic work for private investors, industrial clients, tribal and citizens groups, non-governmental organizations, law firms, and governmental agencies at all levels. His experience includes the following representative project assignments.

2003 to Present: Michael-Moran Associates, LLC:

- Contraloría General de la República & IKV Pax Christi, Bogota, Colombia. Provide assistance and training to the independent auditing arm of the Colombian government on mining & environmental audits and legislation.
- The Black Hills Wild Horse Sanctuary, and Bangs, McCullen, South Dakota. Expert opinions and testimony before State regulatory agencies regarding Large-Scale Mine and Water Use permits for the proposed Dewey-Burdock in-situ uranium operations.
- Sims Murray Ltd. and the Town of Florence, Arizona. Review of Town nuisance ordinance related to proposed in-situ mining and aquifer impacts. Expert opinions for litigation.
- Wild Salmon Center & World Wildlife Federation (Russia), Moscow, Russia. Elaboration and presentation of mining and water-related issues to members of Russian government, industry and the environmental communities.

- Citizens of Cañon City / Colorado Citizens Against Toxic Waste, Inc. (CCAT); Cañon City, Colorado. Technical assistance to citizen's group on hydrogeologic and geochemical issues related to contamination from disposal of radioactive, etc. materials at the Cotter uranium mill site.
- Environmental Defender Law Center and GRUFIDES (NGO), Cajamarca, Peru. Review of Environmental documents relating to the Conga Mine; site visit; report preparation.
- Roanoke River Basin Association; Virginia. Assistance on technical issues related to proposed uranium mine and processing facilities; presentations to public and regulators; participation in government planning meetings.
- Human Development Center "Tree of Life"; Bishkek, Kyrgyzstan. Review of operations at Kumtor Gold Mine using funds from Bankwatch, Kiev, Ukraine.
- Za Zemiata (Sofia) and the University Autonoma de Barcelona; Krumovgrad, Bulgaria. Review of the EIS for a proposed gold mine; municipal / public meeting presentations; prepare report using E.U. funds.
- Powder River Basin Resource Council; Oshoto, Wyoming.
  Review of Strata Energy NRC License Application to operate an in-situ leach uranium operation; provide technical opinions.
- Pro Patrimonio (the National Trust of Romania); Brussels, Belgium. Presentation to members of European Union Parliament regarding environmental aspects associated with the proposed Rosia Montana Mine, Romania.
- Trustees for Alaska. Prepared expert report on hydrogeologic and water quality impacts from exploration activities at the Pebble Mine site. Opinions prepared for litigation in Alaska Superior Court on behalf of *Nunamta Aulukestai, et. al. v. State of Alaska, et. al.* (Pebble Limited Partners); deposition and trial testimony.
- Bank Information Center and Earthworks, Washington, D.C. Report on hydrogeologic and geochemical impacts at the proposed Weda Bay, Indonesia, cobalt-nickel mine; delivered to Multilateral Investment Guarantee Agency.
- IKV Pax Christi (Netherlands), Bogota, Colombia. Prepare mining-environmental best practices report for presentation to Colombian Ministry of Environmental Affairs.
- Oglala Sioux Tribe, Western Mining Action Project, Gonzalez Law Firm, South Dakota. Review of Powertech License Application, EIS and provide expert opinions: Dewey-Burdock In Situ Uranium Project.
- Comisión de Gestión Integral de Aguas de Bolivia (Commission for the Integrated Management of Bolivian Waters) and Federación Regional Única de los Trabajadores Campesinos del Altiplano Sud (Regional Farmers Federation of the Southern Altiplano), Bolivia. Review of present mining activities and documents related to the San Cristobal Mine. Activities funded by the Municipality of Colcha K (Potosí, Bolivia), the Centro de Estudios de la Universidad de San Simón, Cochabamba, and Global Green Grants Fund.

- Shute, Mihaly & Weinberger / San Diego State University Research Foundation. Review of hydrogeologic / environmental impacts associated with quarry construction near a university wildlife refuge.
- Sarah Vogel Law Firm, North Dakota. Litigation support and evaluation of environmental impacts resulting from a release of oilfield waters onto livestock lands and waters.
- IKV Pax Christi (Netherlands), Tolima, Colombia. Technical review of proposed La Colosa gold project (Anglo Gold Ashanti); interaction with regulators, civil society and company; prepare recommendations & report.
- Thompson Divide Coalition, Western Colorado. Technical assistance to a consortium of environmental groups in designing and conducting a baseline water sampling program in anticipation of gas drilling activities. Preparation of summary report.
- Global Green Grants / Nature's Own, Papua New Guinea.
  Prepare technical / policy papers on marine disposal of mining wastes.
- SAVIA, School of Ecological Thought / Comision Pastoral Paz y Ecologia, Guatemala. Presentations on ecological aspects of resource legislation to Guatemalan government ministries, high-level officials, and educational institutions. Conduct water quality training classes; assist with development of laboratory capabilities.
- Astrella & Rice, Colorado, U.S.A. Technical assistance in preparing litigation arguments for citizen lawsuit involving alleged drinking water contamination by oil and gas activities.
- Office of the Prime Minister, Iraqi Kurdistan. Development of information infrastructure and management training for numerous ministries in Northern Iraq; done in partnership with faculty of American University, Washington, D.C. Headed an audit team for the Regional Statistics Organization.
- Southwest Research and Information Center / Buryat Regional Organization on Baikal / Mongolia Nature Protection Coalition; Buryatia, Siberia, Russia and northern Mongolia. Technical information exchanges with local NGOs, government officials and mining company staffs.
- Rulison Citizens Group / Public Counsel of the Rockies. Colorado. Development of technical arguments and potential litigation support intended to define environmental issues related to gas development near the Rulison underground nuclear test site. Hearing testimony.
- The Nature Conservancy, Trout Unlimited, Alaska Conservation Foundation, Trustees for Alaska and Renewable Resources Coalition, Alaska. Presentations to public interest groups and development of technical issues and papers relating to construction of the Pebble copper-molybdenum-gold mine, proposed for operation above the largest sockeye salmon fishery in the world.
- Wild Salmon Center, Alaska. Technical evaluation of hydrogeological and chemical issues that may impact fisheries near the proposed Pebble Mine.

- Miller, Axline & Sawyer / Meyers, Nave, Riback, Silver & Wilson / City of Grass Valley, California. Technical and litigation support in a suit alleging contamination by Newmont Mining Corporation; deposition testimony.
- Latin American Water Tribunal. San Salvador, El Salvador. Prepare presentations and conduct workshops on water and water quality. Funding: Heinrich Boll Foundation.
- Alburnus Maior, Rosia Montana, Romania. Evaluation of EIA and preparation of summary report on a proposed gold mine in Transylvania. Funded by the Staples Trust, U.K. and the Open Society Foundation, Romania.
- Asociacion de Desarrollo Social Santa Marta (ADES), El Salvador. Evaluate EIA and related documents, El Dorado Mine; technical presentation at national forum; prepare review report. Funded by DIAKONIA, Swedish Ecumenical Action.
- Alburnus Maior, Romania. Review documents and prepare comments related to development of proposed Rosia Montana Mine for a Romanian NGO.
- La Lumiere, Senegal and WACAM, Ghana. Conducted water quality training sessions for NGO and government staffs, as related to mining and other development activities. Funded by Oxfam America.
- ESRI (Environmental Systems Research Institute). Provide technical assistance to several Iraqi Ministries to define information management needs, deploy map-based systems (GIS), and establish a Middle East-based Center of Excellence to support these ministries. Performed in conjunction with NGA.
- Colectivo Madre Selva, Guatemala. Evaluation of Marlin Mine site, review of EIA and preparation of report; attendance at national and indigenous mining forums; conducted water quality training; review of CAO / IFC documents. Funded partly by Misereor, Catholic Bishops' Development Organization, Germany.

1996 to 2003: Moran and Associates, Inc.:

- International Union for Conservation of Nature and Natural Resources (IUCN, Switzerland). Review of the Mining and Metals Supplement of the Global Reporting Initiative (GRI).
- World Bank, Extractive Industry Review. Member of Advisory Group assisting WB in evaluating extractive industry practices; London, Lisbon.
- Nishnawbe Aski and other Ontario First Nation bands---Ontario, Canada. Review of environmental documents relating to Montcalm Mine, a proposed copper-nickel facility. Activities paid for by Falconbridge Limited.
- Kazakh Institute of Physics and Technology / ISTC---Almaty, Kazakhstan. Technical oversight of environmental program, evaluating migration of radionuclides at the Semipalatinsk Nuclear Test site.
- Greenpeace Argentina / Mineral Policy Center---Esquel, Argentina. Review of EIA (water, environ. issues) and conditions at proposed mine in Patagonia.

- Oxfam America / Sahel Development Foundation: Syama Mine, Southern Mali. Review of environmental conditions and documents related to an IFC-funded gold mine (2003); conduct technical workshops and policy meetings with Mali government and press (2004).
- Kivalina Relocation Planning Committee---Alaska. Litigation support to Center on Race, Poverty & the Environment regarding water quality issues, Red Dog Mine. Deposition testimony.
- Asociation de Organismos No Gubernamentales—Santa Rosa de Copan, Honduras. Independent review of water / environmental issues at San Andres mine; funded by Dan Church Aid (Danish government and NGOs) and Christian Aid (English NGO).
- Oxfam America / Friends of the Earth Int'l. / Global Green Grants---Quellaveco, Peru. Independent review of mining, water and environmental issues at request of Asociacion Civil "Labor", Lima.
- Oxfam America / Mineral Policy Center / Environmental Mining Council of B. C.: Tambogrande, Peru. Independent review of mining water and environmental issues. Includes numerous public presentations to citizens and governmental groups, including members of the Peruvian Congress.
- New Mexico Environment Department---New Mexico. Review of cost estimates for water treatment systems for closure plans / bonding calculations, Chino and Tyrone Mines.
- International Institute for Environment and Development—London, U.K. Consultant to MMSD project on sustainable development / mining issues.
- Technical Chamber of Greece---Thrace, Greece. Technical assistance to advisory arm of the Greek government and citizens groups regarding gold mining / environmental issues.
- Malerah-Wahlabul Native Title Claimants / Friends of the Earth—Sydney, Australia. Review of water quality issues related to cyanide leach gold operations on aboriginal lands, and testimony at Land and Environment Court.
- Loeb Aron &Co.---London, U.K. Preparation of report evaluating the Baia Mare, Romania waste spill for an investment banking firm.
- Centro de Investigacion y Planificacion del Medio Ambiental (CIPMA) / World Resources Institute / International Development Research Centre---Chile. Evaluation of environmental costs associated with copper mining in Chile.
- Carl Duisberg Gesellschaft / Univ. of Witwatersrand / United Nations---South Africa. Training in cyanide and environmental technology assessment issues.
- Dogrib Nation / Pape and Salter---Yellowknife, Canada. Geochemical consulting and testimony regarding the proposed Diavik diamond mine.
- Soros Foundation Kyrgyzstan---Bishkek, Kyrgyzstan. Water quality instruction to regulators and NGOs regarding mining, sampling, laboratory procedures, and general environmental issues. Review laboratory.

- General Chemical / Sierra Club---Piceance Basin, Colorado. Review of water quality, treatment, legal and policy issues regarding the proposed Yankee Gulch soda ash mine; hearing testimony.
- Sierra Club Legal Defense Fund / Okanogan Highlands Alliance----Crown Jewel Mine, Washington. Litigation support on water quality, geochemistry, treatment issues to groups opposing proposed gold operation; test case on federal mining law; deposition testimony.
- National Wildlife Federation---Carlota Mine, Arizona. Litigation support for challenge of EPA regarding water quality/ treatment issues at copper mine. Review of TMDL issues related to Pinto Creek for NWF and local citizens.
- International Rivers Network---Review of proposed dam project and associated mine water quality issues at the San Roque site, Philippines.
- Mineral Policy Center---Preparation of technical documents on the environmental behavior, analysis and toxicity of cyanides.
- Holnam Industries---Penrose, Colorado. Ground water quality/ geochemistry study for cement operation.
- World Resources Institute---mining water quality/ geochemistry assistance on Venezuelan forestry / mining environmental regulations, and environmental economics of copper mining practices, Chile.
- U.S. EPA / American Geological Services---French Gulch, Colo. Geochemical / treatment /remediation support at an abandoned mine site; negotiated Superfund issues.
- Stoel Rives / Richmond Hill Mine, So. Dakota. Review water quality treatment and geochemistry issues at a closed gold mine site with discharge violations.
- Nacho Nyak Dun First Nation / Pape and Salter—Yukon, Canada. Evaluation of proposed heap-leach gold mining facilities and practices for native group and barristers.

1992—1996: Woodward-Clyde Consultants, Inc.
-Molycorp / Unocal—Questa, New Mexico. Review of water quality, geochemical, & aquatic biology issues at a molybdenum mine / mill site.

-Minera Escondida Ltda.---Chile. Review of geochemical data for copper mine.

-Homestake Mining---Lead, South Dakota, U.S.A. Review of water quality and geochemical problems and waste rock storage and tailings stability issues.

-U.S. Bureau of Land Management / Summo Minerals—Lisbon Valley, Utah. Review of water quality and geochemistry, and assistance in preparation of an EIS at a proposed copper mining and recovery site.

-Southern Peru Copper Corp.--Toquepala, Peru. Design and oversight of water quality, geochemistry, and remediation issues at an open-pit copper mine, mill, and waste facilities.

-Cortez Mining/ Placer Dome / U.S. Bureau of Land Management - Pipeline Project, Nevada. Review of water quality and geochemistry and preparation of EIS-related reports at this proposed open pit gold site.

-Kennecott Utah Copper. Interacted with the law firm of Bogle and Gates to assist an active metal mining company in defending against a CERCLA listing. Activities involved interpreting water quality/geochemical and other environmental data within the Hazardous Ranking System (HRS) context.

-ASARCO - Leadville, Colorado. Oversight of water quality and geochemical activities at a historic metal mining and processing site where the client is involved in CERCLA negotiations. Interaction with State and EPA representatives and legal staff.

-Cambior Minerals - Metates Mine, Mexico. Water quality and geochemistry evaluation of a new gold property.

-Fraser Stryker and the Lindsey Chemical Co. - Nebraska. Technical support to legal staff involved in negotiations regarding a Superfund industrial processing site.

-W.R. Grace - Motorwheel Site, Michigan. Technical assistance to Grace legal staff involved in CERCLA negotiations at a hazardous waste site.

-Zortman Mining Co. / U.S. Bureau of Land Management. Technical and management responsibilities for water resources and geochemistry tasks in preparation of revised EIS at a gold-cyanide leach site with existing acid drainage problems.

-Echo Bay Mining, Lamefoot Mine, Republic, Washington. Responsible for geochemistry and water quality aspects of a supplemental EIS at a new gold mine site. Development of monitoring, testing and remedial recommendations to the BLM.

-Angelina Farms, Louisiana. Technical support to legal staff of oil production companies accused of contaminating groundwaters with brines.

-Amax Gold / Haile Mining, South Carolina. Water quality consulting at a gold mining site with existing acid drainage problems.

-Chino Mines, New Mexico. Technical evaluation of water quality and geochemical issues associated with leaching operations at an operating copper facility.

1983 to 1992: Moran and Associates, Inc.:

-Shea and Gardner / Rockwell--Rocky Flats Nuclear Plant, Colorado. Reviewed and evaluated geochemical studies; proposed future activities in preparation of potential environmental-criminal litigation.

-Saunders, Snyder, Ross and Dickson / American Water Development, Inc. - San Luis Valley, Colorado. Coordinated water quality and geochemistry activities in support of water rights litigation. Oversaw water quality sampling, evaluated water quality and remote sensing data, assisted attorneys in technical strategy development and opponents' depositions; supplied deposition testimony.

-Arnold and Porter / Keystone Ski Corporation - Keystone, Colorado. Designed water quality and geochemical sampling program for ski area expansion in a previously mined area. Evaluated data and proposed remediation activities.

-Advanced Sciences, Inc. / EG&G - Rocky Flats Nuclear Plant, Colorado. Evaluated existing water quality and geochemical sampling programs; prepared document on non-facility related sources of chemical constituents and background.

-City of Brighton - Brighton, Colorado. Evaluated existing surface and groundwater quality data and suggested remedial activities to deal with excessive manganese and dissolved organic concentrations. Provided testimony to City Council.

-Chadwick & Associates, Inc. / Newmont Mining - Telluride, Red Mountain, Colorado. Provided diverse water quality and geochemical consulting relating to remediation of acid mine drainage problems.

-Intergraph Corp. - Reston, Virginia. Assisted in technical development and marketing of a new environmental data management / GIS product.

-U.S. Forest Service - Salmon, Idaho. Geochemical / water quality consultant at the Beartrack mine site, a proposed cyanide-leach gold project.

-Earth Satellite Corporation / Navajo Nation / Patton, Boggs, and Blow - Window Rock, Arizona. Conducted a preliminary reconnaissance of water resources on the joint-use area of the Navajo/Hopi reservations using satellite imagery.

-Mission-Viejo / Morrison and Forester - Denver Basin, Colorado. Acted as a geochemical consultant in a groundwater rights dispute.

-Bunker Hill Corporation / Dames and Moore - Kellogg, Idaho. Reviewed field and laboratory water quality procedures at a CERCLA metal-mining and processing facility. Audited proposed laboratory.

-Saunders, Snyder, Ross, and Dickson / Adolph Coors Company - Golden, Colorado. Water quality consultant; reviewed data from Central City/Blackhawk, CERCLA site, and determined potential impact to the Coors water treatment plant. Provided testimony at stream classification hearings, Colorado Water Quality Control Commission.

-Colorado Water Resources and Power Authority - San Luis Valley, Colorado. Conducted water quality/geochemical and Landsat evaluations of deep groundwater to aid in development decisions.

-Armstrong, Teasdale, Kramer, Vaughan, and Schlafly / Anschutz Corp.-- Fredricktown, Missouri. Supervised technical activities of a CERCLA / SARA-related lawsuit; acted as a technical liaison with attorneys and regulators; managed consultants; authored reports; deposition testimony.

-Holland and Hart / White and Jankowski / Weller, Friedrich, Ward and Andrew / Breckenridge Ski Corporation - Breckenridge, Colorado. Technical supervision of water quality-related issues in a private lawsuit against Breckenridge Ski Corporation. Managed sampling and data interpretation; interacted with attorneys on strategy and assisted at depositions; authored reports; expert witness.

-Dames and Moore / Hecla Mining Corporation - Leadville, Colorado. Acted as hydrogeological/geochemistry consultant to Hecla on a natural resources damage suit; interacted with attorneys at Davis, Graham and Stubbs.

-Dames and Moore / Davis, Graham and Stubbs - Eagle Mine, Colorado. Supervised water quality/hydrogeology activities in preparation of a legal defense of Gulf and Western Corporation versus the State of Colorado in a natural resources damage suit; supervised and participated in all sampling; QA activities and report preparation; interacted with attorneys and regulators; assisted at depositions; deposition testimony; testified before Colorado Water Quality Control Commission on appropriateness of proposed metals standards.

-Jacobs Engineering - Albuquerque, New Mexico. Prepared policy documents on water quality/geochemistry procedures associated with the Uranium Mill Tailings Remedial Actions Project (UMTRA).

-University of Wisconsin. Designed a proposed groundwater exploration program for Gambia, West Africa, in conjunction with Earth Satellite Corporation.

-Harza Engineering Company / University of Michigan - Senegal, Guinea, and Gambia, West Africa. Evaluated potential impacts of new dam construction within the Gambia River basin. Reviewed local hydrogeology, mining production and exploration data; interacted with local officials.

-Engineering-Science, Inc. Faisalabad, Pakistan. Assisted in design of a well field for a groundwater supply in the central Punjab where high salinity and TDS were major problems; negotiated with local officials; prepared reports for Asian Development Bank.

1981-1983: Gibbs & Hill, Inc.

-Holme Roberts and Owen - Canon City, Colorado. Reviewed and interpreted existing hydrogeology and water quality data at the Cotter uranium mill and tailings; proposed future activities; interpreted background concepts, prepared position papers for attorneys in negotiations with State of Colorado.

-Earth Satellite Corporation - Sultanate of Oman. Conducted an interpretive study of regional groundwater potential in Oman, with the staff of Earth Satellite Corporation. Activities included interpretation of existing geology and Landsat imagery combined with conventional low altitude flight and ground reconnaissance. Prepared reports for government of Oman.

-Anschutz Mining Corporation - Fredericktown, Missouri. Managed water resource-related activities for environmental baseline studies at a proposed cobalt/ nickel mine. Designed sampling programs, oversaw sampling, data interpretation, and report preparation.

-Kemmerer Coal Company - Frontier, Wyoming. Managed and conducted hydrogeologic and water quality studies at a proposed open-pit coal mine. Supervised well installation, aquifer testing, sampling, report preparation; interacted with state regulators.

-Anaconda Copper Company - Rico, Colorado. Conducted an investigation of hydrology, water chemistry, and aquatic biology at a complex-ore mining district.

-Union Carbide Corporation - Uravan, Colorado. Managed and conducted a water quality monitoring program for a proposed uranium tailings disposal area and effluent evaporation basin. Assisted in design of geochemical testing program to evaluate potential leachate quality.

-Anschutz, Mining Corporation - Laredo, Texas. Managed and conducted an investigation of groundwater hydrology and soils geochemistry and associated hazardous wastes at a metal ore handling and reagent storage facility. Designed sampling protocol; prepared reports; negotiated with state regulators; interacted with attorneys at Baker, Botts.

-Snowmass Coal Company - Carbondale, Colorado. Managed and conducted hydrogeology investigation of an underground coal mine with steeply dipping seams.

-Marline Uranium Corporation / Union Carbide Corporation - Danville, Virginia. Managed water resources portion of a baseline investigation at a proposed hard-rock uranium mine site. Oversaw well installation monitoring programs and dewatering investigations.

-Southern Pacific Petroleum - Means, Kentucky. Conducted baseline hydrogeological/geochemical investigations at a proposed oil shale mine and retort facility.

1980-1981: Envirologic Systems, Inc.

-Central Arizona Association of Governments - Globe/Miami, Arizona. Conducted study to determine hydrogeologic/geochemical impact of long-term copper mining and processing facility. Designed monitoring programs; interacted with federal, state, local and tribal officials; prepared numerous reports.

-United Nuclear - Homestake Partners - Milan, New Mexico. Conducted hydrogeological/geochemical evaluation of an existing monitoring program for a uranium milling and waste-disposal facility.

-Homestake Uranium - Marshall Pass, Colorado. Hydrogeological / geochemical evaluation of a proposed, hardrock, open-pit uranium mine.

1979-1980: Sultanate of Oman / Tetra Tech International - Muscat, Oman. Member of Water Resources Council Staff, Sultanate of Oman, based in Muscat, Oman. The Water Resources Council was an inter-ministerial body intended to coordinate all water-related activities within the Sultanate. Duties involved planning and design of surface and groundwater projects (both exploration and utilization) for the Omani government; development of water resources policy for the government; hydrogeological field work on both exploration and resource characterization projects - aquifer testing, borehole geophysics, water quality sampling, hydrogeologic mapping; review of work performed (or planned) by other consultants to the government, published reports on water resources of Oman.

1978-1979: Science Applications Inc.:

-EG&G - Idaho National Engineering Laboratory, Idaho Falls, Idaho. Managed a hydrologic investigation of transuranic nuclide migration in groundwater. Contributed geochemical expertise to evaluation of waste isolation and transport modeling.

-Kerr-McGee Corporation - Grants, New Mexico. Conducted investigation into geochemistry of selenium associated with uranium mining/ milling.

1972—1978: U.S. Geological Survey Water Resources Division; responsible for the design, management, and implementation of the following hydrogeological / geochemical studies:

-Metal-Mine Drainage - Colorado. Study of impacts of mining activities (metals, uranium, coal) on the quality of streams in all major Colorado mining districts.

-Selenium in Groundwater - Golden, Colorado. Hydrogeological / geochemical investigation of selenium, uranium and associated constituents at the margins of the Rocky Flats nuclear plant.

-Geothermal Resources - Colorado. Reconnaissance investigation of potential geothermal resources throughout Colorado.

-Underground Coal Mine Water Quality - Colorado. Evaluation of existing and potential water quality problems from underground coal mines.

-In Situ Uranium Leaching - Grover, Colorado. Study of geochemical and hydrologic processes associated with in situ uranium mining and reinjection of waste products.

-Alluvial Metal Transport - Telluride, Colorado. Investigation of metal (especially chromium) movement from tailings ponds into alluvium.

-Southwest Colorado Groundwater - Colorado. Study to determine availability and quality of groundwater in southwestern Colorado.

-Oil Shale Waters - Piceance Basin Colorado. Evaluation of disposal of saline groundwater discharged to the surface during oil shale development.

-Grace Coal Site - Axial Basin, Colorado. Hydrogeological / water quality study of proposed open-pit coal site.

1970, 1971, Summers: Texas Bureau of Economic Geology. Evaluation of the aqueous geochemistry and biochemistry of Gulf Coastal sedimentary sulfur and uranium deposits and their relationships with hydrocarbons: interpretation of geologic and geophysical logs, water quality data.

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Moran, R.E., 1976. Geochemistry of Selenium in Groundwater near Golden, Jefferson County, Colorado. Abstracts with Programs, Geological Society of America. 1976 Annual Meeting. November 8-11, 1976. 8(6):1018.

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Moran, R.E. 1979. Available and Potential Water Resources of Oman. Submitted to Water Resources Council, Sultanate of Oman.

Moran, R.E. and J.V. Rouse, 1981. Procedures for Collection of Water Quality Samples and Data. Envirologic Systems, Inc. Denver, Colorado. 61 pp. Prepared for the Central Arizona Assoc. of Gov'ts.

Moran, R.E. 1984. Impacts of Proposed Mining and Hydrogeological Activities on Development within the Gambia River basin, Senegal, Guinea and Gambia. Submitted to Harza Engineering.

Moran, R.E. 1984. Preliminary Design Report, Groundwater Supply, Faislabad, Pakistan. Submitted to Engineering Science, Inc.

Harlan, R.L. and R.E. Moran, 1986. Closure of Metal Mining Sites: Hydrologic, Environmental and Legal Issues. Abstracts from Society of Mining Engineers Meeting, September 7-10, 1986, St. Louis, Missouri.

HRS Water Consultants and R.E. Moran, 1987. San Luis Valley Confined Aquifer Study. Three reports prepared for the Colorado Water Resources and Power Development Authority. http://digital.library.colostate.edu/cdm4/document.php?CISOROOT=/cowaters&CISOPTR=4681&CISOSHOW=4379; http://digital.library.colostate.edu/cdm4/document.php?CISOROOT=/cowaters&CISOPTR=5539&CISOSHOW=4888

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Patton, C.A., K.M. McGaffey, J.L. Ehrenzeller, R.E. Moran, and W.S. Eaton. “The Hazard Ranking System: Special Considerations for Mining Sites.” Presented at the 8th Annual Regional Environmental Business & Management Conference & Expo, Denver, Colorado. October 1994.

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
POWERTECH (USA) INC.,	)	Docket No. 40-9075-MLA
	)	ASLBP No. 10-898-02-MLA-BD01
(Dewey-Burdock In Situ Uranium Recovery Facility)	)	
	)	

WRITTEN REBUTTAL TESTIMONY OF DR. ROBERT E. MORAN

I, Dr. Robert E. Moran, do hereby swear that the following written testimony is true to the best of my knowledge:

The opinions and testimony below are based on my review of the materials in the hearing record, including written testimony, and those materials referenced in my previous declarations, my opening written testimony, and in the testimony below. My qualifications as an expert in hydrogeology and geochemistry are set out in my opening written testimony.

Rebuttal Testimony: Contentions 2 & 3

The opening written testimony provided by Powertech's consultants regarding Contentions 2 and 3 provides further support for my opening testimony regarding the inadequacy of baseline characterizations and resulting errors in characterization of the interrelated hydrogeology, water quality, and water quantity of the project area and region.

Based on my review of the written testimony of Powertech's consultants, Mr. Lawrence (APP-037), Mr. Demuth (APP-013), and Mr. Fritz (APP-046), it is my further opinion that adequate hydrogeological analysis and data gathering can be conducted without construction and operation of the Nuclear Regulatory Commission (NRC)-approved well field and is necessary for a scientifically competent, interdisciplinary analysis of baseline water quality, water quantity, and hydrogeology. Examples of such sources of information are contained in and include published reports (e.g. TVA, 1979; Boggs & Jenkins, 1980; Boggs, 1983; Knight Piesold, 2008).

Contention 2: Baseline Characterizations are Inadequate

A. Past Uranium Mining and Other Contamination.

1. *Expert Opinion*: Analysis of impacts from past mining and other contamination are critical to assessing the baseline water quality, and potential impacts of future mining activity at the proposed site.

2. *Response to Powertech Testimony:*

I have reviewed the opening written testimony of Mr. Lawrence (APP-037), Mr. Demuth (APP-013), and Mr. Fritz (APP-046) and it appears each confirms that the license conditions approved by NRC Staff allow a delay in the gathering of detailed hydrogeological data and water quality testing until after NRC license approval and National Environmental Policy Act (NEPA) analysis is complete. The confirmation of delayed gathering provides further support for my opinion that the data are inadequate to establish a hydrogeological and water quality baseline for the aquifers that would be impacted by the Dewey-Burdock Project.

Powertech's consultants confirm that the information that may be gathered in the future is critical to a baseline characterization and in turn, a reasonably complete analysis of the environmental impacts of the project. There is no doubt that this information was unavailable for review by expert agencies such as USGS and EPA, and experts such as myself who assisted persons participating in the NEPA process. The lack of data during the NEPA process and during the licensing process prevents an adequate disclosure and analysis of the impacts of the D-B Project, and prevents the analysis, comparison, and choice of adequate mitigation measures.

Powertech consultants are incorrect in asserting that the individual well fields must be constructed and put in operation before the requisite level of hydrogeologic testing, sampling and analysis can be performed. For example, Mr. Demuth (APP-013) answers a misleading question posed by Powertech:

> Q.29. Can Powertech conduct pumping tests for each wellfield prior to license issuance?
>
> A.29 No. Powertech cannot conduct the aquifer pumping tests for each wellfield prior to license issuance, since it cannot construct the wellfield monitoring network for any wellfield until the license is granted (see A.22 of this written testimony). […]

Mr. Demuth's response and the original question are misleading in that the question implies that a licensed, operating wellfield is necessary to create a reliable baseline.

In my opinion, pumping tests designed to establish the baseline site characteristics can be designed and carried out without constructing the ultimate wellfield monitoring network. For example, both Tennessee Valley Authority (TVA) and Knight Piesold conducted pump tests within the Dewey-Burdock area prior to NRC permit approval. Also, Mr. Demuth confuses hydrogeological testing that is needed to establish, analyze, and disclose the hydrogeological setting as part of the NEPA-based NRC permit-approval with the more specialized production tests Powertech will conduct on constructed wellfields.

Mr. Demuth's answer at APP-13 A.29 also claims, without support, that the admitted delay in gathering baseline data "does not mean that information needed to assess potential groundwater impacts is lacking at this stage of the licensing process." It is my expert testimony that the information is lacking. The specific information lacking is listed in my Opening Written Testimony (OST-1) at C.2. Based on my experience and training, it is my opinion that it is standard hydrogeological practice to collect and interpret such data (see OST-1 at C.2) in order to define ground water flow pathways and possible future impacts. Such data are also needed to provide reliable inputs for any computer modeling that may be employed. The present Powertech modeling is based on incorrect hydrogeological assumptions and inadequate data and therefore generates unreliable predictions. In my opinion, Mr. Demuth's answer at APP-13 A.29 contradicts standard hydrogeological practices.

Powertech's consultants now assert that the data relied upon in its application materials and the NEPA analysis are not useful. For example, Mr. Lawrence asserts at APP-037 A.56 and A.57 that the D-B exploration boreholes are closed through natural processes and in other testimony that they are open. Mr. Lawrence also concludes at APP-037 A.80 and A.85 that these borehole problems have rendered the pump test results useless. Mr. Lawrence further testifies that some of the leakage was due to an improperly completed well, but he supplies no proof of the improperly completed well, and none of the earlier consultant's reports mentioned this limitation.

I agree that the Dewey-Burdock pump tests alone are inadequate to establish a hydrogeological and water quality baseline. Further, the previously undisclosed irregularities in the data provided by Powertech provide further support for my testimony that Powertech and the NEPA analysis both failed to adequately define the detailed hydrogeologic conditions of the Dewey-Burdock aquifers and confining zones, or likely impacts.

Throughout the written testimony of Powertech's consultants, each selects only information and sources that support their preferred conclusions and fail to analyze information or analyses that disclose difficult problems —which means they failed to include some of the most important, relevant hydrogeological studies. In my opinion, Mr. Lawrence and the other Powertech consultants simply ignore difficult problems, effectively sweeping them under the rug and out of view of persons reviewing the NEPA analysis and license materials. The unreliable hydrogeological and water quality baselines presented by Powertech and the NEPA analysis are confirmed where Powertech consultants' assertions contradict their own previous assertions regarding the reliability of existing data.

For example, Demuth testifies at APP-013 A.29: "NRC staff **reviewed** Powertech's procedures for locating and installing monitor wells and for conducting the pumping tests and determined those procedures meet regulatory requirements (see below). The results of those pumping tests **will be provided** to NRC and EPA staff for review and will have to demonstrate adequacy of the monitoring network prior to operating each wellfield." (emphasis added). Mr.

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Demuth confirms that the hydrogeological information provided in the Dewey-Burdock documents is inadequate to reliably characterize hydrogeological conditions and evaluate future changes and impacts to water resources.

Mr. Demuth's statement at APP-013 A.32 goes on to argue that the NRC-approved pump tests were flawed (TVA & 2008) and do not confirm whether or not the site involves leaky aquifers. This inconsistent statement supports my contention that the FSEIS failed to adequately define the hydrogeologic behavior of the Dewey-Burdock aquifers, confining zones and likely impacts.

Mr. Demuth testifies at APP-013 A.12**:** "It is also my testimony that, according to NUREG-1569 and federal regulations in 10 CFR Section 40.32(e), a **license applicant is not permitted** until after license issuance to install a complete wellfield monitor well network that is used to establish Commission-approved background (CAB) groundwater quality within the production zone of each wellfield and upper control limits (UCLs) that are used for excursion monitoring in underlying, overlying and perimeter monitor wells." Similar to Mr. Demuth's misleading testimony at APP-013 A.29, the explanation at A.12 confuses testing and analysis that is routinely performed by hydrogeologists in order to understand numerous hydrogeologic processes in almost any project and before NRC permit approval, with requirements after NRC-permit approval.

Mr. Demuth at APP-013 A.53 states that industry "success" at historic ISL sites has been confirmed by studies partially-summarized at 3 ISL sites out of possibly 35 to 40 sites that have long-term operational histories. In my experience, no ISL site has ever been returned to baseline. Mr. Demuth's statements confirm that the FSEIS has not adequately summarized the industry aquifer restoration successes and failures. Mr. Demuth's assertions help explain that the failure to timely restore aquifers to baseline conditions after cessation of ISL operations is partly a result of delaying the collection of necessary hydrogeological and water quality data until after NRC Staff approval, which avoids scrutiny of expert agencies and the public. Thus, license conditions that delay collection of these necessary hydrogeologic and water quality data / information until after NRC permit approval ensures that much of the detailed information will never become public or face careful review by other agencies and the public in a NEPA process.

Last, at APP-013 A.33 Mr. Demuth cites the ground water samples collected by Johnson, but fails to mention that these USGS data contain many more chemical constituents than are included in the Powertech water quality data. In my opinion, many of the constituents identified by the USGS should have been included as part of the "baseline" monitoring data, but were not. Mr. Demuth also fails to note that these USGS samples, although useful for other purposes, were not collected after long-term pumping, and do not represent long-term conditions. These USGS water quality / geochemistry samples were not collected as part of an integrated hydrogeology / water quality study. As stated in my written testimony, reliable conclusions about leakage between geologic units and ground water-surface water interactions require more detailed, integrated testing.

B. Inadequate Baseline Concept and Baseline Data.

1. *Expert Opinion*: The Application and Final Supplemental Environmental Impact Statement (FSEIS) are inadequate to establish a hydrogeological baseline for the aquifers that would be impacted by the Dewey-Burdock Project.

2. *Response to Powertech Testimony:* See response in A.2.

C. Fundamental Hydrogeologic Information is Lacking.

1. *Expert Opinion*: The FSEIS and Application lack necessary scientifically-defensible hydrological and hydrogeological information.

2. *Response to Powertech Testimony:* See response in A.2

D. Data Provided Entirely by the Applicant is not an Accepted or Reliable Basis for Analysis.

1. *Expert Opinion*: Analytical results that rely entirely on data provided by the project proponent are not considered reliable by professional hydrogeologists and other water experts.

2. *Response to Powertech Testimony*: See response in A.2

Powerech has split the water-related testimony among three consultants, none of whom claim to have preformed any of the original hydrogeological testing or water quality sampling. None of Powertech's testifying consultants claim to be familiar with the actual details that influence the larger interpretations. The result of this disconnect between data gathering and analysis/interpretation is to confirm the inadequacy of the data obtained and the lack of interdisciplinary analysis in the NEPA analysis.

Contention 3: The Targeted Production Zones are Unable to Contain Fluids.

My response to Powertech testimony provided by Mr. Lawrence (APP-037), Mr. Demuth (APP-013), and Mr. Fritz (APP-046) affecting Contention 3 applies across all my opinions. Further, Powertech consultant's written testimony is based on the false assumption that the targeted production zones are able to contain fluids and do not leak horizontally or vertically into other water-bearing zones. It is my opinion that the targeted production zones involve "leaky aquifers."

The written testimony of Powertech's consultants, like the application and NEPA documents, select only information and sources that support their preferred conclusions and fail to cite those in opposition—which means they failed to look at or cite some of the most important, relevant hydrogeological studies. In my opinion, such a methodology is not scientifically defensible and not up to the industry standard. Powertech consultants' written testimony are based on assertions that contradict opinions of all the other investigators who actually conducted and interpreted the D-B pump tests (Boggs & Jenkins, 1980; Boggs, 1983; KP, 2008), who state that there is leakage between the Fall River and the Lakota through the Fuson, and leakage within the facies of the Lakota. Mr. Lawrence totally disregards the same and related inconvenient opinions within, for example, Gott, et. al. 1974; Keene, 1973; TVA Envir. Statement, 1979; Butz, et. al., 1980; Boggs, 1983; Bredehoeft, Neuzil & Milly, 1983; SRK, 2012.

Leakage between geologic facies was not addressed, even though the overall hydrogeological literature and my experience indicate that leakage occurs (between the mined aquifers and the "confining" units) at most ISL sites operated in similar fluvial sedimentary uranium hydrogeologic settings during long-term pumping. *However, because the detailed hydrogeologic and water quality testing are delayed until after NRC permit approval, most of this information never becomes available to the public.*

Mr. Demuth's testimony at APP-013 Q.7 provides an inadequate description and conceptual diagram as a basis for his further assertion: "Within an aquifer water flows by porous media flow in interstitial spaces between the sand grains that make up the aquifer. This is depicted in the enlargement on the right of the conceptual diagram." Mr. Demuth's simplistic approach is inapplicable and misleading when applied to the majority of inter-bedded sediment packages in the project area. Instead, much of the water in leaky aquifers is actually supplied via leakage from confining units after long-term pumping.

The erroneous picture presented by Mr. Demuth's simplistic approach is confirmed by basic hydrogeological principles discussed in my opening written testimony: For example, **Freeze & Cherry, 1979, Groundwater at** p. 320 discuss the dangers of calculations that assume any aquifer is confined. "The assumption inherent in the Theis solution that geologic formations overlying and underlying a confined aquifer are completely impermeable is seldom satisfied. Even when production wells are screened only in a single aquifer, it is **quite usual for the aquifer to receive significant inflow from adjacent beds. Such an aquifer is called a *leaky aquifer,* although in reality it is the aquitard that is leaky."** (emphasis added).

Freeze and Cherry go on to explain at p. 332 that "The most common geological occurrence of exploitable confined aquifers is in sedimentary systems of interbedded aquifers and aquitards. In many cases the aquitards are much thicker than the aquifers and although their permeabilities are low, their storage capacities can be very high. In the very early pumping history of a production well, most of the water comes from the depressurization of the aquifer in which the well is completed. **As time proceeds the leakage properties of the aquitards are brought into play and at later times the majority of the water being produced by the well is aquitard leakage. In many aquifer-aquitard systems, the aquitards *provide* the water and the aquifers *transmit* it to the wells." (emphasis added).**

It is my expert opinion that both quantity and quality must be addressed in an interdisciplinary manner because as the leakage progresses, the chemical quality of the water being pumped changes. Powertech failed to conduct hydrogeological testing that was integrated with water quality sampling and analysis.

It is my expert opinion that the Powertech consultants' testimony relies on oversimplified and conceptual assumptions to assert that the aquifer is totally confined. In my opinion, the limited data provided, read consistently with accepted hydrogeological principles, confirm that the D-B project involves leaky aquifers, which require additional data to adequately characterize.

Contention 4: Failure to Adequately Analyze Ground Water Quantity Impacts.

A. Water Consumption

1. *Expert Opinion:* The applicant will use and contaminate tremendous quantities of ground water, thereby preventing / restricting the use of these waters by others.

2. *Response to Powertech Testimony*:

Mr. Demuth answers Q.27 by stating at A.27 that "**The latter [hydrogeologic] information is not required to assess potential impacts to groundwater** but instead to confirm that proper operational and monitoring procedures are followed to prevent groundwater contamination." It is my opinion that Mr. Demuth's conclusion confirms that hydrogeologal information was ignored by Powertech and the NEPA documents. In my opinion, defining the hydrogeological setting is critical to analyzing potential ground water quantity impacts.

At A.45, Mr. Demuth wrongly asserts that water lost via evaporation from the waste ponds has no effect on the volumes of water used by the D-B project. Mr. Demuth wrongly asserts that my expert opinion was "based on a false premise – that water loss through evaporation would somehow increase the overall water consumption rate." My testimony is not based on the increase in consumption rate. My testimony is based on the conclusion that such evaporation and any other categories of water loss not accounted for in the FSEIS estimate will increase the total volumes of water used by the D-B project.

B. Water Balance

1. *Expert Opinion*: The FSEIS relied on an inadequate and unreliable analysis of water use, and failed to provide a water balance.

2. *Response to Powertech Testimony:*

Mr. Fritz does not indicate that he conducted any of the data collection or initial analysis. Instead, Mr. Fritz' written testimony appears to attempt to identify materials in the hearing record that could be construed as part of a water balance. The comments of Mr.

Fritz do not change my opinions or the basis of my opinion that the FSEIS does not contain a water balance.

For example, at APP-046 A.6, Mr. Fritz points out that "Groundwater use was a primary focus of the June 2011 TR RAI responses (Exhibit APP- 016-A through 016-BB), including providing a project-wide **water balance** in support of the discussion on handling liquid waste (P&R-14(c), Exhibit APP-016-B at 68-73). This RAI response provides a detailed description of the quantity of **water anticipated to be used from the production zone aquifer (Inyan Kara) and from the Madison aquifer** (primarily for groundwater restoration) during production and groundwater restoration operations. Much of this information has been incorporated into the FSEIS (i.e., Sec. 2.1.1.1.3.3)."

The question posed to Fritz at APP-013 Q.7 mischaracterizes my testimony. Mr. Fritz is asked: "How do you respond to the allegation that the FSEIS provides conflicting information on the volumes of water to be used such that the water consumption impacts of the project cannot be accurately evaluated (CI 2013 at 27, CI 2014a at 25, **Moran 2013 at 12**, OST 2013 at 19, OST 2014a at 19)?" The response at Moran 2013 at 12 is not related to volumes of water. It appears, from this and other examples, that Mr. Fritz and other Powertech consultants have simply inserted random supporting citations that are unrelated to my expert opinion that the FSEIS does not contain a water balance.

Pursuant to 10 C.F. R. §22.304(d) and 28 U.S.C. §1746, I declare under penalty of perjury, that the foregoing is true and correct to the best of my knowledge and belief.

Signed on the 15th day of July, 2014

Robert E. Moran

Dr. Robert E. Moran, Ph.D.

From:	Jeffery C. Parsons
To:	Shea, Valois
Cc:	"Roger Flynn"
Subject:	FW: Oglala Sioux Tribe Comment Attachments 4.1
Date:	Monday, June 19, 2017 5:38:51 PM
Attachments:	OST-9 TVA Edgemont Uranium Mine DES 1979.pdf

Email #4.1

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Jeffrey C. Parsons
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From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:39 PM
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Email #4

****

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****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
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To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
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Subject: RE: Oglala Sioux Tribe Comment Attachments

****

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From: Jeffery C. Parsons [mailto:wmap@igc.org]
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Email #2

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From: Jeffery C. Parsons [mailto:wmap@igc.org]
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Subject: Oglala Sioux Tribe Comment Attachments

Ms. Shea – in support of the comments submitted this day (June 19, 2017) by the Oglala Sioux Tribe, attached are supplemental documents. As there are several such documents, there are likely to be a series of emails to follow. Thank you.

****

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TENNESSEE VALLEY AUTHORITY

DRAFT ENVIRONMENTAL STATEMENT

EDGEMONT URANIUM MINE

SUMMARY SHEET
ENVIRONMENTAL STATEMENT
EDGEMONT URANIUM MINING PROJECT

(X) Draft ( ) Final environmental statement prepared by the Tennessee Valley Authority. For additional information, please get in touch with:

Dr. Harry G. Moore, Acting Director
Division of Environmental Planning
268 401 Building
Chattanooga, Tennessee 37401
(615) 755-3161

1. (X) Administrative Action ( ) Legislative Action

2. The proposed action is for TVA to mine, through its operator, the uranium-vanadium deposits located in the Southwestern Black Hills area of Fall River and Custer Counties in South Dakota and in Weston and Niobrara Counties in Wyoming.

3. Construction and operation of the initial underground mines are expected to have the following environmental effects: Dewatering operations will cause a depression of ground water levels in the Lakota Formation which will result in some wells to cease flowing; however, water will still be available by pumping. The impacts on the Fall River Formation because of shaft construction and mining operation will result in a decrease in water levels in wells. Following mining, it is possible that areal potentiometric heads in the Fall River will not recover to pre-mining levels within the affected nearby area because open flow from private wells exceeds recharge under present conditions.

   Some population increase will be caused by the project placing additional pressure on the surrounding communities and counties to provide needed community services. At the same time, state and local revenues will be increased. Specific topographic features near the underground and surface mine sites will be altered. There will be a temporary minor degradation of air quality in the immediate vicinity of the mining operations. There will be a loss of some plant and animal species on the site due to the disruptions of natural habitat. There will be a temporary change in land use from rangeland and forest to mineral extraction during the life of the project.

4. Alternatives of securing uranium ore by other methods were considered, but were found impracticable from standpoints of both scheduling and economics. The alternatives explored showed no ultimate environmental advantage over the proposed project.

Table of Contents

Introduction

The Tennessee Valley Authority (TVA), a corporate agency of the United States,* in order to comply with statutory obligations under the TVA Act to ensure an ample supply of electrical power to the area it serves, has committed to a total installation of approximately 21,500 megawatts of nuclear-fueled generating capacity to be in service by the end of 1986. This capacity will be supplied by 7 plants containing a total of 17 light-water reactors. Browns Ferry, a 3-reactor plant, is now in commercial operation. TVA estimates a requirement of approximately 41.5 million kg (kilograms) (91.5×10^6 lb, (pounds)) of uranium oxide (U_3O_8) to meet the nuclear fuel needs for the 17 committed reactors through 1990.

As one of many activities TVA has undertaken to ensure an adequate supply of uranium, TVA purchased, on August 16, 1974, the mineral rights on about 41,000 ha (hectare) (101,000 acre) in Fall River and Custer Counties, South Dakota and Weston and Niobrara Counties, Wyoming (Figure 1.1.1-1). Since that time, minable reserves of uranium have been delineated through the discovery of a major new ore deposit and the extension of existing ore deposits in Fall River and Custer counties. Exploration on the subject properties is continuing and the identified reserves of uranium are expected to increase.

TVA, through its operator, proposes to mine the uranium/vanadium ore deposits in the project area. Mining is scheduled to begin in late 1979.

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*TVA was created by the Tennessee Valley Authority Act of 1933 (48 Stat., 58 as amended, 16 U.S.C. SS 831-831dd (1970; Supp. VI, 1976))

1.1 Mining

1.1.1 Mine Site Location - All of the proposed mine site locations delineated are located in western Fall River and southern Custer Counties in South Dakota. These sites are within 24 km (kilometer) (15 mi (miles)) of Edgemont, South Dakota. The Edgemont Uranium Mining Project encompasses approximately 41,000 ha (101,000 acre) of uranium property, consisting of 151 claim groups, 23 state leases, and 65 private leases. (Figure 1.1.1-1.) As planned, the initial shaft for the underground mine, Burdock, will be located on the Francis Peterson Lease in Section 15, T7S, R1E (Township 7 South, Range 1 East); the surface mine, the Spencer-Richardson, is located on the Bud Claims in Section 35, T6S, R1E.

1.1.2 Mining Techniques

1.1.2.1 Underground Mining - Because of the depth and size of the uranium ore bodies, underground mining is considered by TVA as the most feasible method of extracting the ore contained in the Burdock, Darrow, and Runge East deposits. (Figure 1.1.1-1.) The Burdock deposit, which comprises most of the reserves, will be developed and mined from shafts, the first of which is scheduled for construction in late-1980. Minor production is anticipated from the Darrow and Runge East deposits; however, additional drilling is necessary to further delineate these reserves. These deposits will not require extensive development for production because development will be limited to the extension of existing mines. Production from these mines is scheduled for 1981.

Burdock Development and Mining - Two shaft sites have been selected near Burdock. The possibility of a third shaft is being considered, and others may be required as development drilling and mining progress. The shafts will be positioned adjacent to known ore deposits and downdip from them to facilitate water drainage. The rock units that will be penetrated by the shafts will be cored to determine their structural characteristics. Each shaft site will be leveled and prepared for surface facilities. (Figure 1.1.2.1-1.) Roads will be upgraded and all utilities will be made available to service the mine. The initial 4.3 m (Meter) (14 ft (foot)) diameter production shaft at Burdock will extend to a depth of approximately 180 m (600 ft) and the second approximately 130 m (425 ft). One station will be cut about 15 m (50 ft) above the bottom of each shaft to handle men, material, and rock. Figure 1.1.2.1-2 depicts a generalized underground uranium mine and support facilities.

Hydrologic tests have been conducted to determine the water quality and quantity expected in the mines. Plans call for a partial dewatering of the shaft area by two or three wells. (See Section 2.5 for location.) Dewatering may commence up to six months before penetration of the target aquifer by the shaft. These wells are 20 cm (centimeter) (8 in (inch)) or larger in diameter and will each be pumped at an average rate of 14.2 l/sec (liter/second) (225 gal/min (gallon/minute)). Additional water wells may be necessary to ensure greater recovery of ore and for safety of operation personnel.

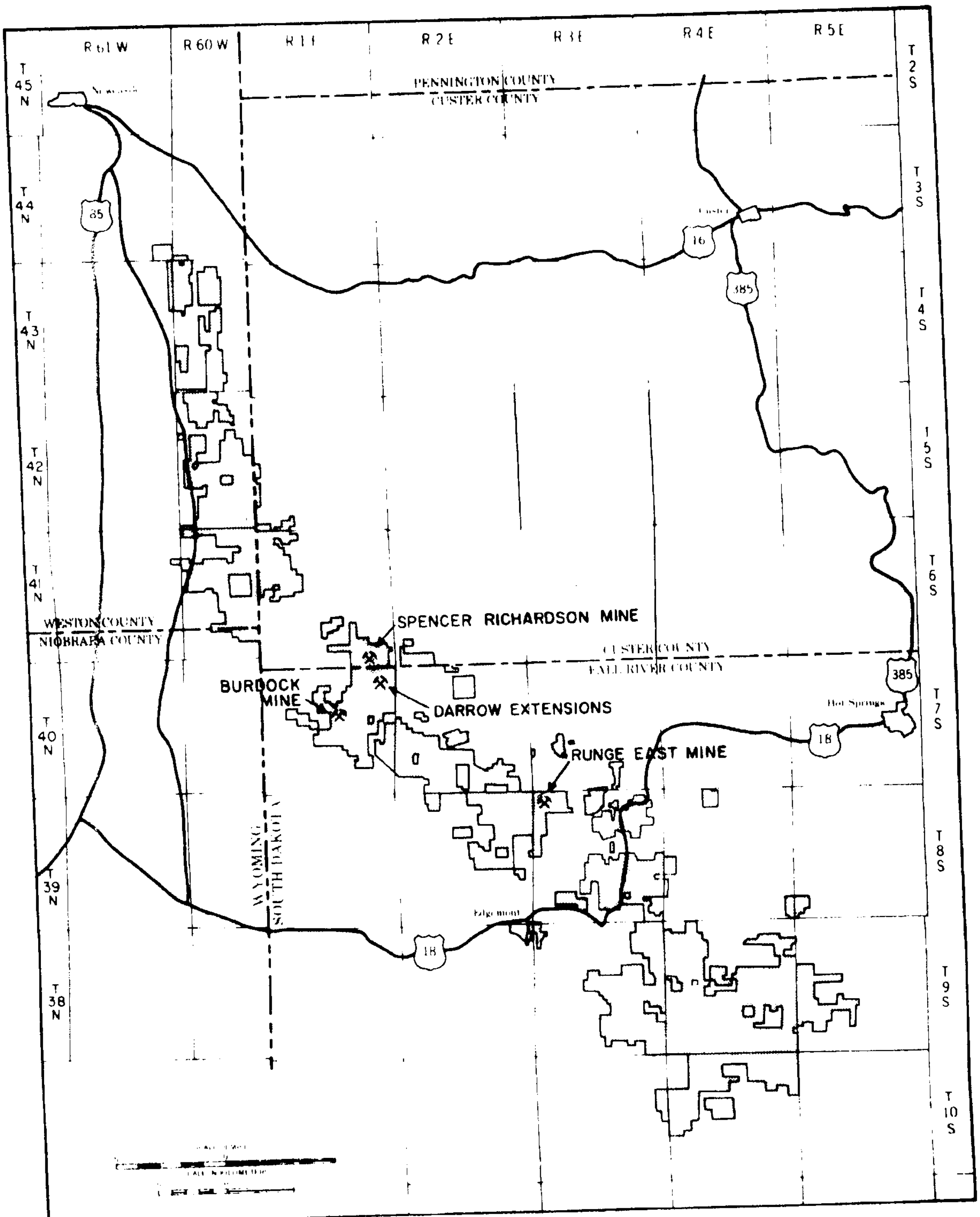

Figure 1.1.1-1 Regional Location of TVA's Edgemont Uranium Mining Project

4

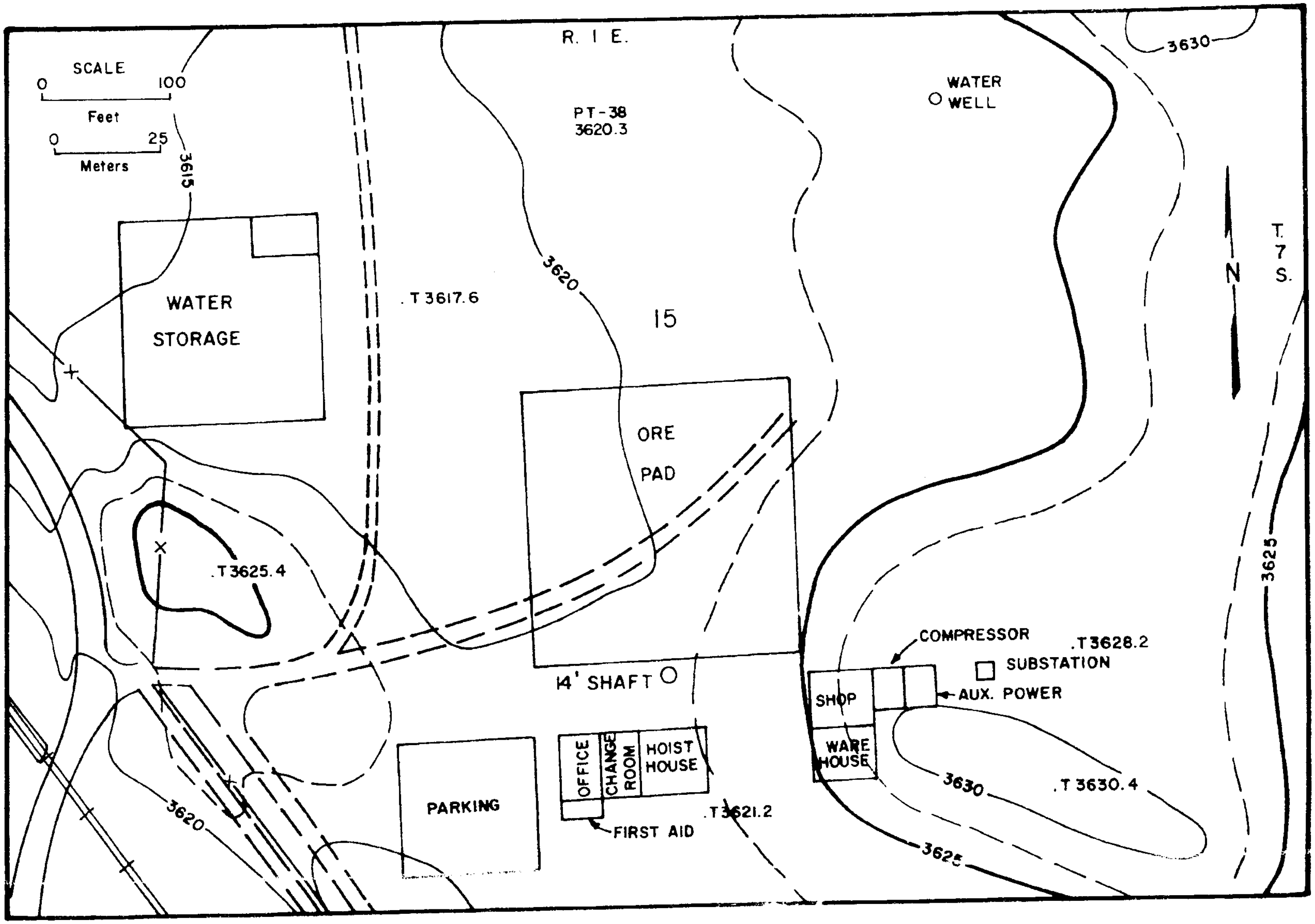

Figure 1.1.2.1-1 Proposed Initial Shaft Site Layout

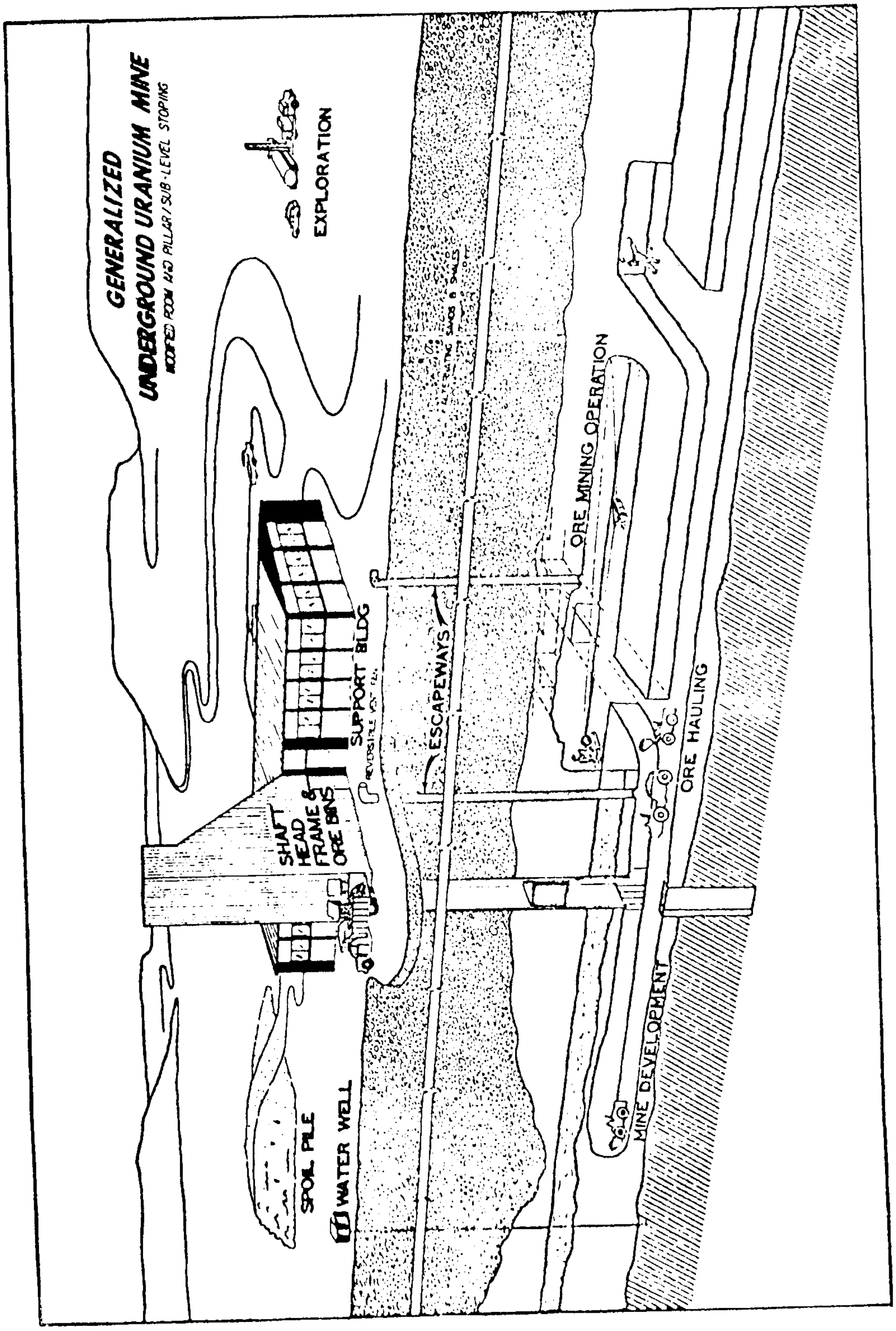

Figure 1.1.2.1-2 Trackless Haulage

At least three 1.2 m (48 in) diameter ventilation shafts are planned with one located within 91 m (300 ft) of the initial production shaft. The ventilation shaft will be equipped with surface hoisting facilities and used for emergency escape. Additional ventilation shafts will be positioned along the axis of the ore deposit in conformance with 30 CFR 57.5 (Air Quality, Ventilation, Radiation and Physical Agents). Refuge chambers and additional escapeways through ventilation shafts will be provided in conformance with 30 CFR 57.11-50.

As necessary, longholes will be drilled to delineate the ore body and to assist in dewatering the ore horizon. Mine water will be drained to a sump in the station where it will be pumped to the surface. Ore production from the stoping operation can begin as soon as sufficient mine development has been completed.

Major equipment to be used underground and in surface support facilities for each shaft is listed in Table 1.1.2.1-1. The ore will be transported to the shaft stations where it will be hoisted to the surface. Waste material will be handled in a similar manner. At the surface, it will be automatically dumped and transported to storage areas.

Permanent roof supports in the mine will consist of timber sets, roof bolts, wire mesh, steel arches, and shotcrete These supports will be used in the main haulage drifts and shaft stations and as required in the mining areas.

Mine ventilation will be provided by axivane-type blowers mounted in the ventilation shafts. Plans are to draw air down the ventilation shafts, through the mine and out the production shafts. The total ventilation rate for each production shaft is estimated to be 3,400 m^3/min (120,000 ft^3/min). Provisions will be made to allow for reversal of the direction of ventilation flow, if required in an emergency.

It is estimated that approximately 100 people (excluding supervisory and technical staff) will be employed in the underground mining operation. A 2-shift, 5-day workweek is planned for ore production. It is expected that shaft sinking and development will be on a 3-shift, 7-day workweek.

Other Underground Mines - Based on present knowledge of ore reserves, less than 5 percent of the total production of the project is expected from the Runge East and Darrow deposits. Detailed mine plans will be prepared after the extent of the deposits is determined by additional drilling. Both mines will be further developed when ore production from them is needed. Mining of the Runge East, an existing mine developed by means of a decline, will involve about 4 ha (10 acre) of surface disturbance for constructing or upgrading support facilities. Mining of the Darrow deposits will be accomplished through a series of adits developed into existing pit walls along ore trends. The five existing pits and associated surface facilities cover approximately 125 ha (310 acre); no significant new surface disturbance should be necessary for mine development.

1.1.2.2 Surface Development and Mining - A schematic open pit mining operation is shown in Figure 1.1.2.2-1. The only proposed surface mining operation is the Spencer-Richardson mine,

Table 1.1.2.1-1

Burdock Mining Equipment
(Partial List Per Mine Shaft)

Underground	No.	Operating Frequency (Hrs/Day)	Specifications	Fuel Requirements
Pumps	4	12	150 HP, 450 gal/min	
Loaders	3	10	2 yd^3, 78 HP Diesel	19 l/hr (5 gal/hr)
	1	6	14 m^3/min (500 ft^3/min) Air	
	3	10	50 HP Electric	
Trucks	4	10	4 yd^3, 76 HP Diesel	19 l/hr (5 gal/hr)
Locomotive	1	6	4.5 tonne (5 ton) Battery	
Drills	20	6	3 m^3/min (100 ft^3/min) Air	
	2	10	8 m^3/min (300 ft^3/min) Air	
Fans	12	24	15 HP, Electric	
	3	24	30 HP, Electric	
Slushers	10	6	25 HP, Electric	
	5	6	10 HP, Air	
	1	10	50 HP, Electric	
Surface				
Hoists	1	10	300 HP, DBL Drum	
	1	10	400 HP, Sal. Drum	
	1	-	Escape Hoist	
Compressors	2	16	350 HP, Electric	
Dewatering Well Pumps	3	24	Electric 50 HP, 225 gal/min	

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Table 1.1.2.1-1 (Continued)

Surface	No.	Operating Frequency (Hrs/Day)	Specifications	Fuel Requirements
Ventilation Fans	2	24	150 HP, Electric	
Auxiliary Generators	1	Standby	675 KW, Diesel	
Haul Trucks	1	10	300 HP, Diesel	19 l/hr (5 gal/hr)
Heating Plant	1	0-24	400,000 BTU/Hr	11 l/hr (3 gal/hr)
Utility Truck	1	10	2.7 tonne (3 ton)	11 l/hr (3 gal/hr)
End Loader	1	10	5 yd^3, Diesel	11 l/hr (3 gal/hr)
Road Grader	1	8	225 HP, Diesel	11 l/hr (3 gal/hr)
Forklift	1	8	50 HP, Diesel	8 l/hr (2 gal/hr)

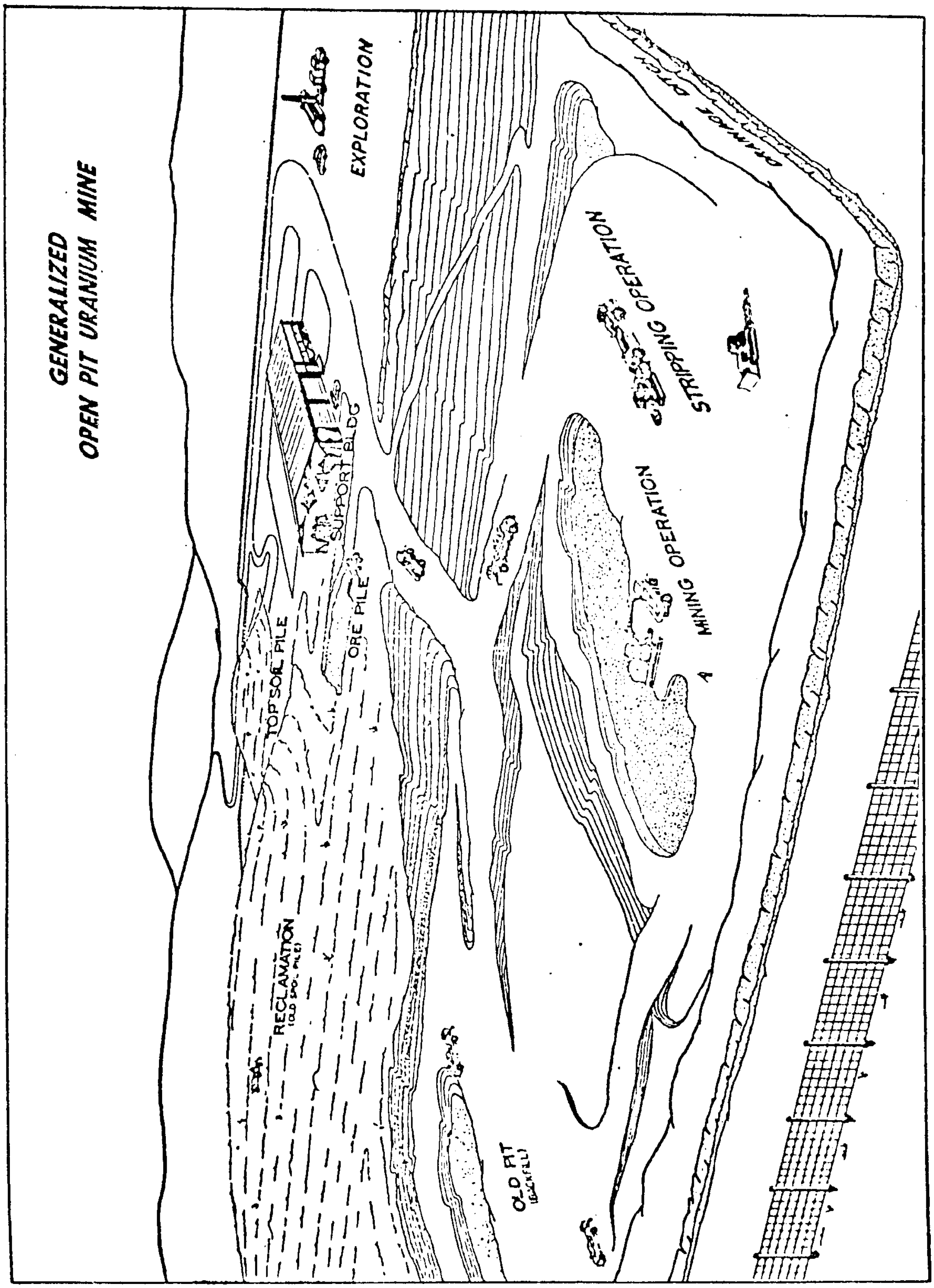


Figure 1.1.2.2-1

an existing open pit where approximately 70 percent of the overburden was removed by the previous owner of the mineral rights. This deposit will be held as a contingency reserve to be mined when necessary to maintain production schedules. Exploration and development drilling is continuing and additional surface mining areas may be delineated.

Where feasible for the existing open pit, topsoil and suitable subsoil will be segregated from the other overburden and stockpiled. Conservation measures will be taken to control erosion. If the stockpiled material is not to be used for an extended period of time, it will be seeded within 5 months to provide temporary cover and stabilization. (See Section 3 for more details.)

In the initial pit, which presently occupies approximately 8.1 ha (20 acre), the remaining overburden will be removed with bulldozers and scrapers; extensive blasting is not anticipated. Removed overburden will be placed on a nearby existing spoil pile. All material moved e.g., waste, ore, topsoil, etc., will be placed in separate piles and conspicuously marked as to content.

Ore production will commence following overburden removal. Proposed surface mining equipment is listed in Table 1.1.2.2-1. Each truck-load of material will be sampled and assayed to determine the ore grade and will then be hauled to the proper stockpile or waste area. Under certain circumstances it may be necessary to drive adits into the wall of the open pit to recover ore from small, narrow trends. The adits will be timbered, with portal sets extending into the open pit to provide adequate protection against pit wall sloughing. Adits are commonly driven by conventional drilling and blasting techniques directly along the ore trends. All material handling is typically accomplished by diesel-powered load-haul-dump vehicles with built-in scrubbers.

A work force of approximately 10 people (excluding supervisory and technical staff) will be employed in the open pit development and ore production operation. This operation is expected to require 6 months.

1.1.3 Surface Facilities

Mine Water Installations - During the development and mining phases of the underground workings, water from underground dewatering will be pumped to the surface and directed to holding ponds to reduce sediments. Based on subsurface hydrologic studies, it is estimated that dewatering will produce 28.4 to 42.6 l/sec (450-675 gal/min). A permit is being applied for under the National Pollutant Discharge Elimination System (NPDES), as implemented by the South Dakota Environmental Protection Agency. If the water meets applicable requirements, as will be delineated in the NPDES permit, it will be discharged into local drainages. Otherwise, it will be treated in conformance with the NPDES permit prior to release.

A drainage system will be built and maintained to minimize the accumulation of surface water and to control runoff at the Spencer-Richardson mine. The system will include:

Table 1.1.2.2-1

Surface Mine Machinery

Equipment	Number	Operating Frequency (hrs/day)	Specifications	Fuel Requirements
Scrapers	2	8	420 HP Diesel	57 l/hr (15 gal/hr) each
Hydraulic Backhoe	1	8	130 HP Diesel	38 l/hr (10 gal/hr)
Tractor	1	8	240 HP Diesel	57 l/hr (15 gal/hr)
Ore Trucks	1	8	300 HP Diesel	57 l/hr (15 gal/hr)
Utility Truck	1	8	175 HP Diesel or Gasoline	11 l/hr (3 gal/hr)

- Dikes and ditches to direct surface runoff away from the open pit area.
- Drainage ditches constructed below the spoil piles to collect runoff.
- Sump pumps and piping systems to remove water from the floors of the open pit mines if required.
- Dikes around impervious ore pads.

Figure 1.1.3-1 shows a typical layout of surface-water control facility in an open pit mine and waste dump area.

Roads - Access to the proposed underground and open pit mine locations will be provided by existing dirt and asphalt roads. However, some will require upgrading and widening. All roads will have culverts where they cross major drainage channels; drainage ditches will be constructed alongside the roads. Unpaved roads will be sprinkled as weather and ground conditions require to control dust.

Utility Services - The utility requirements for the proposed mines and their surface support facilities include electric power, telephone, industrial and potable water, and sanitary sewage disposal.

It is expected that electric power required at the underground sites will be supplied via a 14.4/24.9 kV (kilovolt) primary transmission line. A transformer substation will be installed in the vicinity of the initial underground mine site to supply required voltages for use at the underground mine. The estimated connected electrical load at the underground mine sites is 3,500±500 kVA (kilovoltampere). All underground and surface mining electrical installations will comply with Mine Safety and Health Administration (MSHA) standards.

Natural gas is not available near any of the mine sites and propane will be used where necessary. No. 6 fuel oil is planned for space heating use.

Offices at Edgemont are serviced by the Peoples Telephone and Telegraph System. Current and future field communications will utilize telephone and radio with the base station located at the Edgemont offices. Telephone routing has not yet been established. At the underground mine sites, communications between the shaft stations and surface will be by telephones and a bell system. These communications systems will comply with MSHA safety regulations.

It is anticipated that industrial water required at the underground mine will be provided by dewatering discharge which will be treated as necessary. Industrial water, will be utilized in the mine operations for dust suppression on active haul roads. Maximum use of water for dust suppression may approach 22,800 l/d (6,000 gal/d) during the summer period. Little of this water will run off because of the porous nature of the materials used to upgrade the haul roads. Potable water will be supplied from an approved source.

An approved sanitary sewage system consisting of a combination of septic tanks, sewage lagoons and/or another acceptable system will be constructed at the Burdock underground

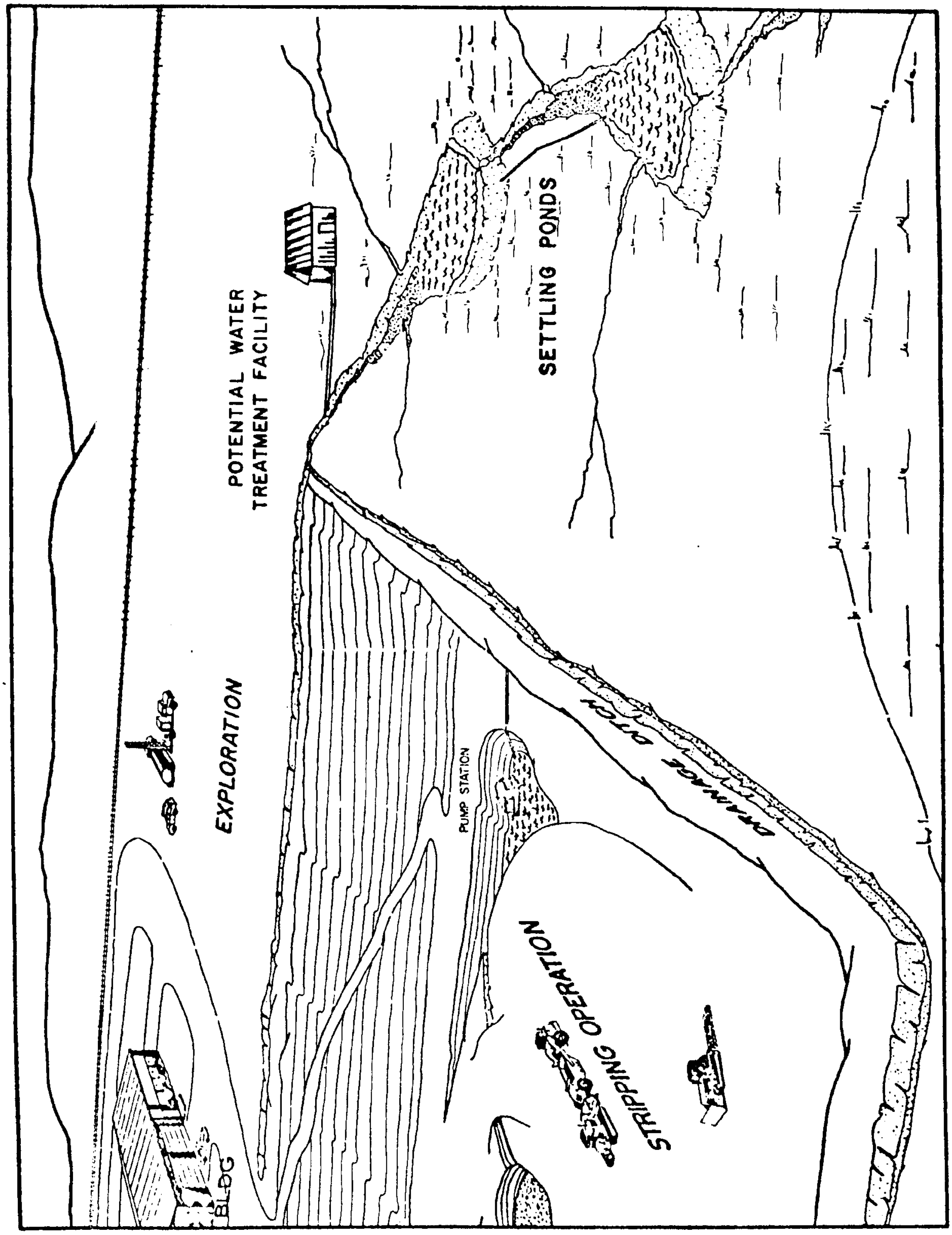


Figure 1.1.3-1 Generalized Water Treatment Facility

site. This facility will accommodate in excess of 19,000 l (5,000 gal) of sanitary sewage daily. At the other proposed mine sites, portable toilet facilities will be provided.

Office and Shop Buildings - Present plans call for several single story steel paneled buildings to be constructed at each Burdock shaft site. They will be set on concrete slab foundations with approximately 929 m^2 (10,000 ft^2) of floor space. The buildings will contain hoists, mine offices, change rooms, warehouse, shops, mine rescue and first aid station, compressors, and auxiliary power.

A 26 m (85 ft) high head frame will be erected. It will be fabricated steel, and will support three sheave wheels. Skips will dump ore and waste material into a surge bin in front of the head frame to be trucked to separate storage areas. One compartment in the main shaft will be an emergency escapeway equipped with a ladder. Explosives magazines will be located on the surface in compliance with Federal and state requirements. These will provide safe storage for explosives required by the project.

Mine Ore Control Facilities - Adequate facilities equipped with ore sample dryers, pulverizers and beta-gamma or X-ray detection units, used to determine ore grades and to maintain ore stockpile control, will be located adjacent to mines and/or mine haulage roadways.

Fixed Equipment - There is no proposed major fixed, energy-consuming equipment planned for the surface mining operation. Major fixed, energy consuming equipment at the initial underground shaft site is shown in Table 1.1.2.1-1.

On-Highway Support Equipment - About 40 vehicles will be used on the project, consuming approximately 325 l/d (85 gal/d) of gasoline.

1.1.4 Health and Safety - The proposed mine will operate under applicable Federal mine safety regulations. New employees at the mines will be given initial training in safety rules and safe working procedures.

First aid training will be made available to all employees. Fire prevention and fire-fighting instruction will also be given.

All underground employees will be instructed in the use of self-contained respirators and on the location of mine escape routes and procedures applicable in the event of mine fires or other emergencies.

A mine rescue team will be selected, trained, and available for rescue operations at any of the shafts.

On the surface, selected ventilation shafts will be equipped with an emergency hoist and torpedo-shaped man cage. Each shaft site and ventilation shaft will have a 1.83 m (6 ft) chainlink fence on the perimeter to prevent inadvertent access by livestock and humans.

1.1.4.1 Fire Control - All surface structures within 30.5 m (100 ft) of each shaft will be constructed with fireproof materials. The headframes will be structural steel. Any nonfireproof structures will be placed more than 30.5 m (100 ft) from the shaft. The areas surrounding the surface building will be kept clear of combustible materials. Fuel and lubricating oils will be stored at least 30.5 m (100 ft) from any mine opening and will be surrounded by retention dikes capable of retaining 110 percent of the volume of the storage tanks.

Shaft lining will be concrete and supporting frameworks within the shafts will be steel. Where timber is used for sets and lagging at the shaft access station, the timber will be treated with fire-resistant coatings. Where fire doors are used underground, they will be constructed of steel.

Underground storage of lubricating oils and diesel fuel will comply with applicable Federal regulations regarding quantity and location.

Water for firefighting will be available throughout the active areas of the mine. Fire extinguishers will be available at the shaft stations, shops, and storage areas for fuel and lubricating oils. Extinguishers designed for electrical fires will be placed near the electrical substations. Each diesel-powered locomotive will carry a fire extinguisher for use on diesel fuels. Routine inspections will be made of all in-place extinguishers, and used extinguishers will be replaced immediately. All personnel will receive instruction in the use of each type of fire extinguisher.

Emergency exits from each mine will be provided at selected ventilation shafts by means of emergency hoists with man cages. At several locations within the mine, rescue chambers will be constructed. Each chamber will contain food, air, and potable water.

1.1.4.2 Ground Control - Ground control (support) practices at each mine site will be tailored to the particular geological conditions that exist at that site.

During the driving of drifts, temporary supports consisting of jacks with headboards or stulls with headboards will be used until permanent supports can be installed. Permanent support, where required, will be installed within 3 m (10 ft) of the drift face. For roof support in haulage drifts and other permanent mine openings, roof bolts in conjunction with wire mesh will generally be used. Steel sets will be used in large openings near the shaft station. Timber sets will be used for temporary support and, where practical, for permanent support. In mined-out areas of the mine where ground conditions present a hazard, induced caving of the roofs may be employed. Also waste rock from other areas of excavation may be used as backfill material in excavated areas where caving would not be desirable.

Compliance with all applicable Federal Mine Safety regulations will be maintained.

1.1.4.3 Radiation - The Mine Safety and Health Administration (MSHA) requires that when radiation measurements in areas where personnel are working indicate exposure to concentrations of radon daughters in excess of 0.3 working level (WL), complete individual exposure records shall be kept for all employees entering these areas. A working level is defined by 30 CFR 57.2 as follows:

> In those standards which relate to radiation, a working level" (WL) means any combination of the short-lived radon daughters in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV (million electron volts) of potential alpha energy, and exposure to these radon daughters over a period of time is expressed in terms of "working level months" (WLM). Inhalation of air containing a radon daughter concentration of 1 WL for 173 hours results in an exposure of 1 WLM.

In order to maintain concentrations less than a 0.3 WL, the ventilation program will be regularly updated; and every area of the mine where men are working will be checked for radon or its short-lived daughters on a scheduled basis and spot checked when necessary. Radon (daughter) checks will be made in compliance with federal regulations at all working areas throughout the underground mine. Individual radon (daughter) exposure records will be kept up-to-date monthly, based on the results of the periodic readings. Records will be made available for inspection at the Safety Director's office at any time.

2. Environmental Description, Impacts, and Interim Mitigation

2.1 Land Use

2.1.1 Description - Land use for Fall River County is shown on Figure 2.1.1-1 and statistics which were derived from the map are contained in Table 2.1.1-1.[1] The predominant land use is rangeland (85 percent) with the remaining consisting mostly of forest (11 percent) and cropland (3 percent). The county is very sparsely settled as indicated by the average population density of 1.9 persons/km^2 (5 persons/mi^2). A combination of the population and land areas of Edgemont and Hot Springs results in a rural population density of 0.4 persons/km^2 (one person/mi^2).

2.1.2 Impacts - Mining activities will disturb and/or restrict the use of 32 ha (80 acre) of shrubland, woodland, and grassland. Rangeland and forest total over 404,700 ha (1×10^6 acre) so the small amount temporarily impacted will have no significant effect on land use in Fall River County. Further, because of the sparse settlement pattern, the operation should have no significant effect on inhabitants (see Section 2.10). After production, the reclamation procedures should result in land uses which would be essentially the same as present uses; thus no permanent impacts are expected.

The only planned mining activity outside Fall River County will be the surface mining operation at the existing Spencer-Richardson open pit mine which occupies 8.1 ha (20 acre) in Custer County, less than 1 km (.6 mile) north of the Fall River County line (refer to Figure 1.1.1-1). No additional land disturbance is expected from this mining operation and therefore, no land use changes will occur.

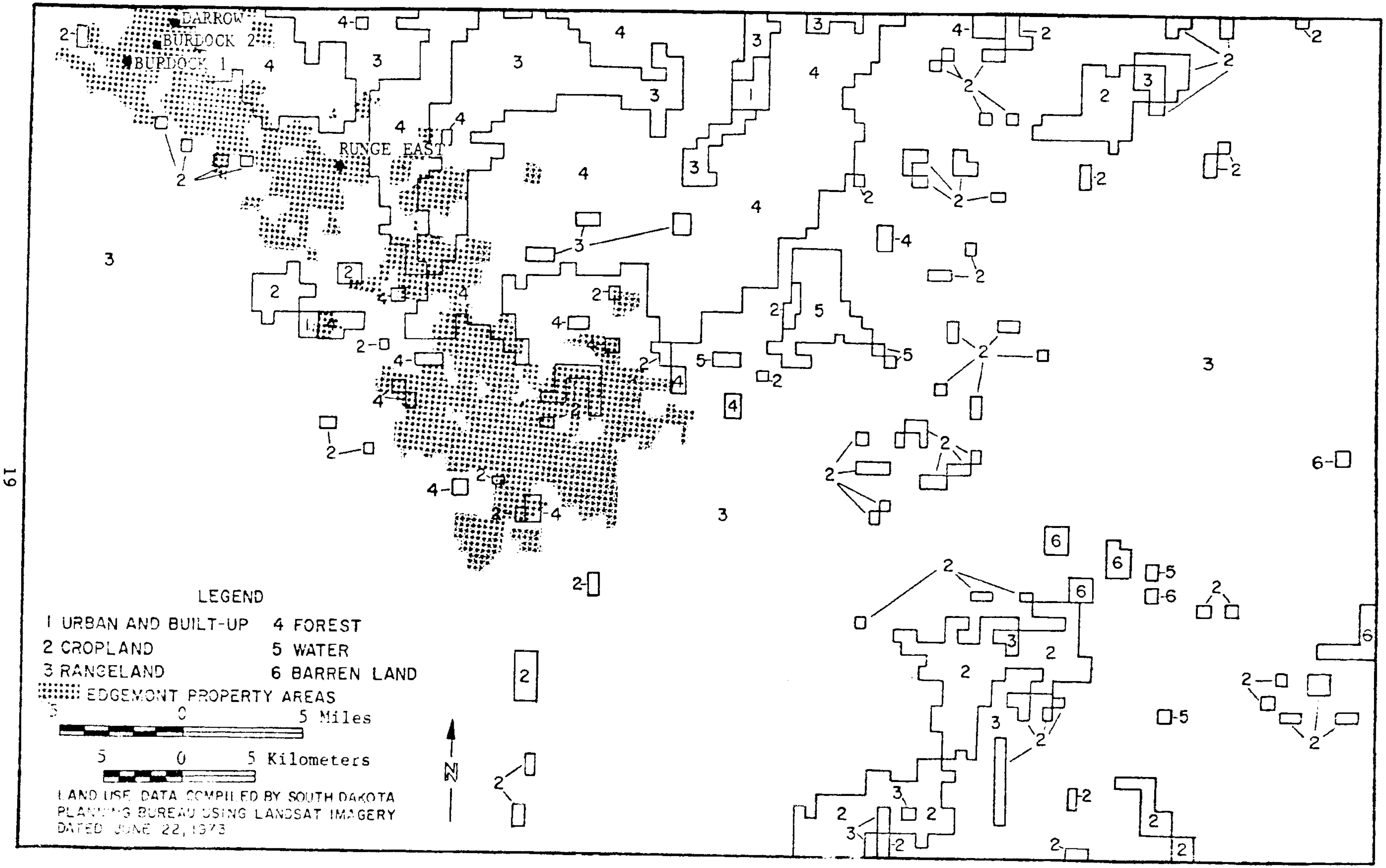


Figure 2.1.1-1 Existing Land Use Fall River County

Table 2.1.1-1

Fall River County Land Use

1973*

	Acres	Percent
Urban and Built-Up	1,920	0.2
Cropland	33,600	3.0
Rangeland	947,520	84.9
Forest	122,880	11.0
Water	6,240	0.6
Barren Land	3,520	0.3
Total	1,115,680	100.0

*Land use data is based on interpretation of LANDSAT scene 1334-17130 taken June 22, 1973. The interpretation and estimations were prepared by the South Dakota State Planning Bureau.

2.1 References

1. Loveland, Thomas A. Land Use Data Analyst. South Dakota State Planning Bureau, letter and enclosure to George DeVenny, TVA. November 8, 1977.

2.2 Geology

2.2.1 Geomorphology - The Edgemont project is located on the southwest flank of the Black Hills Uplift in the southwest corner of the State of South Dakota. Flat to rolling topography, deep intersecting canyons, numerous small mesas, cuestas, and hogbacks characterizes the area which is drained by the Cheyenne River and its tributaries. Elevations in the project area range from 1,006 m (3,300 ft) in the low areas of the Cheyenne River Drainage to 1,417 m (4,675 ft) at the crests of the surrounding ridges. In the project area, the local relief is about 75 m (250 ft).

2.2.2 Stratigraphy - The stratigraphy of the southwestern flank of the Black Hills Uplift is composed of a sequence of rocks which range in age from Precambrian to Recent (Table 2.2.2-1). Precambrian rocks outcrop near the center of the Black Hills Uplift and progressively younger rocks outcrop southwesterly to the Powder River Basin. Within the project area, the outcropping rocks range in age from Jurassic to Recent (Table 2.2.2-2).

To date, all of the economically significant uranium occurrences are contained within the Fall River and Lakota Formations of the Inyan Kara Group of Lower Cretaceous age (Figure 2.2.2-1). The Lakota and Fall River Formations were deposited in continental and marginal marine environments, respectively. The Inyan Kara Group is composed of subequal amounts of complexly interbedded and intertonguing sandstones and claystones.[1] The Inyan Kara Group is underlain by continental sedimentary rocks of the Morrison Formation of Jurassic age and is overlain by the marine Skull Creek Shale of Lower Cretaceous age. Resistant Inyan Kara sediments form the outermost hogback ridges circumscribing the Black Hills.[2]

2.2.3 Geologic Structures - The project area is on the southwest flank of the Black Hills Uplift, an elongate north-west trending dome of Laramide age about 200 km (125 mi) long and 97 km (60 mi) wide.[3] To the west and southwest of the project area is the Powder River Basin.[4] Superimposed on the Black Hills Uplift are numerous folds plunging radially outward. Within the project area, local structures of this type are the Chilson Anticline and Sheep Canyon Monocline east of the community of Edgemont, and the Cottonwood Creek Anticline trending southwest from the community of Edgemont (Figure 2.2.2-1). The regional dip of the sedimentary rocks in the project area is 2 to 4 degrees southwesterly.

Two major structural zones, Dewey and Long Mountain, are conspicuous within the project area (Figure 2.2.2-1). These structural zones consist principally of a number of <u>en echelon</u> faults. Two subordinate fracture systems are prevalent within the project area. One set of fractures strikes about N 30-60 degrees W and the second set strikes about N 30-60 degrees E. Movement along the fractures appears to have been less than 2 m

Table 2.2.2-1

Generalized Stratigraphic Section of the Black Hills

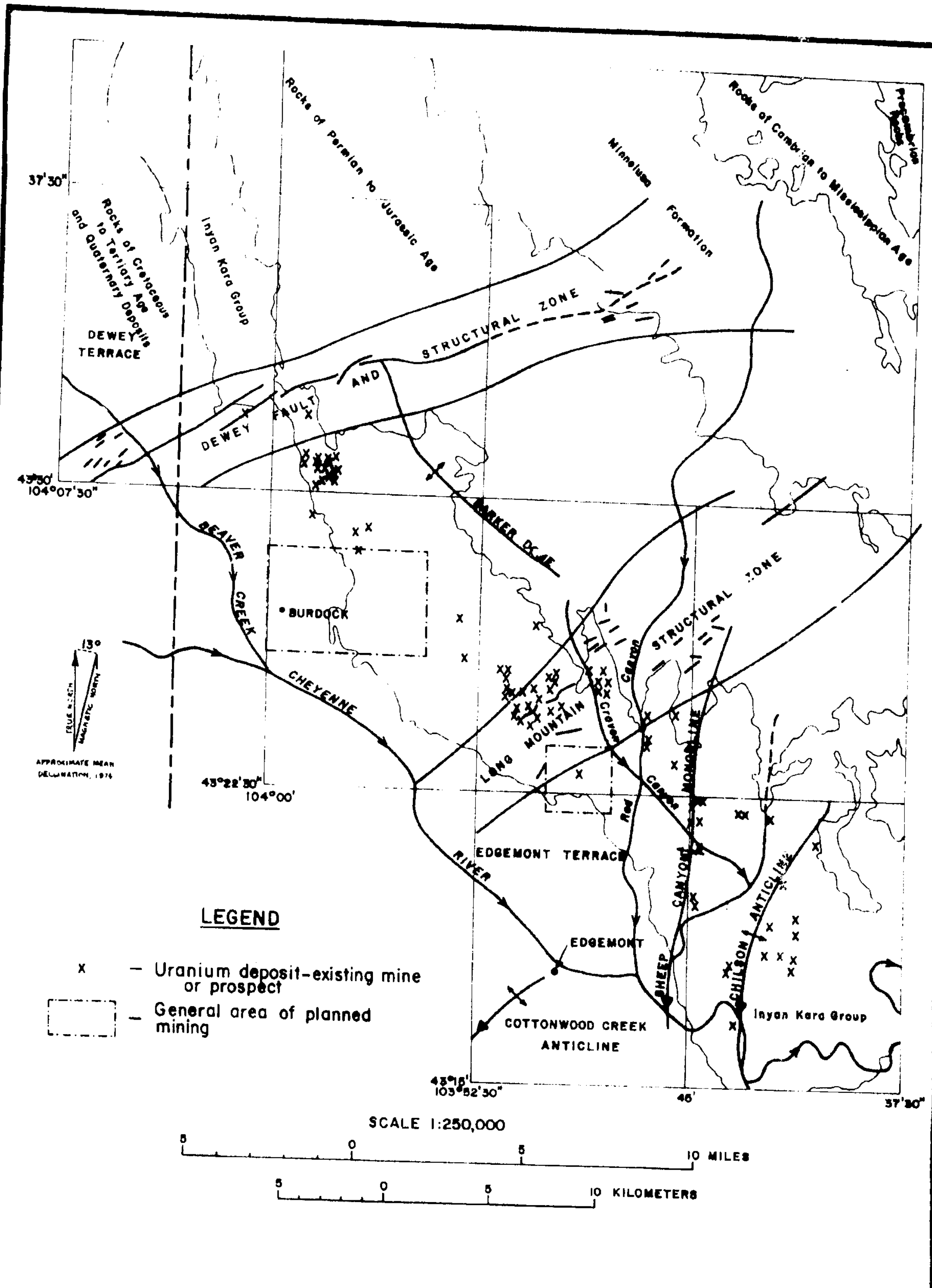
(Modified from the Geologic Map of South Dakota by N. H. Darton 1951)[2]

Age	Formation	Description
Upper Cretaceous	Pierre shale	Dark shale
Upper Cretaceous	Niobrara	Impure chalk and limy shale
Upper Cretaceous	Carlile shale	Dark shale
Upper Cretaceous	Greenhorn limestone	Limestone
Upper Cretaecous	Belle Fourche and Mowry Shales	Dark shales
Lower Cretaceous	Skull Creek Shale, Inyan Kara Group Fall River, Lakota	(See Table 2.2.2-2)
Jurassic	Morrison	Shale, mostly gray; sandstone and limestone
Unconformity		
Jurassic	Sundance	Greenish shale, buff, and red sandstone
Triassic (?)	Spearfish	Red sandy shale and sandstone; gypsum members
Permian	Goose Egg Formation Minnekahta Member Opeche Member	Limestone Red sandy shale
Pennsylvanian	Minnelusa	Gray, red, and buff, sandstone, mostly limy; red shale at base
Mississippian	Pahasapa & Englewood	Limestone Limestone
Unconformity		
Ordovician	Whitewood	Limestone
Unconformity		
Upper Cambrian	Deadwood	Sandstone, shale, congomerates
Unconformity		
Precambrian		Igneous and Metamorphic Rocks

Table 2.2.2-2

Generalized Stratigraphic Section
for the Project Area

Age	Formation	Member	Thickness meters (feet)	
Quaternary	Alluvium & Terrace Deposits		0-2 (0-5)	Alluvial sand, gravel, and clay.
Cretaceous	Mowry Shale		0-30 (0-100)	Gray, siliceous shale and many thin bentonite beds.
Cretaceous	Newcastle Sandstone		0-12 (0-40)	Sandstone, gray and brown shale, and some bentonite and shaly coal.
Cretaceous	Skull Creek Shale		0-60 (0-200)	Grayish-black shale and a few thin beds of sandstone.
Cretaceous	Fall River Formation	Upper	12-36 (40-120)	Variegated mudstone at the base overlain by fluvial sandstone and its fine-grained equivalents. Highly argillaceous and is characteristically mottled red and gray.
		Middle	10-34 (30-110)	Typically fine-grained fluvial sandstone and the associated marginal fine-grained deposits cemented with calcite and silica. Forms prominent vertical cliffs in canyons.
		Lower	0-16 (0-50)	Principally laminated micaceous carbonaceous siltstone interlayered with thin fine-grained slightly micaceous sandstone. Commonly stained brown or yellowish brown on outcrop.
Cretaceous	Lakota Formation	Fuson	12-18 (40-60)	Typically gray to black to maroon non-calcerous bentonitic shales. Internal sand lenses are common.
		Minnewaste Limestone	0-4 (0-10)	White to gray massive limestone commonly highly brecciated and recemented with calcite. Generally considered to be lacustrine in origin.
		Chilson	30-46(100-150)	Complex intertonguing of sandstones, siltstones and mudstones typical of a fluctuating alluvial depositional environment. Generally contains two well developed sandstone units and has a dark organic fissile shale near the base.
Jurassic	Morrison Formation		24-36 (80-120)	Red and green claystone interbedded near the base with light gray sandstone and limestone.



(MODIFIED FROM PLATE 4 - USGS PROFESSIONAL PAPER 763)[3]

Figure 2.2.2-1 Map Showing Major Structures and Uranium Deposits Edgemont, South Dakota Project

(6 ft) based on observations in existing pits and on information based on electric logs derived from drill holes.

Many small subsidence structures exist in and around the project area.[2] Most of these collapse structures are associated with breccia pipes or with dissolution of beds of anhydrite, gypsum, limestone, dolomite, and possibly salt.

2.2.4 Uranium Deposits - The project area is located within an identified uranium mining district established in 1951.[1] Past production records of this district indicate that production was in excess of 680,400 kg (1.5 x 10^6 lb) of U_3O_8 between 1951 and 1964.

According to O. M. Hart:

> Primary minerals in the deposits are coffinite and uraninite with minor amounts of paramontroseite and haggite. The ore minerals coat sand grains and fill interstices of complexly cross-stratified sandstone along solution fronts similar to "roll" type deposits of the other districts. Minerals of oxidized deposits are typically carnotite and tyuyamunite with different proportions of secondary vanadium accessory minerals. Ground water was the transportation medium and deposition of primary uranium and vanadium minerals occurred in reducing environments produced and controlled by physiochemical characteristics of the sedimentary rocks.[5]

The geochemical cells containing the uranium minerals are typically narrow, 5 to 30 m (15-100 ft), highly sinuous, often kilometers in length and the known deposits occur 1 to 8 km (0.6-5 mi) downdip from the outcrop of the respective sandstone unit.[1] Economic uranium deposits occur intermittently along the trend of the geochemical cells at depths from up to 220 m (720 ft).

2.2.5 Other Mineral Resources - Vanadium generally occurs in association with the uranium in a ratio of approximately 1.5:1 and has been economically recovered during uranium milling operations. No other minerals of economic value have been identified in the project area.

2.2.6 Geologic Impacts - Potential geologic impacts in the project area may be caused by slope instability and subsidence.

Slope Instability - Only minor slope stability problems are anticipated. Some caving and sloughing may occur in open pit mining in areas where pit walls encounter faults or major fracture systems. If these conditions are encountered, action will be taken to avoid unnecessary slumping and to assure safe working conditions for employees. Existing pits within the project area, mined in the 1960's to depths of up to 48 m (150 ft), have had no significant caving or slumping except along fault zones. The existing pit walls are stable with an overall slope ratio of approximately 0.5:1. Existing road cuts in the project area are stable with a slope ratio of 1:1.

Subsidence - Subsidence of less than 1 percent is estimated for uncompacted material from surface mining. In underground mining, no significant surface ground subsidence is anticipated for the following reasons: (a) Existing shallow mines, (15-45m, 50-150 ft, below surface) in and around the project area which were mined in the 1950's and 1960's, show no surface subsidence over the mine workings except for the Gould Mine at which about 6 m (20 ft) of unconsolidated siltstone overlying the adit portal has collapsed. (b) Ground support techniques such as roofbolting, lagging, and timbering will be used when support is necessary, e.g., when faults are encountered which produce unstable ground. The Hauber Mine, located in the northwestern Black Hills, mined in the 1950's and 1960's, has shown no surface subsidence to date. This uranium mine was developed within the Lakota Formation. Ground conditions at the proposed Burdock shaft sites are expected to be similar to those at the Hauber mine.

2.2 References

1. Renfro, A. R. Uranium deposits in the Lower Cretaceous of the Black Hills. Contributions to Geology, Wyoming Uranium Issue, 1969. University of Wyoming, 1969.

2. Darton, H. H. Geologic map of South Dakota. U.S. Geol. Survey, 1951.

3. Gott, G. B., Wolcott, D. E., and Bowles, C. G. Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits Southern Black Hills, South Dakota and Wyoming. U.S. Geol. Survey Prof. Paper 763. 1974.

4. Robinson, C. S., Mapel, W. J., and Bergendahl, M. H. Stratigraphy and structure of the Northern and Western Flanks of the Black Hills Uplift, Wyoming, Montana, and South Dakota. U.S. Geol. Survey Prof. Paper 404, 1964.

5. Hart, O. M. Uranium in the Black Hills. Ore deposits in the United States 1933/1967, Vol I. AIME. Salt Lake City, 1968.

2.3 Seismicity

Seismic events in the Black Hills area have been few in number and of low to moderate magnitude. The National Geophysical and Solar-Terrestrial Data Center files show that only 7 earthquakes of any significance have occurred within a 200 km (124 mi) radius of the planned mines during the period from the first documented earthquake in 1895 through 1976[1] (Figure 2.3-1).

The strongest observed earthquake, which had an intensity of VII based on the Modified Mercalli intensity scale,[2] occurred in 1964 and was centered approximately 178 km (110 mi) east-southeast of the mining sites. Some damage was reported in Alliance and Rushville, Nebraska (Figure 2.3-1). Using attenuation curves for maximum accelerations,[3] the maximum estimated acceleration that could be expected at the mining sites from such an earthquake would be less than 0.04g (gravity). The nearest tremor to the sites occurred in 1895. The epicenter was located approximately 80 km (50 mi) northeast of the sites and the tremor was reported to have had an intensity of V. There was no reported damage associated with that tremor. The maximum acceleration at the sites for a seismic event of this intensity is so small that it cannot be estimated from an attenuation curve.

According to the recent probabilistic acceleration map of the U.S.[4], the proposed project site lies within an area of low seismic risk. The probability that accelerations larger than 0.04g would be experienced at the proposed project sites is 10 percent in 50 years.

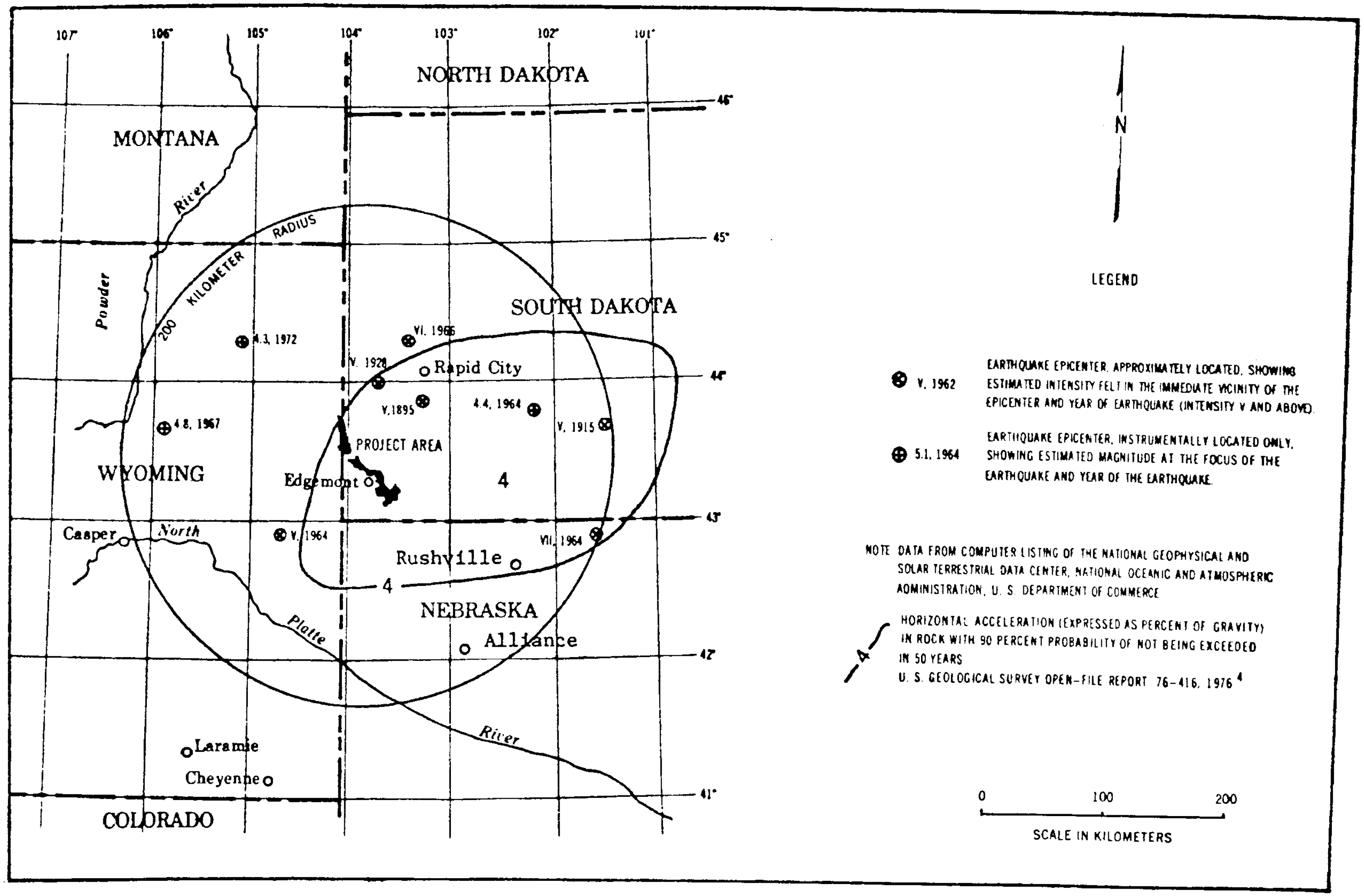


Figure 2.3-1 Regional Seismicity and Seismic Risk

2.3 References

1. National Geophysical and Solar Terrestial Data Center. (Undated). Environmental Data Service Report. NOAA, Department of Commerce.

2. Wood, H. O., and F. Neumann. Modified Mercalli intensity scale of 1931. Bull. Seis. Soc. Am. 21:278-283. 1931.

3. Schnabel, R. B., and H. B. Seed. Acceleration in rock for earthquakes in the western United States. Earthquake Engineering Center Report, #EECR 72-7, p. 15. University of California, Berkley. 1972.

4. Algermissen, S. T. and D. M. Perkins. Probabilistic estimate of maximum acceleration in rock in the contiguous United States. U.S. Geol. Survey Open-file Report 76-416, 45 pp. 1976.

2.4 Soils

2.4.1 Description - The generalized soils of the Edgemont property are shown in Figure 2.4.1-1 and may be divided into eight broad groups that differ in major characteristics.[1,2] A brief description of each of the broad groups follows.

MANUEL-SHINGLE-GRUMMIT ASSOCIATION - All of the surface disturbance from the proposed mining activity will fall within this soil association. The soil series which compose this association range from light brownish gray clays to light brown silty clay loams and are found on nearly level to very steep uplands. Many of the soils within this association provide only fair to poor source material for topsoil due to excessive lime and high clay content. Figure 2.4.1-2 displays, in map form, the soil series that will be potentially disturbed from the proposed mining activity. Detailed information displaying the associated soil interpretations and estimated engineering properties of these series are presented in Appendix A. Interpretations in relation to engineering use can be made from the estimated engineering properties of each soil series listed in Appendix A. These interpretations indicate that the soils of the Manuel-Shingle-Grummit Association have limitations as a source of road fill material because of their low strength and high shrink-swell potential. These soil series also have limitations as septic tank absorption fields because of their high clay content and shallow depth to bedrock. They also generally exhibit a moderate to high corrosivity in relation to untreated steel pipe. Because soil associations include a number of soil series with varying characteristics, a detailed soils engineering study will be performed as part of project engineering. This soils engineering study will be used to determine the site specific soil suitability for the various mining activities anticipated. Other soil associations that surround the proposed mining disturbance on the Edgemont property are briefly described below.

BUTCHE ASSOCIATION - This association is found mainly on broad uplift ridges that have gentle or very steep slopes. Drainageways are deeply entrenched. These soils are shallow with interbedded sandstone and siltstone found below a depth of 23 cm (9 in). Butche soils are poor source material for topsoil because of large stones, thin layers, and because they generally occur on slope positions where they cannot be easily obtained for stockpiling.

TILFORD ASSOCIATION - This soil association is nearly level to gently sloping and is found on stream terraces. Tilford soils are deep and well-developed and provide fair material for topsoil.

NORKA ASSOCIATION - This soil association is found on gently to moderately sloping uplands and valley sideslopes. Norka soils are deep and provide good material for topsoil.

TUTHILL-DAILEY ASSOCIATION - Both of the soils in this association are found on very gently sloping to moderately sloping upland deposits of tablelands and terraces. Tuthill soils are good source material for topsoil while the abundance of sand in the Dailey soils contributes to drought conditions due to its poor water retention characteristics.

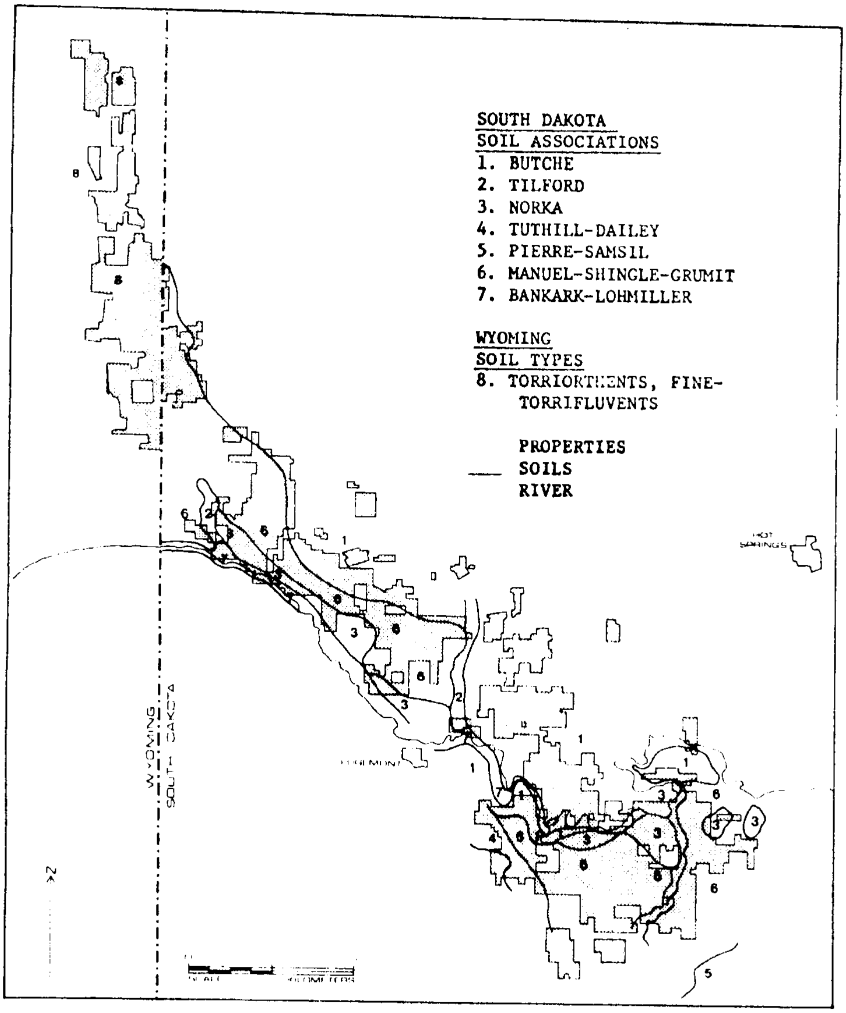


Figure 2.4.1-1

General Soils Map of the Edgemont Project Area

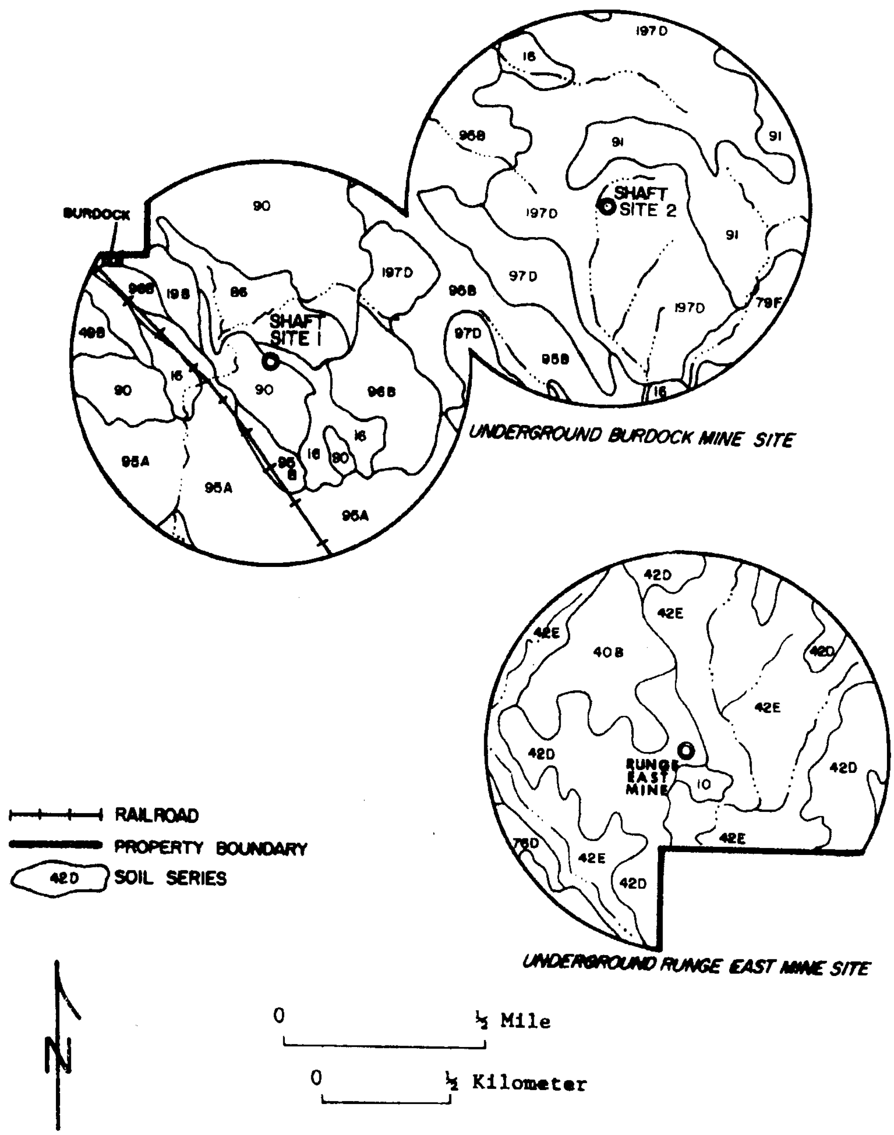


Figure 2.4.1-2 Soils Series of the Immediate Area Surrounding the Burdock and Runge East Mine Sites (Interpretations are Presented in Appendix A)

Shaft site locations are shown in Figure 1.1.1-1.

2.5 Hydrology

2.5.1 Surface Water

Description - The Edgemont project area is drained by the Cheyenne River and tributary streams in an area which lies in Weston and Niobrara Counties along the eastern edge of Wyoming and in Fall River and Custer Counties in southwestern South Dakota. The principal tributaries in this area which enter the Cheyenne River from the north are: Pass Creek; Bennett, Driftwood, Red, and Sheep Canyons; and Beaver Creek and its tributaries (Stockade Beaver, Lime and Hat Creeks). Cottonwood and Hat Creeks are the principal tributaries which enter the Cheyenne River from the south. With the possible exception of Stockade Beaver Creek, all of these streams including the Cheyenne River experience extended periods of no flow.

The Cheyenne River begins on Pine Ridge about 185 km (115 mi) west of Edgemont. The course of the river approximates the boundary between the Black Hills Section and Missouri Plateau Section of the Great Plains Physiographic Province and has a drainage area of 18,500 km² (7,143 mi²) at Edgemont. The river channel is braided, reflecting the low gradient of about 0.0014 in the vicinity of Edgemont. The Cheyenne River is impounded for irrigation, flood control, and power generation purposes by Angostura Reservoir about 54 km (34 mi) downstream from Edgemont. Angostura Dam is about 10.4 km (6.5 mi) southeast of Hot Springs. Contents of the reservoir since initial filling in October, 1949 have ranged from a minimum of 55.96 hm³ (cubic hectometers) (45,350 acre-ft) in September 1960 to a maximum of 179 hm³ (145,200 acre-ft) in June 1962.[1] The Cheyenne River flows northeasterly from Angostura Dam for another 80 km (50 mi) and empties into Oahe Reservoir which is impounded by Oahe Dam on the Missouri River near Pierre, South Dakota. Figure 2.5.1-1 shows the regional drainage surrounding the Edgemont property area.

The U.S. Geological Survey operates or has operated several stream gages in the vicinity of the Edgemont properties. Basic information on the streamflow characteristics of these gaged streams is shown in Table 2.5.1-1.[1,2] Annual runoff at these gaging stations varies widely as indicated[1] by values in the table. The same is true for the ungaged tributary streams draining the Edgemont properties.

The runoff distribution during the year based on the average of the monthly percentages for the Cheyenne River and Hat Creek gages and for the monthly percentages for the Beaver Creek near New Castle gage is shown in Table 2.5.1-2.[2] As indicated in this table, May, June, and July are the months of highest runoff, generally as the result of snowmelt and higher precipitation amounts experienced during these months. Runoff is generally lowest during the fall and winter months when precipitation is low and occurs mostly as snow.

Surface water drainage in the vicinity of the proposed mine locations as shown on Figures 2.5.1-2, and 3, is described in the following paragraphs.

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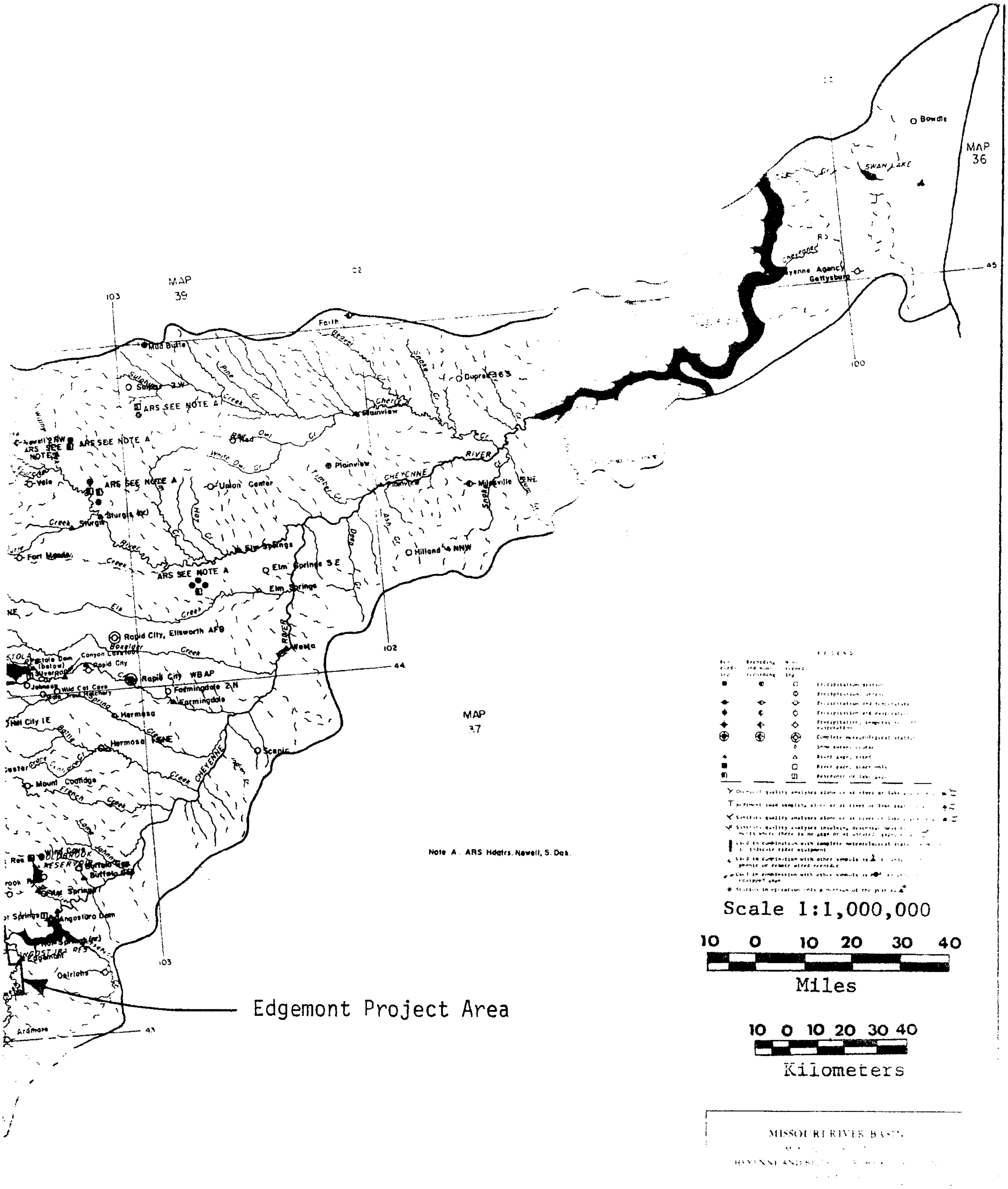


1.1 Regional [illegible] Edgemont Project Area

Table 2.5.1-1

Streamflow Characteristics at Stream Gages in the Vicinity of Edgemont Uranium Mining Project[1,2]

	Period of Record	Drainage Area mi^2 (km^2)	Average Discharge cfs (m^3/sec)	Range of Average Annual Discharge Min. cfs (m^3/sec)	Range of Average Annual Discharge Max. cfs (m^3/sec)	Maximum Discharge cfs (m^3/sec)	Minimum Discharge cfs (m^3/sec)	Remarks
			Streamflow Characteristics for Period of Record					
Cheyenne River near Edgemont, SD	1903-1906 1928-1933 1946-1976	7,143 (18,500)	99.5 (2.82)	12.9 (0.37)	434 (12.3)	13,800 (391)	0	Small reservoirs for stock irrigation water upstream. No flow for extended periods most years.
Cheyenne River near Hot Springs, SD	1914-1920 1943-1972	8,710 (22,559)	233 (6.60)	30.9 (0.88)	453 (12.8)	114,000 (3,228)	0.5 (0.014)	Small reservoirs for stock and irrigation water upstream.
Beaver Creek near Newcastle, WY	1944-1976	1,320 (3,419)	32.8 (0.93)	5.1 (0.14)	130 (3.68)	11,900 (337)	0	Diversions for irrigation and small stock reservoirs upstream.
Stockade Beaver Creek near Newcastle, WY	1974-1976	107 (277)	12.8 (0.36)	12.7 (0.36)	12.8 (0.36)	39 (1.10)	8.9 (0.25)	A few small diversions for irrigation upstream.
Hat Creek near Edgemont, SD	1905-1906 1950-1976	1,044 (2,704)	21.3 (0.60)	1.27 (0.036)	112 (3.17)	13,300 (377)	0	No flow many days each year. Flow diversions for irrigation upstream.

Table 2.5.1-2

Average Annual Runoff Distribution for Beaver Creek and the Cheyenne River and Hat Creek

	Percent of Annual Runoff	
	Beaver Creek	Cheyenne River and Hat Creek
January	2.3	0.7
February	8.2	2.5
March	21.3	8.7
April	9.2	7.4
May	12.0	19.1
June	22.9	31.5
July	10.5	15.2
August	4.6	7.8
September	2.1	3.7
October	2.4	1.4
November	2.4	1.1
December	2.1	0.9

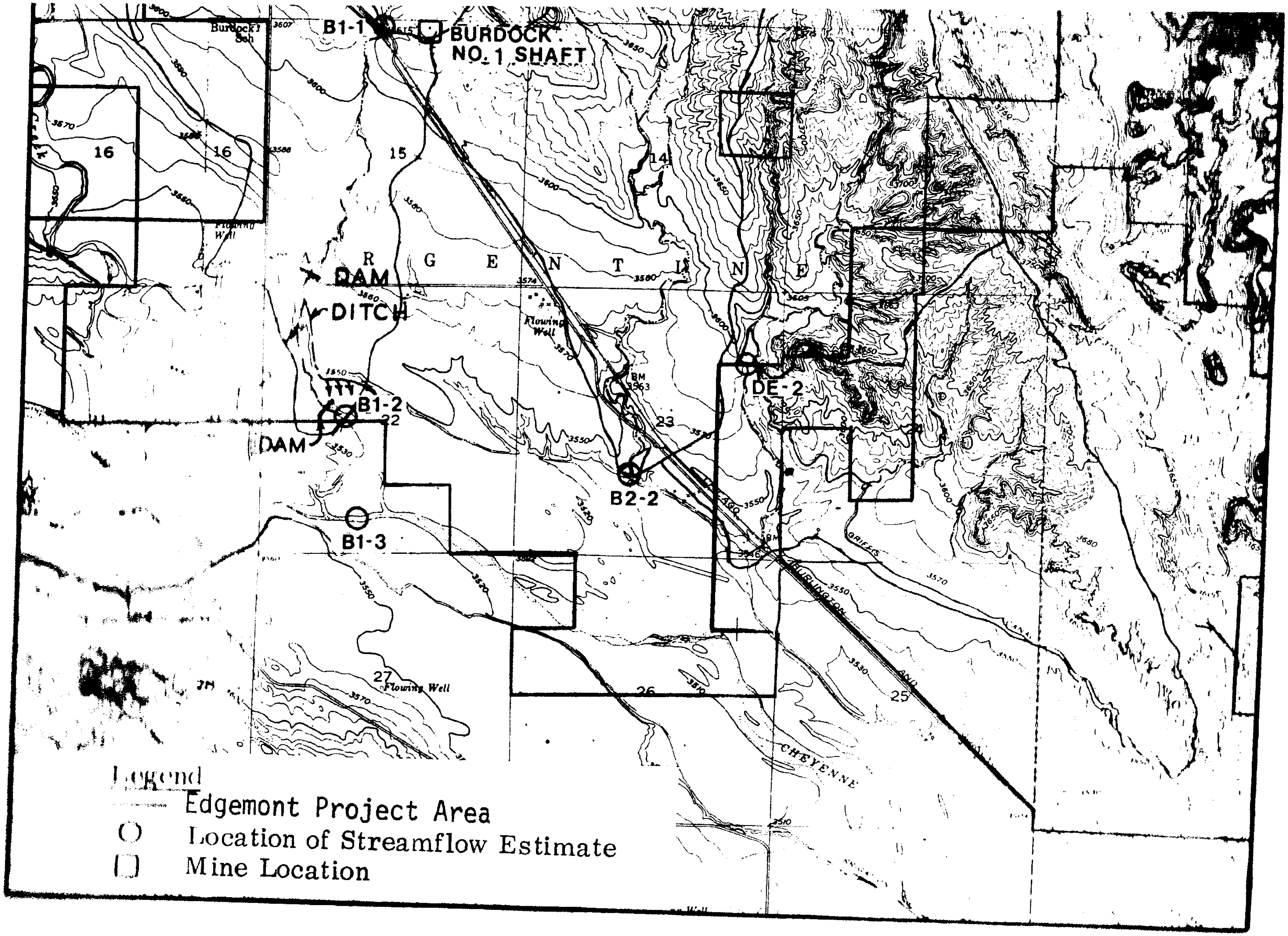
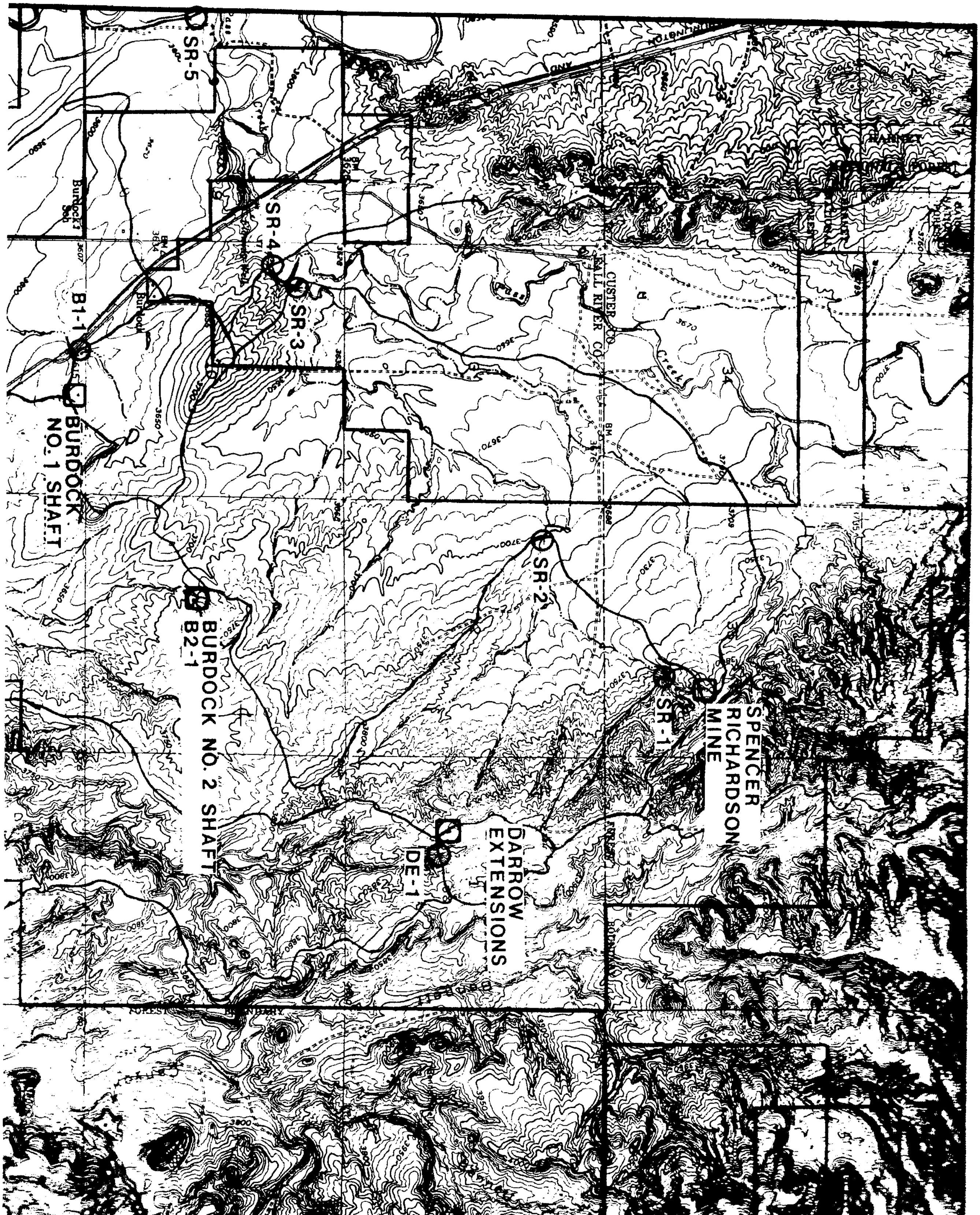


Figure 2.5.1-2 Streams and Subwatersheds - Edgemont Project Area


SR-5
SR-4
SR-3
B1-1
BURDOCK NO. 1 SHAFT
B2-1
BURDOCK NO. 2 SHAFT
SR-2
SR-1
SPENCER RICHARDSON MINE
DARROW EXTENSIONS
DE-1
CUSTER CO
FALL RIVER CO

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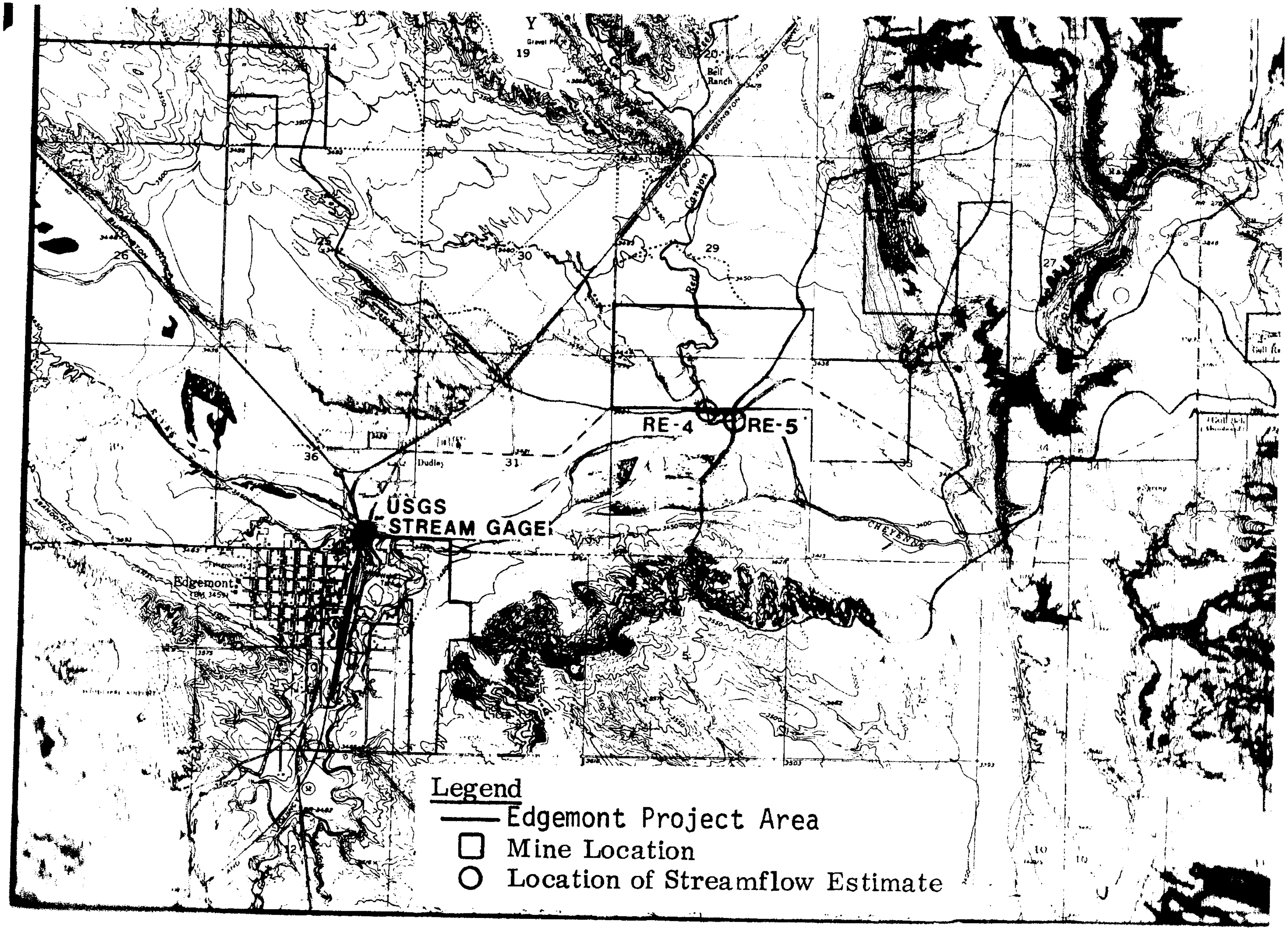

Figure 2.5.1-3 Streams and Subwatersheds - Edgemont Project Area

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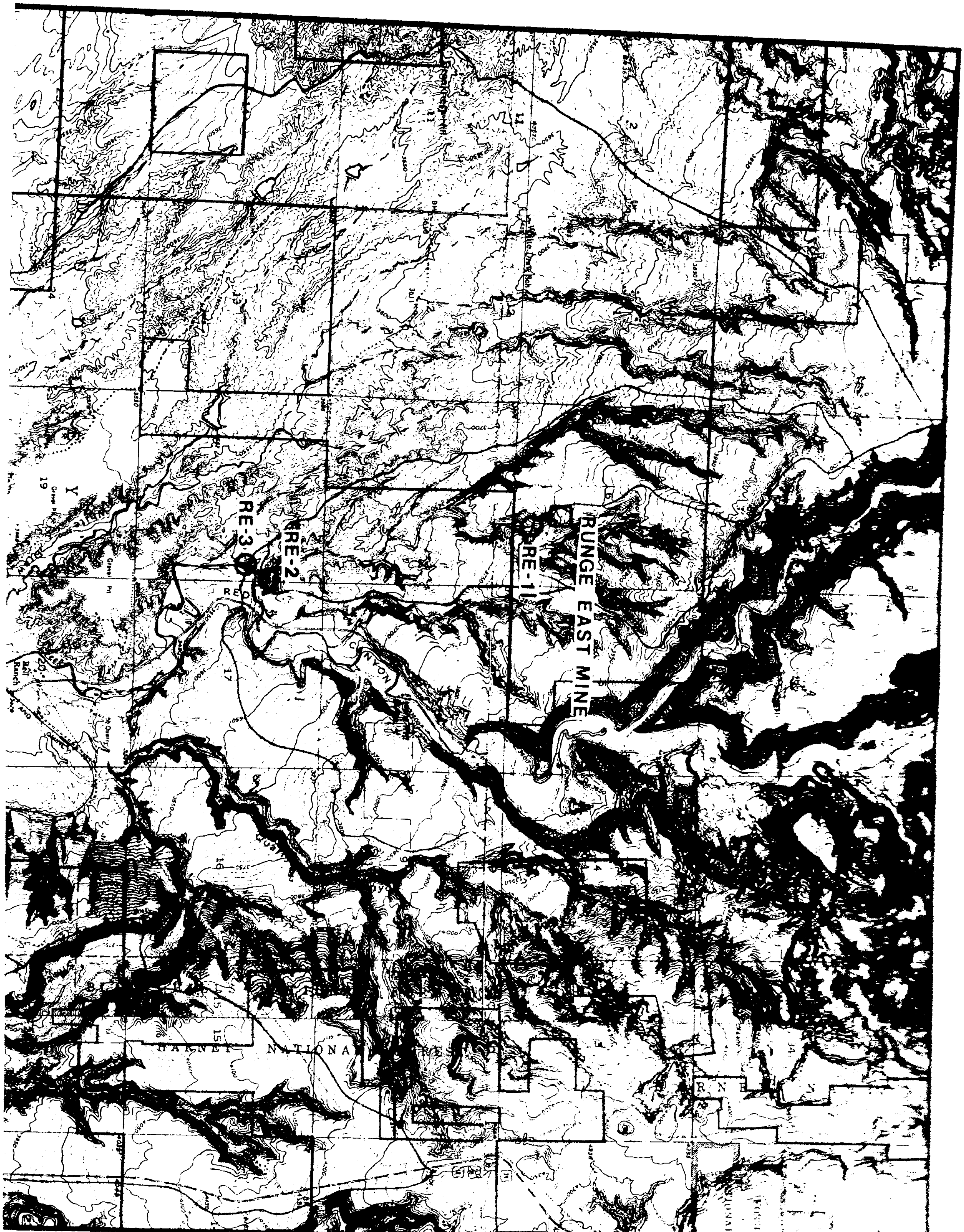

RUNGE EAST MINE
RE-1
RE-2
RE-3
RED
CANYON
HARNEY
NATIONA

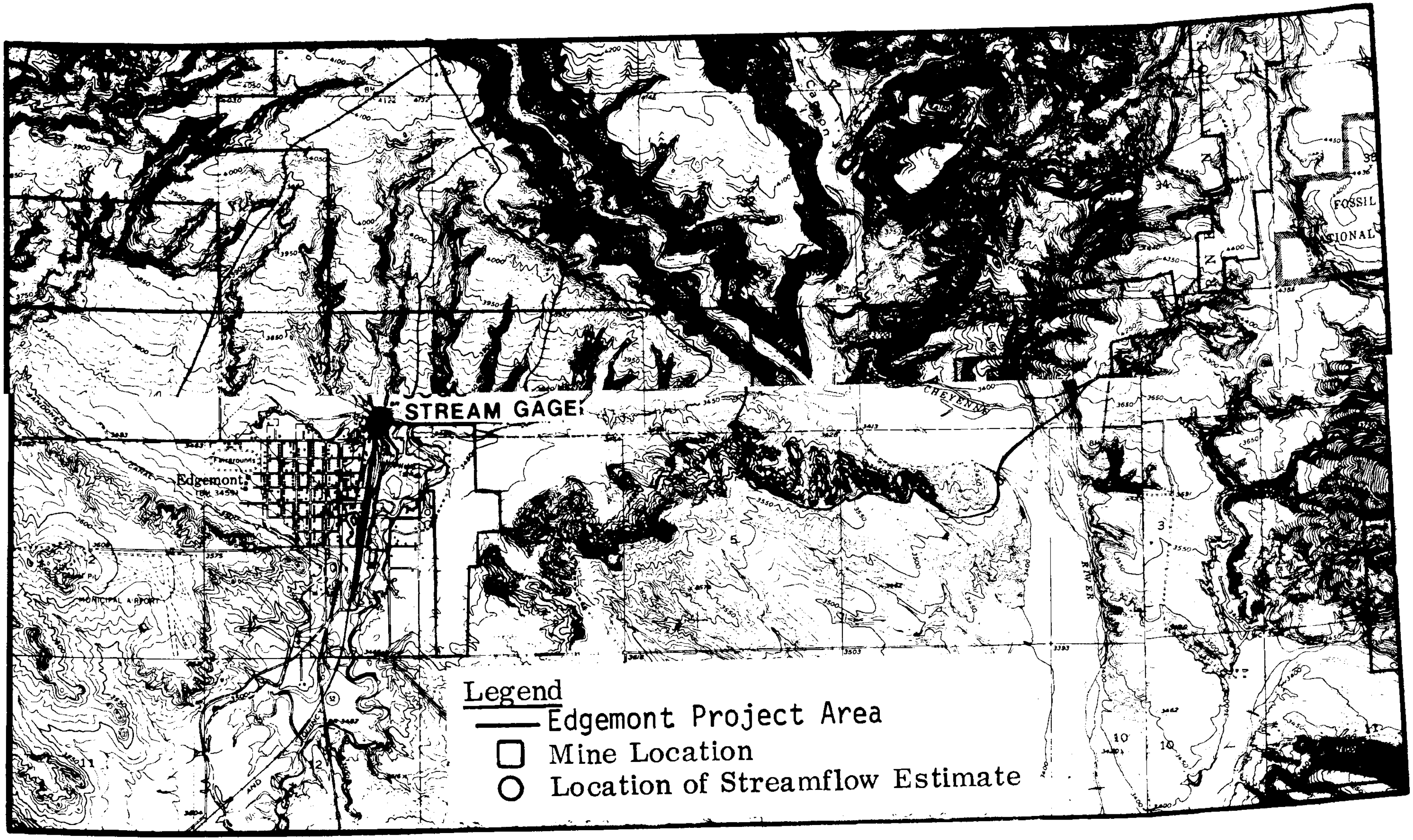


Figure 2.5.1-3 Streams and Subwatersheds - Edgemont Project Area

Burdock No. 1 Shaft - The location of the proposed shaft is shown on Figure 2.5.1-2. This site is drained by an intermittent, unnamed tributary of Beaver Creek. Elevations in the watershed of this tributary range up to 1,137 m (3,730 ft) on a hill north of the mine site and drop to about elevation 1,103 m (3,620 ft) near the shaft site.

A diversion system of two small dams and ditches has been constructed in the lower 1 km (0.6 mile) of the drainage course as shown on figure 2.5.1-2. Flow in the drainage course will be dispersed in the flood plain along Beaver Creek and the Cheyenne River. Elevations in this area are in the range of 1,076 to 1,079 m (3,530-3,540 ft). Runoff characteristics at selected sites on this tributary as well as other streams draining mine locations are presented in Tables 2.5.1-3 and 4. These include estimates of average annual runoff and peak discharges of floods with 2, 10, and 50-year recurrence intervals and of the maximum probable flood. These estimates, at selected locations near the mine sites and at downstream locations, are based on techniques developed by the Water Resources Division of the U.S. Geological Survey.[3,4] As indicated in Table 2.5.1-3 average annual runoff is only 1.80 cm (0.71 in) from an area of 0.88 km² (0.34 mi²) in the vicinity of Burdock No. 1 shaft (B1-1). More than half the runoff can be expected to occur during the months of May, June and July as the result of snowmelt and local, heavy rainfall. Average annual runoff from the larger watersheds above downstream locations (B1-2 and B1-3) is even less, in the order of 0.5 to 1.3 cm (0.2-0.5 in). Annual runoff may vary widely depending upon the occurrence of storm rainfall. Flood peak discharges are generally the result of heavy local thunderstorms. The estimates shown include the magnitude of these discharges which can be expected at or near the mine site. Flooding could occur along the drainage course in the vicinity of Burdock No. 1 shaft, but the shaft site would be located above or protected from anticipated flood levels.

Burdock No. 2 Shaft - This shaft site is drained by an unnamed intermittent tributary of the Cheyenne River. (See Figure 2.5.1-2.) The drainage area above the mine site is only 0.08 km² (0.03 mi²). Elevations in this area, as indicated on the topographic map of the area,[5] range from about 1,130 m (3,710 ft) at the mine site to about 1,146 m (3,760 ft) at the watershed divide. Downstream from the shaft site, the drainage course drops quite rapidly to an elevation of about 1,080 m (3,540 ft) where it flows into a small reservoir near the edge of the Cheyenne River flood plain. Overflow from the reservoir during periods of heavy runoff would either infiltrate into the flood plain along the Cheyenne River or eventually flow into the river. Average annual runoff on the unnamed tributary near the mine site (B2-1) and near its mouth (B2-2) is estimated to be 0.53 cm (0.21 in) as indicated in Table 2.5.1-3. Burdock No. 2 shaft site near the head of the unnamed tributary could be affected by heavy surface runoff depending upon the exact location of the site with respect to the drainage course. Some diversion of the surface runoff may be necessary.

Spencer-Richardson Mine - This existing open pit mine site is located near the top of a ridge; there is practically no drainage area above the mine site so flooding by surface runoff is not a consideration. (See Figure 2.5.1-2.) Drainage from the site is

Table 2.5.1-3

Estimates of Mean Annual Runoff - Drainage Basin Parameters[1] for Watersheds Above Selected Location in Vicinity of Proposed Mine Operations Edgemont Uranium Mining Project Wyoming and South Dakota

Mine and Selected Locations	Drainage Area(A) $mi^2(km^2)$	Forest Cover Percent(F) % +0.1	Maximum 24-Hour-2 Yr. Rainfall (I_{2-24}) in(cm)	Water Content of Snow Mar. 1-16, 25 Yr. Recurrence Interval-Sn_{25} in(cm)	Mean Annual Discharge QA cfs	m^3/sec	acre-ft	in
Burdock No. 1 Shaft								
B1-1	0.34(0.88)	24.1	1.9(4.8)	1.4(3.6)	0.018	0.0005	13	0.71
B1-2	1.48(3.83)	5.5	1.9(4.8)	1.4(3.6)	0.056	0.0016	40	0.51
B1-3	7,083(18,345)	Based on stream gage records at Edgemont (D.A. 7,143 mi^2 (18,500 km^2))			99	2.80	72,500	0.19
Burdock No. 2 Shaft								
B2-1	0.03(0.08)	0.1	1.9(4.8)	1.4(3.6)	0.0005	0.000013	0.3	0.21
B2-2	2.01(5.21)	0.1	1.9(4.8)	1.4(3.6)	0.031	0.0009	22	0.21
Spencer Richardson								
SR-1	0.18(0.47)	11.1	1.9(4.8)	1.4(3.6)	0.008	0.0002	6	0.60
SR-2	0.99(2.56)	12.1	1.9(4.8)	1.4(3.6)	0.045	0.0013	32	0.61
SR-3	3.25(8.42)	6.9	1.9(4.8)	1.4(3.6)	0.13	0.037	94	0.54
SR-4	8.93(23.13)	37.1	1.9(4.8)	1.4(3.6)	0.52	0.147	380	0.79
SR-5 [2]	1,402(3,631)				36	1.02	26,500	0.35
Darrow Extensions								
DE-1	0.11(0.28)	27.1	1.9(4.8)	1.4(3.6)	0.006	0.00017	4.3	0.73
DE-2	1.87(4.84)	21.0	1.9(4.8)	1.4(3.6)	0.095	0.0027	69	0.69

Table 2.5.1-3 (Continued)

Mine and Selected Locations	Drainage Area(A)	Forest Cover Percent(F)	Maximum 24-Hour-2 Yr. Rainfall (I_{2-24})	Water Content of Snow Mar. 1-16, 25 Yr. Recurrence Interval-Sn_{25}	Mean Annual Discharge QA			
	$mi^2(km^2)$	% +0.1	in(cm)	in(cm)	cfs	m^3/sec	acre-ft	in
Runge East								
RE-1	0.56(1.45)	18.1	1.9(4.8)	1.4(3.6)	0.028	0.0008	20	0.67
RE-2	2.29(5.93)	6.0	1.9(4.8)	1.4(3.6)	0.088	0.0025	64	0.52
RE-3	187(484)	64.1	1.9(4.8)	1.4(3.6)	12.4	0.35	8,960	0.90
RE-4	208(539)	58.1	1.9(4.8)	1.4(3.6)	13.5	0.38	9,750	0.88
RE-5[3]	7,502(19,430)				114	3.23	82,500	0.21

1. Significant parameters based on regression analysis as defined by Larimer1/
   Equation used for mean annual discharge:

   $$QA = 6.11\times10^{-3}\ A^{1.002}\ F^{0.224}\ I_{2,24}^{\ 1.916}\ Sn_{25}^{\ 0.624}$$

   A = drainage area in square miles
   F = Percent forest cover + 0.1
   I_{2-24} = Maximum 24-hour rainfall with 2-year recurrence interval as determined from U.S. Weather Bureau Technical Paper No. 40(1961)
   Sn_{25} = Water content of snow for the period March 1-16, having a recurrence interval of 25 years from U.S. Weather Bureau Technical Paper No. 50(1964)
2. Based on stream gage records at Beaver Creek at Newcastle.
3. RE-5 - Cheyenne River below Red Canyon Creek. Based on stream gage records at Edgemont plus local inflow estimates.

Table 2.5.1-4

Flood Peak Discharge Estimates at Selected Locations in Vicinity of Edgemont Uranium Mine Sites

Selected Locations*	Drainage Area $mi^2(km^2)$	Discharge 2-Year cfs	2-Year m^3/sec	10-Year cfs	10-Year m^3/sec	50-Year cfs	50-Year m^3/sec	Max. Probable** cfs	Max. Probable** m^3/sec
Burdock No. 1 Shaft									
B1-1	0.34(0.88)	15	0.42	110	3.1	340	9.6	4,600	130
B1-2	1.48(3.83)	30	0.85	230	6.5	670	19	9,000	255
Burdock No. 2 Shaft									
B2-1	0.03(0.08)	5	0.14	35	0.99	110	3.1	1,500	42
B2-2	2.01(5.21)	35	0.99	260	7.4	760	22	10,000	283
Spencer Richardson Mine									
SR-1	0.18(0.47)	10	0.28	80	2.3	240	6.8	3,500	99
SR-2	0.99(2.56)	25	0.71	180	5.1	540	15	7,500	212
SR-3	3.25(8.42)	45	1.3	330	9.4	940	27	13,000	368
SR-4	8.93(23.13)	80	2.3	530	15	1,480	42	20,000	566
Darrow Extension Mine									
DE-1	0.11(0.28)	5	0.14	60	1.7	190	5.4	2,700	76
DE-1	1.87(4.84)	35	0.99	250	7.1	720	20	10,000	283
Runge East Mine									
RE-1	0.56(1.45)	15	0.42	140	4.0	400	11	5,800	164
RE-2	2.29(5.93)	35	0.99	280	7.9	790	22	11,000	311
RE-3	187(484)	400	11.3	2,270	64	5,930	168	80,000	2,270
RE-4	208(539)	410	11.6	2,340	66	6,090	172	90,000	2,550

*Refer to location maps
**Reconnaissance-level estimates only

to the south and west into intermittent flowing, unnamed tributaries of Pass Creek, also an intermittent stream, which empties into Beaver Creek, a major tributary of the Cheyenne River. A small reservoir is located on one of the tributaries about a mile downstream from the mine site. The tributaries head on the ridge on which the mine site is located. Elevations along the ridge range up to 1,195 m (3,920 ft). The gradient of the tributary to the south of the mine is quite steep, dropping from about elevation 1,173 to about 1,125 m (3,850-3,690 ft) near the reservoir location.

Estimates of average annual runoff and flood peak discharges at selected sites near the mine and at downstream locations (SR-1 - SR-5) are shown in Table 2.5.1-3 and 4. Estimates of average annual runoff on the tributaries and Pass Creek range from 1.37 to 2.00 cm (0.54-0.79 in). Beaver Creek which drains an area of 3,631 km^2 (1,402 mi^2) at site SR-5 below the mouth of Pass Creek has an average annual runoff of 0.89 cm (0.35 in). All of the streams experience extended periods of no flow. Annual runoff varies widely. At the stream gage site on Beaver Creek near New Castle upstream from SR-5, average annual discharge varied from 3.68 m^3/s (130 ft^3/s) in 1962 (water year) to 0.14 m^3/s (5.1 ft^3/s) in 1961 (water year).

Darrow Extensions - The existing pits from which the underground extensions will be mined are located on a ridge which forms the divide between the unnamed tributaries which flow to the west and southwest into Pass Creek described in the preceding paragraphs, and another unnamed tributary which flows southward to the Cheyenne River. The latter tributary, another intermittent stream, drains an area of 0.28 km^2 (0.11 mi^2) at location DE-1 near the mine site. (See Figure 2.5.1-2.) Elevations on the watershed divide range up to about 1,195 m (3,920 ft). The tributary gradient is quite steep, dropping from an elevation of about 1,170 m (3,840 ft) at location DE-1 to 1,091 m (3,580 ft) at a small reservoir at location DE-2, 5.5 km (3.4 mi) downstream. At the reservoir, the topographic map[5] indicates that part of the runoff may be diverted into Griffis Canal for irrigation purposes. The remainder flows out of the reservoir toward the Cheyenne River. The drainage course as defined on the topographic map[5] ends on the flat flood plain along the river. Estimates of average annual runoff and flood peak discharges at location DE-1 and DE-2 are shown in Tables 2.5.1-3 and 4. Average annual runoff is about 1.8 cm (0.7 in) at both locations. Since the mine site is on a ridge, flooding of the site is not a consideration.

Runge East Mine - The existing underground mine site is located in the drainage of an unnamed tributary of Red Canyon Creek. (See Figure 2.5.1-3.) The tributary, an intermittent stream, begins on the southern slopes of a steep ridge where elevations range up to 1,240 m (4,070 ft). The gradient of the tributary in the area above the mine location is very steep, dropping from an elevation of about 1,200 to 1,134 m (3,940-3,720 ft) in about 1.61 km (1 mi). The tributary drains an area of 1.45 km^2 (0.56 mi^2) at location RE-1 near the mine site. It empties into Red Canyon Creek at location RE-2 about 3.1 km (2 mi) to the south. Red Canyon Creek is a fairly large tributary of the Cheyenne River, draining an area of 539 km^2 (208 mi^2) most of which lies in the Black Hills National Forest. It empties into the Cheyenne River about 3.1 km (2 mi) downstream from Edgemont.

Estimates of average annual discharge and flood peak discharges at selected locations on these streams are shown in Tables 2.5.1-3 and 4. Estimates of average annual runoff at the locations on the unnamed tributary (RE-1 and RE-2) are 1.70 and 1.34 cm (0.67 and 0.52 in) respectively. Red Canyon Creek also has extended periods of no flow. The higher annual runoff estimate, about 2.28 cm (0.90 in) is the result of its more forested drainage area and the slightly higher precipitation in the higher elevations of the Black Hills. The flood peak estimates indicate the magnitude of flood discharges which can be expected at the selected sites. Since the mine location is on a slope well above any drainage course, flooding is not a consideration. Minor diversion of local surface runoff may be necessary at the site.

Impacts - Mining plans[6] indicate that dikes and ditches will be used to divert local surface runoff away from mining operations and into existing drainage channels. Improvement of existing access roads may also include some ditching and culvert installations. On-site drainage will include ditches to collect runoff from ore and spoil piles and direct it to holding ponds. Such construction activities would alter local surface drainage patterns to some extent. Since reclamation plans will essentially restore or improve existing landforms and cover, both short-term and long-term effects of constructing mine facilities upon annual runoff volumes or flood peak discharges are considered to be insignificant. At the proposed Spencer-Richardson open pit operation, an area of about 8.1 ha (20 acre) will be mined initially. Because of the small areas involved, the effect of these mining operations upon annual runoff and flood peak discharges is considered to be insignificant.

Mine dewatering will be required at Burdock No. 1 shaft and possibly at Burdock No. 2 shaft. Very little or no dewatering is expected to be required at the Runge East or Darrow Extension underground mines and the Spencer-Richardson open pit mine is expected to be free of ground water. Any water from mine dewatering operations will be directed to retention ponds and treated as required, before release. A maximum rate of pumping of 42.6 l/s (675 gal/min) is anticipated at the Burdock No. 1 shaft. At present, it is anticipated that dewatering at Burdock No. 2 shaft may not be necessary since dewatering at Burdock No. 1 shaft will probably dewater the shaft site at Burdock No. 2 shaft also.

The water from the mining operations will be discharged into local drainages. This water discharge will comply with the effluent requirements of the permit obtained under the National Pollutant Discharge Elimination System as implemented by the South Dakota Environmental Protection Agency. The magnitude of such releases at the Burdock No. 1 shaft could be in the order of 42.6 l/s (675 gal/min). This discharge would be into the unnamed tributary west of the shaft site. Flow in this drainage course will be dispersed in the flood plain along Beaver Creek and the Cheyenne River. Releases at other underground mine sites are unknown but expected to be very small. Released water would in part evaporate or in part infiltrate into the ground and the dry stream beds. These releases could stimulate the growth of natural vegetation along the drainage courses. Prolonged releases may cause some "soft" areas to develop in the drainage courses. Because of the small volumes of water to be released, no significant erosion of drainage courses is anticipated. Releases of treated water at Burdock No. 1 shaft will be dispersed over the flood plain of Beaver Creek and the Cheyenne River near the mouth of Beaver Creek by the existing small diversion system. Releases could eventually reach those streams. Since such releases would be treated as required to meet regulations governing such discharges, no harmful effects are anticipated. Since the quantity of such releases is small, they would have no significant effect upon flood peak discharges.

2.5.2 Ground Water

Regional - Western Fall River County is underlain by five principal aquifers: Quaternary alluvium; the Fall River Formation, 21 to 85 m (70-280 ft) thick, and the Lakota Formation, 43 to 67 m (140-220 ft) thick, both of Cretaceous age; the Sundance Formation, 21 to 137 m (70-450 ft) thick, of Jurassic age; and the Pahasapa Formation, 91 to 192 m (300-630 ft), of Mississippian age.[7] These formations crop out peripherally to the Black Hills, where they receive recharge from precipitation. Ground-water movement is in the direction of dip, radially from the central Black Hills. In most cases, the water is under artesian conditions away from the outcrop areas, and many wells in the region flow at the surface. The common practice for many years has been to allow wells to flow, which undoubtedly has resulted in declining regional potentiometric head.

Alluvium is used locally as a water source for domestic and stock water supplies.

The Fall River and Lakota Formations are the principal sources of water in the area. The Sundance Formation in Fall River County is used as an aquifer near its outcrop area in the central and northwestern parts of the county. The Pahasapa Formation, accessible in Fall River County only by very deep wells, is a source of water for Edgemont.[7]

The Fall River and Lakota Formations together form the Inyan Kara Group.[8] Water in the Fall River is separated from that in overlying formations by the Skull Creek Shale, which consists of 45 to 61 m (150-200 ft) of dark gray shale, and the Mowry Shale, which is up to 30 m (100 ft) of gray shale. Mudstone beds in the Fuson Member of the Lakota, 12 to 18 m (40-60 ft) thick,[8] generally separate water in the Fall River from that in the 30 to 45 m (100-150 ft) thick Chilson Member of the Lakota, which is the principal water-bearing unit of this formation. The Minnewaste Member of the Lakota, consisting of up to 8 m (25 ft) of limestone, lies below the Fuson Member and does not appear to be water bearing. The Lakota Formation is underlain by the Jurassic Morrison Formation, which consists mostly of shale and clay and is not considered to be an aquifer.[7]

Faults and fractures associated with the Dewey and Long Mountain structural zones, which trend southwesterly through northwestern Fall River County, are believed to affect ground-water movement and may be of considerable influence in future areal effects of drawdown caused by mining, but data are not yet available to quantify this.

According to Bowles[9,10], and Gott, Wolcott, and Bowles[11], large volumes of water may migrate upward from the Minnelusa Formation, along solution collapses and breccia pipes associated with fractures, to recharge the Inyan Kara Group near the margin of the Black Hills. This theory, which is supported by water quality data, is used to account for the source and deposition of uranium in the Inyan Kara Group.

In the Burdock project site area, it appears that little recharge to the Fall River Formation may come from the outcrop area, where open-pit mines are dry except for precipitation and inflow from surface water, with the exception of the existing Triangle mine, the mine farthest down-gradient. Also, the scarcity of water wells in the Fall River in this area suggests that the formation may not be saturated here. However, there is insufficient data to identify the source of recharge to the Inyan Kara Group at the project site.

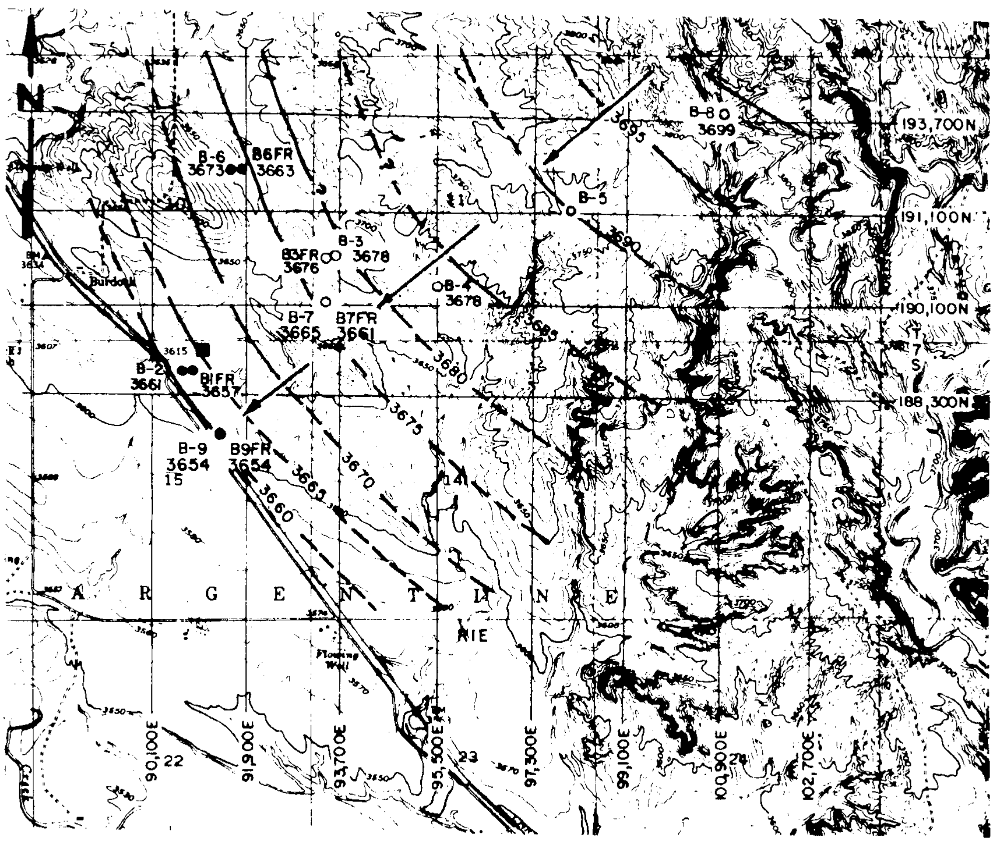
Local - The Fall River and Lakota Formations are the two aquifers of concern to the proposed mining operation at Burdock. The Fall River is the principal aquifer of western Fall River County, followed by the Lakota.[7] These aquifers are of similar thickness and hydrologic characteristics in the vicinity of the project site. At the proposed mine site, the Fall River, which is overlain by up to 61 m (200 ft) of Skull Creek Shale, consists of 23 to 38 m (75-125 ft) of fine-grained sandstone and interbedded carbonaceous shale. The top of the formation is at a depth of about 76 m (250 ft) at the shaft site. Within a 6.4 km (4 mi) radius of the shaft site, 26 wells are known to obtain water from this aquifer; many of these are flowing wells.

The Fuson Member of the Lakota, underlying the Fall River, varies in thickness, but generally is less than 15 m (50 ft) thick. It is expected to be an effective barrier to interaquifer water movement in most of the area. However, results of aquifer tests at the project site suggest that the Fuson Shale is not an effective barrier near and northeast of the shaft site. Interaquifer connection here could result from as-yet-unidentified structural features or old open exploration holes.

The Chilson Member of the Lakota is the ore-bearing and water-bearing unit. It consists of about 40 m (130 ft) of consolidated to semi-consolidated, fine-grained sandstone, the top of which is at a depth of about 134 m (440 ft) at the shaft site. The underlying Morrison Formation, at a depth of 174 m (570 ft), is shale and interbedded sandstone and probably is not water bearing. Within a 6.4 km (4 mi) radius, 23 wells are open to the Lakota, one of which flows an estimated 1.6 l/s (25 gal/min).

Figure 2.5.2-1 is a map showing the approximate potentiometric surface in the Lakota Formation in the vicinity of the project site, and showing the southwesterly gradient of about 9.8 m/km (20 ft/mi). A few water levels in the Fall River are shown, but there are insufficient data to allow contouring. Keene indicates a Fall River aquifer gradient of 9.8 m/km (20 ft/mi) near the project site.[7] Water levels were measured in January 1977, in observation wells installed for an on-site aquifer test. According to Keene[7], potentiometric levels in the Lakota in this area should be somewhat higher than those of the Fall River. This is consistent with data obtained at the project site, where the head in the Lakota is a few feet greater than in the Fall River.

Aquifer Test - A 169 m (555 ft) deep, rotary-drilled 25 cm diameter (10 in) steel cased test well near the proposed shaft site was completed in February 1977. The well is equipped with 17 m (55 ft) of 25 cm (10 in) diameter .030 slot size (0.76 mm)



SCALE:
0 ½ 1 mile
0 ½ 1 kilometer

EXPLANATION

3680 –?– Generalized water-level contour, Lakota Formation, in feet above sea level. Contour interval 5 feet. Dashed and queried where doubtful.

B-6 3673 Flowing well -- number and head in feet above sea level.

B-3 3678 Non-flowing well number and head in feet above sea level.

Proposed shaft site

Generalized direction of ground-water movement

B6FR Water level in Fall River Formation (not contoured)

NOTE:
Topography taken from USGS 7.5' quadrangles. Contour interval 10 feet.

Figure 2.5.2-1 Water-Level Contour Map in the Area of the Proposed Burdock Mine stainless steel wire-wound screen, gravel-packed, opposite the Fall River aquifer, [85-102 m (280-335 ft)] and 23 m (75 ft) of 20 cm (8 in) diameter screen, gravel packed, opposite the Lakota aquifer [146-169 m (480-555 ft)]. Upon completion, the well flowed about 3.2 l/s (50 gal/min).

A constant-discharge aquifer test began on February 11 and continued until February 25, 1977, at an average discharge of 16.5 l/s (261 gal/min). Discharge water was piped to a holding pond specially enlarged for the purpose. Water quality samples were obtained during the test.

Water-level responses were observed in nine piezometers, six of which were open to the Lakota and three to the Fall River. Locations of wells are shown on Figure 2.5.2-1.

A second aquifer test was run in November 1977, in which an inflatable packer was used to isolate the two aquifers, and the Lakota was pumped at an average rate of 12.2 l/s (194 gal/min) for 3.25 days. Analysis of results of this test indicates that the transmissivity of the Lakota is about 17.36 m^2 (1400 gal/day/ft) and the storativity is $2x10^{-4}$. Significant drawdown was measured in the Fall River Formation in the vicinity of the pumped well and to the northeast of the site. The estimated hydraulic conductivity of the aquitard is about .13 m/da (3.4 gal/day/ft^2). The estimated transmissivity of the Fall River is about 9.9 m^2 (800 gal/day/ft). These values were used in calculations of projected drawdowns resulting from mine development and operation. Projections of impacts on potentiometric head are based on these aquifer properties. what are they?

Water Use - An inventory of water-supply wells within a 6.4 km (4 mi) radius of the proposed shaft site was made in August 1976, during which 61 wells were located, as shown on Figure 2.5.2-2 and summarized in Table 2.5.2-1. Of these, 57 furnish domestic or stock water and 4 are not used. Thirty-five wells were flowing at rates from less than 4 to an estimated 76 l/min (1-20 gal/min). Estimated total flow, almost entirely from the Inyan Kara Group, was about 655 m^3/d (173,000 gal/d), or 23.4 ha-m/yr (190 acre ft/yr). Figure 2.5.2-3 is a generalized water-level contour map showing the area of flowing wells within a 6.4 km (4 mi) radius of the mine site.

A 40 km (25 mi) radius well inventory was completed in 1978. This inventory included all known wells in the Inyan Kara Group. Within the area in South Dakota, 140 wells were visited, 55 of which are in the Lakota, 54 in the Fall River, and 31 for which the aquifer is not identified. Thirty-seven wells are reported to flow from the Lakota, 34 from the Fall River, and 16 from wells in unidentified aquifers.[12]

Impact Assessment - The potentiometric head in the Fall River Formation is expected to be affected by shaft construction, and during mine development and operation, by vertical leakage from the Fall River to the Lakota in those areas where such leakage occurs. Direct impacts on the Fall River Formation from shaft construction will be short-term. Shaft construction through the formation will require about 30 days. Cement or chemical grouting may be required to control water inflows to the shaft sinking operations during construction. An average inflow to the

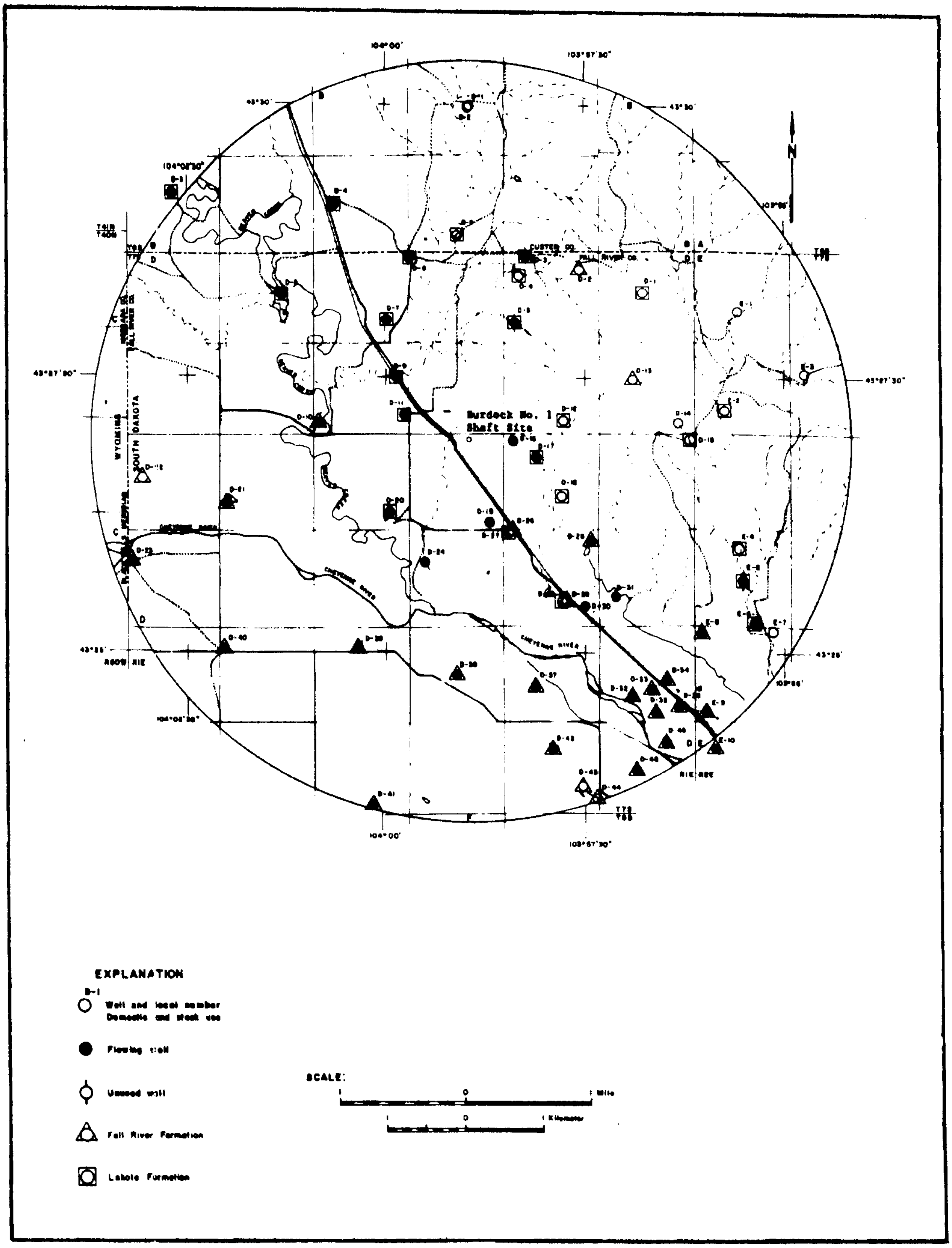


Figure 2.5.2-2 <u>Location of Wells Within a 4-Mile (6.4 km.) Radius of the Proposed No. 1 Shaft Site</u>

Table 2.5.2-1

Summary of Wells Within a Four-Mile (6.5 km.) Radius of the TVA Burdock, No. 1 Shaft Site

Well No.: Based on the Federal system of township and range. Each township within the project area is assigned a letter in consecutive order beginning with "A" in the northeast corner and ending with "F" in the southern part. Similarly, wells are numbered in consecutive order within a township--for example: B-1, B-2, etc. Location: Number based on township, range, section, 1/4 section, and 1/4 section. Aquifer: Qa, Quaternary alluvial deposits; Kf, Cretaceous, Fall River Formation; Kl, Cretaceous, Lakota Formation; Jm, Jurassic, Morrison Formation; Js, Jurassic, Sundance Formation; Trs, Triassic, Spearfish Formation; PmK, Permian, Minnekahta Limestone. Depth: Given in feet (ft.) and meters (m.) below land surface. Use Rate and Flow Rate: In gallons per minute (gpm) and liters per second (l/s). Elevation of Land Surface and Elevation of Water Surface: In feet (ft.) and meters (m.) above sea level. Superscript a indicates flow rate less than 1 gpm. Superscript b indicates estimated water surface elevations.

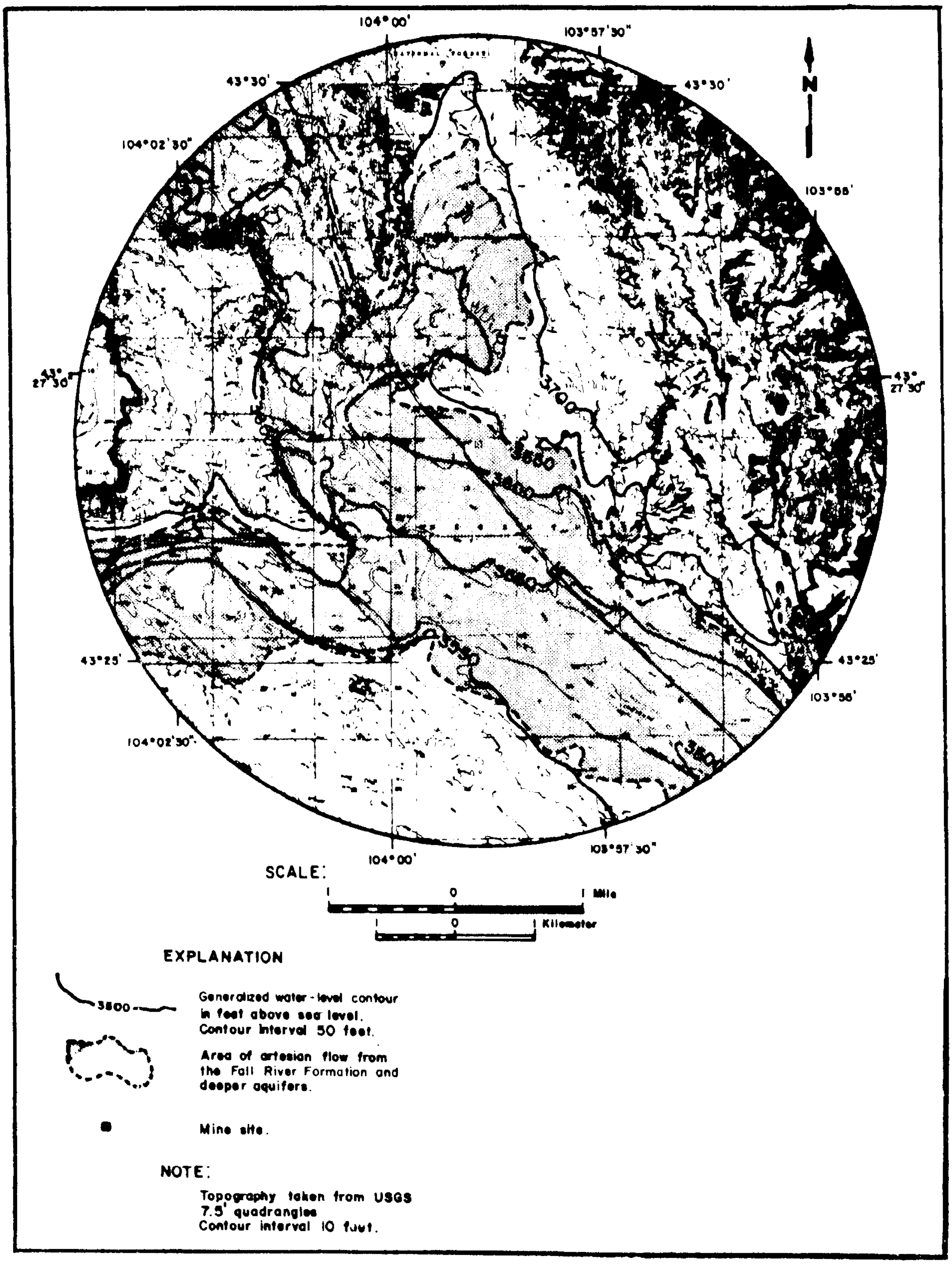
Well No.	Latitude	Longitude	Location	Aquifer	Depth (ft)	Depth (m)	Use Rate (gal/min)	Use Rate (l/s)	Flow Rate (gal/min)	Flow Rate (l/s)	Elevation Land Surf. (ft)	Elevation Land Surf. (m)	Elevation Water Surf. (ft)	Elevation Water Surf. (m)	Remarks
B-1	43°30'00"	103°58'57"	6-1-27Db	Qa	50	15	30	1.9	-	-	3715	1132	3700	1128	
B-2	43°29'59"	103°58'57"	6-1-27Db	Qa	46	14	30	1.9	-	-	3715	1132	3703^b	1128	
B-3	43°29'10"	104°02'43"	6-1-31Bd	-	-	-	-	-	12	.8	3605	1099	3610^b	1100	
B-4	43°29'09"	104°00'40"	6-1-33Bc	Kl	550	168	-	-	2	.1	3630	1106	3630^b	1106	
B-5	43°28'51"	103°59'06"	6-1-34Dc	Kl	350	107	-	-	-	-	3663	1116	-	-	Flowed until Triangle mine de-watered. 1/3 h.p. pump.
D-1	43°28'20"	103°56'47"	7-1-18d	Kl	330	101	-	-	-	-	3995	1190	3747	1146	
D-2	43°28'32"	103°57'34"	7-1-2Aa	Kf	180	55	10	.6	-	-	3749	1143	-	-	Water contains iron.
D-3	43°28'35"	103°58'15"	7-1-2Bb	Kl	495	151	-	-	a	-	3705	1129	3705^b	1129	Unused.
D-4	43°28'26"	103°58'20"	7-1-2Bc	Kl	280	85	5	.3	-	-	3698	1127	3674^b	1120	Water contains iron.
D-5	43°28'01"	103°58'22"	7-1-2Cc	Kl	470	143	-	-	a	-	3679	1121	3680^b	1122	Unused.
D-6	43°28'38"	103°59'42"	7-1-3Bb	Kl	500	152	-	-	2	.1	3660	1116	3661^b	1116	A.E.C. water analysis.
D-7	43°28'02"	104°00'00"	7-1-4Dd	Kl	805	245	-	-	1	.06	3645	1111	3646^b	1111	
D-8	43°28'17"	104°01'19"	7-1-5Ac	Kl	600	183	-	-	25	1.6	3600	1097	3610^b	1100	Flow rate in 1969, 30 gpm (1.9 l/s).
D-9	43°27'30"	103°59'52"	7-1-9Ad	Kl	550	168	-	-	16	1.0	3615	1102	3620^b	1103	Water contains iron & sulphur.
D-10	43°27'03"	104°00'54"	7-1-9Cc	Kf	527	161	-	-	8	.5	3700	1128	3701^b	1128	

TABLE 2.5.2-1 (continued)

Well No.	Latitude	Longitude	Location	Aquifer	Depth (ft.)	Depth (m)	Use Rate (gal/min)	Use Rate (l/s)	Flow Rate (gal/min)	Flow Rate (l/s)	Elevation Land Surf. (ft)	Elevation Land Surf. (m)	Elevation Water Surf. (ft)	Elevation Water Surf. (m)	Remarks
D-11	43°27'05"	103°59'46"	7-1-9Dd	Kl	600	183	-	-	1	.06	3624	1105	3631	1107	Water contains iron.
D-12	43°27'05"	103°57'47"	7-1-11Dc	Kl	525	160	-	-	-	-	3700	1128	-	-	A.E.C. water analysis.
D-13	43°28'29"	103°56'53"	7-1-12Bd	Kf	156	48	-	-	-	-	3750	1143	-	-	
D-14	43°27'04"	103°56'21"	7-1-12Dd	-	-	-	-	-	-	-	3830	1167	-	-	
D-15	43°26'55"	103°56'12"	7-1-13Aa	Kl	200	61	-	-	-	-	3740	1140	3662[b]	1116	
D-16	43°26'54"	103°58'24"	7-1-14Bb	-	-	-	-	-	a	-	3675	1120	3675[b]	1120	
D-17	43°44'45"	103°58'25"	7-1-14Ba	Kl	850	259	-	-	7	.4	3630	1105	3634[b]	1108	Water contains iron.
D-18	43°25'23"	103°57'48"	7-1-14Db	Kl	280	85	1	.06	-	-	3610	1100	3598[b]	1097	
D-19	43°25'09"	103°58'43"	7-1-15Dd	-	2264	690	-	-	-	-	3576	1090	3580[b]	1091	
D-20	43°25'15"	103°59'58"	7-1-16Dd	Kl	640	195	-	-	15	.9	3555	1084	3560[b]	1085	A.E.C. water analysis.
D-21	43°25'16"	104°02'01"	7-1-17Cb	Kf	530	162	-	-	4	.3	3555	1084	3558[b]	1084	A.E.C. water analysis.
D-22	43°25'33"	104°03'06"	7-1-18Bc	Kf	740	226	-	-	-	-	3700	1128	-	-	
D-23	43°25'48"	104°03'12"	7-1-19Bc	Kf	910	277	-	-	15	.9	3580	1091	3585[b]	1093	
D-24	43°25'48"	103°59'31"	7-1-22Bc	-	2400	732	-	-	3	.2	3548	1081	3550[b]	1082	
D-25	43°25'59"	103°57'24"	7-1-23Aa	Kf	90	27	-	-	3	.2	3625	1105	3625[b]	1105	Flow rate 1969, 10 gpm (.6 l/s).
D-26	43°25'02"	103°58'26"	7-1-23Bb	Kl	500	152	-	-	5	.3	3574	1089	3574[b]	1089	
D-27	43°26'03"	103°58'29"	7-1-23Bb	Kf	200	61	3	.2	-	-	3574	1089	3561[b]	1085	
D-28	43°25'26"	103°57'48"	7-1-23Dc	Kl	500	152	-	-	5	.3	3542	1080	3542[b]	1080	Casing perforated in 10 ft (3 m.) intervals below elevations 3222 (982 m.) and 3384 (1031 m.).
D-29	43°25'27"	103°57'44"	7-1-23Dc	Kf	240	73	-	-	1	.06	3542	1080	3542[b]	1080	
D-30	42°25'24"	103°57'30"	7-1-23Dd	Js-PmK	1470	448	-	-	5	.3	3550	1082	3556[b]	1082	
D-31	43°25'30"	103°57'07"	7-1-24Cb	Js-PmK	2480	756	-	-	6	.4	3577	1090	3576[b]	1091	
D-32	43°24'33"	103°55'58"	7-1-25Ca	Kl	375	114	-	-	2	.1	3508	1069	3508[b]	1069	
D-33	43°24'40"	103°56'37"	7-1-25Db	Kf	96	29	-	-	1	.06	3510	1070	3510[b]	1070	
D-34	43°24'45"	103°56'29"	7-1-25Db	Kf	90	28	-	-	1	.06	3528	1075	3528[b]	1075	

TABLE 2.5.2-1 (continued)

Well No.	Latitude	Longitude	Location	Aquifer	Depth (ft)	Depth (m)	Use Rate (gal/min)	Use Rate (l/s)	Flow Rate (gal/min)	Flow Rate (l/s)	Elevation Land Surf. (ft)	Elevation Land Surf. (m)	Elevation Water Surf. (ft)	Elevation Water Surf. (m)	Remarks
D-35	43°24'26"	103°55'36"	7-1-25Dc	Kf	130	40	-	-	1	.06	3510	1070	3510[b]	1070	
D-36	43°24'30"	103°56'2[illegible]"	7-1-25Dd	Kf	450	137	-	-	3	.2	3508	1069	3508[b]	1069	
D-37	43°24'42"	103°57'5[illegible]"	7-1-26Ca	Kl	260	79	-	-	2	.1	3530	1076	3530[b]	1076	
D-38	43°24'47"	103°59'07"	7-1-27Ac	Kf	350	107	-	-	—	—	3560	1085	3560	1085	
D-39	43°25'01"	104°00'[illegible]"	7-1-28Ba	Kf	600	183	-	-	-	—	3576	1090	3553[b]	1083	
D-40	43°25'01"	104°02'[illegible]"	7-1-29Bb	Kf	600	183	-	-	1	.06	3590	1094	3590[b]	1094	
D-41	43°23'30"	104°00'[illegible]"	7-1-33Dc	Kl	600	183	-	-	-	-	3670	1119	-	-	
D-42	43°24'05"	103°57'[illegible]"	7-1-35Ac	Kf	350	107	-	-	1	.06	3545	1081	3545[b]	1081	Slight flow in 1969; no flow in 1976.
D-43	43°23'44"	103°57'3[illegible]"	7-1-35Da	Kf	320	98	-	-	-	-	3555	1084	3545	1081	
D-44	43°23'37"	103°57'22"	7-1-35Dd	Kf	320	98	-	-	-	-	3555	1084	-	-	1969 Flow, 15 gpm (.9 l/s); no flow in 1976.
D-45	43°23'10"	103°56'[illegible]"	7-1-36Aa	Kf	92	28	-	-	9	.6	3500	1067	3504[b]	1068	
D-46	43°23'55"	103°55'5[illegible]"	7-1-36Ca	Kf	100	30	-	-	1.5	.2	3535	1077	3536[b]	1078	
E-1	43°28'08"	103°55'3[illegible]"	7-2-6Ca	-	40	12	-	-	-	-	3860	1177	-	-	
E-2	43°27'11"	103°55'4[illegible]"	7-2-7Cd	—	365	111	-	-	-	-	3755	1145	3475	1059	Unused.
E-3	43°27'32"	103°54'4[illegible]"	7-2-8Bc	Js	470	143	-	-	-	-	3970	1210	-	-	
E-4	43°25'57"	103°55'3[illegible]"	7-2-19Ba	Kl	145	44	-	-	-	-	3640	1109	-	-	Flow rate in 1969, 2 gpm (.1 l/s); no flow in 1976;unused.
E-5	43°25'38"	103°55'3[illegible]"	7-2-19Ca	Kl	148	45	-	-	-	-	3620	1103	-	-	
E-6	43°25'15"	103°55'2[illegible]"	7-2-19Dc	Kl	255	78	-	-	10	.6	3600	1097	3605[b]	1099	
E-7	43°25'11"	103°55'0[illegible]"	7-2-30Aa	-	-	-	-	-	-	-	3600	1097	-	-	
E-8	43°25'13"	103°56'[illegible]"	7-2-30Bb	Kl	330	101	-	-	2	.1	3530	1076	3530[b]	1076	
E-9	43°24'27"	103°55'5[illegible]"	7-2-30Cc	Kf	90	27	-	-	4	-	3522	1074	3522[b]	1074	
E-10	43°24'07"	103°55'52"	7-2-31Bc	Kf	104	32	-	-	1.3	.08	3495	1065	3500[b]	1067	



F'gure 2.5.2-3 Generalized Water-Level Contour Map Within a 4-Mile Radius of the Proposed Mine Shaft Site shaft of 12.6 l/s (200 gal/min) is expected during this time. The effects on the Fall River Formation resulting from leakage during mine development and operation will continue as long as water is removed from the lower aquifer. The rate of leakage will decrease with time and the magnitude of leakage will decrease with distance from the area in which leakage occurs. Water levels in wells in the Fall River Formation near the mine workings will be affected, but it is not anticipated that the aquifer will be dewatered.

It is possible that after mining, areal potentiometric heads will not recover to pre-mining levels within the affected area because of open flow from private wells. Discharge from flowing wells outside the radius of influence will continue, and may be sufficient to prevent complete recovery within the affected area.

The Lakota Formation will require depressurizing before it is entered by the shaft, since it is under at least 146 m (480 ft) of head, or more than 14.0 kg_f/cm^2 (200 lb_f/in^2). Two or more wells will be required, pumped at an estimated average total rate of 42.6 l/s (675 gal/min) for 180 days prior to entry into the aquifer by the shaft.

Inflow will increase as station and haulageway construction begin, then decrease gradually as the mine is developed and operated. If inflow averages 25.2 l/s (400 gal/min) over the 10-year expected life of the mine, the theoretical radius at which the potentiometric head will be reduced by 30 cm (1 ft) is about 105 km (65 mi), under the assumptions listed above. However, from experience in other mining areas, in rocks having similar hydrologic properties, lateral geologic changes should limit the growth of the cone of depression. The induced leakage from the Fall River may also limit the growth of the cone in the Lakota. The actual radius of effect is expected to be substantially less than the theoretical radius. The presence of the Long Mountain and Dewey structural zones is expected to constrain growth of the cone, but the extent of effect can not be quantified based on presently available information. Many wells that now flow within the area affected by decreased potentiometric head will cease to do so at some time after mining operations begin. The aquifers will remain saturated, however, and water will still be available by pumping except possibly in the immediate vicinity of the mine.

The planned expansion and deepening of the existing open-pit mine in the area should have little impact on the aquifer systems. The pit will be wholly within the unsaturated portion of the Fall River Formation. If the outcrop area is only a minor source of recharge, little effect on ground water flow should result. Any ground water entering the pits would come from the underlying Lakota Formation via structural features, which would result in local drawdown in the Lakota created by pit dewatering. Only one existing pit (the Triangle) contains ground water; some of the pits bottom near the Fuson Shale. Underground mining in the vicinity of an open pit will lower the potentiometric surface in the Lakota, reducing inflow, if any, to the pit.

Mitigation - Adverse effects on ground-water supplies attributable to the mining operation will be corrected in a manner acceptable to the owner of the supply. It is planned that such problems will be handled on a case-by-case basis. Possible alternatives include installation of electric pumps where power is available; distribution of water by pipeline; construction of new wells into deeper aquifers; renovation of wells if cessation of flow causes well collapse; or reimbursing the landowner for the cost of repairing or replacing a water supply. Whatever action is taken, one main objective, in all cases, will be water conservation.

A comprehensive observation program in which pressure heads, flows, and water levels are measured periodically in selected wells has begun. This program will document premining conditions and changes in potentiometric head before and during mining, in both aquifers, and also will allow assessment of any post-mining impacts.

2.5 References

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2.6 Nonradiological Water Quality

2.6.1 Description of Existing Water Quality Environment - This section describes the non-radiological water quality characteristics in the region of the Edgemont Uranium mining project. (See Section 2.8, for a description of the radiological characteristics.)

2.6.1.1 Surface Water Quality - The Edgemont Uranium Mining Project area is drained by the Cheyenne River and several tributary streams. These streams including the Cheyenne River experience extended periods of no flow. The State of South Dakota[1] has classified the Cheyenne River in the project vicinity as being suitable for the following uses: (1) warm water semi-permanent fish life propagation, (2) limited contact recreation, (3) wildlife propagation and stock watering, and (4) irrigation. Beaver Creek (South Dakota) has been classified as being suitable for the same uses as the Cheyenne River except that this stream has been classified as being suitable for cold water marginal fish life propagation rather than warm water semi-permanent fish life propagation. The State of Wyoming[2] has classified Beaver Creek and Stockade Beaver Creek in the project vicinity as presently supporting game fish or having the hydrologic and natural water quality potential to support game fish. Beaver Creek has also been classified by Wyoming as a warm water fishery.

Surface water quality investigations were performed at the project during the period of December 1974 through September 1977. Additional water quality data from the USGS and the State of South Dakota were utilized in this assessment. A summary of results of water quality analyses of surface water samples obtained on and near the project site are listed in Tables 2.6.1.1-1 and 2. Their locations are shown in Figure 2.6.1.1-1. Table 2.6.1.1-3 provides various water quality standards and criteria for a comparison with the previously reported ranges of water quality parameters. Specific aspects of these data are discussed below.

The warmest water temperature [36.0°C (96.8°F)] within the Cheyenne River was observed at station S-5 in June 1974, which is upstream of Red Canyon Creek. The warmest temperature [31.0°C (87.8°F)] within Beaver Creek was observed at Station S-3, which is near the mouth of the creek. The South Dakota temperature standard for the Cheyenne River [32.2°C (90°F)] was exceeded in August 1973 and June 1974 at Station S-5, and the South Dakota temperature standard for Beaver Creek 23.9°C (75°F) was exceeded in July 1976 at Station S-3.

In the Cheyenne River and Beaver Creek, observed dissolved oxygen concentrations were normally well above State standards. The pH values were observed to be in the normal range of 6.5 to 9.0 Standard Units. Total alkalinity and hardness of the Cheyenne River averaged 156 mg/l (miligram/liter) and 1,390 mg/l, respectively, and Beaver Creek averaged 148 mg/l and 1,425 mg/l, respectively. Both waters are considered to be very hard. Dissolved solid concentrations for the Cheyenne River and Beaver Creek averaged 3,513 mg/l and 2,960 mg/l, respectively. The mean dissolved solids concentrations of the Cheyenne River exceed established criteria for livestock watering, and mean dissolved

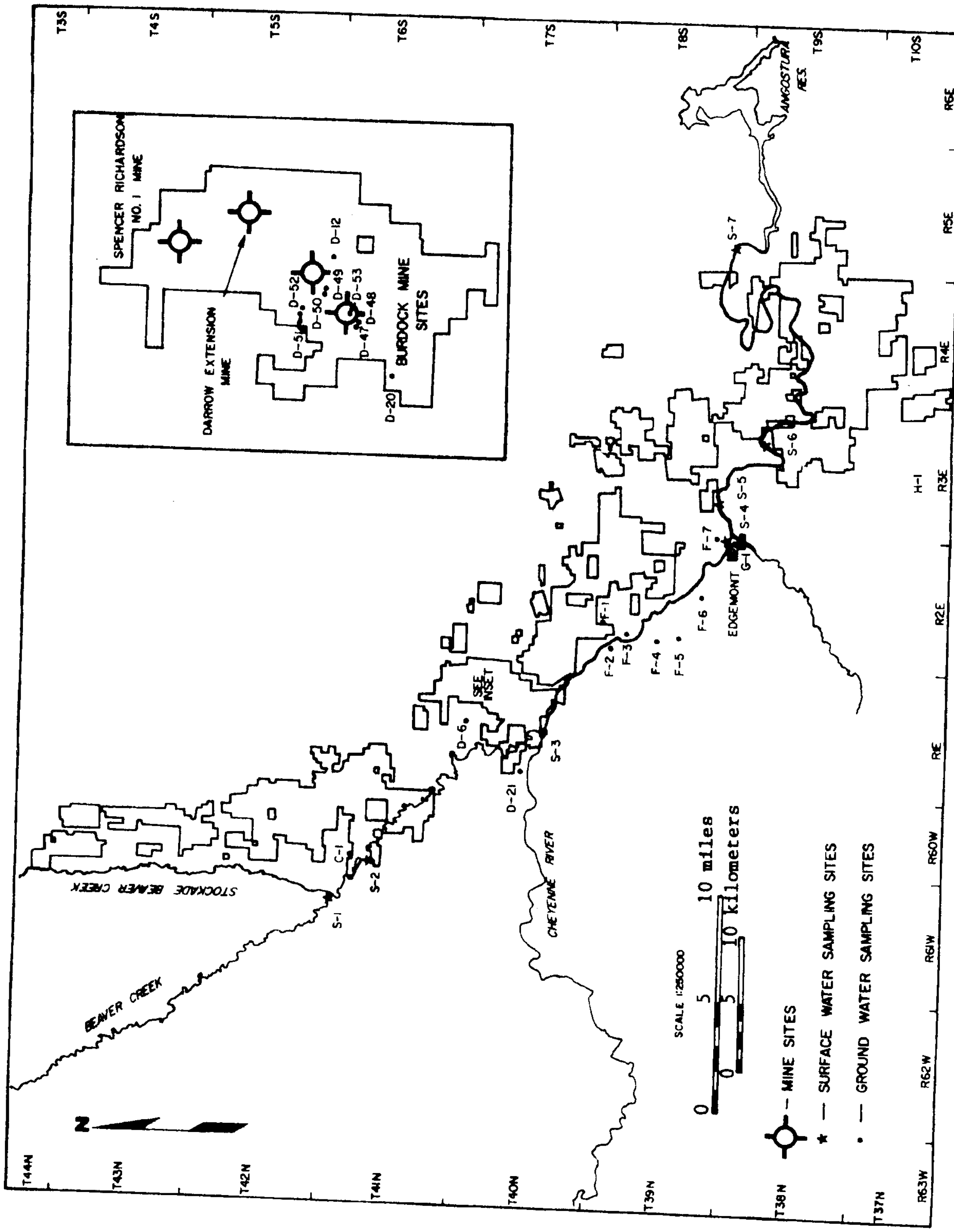

Figure 2.6.1.1-1 Water Quality Sampling Sites

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Table 2.6.1.1-1

Summary of Physical and Bacteriological Surface Water Quality Data for the Cheyenne River and Beaver Creek in the Vicinity of the Edgemont Uranium Mining Project

Stream and Mileage		Water Temp. °C	Dissolved Oxygen mg/l	pH S.U.	Total Alkalinity as $CaCO_3$ mg/l	Hardness as $CaCO_3$ mg/l	True Color PCU	Apparent Color PCU	Turbidity JTU	Solids Dissolved mg/l	Solids Suspended mg/l	Coliform (No./100 ml.) Fecal	Fecal Streptococci	Total
Beaver Creek[1] (S-1)	Maximum	24.0		8.0	289	1933	95	2400	1100	5700	1300			
	Minimum	14.5		7.4	78	340	12	21	11	750	14			
	Mean	18.1		7.6	151	1343	36	620	300	4060	350			
	No. of Samples	4		4	3	4	4	4	4	4	4			
Beaver Creek[2] (S-2)	Maximum	25.5	10.8	8.2	273	3100	80	29000	11000	5300	19000			
	Minimum	0.0	-	6.5	56	300	6	18	64	630	22			
	Mean	9.8	-	7.7	150	1400	30	7280	2800	2980	4790			
	No. of Samples	68	1	50	68	69	4	4	4	27	4			
Beaver Creek[3] (S-3)	Maximum	31.0	9.7	7.9	130	1825	60	7400	3200	3200	4800			
	Minimum	13.3	-	7.6	96	390	7	70	22	600	70			
	Mean	19.4	-	7.7	100	1221	30	2040	860	1700	1310			
	No. of Samples	4	1	4	3	4	4	4	4	4	4			
Cheyenne River[4] (S-4)	Maximum	29.0	13.1	8.9	433	2770	100	6000	2700	7571	8593	4800	7500	5000
	Minimum	0.0	0.7	7.0	70	260	5	7	8.4	695	0	0	<4	0
	Mean	11.5	9.6	8.6	189	1390	30	1200	700	3526	692	480	620	1300
	No. of Samples	100	74	94	63	65	5	5	4	67	41	52	27	19
Cheyenne River[5] (S-5)	Maximum	36.0	13.7	8.4						4200	17			
	Minimum	0.0	8.3	6.9						3800	17			
	Mean	10.7	10.9	7.9						4000	17			
	No. of Samples	23	21	22						2	2			
Cheyenne River[6] (S-6)	Maximum	26.0	12.4	8.2	180	1900	90	6200	3200	6300	5500			
	Minimum	18.0	-	6.7	84	880	7	14	11	990	9			
	Mean	22.8	-	7.6	130	1400	30	1400	840	3560	960			
	No. of Samples	4	1	5	4	5	5	5	4	6	6			
Cheyenne River[7] (S-7)	Maximum	20	8.4	8.2	163	1692	10	210	68	2700	120			
	Minumum	-	-	8.1	160	1600	5	8	4.4	2500	21			
	Mean	-	-	8.2	162	1646	8	110	36	2600	70			
	No. of Samples	1	1	2	2	2	2	2	2	2	2			
South Dakota Water Quality Standards[8]		32.2 (23.9)	5	6.3-9.0 (6.5-8.8)	750				50	1500	90	1000		5000
Wyoming Water Quality Standards[9]		32.2	6	6.5-8.5					10 (Maximum increase)				1000	
EPA Drinking Water Standards[10]				6.5-8.5			15		5*	500		4*		
NAS-NAE Irrigation Water Criteria[11]				4.5-9.0										
NAS-NAE Livestock Watering Criteria[11]										3300				

1. Beaver Creek (S-1); 43°31'44", 104°09'16"; Upstream of mouth of Stockade Beaver Creek, Wyo; Data Source, TVA (9/75 through 9/77).
2. Beaver Creek (S-2); 43°32'07", 104°07'02"; Upstream of Old US 85 bridge, Wyo; Data Sources, TVA (9/75 through 9/77) and USGS (1/72 through 5/77).
3. Beaver Creek (S-3); 43°25'28", 103°59'30"; ~275 m. upstream of confluence with Cheyenne River, S.D.; Data Source, TVA (9/75 through 9/77).
4. Cheyenne River (S-4); 43°18'20", 103°49'17"; Upstream of US Hwy. 18 bridge at Edgemont, S.D.; Data Sources, TVA (12/74 through 9/77), USGS (1/72 through 9/76), and the State of South Dakota (11/72 through 5/77).
5. Cheyenne River (S-5); 43°18'49", 103°47'16"; ~2.5 km downstream of Edgemont, SD, above Red Canyon Creek; Data Sources, TVA (12/74 through 6/75) and USGS (7/73 through 6/74).
6. Cheyenne River (S-6); 43°17'07", 103°44'21"; ~10 km downstream of Edgemont, SD; Data Source, TVA (12/74 through 9/77).
7. Cheyenne River (S-7); 43°18'23", 103°33'43", Upstream of SR 71 bridge at Angostura Reservoir, SD; Data Source, TVA (6/77 through 9/77).
8. Standards for Beaver Creek are the same as the Cheyenne River with the exception of those more stringent standards in parenthesis which are for Beaver Creek. Reference number 1.
9. Reference number 2.
10. Standards marked with (*) are primary drinking water standards and unmarked standards are the proposed secondary drinking water standards. References numbers 3 and 4.
11. Reference number 5.

Table 2.6.1.1-2

Summary of Chemical Surface Water Quality for the Cheyenne River and Beaver Creek in the Vicinity of the Edgemont Uranium Mining Project*

Stream and Mileage

Parameter	Beaver Creek[1] (S-1) Observed Concentrations Maximum	Minimum	Mean	Number of Samples	Beaver Creek[2] (S-2) Observed Concentrations Maximum	Minimum	Mean	Number of Samples
Aluminum, µg/l	13000	<200	3500	4	8600	300	2400	4
Ammonia nitrogen, mg/l	0.02	0.01	0.02	2	0.19	<0.01	<0.10	2
Arsenic, µg/l	19	<2	9	4	85	<2	<25	4
Barium, µg/l	17000	<100	4400	4	16000	<100	4100	4
Beryllium, µg/l	<10	<10	<10	2	<10	<10	<10	2
Boron, µg/l	710	270	440	3	730	100	240	26
Cadmium, µg/l	3	<1	<2	4	180	<1	50	4
Calcium, mg/l	490	97	340	4	815	79	384	69
Chemical oxygen demand	61	38	50	2	140	11	75	2
Chloride, mg/l	1300	40	750	4	1400	32	504	69
Chromium (total), µg/l	13	<5	<7	4	10	<5	<6	4
Cobalt, µg/l	<5	<5	<5	2	18	<5	12	2
Conductivity, µmhos	7000	1380	5070	4	7910	1060	3800	50
Copper, µg/l	40	10	30	4	50	<10	40	4
Fluoride, mg/l	0.60	0.34	0.50	4	1.6	0.35	0.95	69
Iron (total), mg/l	2.60	0.20	1.00	4	4.6	0.0	0.38	27
Lead, µg/l	18	<10	<12	4	20	<10	12	4
Lithium, µg/l	160	80	120	2	160	70	120	2
Magnesium, mg/l	170	24	120	4	320	17	120	69
Manganese (total), µg/l	440	50	270	4	2800	30	770	4
Mercury, µg/l	0.6	<0.2	<0.3	4	0.7	<0.2	<0.4	4
Molybdenum, µg/l	<100	<100	<100	4	<100	<100	<100	4
Nickel, µg/l	<50	<50	<50	3	<50	<50	<50	3
Nitrate nitrogen, mg/l					5.6	0.0	0.3	55
Nitrate plus nitrite nitrogen, mg/l	0.28	<0.01	0.15	2	0.30	<0.01	0.17	3
Organic nitrogen, mg/l	0.92	0.37	0.65	2	1.6	0.28	0.90	2
Phosphorus (total), mg/l	0.97	0.02	0.50	2	1.6	0.0	0.1	44
Potassium, mg/l	7.9	6.8	7.4	2	10	2.3	6.2	67
SAR	-	-	9.1	4	-	-	5.2	69
Selenium, µg/l	3	<1	2	4	4	<1	2	4
Silica (total), mg/l	4.8	0.8	2.5	3	15	0.0	7	68
Silver, µg/l	<10	<10	<10	3	<10	<10	<10	3
Sodium, mg/l	1300	110	770	4	1300	96	460	69
Strontium, µg/l	3500	830	2160	2	4900	1100	3000	2
Sulfate, mg/l	2700	210	1280	4	3600	230	1510	69
Titanium, µg/l	<1000	<1000	<1000	2	<1000	<1000	<1000	2
Vanadium, µg/l	<100	<100	<100	4	<500	<100	<200	4
Zinc, µg/l	60	10	30	4	30	10	40	4

Table 2.6.1.1-2 (continued)

Parameter	Beaver Creek[3] (S-3) Observed Concentrations Maximum	Minimum	Mean	Number of Samples	Cheyenne River[4] (S-4) Observed Concentrations Maximum	Minimum	Mean	Number of Samples
Aluminum, μg/l	7200	700	3200	4	400	<200	<300	3
Ammonia nitrogen, mg/l	0.03	0.01	0.02	2	0.35	<0.01	0.11	19
Arsenic, μg/l	15	<2	9	4	53	<2	<13	6
Barium, μg/l	19000	<100	4900	4	14000	<100	<2900	5
Beryllium, μg/l	<10	<10	<10	2	<10	<10	<10	2
Biochemical oxygen demand (5-day), mg/l					3.0	0.5	1.4	37
Boron, μg/l	560	140	360	3	1300	240	500	7
Cadmium, μg/l	5	<1	<3	4	8	0	2	7
Calcium, mg/l	530	110	340	4	650	67	370	61
Chemical oxygen demand, mg/l	170	18	94	2	150	16	83	2
Chloride, mg/l	940	55	410	4	1190	30	410	66
Chromium (total), μg/l	11	<5	<7	4	42	0	<9	10
Cobalt, μg/l	43	<5	<24	2	11	<5	<8	2
Conductivity, μmhos	5800	1200	3600	4	7690	590	3980	93
Copper, μg/l	50	<10	40	4	50	3	20	9
Fluoride, mg/l	0.66	0.41	0.51	4	0.8	0.2	0.6	31
Iron (total), mg/l	4.1	1.2	2.6	4	80	0.02	5.8	38
Lead, μg/l	23	<10	<13	4	27	0	11	9
Lithium, μg/l	120	110	120	2	280	120	210	3
Magnesium, mg/l	150	27	92	4	301	22	126	61
Manganese (total), μg/l	2000	130	620	4	4150	70	490	37
Mercury, μg/l	0.8	<0.2	<0.4	4	0.9	0.1	<0.3	7
Molybdenum, μg/l	<100	<100	<100	4	<100	2	<80	9
Nickel, μg/l	<50	<50	<50	3	80	5	<40	7
Nitrate plus nitrite nitrogen, mg/l	0.28	<0.01	0.15	2	0.64	<0.01	0.18	18
Organic nitrogen, mg/l	1.6	0.25	0.90	2	4.1	0.08	1.0	23
Phosphorus (total), mg/l	2.2	0.05	1.1	2	1.9	0.0	0.2	59
Potassium, mg/l	10	9.4	9.7	2	25	1.2	10	56
SAR	-	-	5.3	4	-	-	6.0	61
Selenium, μg/l	2	1	2	4	3	<1	<2	7
Silica (total), mg/l	5.1	1.8	3.6	3	12	3.9	8.4	25
Silver, μg/l	<10	<10	<10	3	10	0	6	5
Sodium, mg/l	850	100	430	4	1310	110	530	58
Strontium, μg/l	4900	1000	3000	2	4700	1600	3150	2
Sulfate, mg/l	1700	260	940	4	3720	350	1730	63
Tin, μg/l					<100	-	-	1
Titanium, μg/l	<1000	<1000	<1000	2	<1000	<1000	<1000	2
Vanadium, μg/l	<500	<100	<200	4	<500	3.3	<200	9
Zinc, μg/l	90	10	40	4	420	<10	80	9

Table 2.6.1.1-2 (continued)

Parameter	Stream and Mileage: Cheyenne River[5] (S-5) Observed Concentrations Maximum	Minimum	Mean	Number of Samples	Cheyenne River[6] (S-6) Observed Concentrations Maximum	Minimum	Mean	Number of Samples
Aluminum, µg/l					1100	200	700	3
Ammonia nitrogen, mg/l					0.05	0.01	0.03	2
Arsenic, µg/l	<5	-	-	1	90	<2	<20	5
Barium, µg/l					15000	<100	3100	5
Beryllium, µg/l					<10	<10	<10	2
Boron, µg/l					820	260	520	4
Cadmium, µg/l					4	<1	<2	5
Calcium, mg/l					490	220	340	5
Chemical oxygen demand					240	19	130	2
Chloride, mg/l					890	75	420	5
Chromium (total), µg/l	<5	<5	<5	2	18	<5	<7	6
Cobalt, µg/l					27	<5	<16	2
Conductivity, µmhos	5500	545	3925	22	6100	1490	3790	4
Copper, µg/l	70	<10	<40	2	50	<10	30	6
Fluoride, mg/l					0.61	0.43	0.52	5
Iron (total), mg/l	0.40	0.14	0.27	2	5.00	0.11	1.36	6
Lead, µg/l	13	<10	<12	2	21	<10	14	6
Lithium, µg/l					180	150	170	3
Magnesium, mg/l					190	69	130	5
Manganese (total), µg/l					3900	50	1100	5
Mercury, µg/l					<0.2	<0.2	<0.2	4
Molybdenum, µg/l	<100	<100	<100	2	<100	<100	<100	6
Nickel, µg/l	<50	<50	<50	2	100	<50	<60	4
Nitrate plus nitrite nitrogen, mg/l					0.56	0.10	0.33	2
Organic nitrogen, mg/l					3.60	0.31	2.00	2
Phosphorus (total), mg/l					2.80	0.07	1.40	2
Potassium, mg/l					25	9.6	18	3
SAR					-	-	6.6	6
Selenium, µg/l					4	<1	<2	5
Silica (total), mg/l					8.8	2.1	6.1	3
Silver, µg/l					10	<10	<10	3
Sodium, mg/l					910	170	560	5
Strontium, µg/l					4600	2000	3300	2
Sulfate, mg/l					2700	640	1590	5
Tin, µg/l	<100	-	-	1				
Titanium, µg/l					<1000	<1000	<1000	2
Vanadium, µg/l	<500	<500	<500	2	<500	<100	<200	6
Zinc, µg/l	60	10	40	2	100	<10	50	6

Table 2.6.1.1-2 (continued)

Stream and Mileage

Cheyenne River[7]
(S-7)

Parameter	Observed Concentrations			Number of
	Maximum	Minimum	Mean	Samples
Aluminum, µg/l	1700	<200	1000	2
Ammonia nitrogen, mg/l	0.01	0.01	0.01	2
Arsenic, µg/l	4	<2	<3	2
Barium, µg/l	230	<100	<160	2
Boron, µg/l	140	-	-	1
Cadmium, µg/l	8	<1	<4	2
Calcium, mg/l	510	470	490	2
Chemical oxygen demand	19	5	12	2
Chloride, mg/l	160	150	160	2
Chromium (total), µg/l	<5	<5	<5	2
Cobalt, µg/l	<5	<5	<5	2
Conductivity, µmhos	3000	2770	2880	2
Copper, µg/l	40	20	30	2
Fluoride, mg/l	0.82	0.66	0.74	2
Iron (total), mg/l	0.65	0.14	0.40	2
Lead, µg/l	<10	<10	<10	2
Magnesium, mg/l	100	100	100	2
Manganese (total), µg/l	100	20	60	2
Mercury, µg/l	0.6	<0.2	<0.4	2
Molybdenum, µg/l	100	100	100	2
Nickel, µg/l	<50	-	-	1
Nitrate plus nitrite nitrogen, mg/l	1.60	0.17	0.89	2
Organic nitrogen, mg/l	0.55	0.03	0.29	2
Phosphorus (total), mg/l	0.29	0.01	0.15	2
SAR	-	-	2	2
Selenium, µg/l	2	2	2	2
Silica (total), mg/l	13	-	-	1
Silver, µg/l	<10	-	-	1
Sodium, mg/l	230	140	180	2
Strontium, µg/l	4900	4600	4750	2
Sulfate, mg/l	2200	1600	1900	2
Vanadium, µg/l	<100	<100	<100	2
Zinc, µg/l	30	10	20	2

Table 2.6.1.1-3

Water Quality Standards and

Criteria for Comparison Purposes

Parameter	South Dakota Water Quality Standards[8]	EPA Drinking Water Standards[10]	NAS - NAE[11] Irrigation Water Criteria	NAS - NAE[11] Livestock Watering Criteria
Aluminum, μg/l			5000	5000
Ammonia nitrogen, mg/l	1.0			
Arsenic, μg/l		50*	100	200
Barium, μg/l		1000*		
Beryllium, μg/l			100	
Boron, μg/l			750	
Cadmium, μg/l		10*	10	50
Calcium, mg/l				
Chemical oxygen demand				
Chloride, mg/l		250		
Chromium (total), μg/l		50*	100	1000
Cobalt, μg/l			50	1000
Conductivity, μmhos	2500			
Copper, μg/l		1000	200	500
Fluoride, mg/l		1.4→2.4*	1.0	2.0
Iron (total), mg/l	0.2	0.3	5	
Lead, μg/l		50*	5000	100
Lithium, μg/l			2500	
Magnesium, mg/l				
Manganese (total), μg/l		50	200	
Mercury, μg/l		2*		10
Molybdenum, μg/l			10	
Nickel, μg/l			200	
Nitrate nitrogen, mg/l	50(as NO_3)	45(as NO_3)*		
Nitrate plus nitrite nitrogen, mg/l				100
Organic nitrogen, mg/l				
Phosphorus (total), mg/l				
Potassium, mg/l				
SAR	10			
Selenium, μg/l		10*	20	50
Silica (total), mg/l				
Silver, μg/l		50*		
Sodium, mg/l				
Strontium, μg/l				
Sulfate, mg/l		250		
Titanium, μg/l				
Vanadium, μg/l			100	100
Zinc, μg/l		5000	2000	25000

*Refer to Table 2.6.1.1-1 for footnotes.

solids concentrations for both streams exceed the State of South Dakota water quality standard.

Coliform bacteria data at Edgemont (S-4) showed that high concentrations of fecal, fecal streptococci, and total coliforms were present during various times of the year. The fecal to fecal streptococci ratios indicate the source of pollution to be animal feces.

The chemical water quality of the Cheyenne River and Beaver Creek was poor. Mean concentrations of barium and some arsenic measurements were above those concentrations identified by the EPA "National Interim Primary Drinking Water Standards"[3] for finished drinking water. Mean concentrations of cadmium above these standards were observed in Beaver Creek. Mean concentrations of chlorides, iron, manganese, and sulfates in both the Cheyenne River and Beaver Creek were above those concentrations identified by the EPA "Proposed Secondary Drinking Water Standards."[4] This data supports the fact that those streams are not classified for domestic water supply use. Concentrations of iron and conductivity levels in the Cheyenne River and Beaver Creek exceeded the State of South Dakota water quality standards. Based upon the "1972, NAS - NAE Water Quality Criteria,"[5] water from both the Cheyenne River and Beaver Creek is unsuitable for irrigation use (continuously on all soils). High concentrations of chemical oxygen demand were observed in both the Cheyenne River and Beaver Creek in the project vicinity.

Water quality data resulting from the surveys performed during the late summer and early fall months correlate closely with regional historical ground water quality data[4] from the upper Quaternary and Pierre Formations. This indicates that during this time of the year flow in Beaver Creek and the Cheyenne River are predominately composed of ground water base flows which enter the stream beds through seeps, springs, and flowing wells. Conversely, water quality data resulting from the surveys performed during the spring and early summer months show concentrations of those constituents characteristic of stormwater runoff and snow melt (increased concentrations of suspended solids, color, nutrients, iron, manganese, etc.).

<u>2.6.1.2 Ground Water Quality</u> - In the Edgemont project area the Fall River and Lakota Formations, which together form the Inyan Kara Group, are the principal sources of water for domestic water supplies, irrigation, and stock watering. Water in these formations is under artesian conditions. The Chilson Member of the Lakota Formation is the ore-bearing unit and is the main aquifer to be impacted by underground mining activities. Mining of ore at outcrop regions of the Fall River Formation will occur at surface mining sites.

Ground water quality investigations were conducted at the project during the period of November 1976 through November 1977. A summary of results of water quality analysis of ground water samples obtained on and near the project site are listed in Table 2.6.1.2-1. Their locations are shown on Figure 2.6.1.1-1. This table provides a comparison of reported ranges of water quality parameters with various water quality standards and criteria.

Table 2.6.1.2-1

Summary of Groundwater Quality Data in the Vicinity of the

Edgemont Project Area

Parameter	Burdock Mines Composite Groundwater Pump Test Results[1] Max	Min	Mean	Number of Observations	Burdock Mines Piezometers Lakota Formation[2] Max	Min	Mean	Number of Observations	Burdock Mines Piezometers Composite Groundwater[3] Max	Min	Mean	Number of Observations	Regional Data from the Lakota Formation[4] Max	Min	Mean	Number of Observations	Regional Data from the Fall River Formation[4] Max	Min	Mean	Number of Observations	EPA Drinking Water Standards[6]	NAS-NAE[6] Irrigation Water Criteria	NAS-NAE[6] Livestock Watering Criteria
Temperature, °C	14	13	13	3	14	6	11	7	13	5	10	7	14	-	-	1							
pH, S.U.	7.9	7.3	7.6	3	7.8	6.8	7.2	4	7.7	6.7	7.2	3	7.9	7.0	7.6	6	8.9	7.7	8.3	7	6.5-8.5	4.5-9.0	
Specific Conductance, µmhos	1675	1410	1580	3	1490	1050	1270	7	1850	1030	1320	7	2600	1098	1800	4	5100	1410	2850	4			
Alkalinity (as $CaCO_3$), mg/l	209	202	206	2	210	22	140	6	210	24	90	6	400	207	272	6	952	238	596	7			
Calcium, mg/l	170	150	160	3	150	7.3	80	7	92	8.1	47	7	260	62	109	6	104	2.8	26	8			
Chloride, mg/l	10	9	9	3	130	9	50	6	130	10	50	6	135	0.15	30	6	286	0.17	84	8	250		
COD, mg/l	10	6	8	3	-	-	-	-	140	56	98	2											
Fluoride, mg/l	0.26	0.24	0.25	3	0.64	0.17	0.40	5	0.80	0.32	0.56	6	0.95	0.10	0.50	6	2.4	0.6	1.5	7	1.4-2.4*	1.0	2.0
Hardness (as $CaCO_3$), mg/l	670	610	634	3	579	130	360	7	360	54	190	7	382	50	216	2	412	10	136	4			
Iron, mg/l	0.38	0.16	0.24	3	48	0.64	15	7	22	0.28	7.0	7	1.60	0.02	0.80	5	2.9	0.08	0.6	7	0.3	5	
Magnesium, mg/l	59	53	57	3	49	3.8	32	7	34	8.2	18	7	125	3.1	46	6	37	0.7	10	8			
Nitrogens																							
Ammonia, mg/l	0.11	0.10	0.10	3	0.37	0.03	0.18	3	0.37	0.08	0.18	3											
Organic, mg/l	0.02	<0.01	0.01	3	1.20	0.12	0.55	3	0.63	0.29	0.38	3											
Nitrite plus Nitrate, mg/l	<0.01	<0.01	<0.01	3	0.26	0.08	0.14	3	0.17	0.07	0.10	3	0.1(NO_3)	-	-	1						45(NO_3)*	100
Phosphorus, mg/l	0.02	0.01	0.01	3	0.33	0.01	0.12	3	0.10	0.03	0.06	3											
Potassium, mg/l	7.5	7.3	7.4	3	210	14	90	6	140	9	50	6	23	-	-	1							
Silica, mg/l					8.1	0.09	3.9	3	1.4	0.02	0.50	3	10	8.4	9.7	5	17	5.4	12	7			
Sodium, mg/l	120	120	120	3	250	110	150	7	270	110	200	7	390	107	236	6	1064	167	470	8			
Solids (dissolved), mg/l	1000	1000	1000	3	1200	680	940	6	1300	480	870	[illegible]	2091	829	1358	6	3189	1010	1689	8	500		
Sulfate, mg/l	580	540	560	3	690	230	510	6	900	180	520	6	1102	246	679	6	1790	8	533	8	250		3300
Aluminum, µg/l	<200	<200	<200	3	520	<200	300	7	500	<200	<270	7										5000	5000
Arsenic, µg/l	2.8	1.6	2.4	3	6	<2	2	7	<2	<2	<2	7									50*		
Barium, µg/l	<100	<100	<100	3	200	<100	<110	7	<100	<100	<100	7									1000*		
Beryllium, µg/l					<10	<10	<10	3	<10	<10	<10	3										100	
Boron, µg/l	120	50	80	3	440	140	240	6	580	160	270	6	70	-	-	1						750	
Cadmium, µg/l	<1	<1	<1	3	2	<1	<1	7	2	<1	<1	7									10*	10	50
Chromium, µg/l	<5	<5	<5	3	<5	<5	<5	7	<5	<5	<5	7									50*	100	1000
Colbalt, µg/l	<5	<5	<5	3	<5	3	<5	7	8	<5	7	7										50	1000
Copper, µg/l	20	10	20	3	140	<10	50	7	160	<10	<30	7									1000	200	500
Lead, µg/l	20	<10	<10	3	1600	<10	360	7	380	<10	80	7									50*	5000	100
Lithium, µg/l					110	40	80	4	90	50	70	4										2500	
Manganese, µg/l	240	230	240	3	530	140	270	7	390	30	180	7									50	200	
Mercury, µg/l					0.5	<0.2	<0.3	5	0.4	<0.2	<0.3	5									2*		10
Molybdenum, µg/l	<100	<100	<100	3	<100	<100	<100	6	<100	<100	<100	6										10	
Nickel, µg/l	<50	<50	<50	3	<50	<50	<50	6	<50	<50	<50	6										200	
Selenium, µg/l	<1	<1	<1	3	2	<1	<1	6	1	<1	<1	6									10*	20	50
Silver, µg/l	<10	<10	<10	3	<10	<10	<10	6	<10	<10	<10	6									50*		
Strontium, µg/l	3700	3400	3600	3	2100	1300	1670	6	2200	370	1130	6											
Vanadium, µg/l	<100	<100	<100	3	<100	<100	<100	7	<100	<100	<100	6										100	150
Zinc, µg/l	290	100	180	3	7700	<10	2250	6	210	40	140	7									5000	2000	25,000
Hydrogen Sulfide, mg/l													2	0.1	1	3	5+	5	5+	3			
SAR	-	-	2.1	3	-	-	3.6	7	-	-	6.2	7	-	-	4.9	6	-	-	20	8			

1. Groundwater samples were obtained during a pump test of well D-53, and represents a composite of water from the Lakota and Fall River Formations (see section 2.5.2). Data Source: TVA, 11/14-17/77.
2. Groundwater samples were from flowing (F) and nonflowing (NF) piezometers D-47 (F), D-49 (NF), and D-51 (F). Data Source: TVA, 1976-1977.
3. Groundwater samples were from flowing (F) and nonflowing (NF) piezometers D-48 (F), D-50 (NF), and D-52 (F). Samples represent a composite of water from the Lakota and Fall River Formations (see section 2.5.2). Data Source: TVA, 1976-1977.
4. Samples were obtained from wells D-6, D-12, D-20, F-1, and G-1 (Data Source: Reference No. 6) and Well G-1 (Data Source: USGS, 1972).
5. Samples were obtained from wells D-21, F-2, F-3, F-4, F-5, F-6, F-7, and H-1 (Data Source: Reference No. 6).
6. Standards marked with (*) are primary drinking water standards and unmarked are the proposed secondary drinking water standards. Reference numbers 3 and 4.
7. Reference number 5.

Hydrologic studies at the Burdock mine sites were conducted utilizing well D-53 and site piezometers during the period of November 14-17, 1977. The results of this study revealed that in the vicinity of the Burdock mines, waters from the Lakota and Fall River Formations intermix and water samples from this well represent a composite of water from these two aquifers (section 2.5.2).

Well D-53 may be utilized as a depressuring well for the Burdock underground mine. Evaluation of water quality data from this pumped well show its physical-chemical quality to be fair. Concentrations of dissolved solids averaged 1,000 mg/l and the ground water is considered to be very hard. The principal cations were calcium and sodium, and the principal anions were sulfate and bicarbonate. Concentrations of analyzed primary (health) trace metals were less than those specified by the EPA for finished drinking water.[4] Mean concentrations of dissolved solids, sulfates, and manganese were greater than those concentrations specified by the proposed EPA secondary (aesthetically undesirable) standards for finished drinking water.[4] Using the USDA[7] diagram for evaluating ground water for irrigation purposes, the ground water is unsuitable for irrigation purposes because of its high salinity hazard.

When depressuring of the Lakota Formation is not in progress, water from the Lakota Formation enters the Fall River Formation because of its greater piezometric head. Piezometers D-47, D-49, and D-51 are screened in the Lakota Formation only thus permitting evaluation of the quality of water in the aquifier. Evaluation of the water quality data from the Lakota Formation, in advance of any hydrologic studies, shows its physical-chemical quality to be poorer than the intermixed ground water obtained during the hydrologic studies. Concentrations of nutrients and most metals were greater than those concentrations observed at well D-53. Nevertheless, except for lead, concentrations of analyzed primary trace metals were less than those specified by the EPA primary standards. An excessively high concentration of lead (1,600 g/l) was observed in a grab sample from piezometer D-49, which is non-flowing. Lower concentrations were observed in D-51 and on a different occasion in D-49, but the observed concentrations still exceeded the EPA standard of 50 g/l for finished drinking water. Mean concentrations of iron, dissolved solids, sulfates, and manganese exceeded those concentrations specified by the proposed EPA secondary standards. The water is considered to be very hard, the principal cations were sodium and calcium, and the principal anions were sulfate and bicarbonate. Based upon the 1972 NAS - NAE criteria[5] the ground water is unsuitable for irrigation and livestock watering purposes and based upon USDA criteria, the salinity hazard for irrigation is high.

Water quality samples were also obtained prior to the hydrologic studies at piezometers (D-48, D-50, and D-52) screened in the Fall River Formation. Based upon hydrologic studies, this ground water also represents a composite of the Lakota and Fall River Formations. An evaluation of the water quality data from samples obtained from these piezometers showed its physical-chemical quality to be better than that of the Lakota Formation. Concentrations of dissolved solids averaged 870 mg/l. The water is considered to be moderately hard, the principal cations were sodium and calcium and the principal anions were sulfate and bicarbonate. Although lower concentrations were observed at these piezometers, the mean concentration of lead, iron, dissolved solids, and manganese exceeded the EPA standards. The highest concentrations of Chemical Oxygen Demand and sulfates were reported in samples from these piezometers. A higher mean Sodium Adsorption Ratio was calculated and based upon USDA criteria the salinity hazards for irrigation is high.

A comparison of the water quality of composite ground water obtained at the piezometers screened in the Fall River Formation and the pumped depressuring well reveals that the pumped depressuring well provides water of better quality containing smaller concentrations of most metals and nutrients. Conversely concentrations of minerals, especially hardness causing minerals, and dissolved solids measured in the piezometer samples were less than the concentrations observed in samples from the pumped well.

Based upon this evaluation, it can be concluded that (1) the water quality of the Fall River Formation is better than the water quality of the Lakota Formation, (2) the pumped depressuring well provides the best source of raw water for various uses, and (3) during depressuring the inflow of water from the Fall River Formation to the Lakota Formation will not degrade water quality, but instead enhance water quality in local private wells which tap the Lakota Formation.

Summaries of historical water quality data from the USGS, the Atomic Energy Commission (replaced by NRC), and the South Dakota School of Mines are also listed in Table 2.6.1.2-1. Evaluation of this data would lead to the conclusion that the water quality of the Fall River Formation is poorer than that of the Lakota Formation. The discrepancy between the historical data and the data obtained on the project site may be explained by several reasons: (1) changes in aquifer water quality with time, (2) well locations in the ground water basin, (3) well design, (4) sampling techniques, and (5) laboratory accuracies.

<u>2.6.2 Water Quality Impact Assessment</u> - Impacts to surface and/or ground water quality potentially can be caused by several activities connected with uranium mining. These activities and proposed mitigative measures will be discussed individually for underground and surface mining. A discussion of liquid wastes, their treatment, discharge, and the impact of this discharge is presented under Section 2.12.1.

<u>2.6.2.1 Underground Mining</u>

<u>2.6.2.1.1 Ground Water Depressuring and Quality Protection Measures</u> - Depressuring of the Lakota Formation at the Burdock Mine will be accomplished by pumped wells and subsurface drainage systems. Depressuring will contribute to the drawdown of the piezometric surface of the Lakota Formation, thus permitting waters from the overlying Fall River Formation to enter the Lakota Formation and form a composite of water from the two aquifers. No significant adverse impact to the water quality of the Fall River and Lakota Formations during mining is anticipated since the depressuring operation will always cause the mine to act as a sink for any potentially contaminated water

rather than a source. Some local change in the water quality of the Lakota Formation will occur but this should represent an improvement over existing conditions (see Section 2.6.1.2). Depressuring will not be conducted at the Darrow Extensions and Runge East Mines since mining will be within unsaturated portions of the Fall River Formation.

Protection of ground water quality in the vicinity of underground mines will be accomplished by (1) the sealing of all ponds which will receive contaminated mine water, (2) the sealing of ore storage pads and the dikes providing containment of runoff in the ore storage area, and (3) the immediate cleanup following accidental spills of fuel and oils.

2.6.2.1.2 Nonpoint Source Runoff - No significant degradation of the area's water resources is expected from nonpoint source discharges at the underground mines since (1) runoff will be limited due to the semiarid climate, (2) existing drainage patterns will be designed to allow runoff outside the boundary of the mining operations to be diverted around the areas disturbed by mining, (3) runoff from overburden storage, topsoil storage, revegetated areas, and other disturbed areas will be controlled as necessary by a system of dikes, trenches, ponds, or other appropriate measures including routing to the lagoon-treatment system, (4) runoff from ore storage areas will be controlled by diking around the impervious ore pad, (5) erosion of haul roads will be minimal because all roads currently exist, drainage ditches will be constructed alongside the roads, and the roads will be well maintained.

2.6.2.1.3 Spill Control - Areas will be designated for the storage of fuel and oil. These materials will be stored within diked areas of sufficient capacity to retain 110 percent of the total volume contained. In the event of an accidental spill within a diked area, the spilled material will be contained and disposed of in an environmentally acceptable manner. Substantial quantitites of other potentially hazardous or toxic materials are not anticipated to be stored at the underground mining sites.

2.6.2.1.4 Post Mining - After operations cease, waste piles, mine water holding ponds, ore storage areas, disturbed areas, and other surface facilities will be stabilized and/or reclaimed to minimize adverse impacts to ground or surface water quality that might result from rainfall or snowmelt runoff, or ground water contacting these areas. Along with this site stabilization, each shaft will be covered with a concrete slab. Requirements applicable at the time of stabilization of these areas, in addition to those described in the reclamation program, will be met. Upon abandonment of a mine shaft, depressuring operations will cease and natural hydraulic gradients in the Lakota and Fall River Formations will likely recover to approach pre-mining conditions. Some deterioration of ground water quality in the Lakota Formation could occur in the immediate vicinity of the mine. This would be a result of oxidation and other chemical reactions within the abandoned mine. At this time, the potential impact on these aquifers is judged to be insignificant because during aquifer gradient restoration the flow will be towards the mine site, thus confining any potentially contaminated ground water to the immediate area. A return to the chemically reduced state will eventually occur due to the natural geochemical reactions in the formations and the reducing characteristics of the natural ground water. Thus, metals associated with the ore body should be converted from a soluble to an insoluble phase; and precipitate in the mine site area. After the restoration period, any dispersion of the soluble form of these metals should be minimal.

2.6.2.2 Surface Mining

2.6.2.2.1 Ground Water Inflows, Overburden Leachates, and Ground Water Quality Protection Measures - Only one surface mine has been planned to date, the Spencer Richardson Mine. Significant volumes of ground water are not expected to be encountered in surface mines because all surface mining should be in unsaturated portions of the Fall River Formation. Runoff from the overburden spoil piles, ground water seepage, rainfall, and/or snowmelt that does enter the mining pit will be handled as specified in Section 2.12.1.

A portion of the rainfall, snowmelt, and ground water inflows, if any, to the open pit will infiltrate the bottom of the pit. When the surface mine is reclaimed, rainwater and snowmelt will infiltrate the implaced overburden. Rainwater has a pH of less than neutral and therefore is capable of leaching minerals and metals from the overburden matrix. The impact of this leaching on the water quality of the Fall River Formation is judged to be insignificant because all surface mining is proposed in aquifer outcrop areas which normally permit the infiltration of rainwater.

If, in the future, mining is proposed for non-outcrop sections of the Fall River Formation, the impact of leaching on groundwater quality should also be insignificant because of several factors: (1) leaching should be short-termed because a hardpan condition is likely to occur on newly disturbed overburden piles after the first few rainfalls, thus reducing the infiltration rates, (2) the low average rainfall quantities expected at the site, 30 to 40 cm/yr, (13 to 16 in/yr) should reduce the time the rainwater is in contact with the overburden, (3) most of the rain expected at the site is of short duration and high intensity thus resulting in greater volumes of runoff and lesser volumes of water infiltrating the overburden surface, (4) the volume of the portion of the aquifer to be mined is insignificant when compared to its total volume, and (5) the attenuation capabilities of the aquifer should decrease leached metal concentrations within a short distance of the mining zone. Only minor post-mining overburden leaching is expected since the same overburden will have been used in the reclamation program.

Protection of ground water quality in the vicinity of the surface mine sites shall be accomplished as discussed in underground mining (Section 2.6.2.1.1, second paragraph).

2.6.2.2.2 Nonpoint Source Impacts - No significant degradation of the area's water resources is expected from nonpoint source discharges at surface mining areas. Drainage and control systems will be built and maintained to control runoff as discussed in underground mining (Section 2.6.2.1.2).

2.6.2.2.3 Spill Control - Fuels and oils will be handled as discussed in underground mining (Section 2.6.2.1.3). Substantial quantities of other potentially hazardous or toxic materials are not anticipated to be stored at the surface mining sites.

2.6.3 Water Quality Monitoring

2.6.3.1 Surface Water Quality Monitoring - Mining wastewaters will be fed to mine water holding ponds where they will be treated and discharged in compliance with applicable requirements which will be identified in the NPDES permit. Site runoff will be controlled as necessary by a system of dikes, trenches, ponds, or other appropriate measures. Monitoring will be carried out in accordance with the discharge permit requirements.

2.6.3.2 Ground Water Quality Monitoring - At the Burdock underground mining area, the Lakota Formation will be depressurized by a series of wells located around the periphery of each mine shaft. This ground water, which represents a composite of the Lakota and Fall River Formations, will be monitored for various parameters at least once annually to detect changes, if any, as a result of the continued leakage of the Fall River Formation into the Lakota Formation. In addition, selected private water wells will be monitored once annually for a limited period to verify the analysis contained in Section 2.6.1.2.

At the Burdock area, mine water holding ponds will be located on top of the Skull Creek Shale Formation, and the pond bottom and dike walls will be sealed to prevent any seepage. If any seepage were to occur, it would be through a dike and appear on the land surface. Therefore, shallow ground water monitoring will not be conducted at the Burdock mining area.

At the Spencer Richardson mine, Darrow Extensions, and Runge East Mines, mining will occur in unsaturated outcrop regions of the Fall River Formation. Significant volumes of ground water are not expected to be encountered at these sites, but water removed from the mine shafts, open pits, and runoff will be routed to sealed mine water holding ponds. To adequately monitor the integrity of the sealed ponds and ensure that they are efficiently retaining waste waters, shallow ground water quality monitoring will be conducted. Wells will be provided in the saturated portion of the Fall River Formation both upgradient and downgradient to the ponds. Sampling will begin prior to mining activities on a quarterly frequency. Samples will be analyzed for various physical and chemical water quality constituents.

Results of the ground water quality monitoring program will be evaluated on a routine frequency to ensure that water quality conditions are not significantly impacted by the mining activity. At the end of one full year of ore production, the program will be reevaluated to ensure that the objectives of the program are being satisfied and appropriate changes will be made as necessary, consistent with these objectives. Additional program evaluations will be conducted as necessary.

2.6 References

1. State of South Dakota. Department of Environmental Protection. Surface Water Quality Standards. Chapter 34:04:02, and Uses Assigned to Streams. Chapter 34:04:04, SDCL 46-25-107.

2. State of Wyoming Department of Environmental Quality. Water Quality Standards for Wyoming. Dated August 8, 1974, and Stream Classifications in Wyoming Oct. 1, 1977; 1973 CS, 35-502.19 and 1973 SI, 35-487-19.

3. U.S. Environmental Protection Agency. National Interim Primary Drinking Water Regulations. CFR. Title 40. Part 141. V. 40, No. 248. December 1975.

4. U.S. Environmental Protection Agency. Proposed National Secondary Drinking Water Regulations CFR. Title 40. Part 143 V. 42, No. 62. March 1977.

5. National Academy of Sciences and National Academy of Engineering. Water Quality Criteria 1972. USEPA R3 73 033. March 1973.

6. Keene, Jack R. Ground-Water Resources of the Western Half of Fall River County, S.D.; South Dakota Geological Survey Rept. of Inv. No. 109. 1973.

7. United States Department of Agriculture. Diagnosis and Improvement of Saline and Alkali Soils. Agriculture Handbook No. 60. 1954.

2.7 Climatology and Air Quality

2.7.1 Physical Environment

2.7.1.1 General Climate - The project area is located in extreme southwestern South Dakota and extreme east-central Wyoming, adjacent to the southwestern extension of the Black Hills. The project area is characterized by low precipitation, high evaporation rates, abundant sunshine, low relative humidities, and moderate temperatures with large diurnal and annual variations.[1,2] The general climate of the project area may be considered as semi-arid continental or steppe with a dry winter season.[3,4]

Migratory storm systems originating in the Pacific Ocean generally release most of their moisture over the Coastal and Cascade Range and Rocky Mountains, thus arriving in the Black Hills area relatively dry, and generally producing only light precipitation. Heavier precipitation normally occurs when these systems reintensify east of the Rocky Mountains and interact with moist air that is either already present or advected into the area from the southeast. Isolated summertime convective storms may also produce heavy localized precipitation, primarily over and adjacent to the Black Hills.

Topography on the lease properties does not vary substantially and therefore should not influence synoptic-scale air flow to any great extent. The adjacent Black Hills, however, are a major barrier to air flow and may cause some variation in the airflow in the general region.

2.7.1.2 Temperature - Temperatures in the project vicinity are reasonably represented by data from nearby Ardmore, South Dakota located approximately 35 km (22 mi) south-southeast of the Edgemont properties . Table 2.7.1.2-1 presents mean monthly and annual mean daily maximum and minimum temperatures for the Ardmore station for 42 years of record.

Temperatures greater than or equal to 32° C (90° F) are estimated to occur on an average of 60 days per year in the project area.[2] The extreme maximum temperature reported for Ardmore is 46° C (114° F).[2] Migrating high pressure systems moving southward out of Canada frequently influence the site area. This fact, combined with elevations of about 3,500 to 3,800 feet MSL (Mean Sea Level), a northern continental location, and infrequent cloud cover, contributes to an average of 198 days per year in the project area recording temperatures less than or equal to 0° C (32° F). The lowest temperature on record for Ardmore is -38° C (-37° F).[2]

Freezing temperatures generally do not occur in the project area after mid-May or before the last of September.[1] However, there are large variations in freeze dates from year to year.

2.7.1.3 Precipitation and Relative Humidity - Maximum precipitation amounts in the project area occur during late spring and early summer, primarily as a result of moist air from the Gulf of Mexico interacting with frontal systems moving across

Table 2.7.1.2-1

Monthly and Annual Mean and Mean Daily Maximum and Minimum

Temperatures in Degrees Centigrade (Fahrenheit)

For Ardmore, South Dakota (1919-1960)[2]

Month	Mean	Mean Daily Maximum	Mean Daily Minimum
January	-6.8 (20)	0.9 (34)	-14.4 (6)
February	-4.1 (25)	3.8 (39)	-11.6 (11)
March	0.8 (33)	8.3 (47)	-7.1 (19)
April	7.0 (45)	14.9 (59)	-0.8 (30)
May	12.9 (55)	20.7 (69)	5.2 (41)
June	18.6 (65)	26.6 (80)	10.4 (5[illegible])
July	23.3 (74)	32.4 (90)	14.3 (58)
August	22.1 (72)	31.3 (88)	12.7 (55)
September	15.9 (61)	25.6 (78)	6.6 (44)
October	8.8 (48)	18.0 (64)	-0.1 (32)
November	1.1 (34)	9.1 (48)	-6.8 (20)
December	-4.8 (23)	2.8 (37)	-12.2 (10)
Annual	7.9 (46)	16.2 (61)	-0.3 (31)

the region. Summertime convective thunderstorm activity also contributes substantially to the precipitation totals during the summer months. Monthly and annual precipitation data from Edgemont, South Dakota (Table 2.7.1.3-1), indicate that approximately one-half of the annual precipitation falls during the months of May, June, and July. Most of the winter precipitation can be expected as snow. Based on snowfall records for Ardmore over a 9 year period of record, the annual average snowfall for the project area is estimated to be approximately 94 cm (37 in).[2]

Based on records from the NWS (National Weather Service) station at Rapid City, South Dakota, located about 105 km (65 mi) northeast of the site, it is estimated that precipitation of 0.25 mm (0.01 in) or more occurs on an average of 90 days per year in the project area.[5,6,7]

The mean annual relative humidity for the project area is estimated to be about 52 percent.[5,7] However, afternoon humidities in the warmer months are often lower than 30 percent.

2.7.1.4 Wind Speed and Direction - Long-term wind information is not available for the immediate project area. The nearest NWS stations with such data are at Rapid City, South Dakota, and Scottsbluff, Nebraska, which are more than 105 km (65 mi) northeast and 160 km (100 mi) south of the site, respectively. Table 2.7.1.4-1 presents monthly and annual mean wind speeds and directions for these two stations. Limited site-specific information for the period March 24, 1977, through March 23, 1978, is presented in Table 2.7.1.4-2.

The NWS data indicate that the general air flow in the region is most frequently from a northwesterly direction with a secondary maximum from a southeasterly direction. Wind speeds are relatively high, generally averaging over 4.5 m/s (10 mi/h). The site specific wind data is reasonably consistent with the NWS information. However, in the site specific data, the wind direction distribution is shifted slightly to a more west-northwest and east-southeast orientation, and the average wind speed during the one year measurement period is lower than that observed over the longer-term NWS period.

2.7.1.5 Severe Weather - Tornadoes are infrequent in western South Dakota and eastern Wyoming. Of those reported, most occurred in the afternoon and early evening hours during the summertime thunderstorm season. Only nine tornadoes were reported within the one-degree (of latitude and longitude) square that includes the project area during the period from 1955 through 1967.[10] Thus, the estimated probability of a tornado striking a point within the project area in any given year is 0.0006.[10,11] In other words, the estimated mean recurrence interval for a tornado occurrence at any point within the project area is about 1,650 years.

Thunderstorms are relatively frequent in southwestern South Dakota and east-central Wyoming during the summer months, occurring on the average of 40 to 45 days per year.[7,12] Hail in

Table 2.7.1.3-1

Mean Monthly and Annual

Precipitation for Edgemont, South Dakota (1949-1957)[2]

Month	Amount (Millimeters)	Amount (Inches)	Years of Record
January	9	.3	9
February	11	.5	9
March	23	.9	9
April	30	1.2	9
May	73	2.9	9
June	67	2.6	9
July	48	1.9	8
August	29	1.1	8
September	28	1.1	8
October	19	.7	8
November	10	.4	9
December	9	.3	9
Annual	356	14.0	

Table 2.7.1.4-1

Monthly and Annual Mean Wind Speeds and Predominant Wind Directions

At Scottsbluff, Nebraska, and Rapid City, South Dakota[7,8,9]

	Scottsbluff, Nebraska		Rapid City, South Dakota	
Month	Mean Speed, m/s (mi/h)[a]	Direction[a]	Mean Speed, m/s (mi/h)[a]	Direction[b]
January	4.7 (10.6)	WNW	4.7 (10.5)	NNW
February	5.1 (11.5)	WNW	4.8 (10.8)	NNW
March	5.5 (12.3)	WNW	5.6 (12.5)	NNW
April	5.8 (12.9)	NW	5.9 (13.2)	NNW
May	5.4 (12.1)	ESE	5.5 (12.4)	NNW
June	4.7 (10.6)	ESE	4.8 (10.7)	NNW
July	4.2 (9.4)	ESE	4.4 (9.9)	NNW
August	4.1 (9.2)	ESE	4.6 (10.2)	NNW
September	4.2 (9.5)	ESE	4.9 (11.0)	NNW
October	4.4 (9.8)	NW	5.0 (11.1)	NNW
November	4.6 (10.4)	NW	4.9 (10.9)	NNW
December	4.8 (10.7)	WNW	4.6 (10.4)	NNW
Annual	4.8 (10.7)	ESE	5.0 (11.1)	NNW

a. Based on 24 years of record.

b. Based on 13 years of record.

TABLE 2.7.1.4-2

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY DIRECTION

DISREGARDING STABILITY CLASS

EDGEMONT MILL METEOROLOGICAL FACILITY

MAR 24, 77 - MAR 23, 78

WIND DIRECTION	WIND SPEED (Mi/h) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.12	0.65	0.50	0.38	0.35	0.16	0.0	0.0	2.16
NNE	0.07	0.69	0.41	0.12	0.10	0.0	0.0	0.0	1.39
NE	0.16	0.87	0.44	0.15	0.20	0.06	0.0	0.01	1.89
ENE	0.09	0.96	0.62	0.40	0.66	0.44	0.07	0.0	3.24
E	0.13	1.30	1.50	1.43	4.13	2.52	0.13	0.0	11.14
ESE	0.09	0.54	1.01	1.32	5.10	2.97	0.20	0.0	11.23
SE	0.06	0.56	0.66	0.87	2.63	0.85	0.15	0.02	5.80
SSE	0.17	1.04	1.04	1.22	1.17	0.50	0.10	0.01	5.25
S	0.32	3.89	1.80	0.78	0.55	0.12	0.0	0.01	7.47
SSW	0.26	1.63	0.99	0.41	0.37	0.07	0.01	0.0	3.74
SW	0.09	0.83	0.33	0.30	0.33	0.02	0.01	0.0	1.91
WSW	0.09	1.27	0.45	0.24	0.29	0.09	0.0	0.0	2.43
W	0.38	4.72	3.32	1.41	1.57	0.66	0.24	0.0	12.30
WNW	0.10	2.44	2.90	1.85	3.08	2.29	1.02	0.21	13.89
NW	0.15	1.57	1.83	1.43	2.36	1.82	0.77	0.39	10.32
NNW	0.07	1.26	1.24	0.66	1.49	0.59	0.11	0.16	5.58
SUBTOTAL	2.35	24.22	19.04	12.97	24.38	13.16	2.81	0.81	99.74

Total hours of valid wind observations	8204
Total hours of observations	8747
Recoveability percentage	93.8
Total hours calm	2[illegible]

All columns and calm total 100 percent of joint valid observations

Meteorological Facility: Wind speed and direction measured at the 33.00 foot level

Mean wind speed = 7.2 Mi/h

association with these thunderstorms is generally reported on an average of 4 to 6 days per year.[12]

Extreme winds of short duration in this area are generally associated with thunderstorms. Table 2.7.1.5-1 presents estimated maximum (fastest mile) wind speeds at 9.1 m (30 ft) above the ground for various recurrence intervals.

Maximum short-duration rainfalls are generally associated with intense thunderstorms. Table 2.7.1.5-2 presents estimated maximum precipitation at any point in the project area for various durations and recurrence intervals.

2.7.1.6 Atmospheric Stability - Based on the input parameters of solar altitude, cloud cover, ceiling height and wind speed, atmospheric stability can be classified into several categories. The closest NWS stations with available long-term atmospheric records from which stability conditions can be estimated are Scottsbluff and Chadron, [located about 85 km (53 mi) southeast of the site], Nebraska, and Rapid City, South Dakota. The percent frequencies of the various stability conditions for these three locations are presented in Table 2.7.1.6-1. The data indicate that stability conditions contributing to good dispersion conditions (generally Pasquill classes A through D) occur more than 65 percent of the time at all three stations.

2.7.2 Existing Air Quality

2.7.2.1 Air Quality Standards - The project area is located in the Black Hills-Rapid City and the Wyoming Intrastate AQCR's (Air Quality Control Regions). Both of these AQCR's are classified as Priority III for sulfur dioxide, nitrogen dioxide, carbon monoxide, photochemical oxidants, hydrocarbons, and particulate matter.[17] This means that existing pollutant levels within these AQCR's are currently below Federal secondary standards for these six criteria pollutants. Federal ambient air quality standards are presented in Table 2.7.2.1-1, South Dakota and Wyoming ambient standards in Tables 2.7.2.1-2 and 2.7.2.1-3, respectively.

In addition to ambient standards, Federal laws on the PSD (Prevention of Significant Deterioration) establish ambient increments (Table 2.7.2.1-4) to protect areas with air quality cleaner than minimum national standards.[18] The project area is presently designated as Class II with respect to significant deterioration. These laws specify both conditions under which major new sources or major source modifications must undergo a PSD preconstruction review and those pollutants for which the source is subject to meeting best available control technology. Because of the uncertainties presently associated with the Environmental Protection Agency's implementation of these laws, it has not been determined whether the Edgemont project will be required to undergo a PSD preconstruction review.

Table 2.7.1.5-1

Annual Extreme - Estimated Fastest Mile Wind Speeds

9.1 Meters (30 Feet) Above Ground Level

For the Edgemont Area[13]

Recurrence Interval (Years)	Wind Speed (m/s)	Wind Speed (mi/h)
2	26.8	60
10	32.6	73
25	35.8	80
50	38.4	86
100	41.1	92

Table 2.7.1.5-2

Estimated Maximum Point Precipitation in Millimeters (Inches)

For Selected Durations and Recurrence Intervals

For the Edgemont Area[14,15]

Duration	2 Years	10 Years	25 Years	50 Years	100 Years
1 hour	25 (1.0)	43 (1.7)	50 (2.0)	58 (2.3)	66 (2.6)
12 hours	40 (1.6)	68 (2.7)	78 (3.1)	88 (3.5)	101 (4.0)
24 hours	48 (1.9)	76 (3.0)	88 (3.5)	101 (4.0)	114 (4.5)
2 days	53 (2.1)	83 (3.3)	99 (3.9)	114 (4.5)	124 (4.9)
7 days	71 (2.8)	109 (4.3)	127 (5.0)	149 (5.9)	162 (6.4)
10 days	81 (3.2)	119 (4.7)	142 (5.6)	152 (6.0)	177 (7.0)

Table 2.7.1.6-1

Percent Frequency Distributions of Pasquill Stability Classes

For Rapid City, South Dakota, and Scottsbluff and Chadron, Nebraska[8,9,16]

Stability Class	Percent		
	Rapid City (1959-1968)	Scottsbluff (1948-1975)	Chadron (1948-1954)
A (extremely unstable)	0.3	0.9	0.5
B (unstable)	4.1	5.4	5.1
C (slightly unstable)	9.7	9.9	9.7
D (neutral)	54.8	52.9	55.1
E (slightly stable)	14.7	15.4	11.6
F (stable)	11.7	11.1	10.1
G (extremely stable)	4.6	4.4	7.1

Table 2.7.2.1-1

Federal Ambient Air Quality Standards[19]

Standard	Carbon Monoxide ($\mu g/m^3$)	Oxidants ($\mu g/m^3$)	Nitrogen Dioxide ($\mu g/m^3$)	Suspended Particulates ($\mu g/m^3$)	Sulfur Dioxide ($\mu g/m^3$)
Primary					
1-hour	40,000	160			
8-hour	10,000				
24-hour				260	365
Annual			100	75[a]	80
Secondary					
1-hour	40,000	160			
3-hour					1,300
8-hour	10,000				
24-hour				150	
Annual			100	60[a]	

a. Annual geometric mean.

Table 2.7.2.1-2

South Dakota Ambient Air Quality Standards[20]

Duration	Carbon Monoxide (ppm)	Photochemical Oxidants (ppm)	Nitrogen Dioxide (ppm)	Soiling Index (COHs/1000 ft)	Suspended Particulates ($\mu g/m^3$)
1-hour	35	0.08	-	-	-
3-hour	-	-	-	-	-
8-hour	9	-	-	-	-
24-hour	-	-	0.10	-	150
7-day	-	-	-	-	-
30-day	-	-	-	-	-
Annual	-	-	0.05	0.2	60[a]

Duration	Hydrocarbons (ppm)	Sulfur Dioxide (ppm)
1-hour	-	-
3-hour	0.24[b]	0.50
8-hour	-	-
24-hour	-	0.14
7-day	-	-
30-day	-	-
Annual	-	0.03

a. Annual geometric mean.

b. Maximum 3-hour concentration.

Table 2.7.2.1-3

Wyoming Ambient Air Quality Standards[21]

Duration	Carbon Monoxide (ppm)	Photochemical Oxidants (ppm)	Nitrogen Dioxide (ppm)	Soiling Index (COHs/1000 ft)	Suspended Particulates ($\mu g/m^3$)	Total Settleable Particulates (g/m^2-month)
1-hour	35	0.08	-	-	-	-
3-hour	-	-	-	-	-	-
8-hour	9	-	-	-	-	-
24-hour	-	-	0.10	-	150	-
7-day	-	-	-	-	-	-
30-day	-	-	-	-	-	5-10[a]
Annual	-	-	0.05	0.4	60[b]	-

Duration	Hydrocarbons (ppm)	Fluorides (ppb)	Sulfur Dioxide (ppm)	Hydrogen Sulfide (ppm)	Total Suspended Sulfate ($mg/100\ cm^2$-day)
1/2-hour	-	-	-	0.05[d]	-
3-hour	0.24[c]	-	0.50	-	-
8-hour	-	1.0	-	-	-
24-hour	-	-	0.10	-	0.5[e]
7-day	-	-	-	-	-
30-day	-	-	-	-	-
Annual	-	-	0.02	-	0.25[e]

a. Includes 1.7 g/m^2 background concentration. The 5 g/m^2-month standard applies to a residential area, the 10 g/m^2-month standard to an industrial area.
b. Annual geometric mean.
c. Maximum 3-hour concentration, 6-9 a.m.
d. To be exceeded only twice per year. A standard of 0.03 ppm is not to be exceeded more than twice within 5 consecutive days.
e. Measured as the sulfation rate by the lead peroxide method.

Table 2.7.2.1-4

Federal Prevention of Significant Deterioration (PSD) Increments[18]

Pollutant	Allowable Increases in Pollutant Concentrations ($\mu g/m^3$) Over Baseline					
	Class I PSD Increment	Class I PSD Increment Subparagraph C[a] Variance[b]	Class I PSD Increment Subparagraph D[a] Variance[c] Terrain Areas[d]		Class II PSD Increment	Class III PSD Increment
			Low	High		
Particulates						
Annual geometric mean	5	19	e	e	19	37
24-hour maximum	10	37	e	e	37	75
Sulfur Dioxide						
Annual arithmetic mean	2	20	2	2	20	40
24-hour maximum	5	91	36	62	91	182
3-hour maximum	25	325	130	221	512	700

a. Conditions for receiving variance specified under Clean Air Act Amendments, 1977.

b. Variance must be approved by Federal land manager.

c. Concentrations up to limits of variance permitted only on 18 days/year. Variance must be approved by governor and Federal land manager or President.

d. The division between high and low terrain is 900 feet above the stack.

e. Not applicable for particulates.

2.7.2.2 Existing Air Quality - There are no existing air quality data available for the immediate project area. However, official monitoring station data on total suspended particulates are available for communities in the general region (Table 2.7.2.2-1). The data show a wide range of concentrations for the different locations and, in some cases, for different years at each location, e.g., a high annual geometric mean of 88 μg/m³ at Gillette during 1972, a low annual geometric mean of 31 μg/m³ at Gillette during 1974. Background particulate levels in the region are highly variable and depend on a large number of factors, such as wind speed, amount of vegetation, soil type, topsoil moisture, and the number and type of anthropogenic sources. The higher concentrations reported at stations like Gillette, Douglas, and Hot Springs may be due to some extent to differences in anthropogenic source activities, such as transportation, construction, and energy production. Background concentrations of other criteria pollutants (sulfur dioxide, hydrocarbons, hydrogen sulfide, total reduced sulfur, photochemical oxidants, nitrogen dioxide, and carbon monoxide) are all expected to be very low in the project area because of the low population density and lack of industrial development.

2.7.3 Air Quality Impacts

2.7.3.1 Sources of Air Pollution - Nonradiological gaseous emissions will result from the combustion of fossil fuels by mining equipment and support vehicles used in the surface and underground mining operations. Lists of the number, type, and probable operation schedules of major fossil-fueled equipment that could be used for this project are presented in Tables 1.1.2.1-1 and 1.1.2.2-1. The estimated total fuel consumption by these vehicles is approximately 7,840 l (2,070 gal) of No. 2 diesel fuel per day. Of this total, 2,540 l (670 gal) per day will be used by the underground equipment and 3,090 l (815 gal) per day will be used by the surface support equipment associated with the initial shaft at the Burdock underground mine: The remaining 2,220 l (585 gal) per day will be used in the various surface mining operations. On-highway support equipment (approximately 40 vehicles) are expected to consume approximately 325 l/day (85 gal/day) of gasoline. Additional fuels will be consumed for building, office, and shaft heating. These heaters will only be operated in the colder months, as weather conditions require.

Because of the limited operation of shop and office heaters, their dispersed locations, and their small fuel consumption rates, the nonradiological air quality impact from their operation obviously will be small. Operation of shaft heaters will result in the emission of nonradiological pollutants into the mine ventilation air. These emissions, when added to other underground nonradiological pollutant emissions, must comply with Federal Mine Safety and Health Administration (MSHA) regulations. Maximum MSHA Air Contaminant Standards are presented in Table 2.7.3.1-1.

Emission rates for nonradiological pollutants resulting from the underground and surface mining operations were

Table 2.7.2.2-1

Measured Particulate Concentrations

(Annual Geometric Mean-μg/m³)[22,23]

Station Name	1972	1973	1974	1975	1976
South Dakota					
Hot Springs	–	–	–	–	54
Spearfish	–	–	–	23	32
Wyoming					
Douglas	–	59	55	33	–
Gillette	88[a]	36	31	56[b]	–
Irene Ranch	–	–	–	23[c]	–
Moorcroft	–	–	–	51	–
Stoddard Ranch	–	–	–	16[d]	–
Torrington	–	20[e]	27	24	–

a. Only data from the last 6 months of 1972 are included.
b. Only data from the first 9 months of 1975 are included.
c. Only data from the first 8 months of 1975 are included.
d. Only 6 months of data are included.
e. Only data from the last 4 months of 1973 are included.

Table 2.7.3.1-1

MSHA Air Contaminant Standards[25]

Pollutant	8-Hour Time-Weighted Averages[a]
Nuisance Particulates	10 mg/m^3
Sulfur Oxides	13 mg/m^3
Carbon Monoxide	55 mg/m^3
Nitrogen Oxides	9 mg/m^3

a. These concentrations represent the maximum allowable 8-hour time-weighted average airborne concentrations to which workers can be exposed. These standards consist of the threshold limit values (TLV's) established for chemical substances in workroom air, adopted by the American Conference of Governmental Industrial Hygienists in 1973.

calculated for the equipment listed in Tables 1.1.2.1-1 and 1.1.2.2-1. These emission rates were calculated using emission factors developed by the EPA (Environmental Protection Agency)[24] and by considering the anticipated schedules of operation. The estimated emissions are presented in Table 2.7.3.1-2.

The material mined and the interior surfaces of the Burdock underground mine are expected to be wet. Therefore, particulates emitted from this mine are likely to consist primarily of particulates produced from operation of the underground equipment and intermittent operation of the shaft heater(s). The interior surfaces of the Runge East underground mine, however, will be drier and will be watered to reduce particulate releases to the atmosphere.

Fugitive dust will result from surface activities (construction and ore and waste handling and storage) in support of the underground mining operations. Fugitive dust will also be released from travel on roads, development and production of the Spencer-Richardson mine and to a limited extent from the mining of adits in the Darrow pits.

2.7.3.2 Nonradiological Air Quality Impacts

Underground Mining Operations - Information concerning the actual concentrations of nonradiological pollutants in air vented from the mine is limited at this time. Emission estimates have therefore been made based on MSHA air contaminant standards.[25] Table 2.7.3.1-1 presents the maximum allowable 8-hour-time-weighted averages of pertinent nonradiological contaminant concentrations in underground mine air. It can be reasonably assumed that these will be the upper limits of average concentrations in the mine ventilation air at the surface.

Mine ventilation air is expected to be exhausted through the production shafts. Estimated maximum average emission rates for Burdock from each shaft were calculated (for those pollutants listed in Table 2.7.3.1-1) by multiplying the indicated concentrations by the maximum expected flow rate per shaft of 56.6 m^3/s (120,000 ft^3/min). For hydrocarbons, the emission estimate shown in Table 2.7.3.2-1 was used to estimate ambient hydrocarbon concentrations. This is the maximum flow rate anticipated for each shaft at the Burdock underground mine. The Runge East underground mine will be much smaller in size and will have lower release rates. Nonradiological emission rates from the Runge East mine vents, and resulting ambient pollution contributions, should therefore be much smaller than those from the Burdock operation. The underground mining in the existing Darrow Pits will be limited to adits along ore trends at the bottom of the pits. Nonradiological emission rates from this mining, and resulting ambient pollution contributions, should also be much smaller than those from the Burdock operations. Therefore, only impacts from the Burdock operation are assessed in any further detail. Estimated maximum emission rates of nonradiological pollutants from the Burdock underground mine are presented in Table 2.7.3.2-1.

Table 2.7.3.1-2

Estimated Vehicular Emissions[24] From Mining Equipment[a]

Pollutant	Emissions					
	Burdock Underground Mine (Initial Shaft)				Spencer-Richardson Surface Mine[b]	
	Underground Equipment[b]		Surface Support Equipment[b]			
Particulates	.12 g/s	2.0 tons/yr	.15 g/s	1.2 tons/yr	.27 g/s	2.1 tons/yr
Sulfur Oxides	.17 g/s	2.8 tons/yr	.21 g/s	1.7 tons/yr	.29 g/s	2.2 tons/yr
Carbon Monoxide	.49 g/s	8.1 tons/yr	.63 g/s	10.4 tons/yr	1.0 g/s	7.7 tons/yr
Nitrogen Oxides	2.55 g/s	42.1 tons/yr	3.23 g/s	53.3 tons/yr	4.0 g/s	31.3 tons/yr
Hydrocarbons	.17 g/s	2.8 tons/yr	.20 g/s	1.6 tons/yr	.37 g/s	2.9 tons/yr

a. Emissions due to diesel fuel consumption.

b. Emissions given in grams per second are for those periods when vehicles are operating. The tons-per-year figures reflect the schedule of operations for the year.

Table 2.7.3.2-1

Estimated Maximum Average Nonradioactive Burdock Production Shaft Emission Rates[a]

Pollutant	Emission Rate Each Vent
Particulates	.56 g/s
Sulfur Oxides	.72 g/s
Carbon Monoxide	3.10 g/s
Nitrogen Oxides	.51 g/s
Hydrocarbons	.17 g/s

a. During operation of fossil-fueled equipment.

Estimates of maximum short-term nonradiological ambient contributions at selected distances from each underground mine shaft release were determined by assuming various combinations of conservative meteorological circumstances. Consideration was given to equipment operating schedules (16 hours per day, 5 days per week) in selecting appropriate atmospheric stabilities for the 8-hour and 24-hour averaging periods.

The estimated maximum shaft emission rates (Table 2.7.3.2-1) were used as input to a standard short-term diffusion equation.* Calculations were made for selected distances from each shaft and for conservative meteorological conditions in accordance with the preceding paragraph. Resultant concentrations (above background levels) were compared with the most stringent Federal and state short-term ambient standards (Table 2.7.3.2-2). These comparisons show that the maximum short-term concentrations at each selected distance should be much less than short term standards.

At project boundaries and beyond, ambient nonradiological contributions due to shaft emissions are expected to be less than allowable Class II significant deterioration increments.

Annual average ambient concentrations were estimated for nonradiological shaft emissions (Table 2.7.3.2-1) using a sector average straight-line model.[26] The onsite meteorological information shown in Table 2.7.1.4-2 combined with D stability, was used to estimate annual average nonradiological ambient pollutant concentrations. The ambient annual average concentration estimates shown in Table 2.7.3.2-2 represent, for selected distances, the maximum concentration values expected to result from production shaft releases. These results indicate that annual average concentrations can be expected to stay well below Federal and state annual ambient standards (see Table 2.7.3.2-3).

Ambient concentrations resulting from the combustion of fuel from the underground mine surface support equipment were not estimated because of the limited number of vehicles operating above ground, their dispersed locations while in operation, and their less frequent operation. Because of these factors, the degradation of the ambient air quality resulting from the combustion of fossil fuel by the surface equipment will be so small that further discussion of their impact is not considered warranted.

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*Turner's equation 3.1[26] is used for short-term estimations of ambient concentrations (1-, 3-, 8-, and 24-hour averaging periods). A sector averaging diffusion equation was used to estimate 24 hour ambient concentrations.[26]

Table 2.7.3.2-2

Calculated Maximum Short-Term Ambient Contributions of Nonradiological Pollutants At Select Distances Downwind From Each Production Shaft[a]

Pollutant	Maximum Contribution ($\mu g/m^3$) at Select Downwind Distances From Shaft Release				Most Stringent Short-Term Ambient Standards		Short-Term Significant Deterioration Increment[b]
	1000 m	2000 m	3000 m	5000 m	Federal $\mu g/m^3$	State[c] $\mu g/m^3$	$\mu g/m^3$
Particulates							
(24-hour average)	29	9.3	4.8	2.2	150	150	37
Sulfur Dioxide							
(3-hour average)	251	85	48	23	1,300	1,300	512
(24-hour average)	27	12	6.2	2.8	365	365	91
Carbon Monoxide							
(1-hour average)	1,278	443	243	117	40,000	40,000	None
(8-hour average)	985	342	187	91	10,000	10,000	None
Nitrogen Dioxide							
(24-hour average)	26	8.3	4.3	2.0		250	None
Hydrocarbons							
(3-hour average)	59	20	12	5.4		160	

a. For 1-, 3-, and 8-hour concentration calculations, emissions from the mine shafts were assumed to diffuse according to Turner's equation 3.1.[26] Estimates of 24-hour average ambient pollutant concentrations are based on application of a standard sector-averaged diffusion equation.[26] Emissions were assumed to occur at ground level.

b. Allowable increase over baseline for Class II areas.

c. South Dakota standards (table 2.7.2-2).

Table 2.7.3.2-3

Calculated Maximum Annual Average Ambient Contributions of Nonradiological Pollutants At Select Distances Downwind From Each Underground Mine Production Shaft[a]

Pollutant	Maximum Contribution ($\mu g/m^3$) at Select Downwind Distances From Shaft Release[c]				Standards		Significant Deterioration Increments[b]
	1000 m	2000 m	3000 m	5000 m	Federal $\mu g/m^3$	State $\mu g/m^3$	$\mu g/m^3$
SO_2	5.9	4.5	2.1	1.1	80	80	20
NO_2	4.3	3.2	1.6	0.8	100	100	None
Particulates[a]	4.5	3.5	1.6	0.8	60[a]	60[a]	19[a]
CO					No annual standards		
Hydrocarbons					No annual standards		

a. Particulate concentrations were calculated as annual arithmetic means. Federal and state ambient particulate standards are listed as annual geometric means. The annual arithmetic mean will always be larger than or equal to the annual geometric mean.

b. Allowable increase over baseline for Class II areas.

c. The indicated pollutant concentrations represent the average concentration values expected to result from production shaft releases. These concentration estimates are based on 1 year of onsite meteorological measurement, and an assumed E stability.

Fugitive dust releases from surface activities around the underground mines are discussed later in this subsection.

Surface Mining Operations - The largest nonradiological air quality impacts expected from surface operations will be at the Spencer-Richardson mine, the only proposed surface mine. However, these impacts will be limited to only about a 6-month period of mining activity. Consequently, air quality impacts from this operation will be of short duration. Estimations of maximum nonradiological air quality impacts at select distances for surface mining are conservatively based on emissions from the limited Spencer-Richardson operation.

In determining emission rates from the Spencer-Richardson mining operation, consideration was given to emissions from the fossil-fueled surface mining equipment (Table 2.7.3.1-2). For calculational purposes, it was assumed that all of the equipment anticipated for all of the surface mining operations will be used in the Spencer-Richardson operation. Fugitive dust was not considered in the source term for particulates in the impact calculation because of the difficulty in obtaining a quantitative release rate with the presently limited preoperational information. However, potential fugitive dust sources will be monitored and controlled as necessary to minimize any impact. A discussion of potential fugitive dust sources is presented in the latter part of this subsection.

The estimated maximum emission rates for this surface mining operation (Table 2.7.3.1-2) were used as input to a standard short-term area source dispersion equation.[26] From preoperational information, it was estimated that most of the emissions would emanate from an area about 300 m (984 ft) on a side. Calculations were made for the meteorological conditions specified in the succeeding paragraph, and resulting concentrations compared with Federal and state air quality standards and PSD standards (Tables 2.7.3.2-4 and 2.7.3.2-5).

It is anticipated that surface mining activities at the Spencer-Richardson mine will be conducted 8 hours per day, 5 days per week over a 6-month period. This operating schedule was assumed in determining the conservative meteorological conditions to use in the nonradiological ambient impact calculations. Since all of the surface mining is during daylight hours, a D-stability was chosen for short-term and annual average ambient impact calculations. For comparison with 1-, 3-, 8-, and 24-hour standards, D-stability was combined with a wind speed of 1 m/s (2.2 mi/h), and a persistent wind direction for ambient contribution estimates at selected distances from the area source. For comparison with annual standards, D-stability and the onsite wind information shown in Table 2.7.1.4-2 was used to estimate annual ambient concentrations for selected downwind distances. All nonradiological releases from surface mining operations were assumed to be ground-level.

The estimated short-term and annual-average ambient contributions presented in Table 2.7.3.2-4 and Table 2.7.3.2-5, respectively, indicate that ambient pollutant concentrations can

Table 2.7.3.2-4

Calculated Maximum Short-Term Contributions of Air Pollutants At Select Distances Downwind From the Spencer-Richardson Surface Mining Operation[a]

Pollutant	Maximum Contribution ($\mu g/m^3$) at Select Downwind Distances From Surface Mine				Most Stringent Short-Term Ambient Standards		Short-Term Significant Deterioration Increment[b]
	1000 m	2000 m	3000 m	5000 m	Federal $\mu g/m^3$	State[c] $\mu g/m^3$	$\mu g/m^3$
Particulates (24-hour average)	1.5	.8	.5	.3	150	150	37
Sulfur Dioxide							
(3-hour average)	7.4	4.0	2.7	1.4	1,300	1,300	512
(24-hour average)	1.8	1.0	.6	.3	365	365	91
Carbon Monoxide							
(1-hour average)	30.7	15.9	10.8	5.8	40,000	40,000	None
(8-hour average)	21.2	11.7	7.5	4.0	10,000	10,000	None
Nitrogen Dioxide (24-hour average)	24.9	13.5	8.7	4.8		250	None
Hydrocarbons	8.9	4.8	3.2	1.7		160	None

a. Emissions from the surface mine were treated as an area source. The dimensions of this area source were defined and a virtual point source determined using methods recommended by Turner.[26] Emissions were assumed to occur at ground level.

b. Allowable increase over baseline for Class II areas.

c. South Dakota standards (table 2.7.2-2).

Table 2.7.3.2-5

Calculated Maximum Annual Average Contributions of Air Pollutants At Select Distances Downwind From the Spencer-Richardson Surface Mining Operation

Pollutant	Maximum Contribution ($\mu g/m^3$) at Select Downwind Distances From Surface Release[c]				Standards		Significant Deterioration Increments[b]
	1000 m	2000 m	3000 m	5000 m	Federal $\mu g/m^3$	State $\mu g/m^3$	$\mu g/m^3$
SO_2	0.4	0.2	0.1	.07	80	80	20
NO_2	6.0	3.1	1.9	1.0	100	100	None
Particulates[a]	0.4	0.2	0.1	.07	60[a]	60[a]	19[a]
CO					No annual standard		None
Hydrocarbons					No annual standard		None

a. Particulate concentrations were calculated as annual arithmetic means. Federal and state ambient particulate standards are listed as annual geometric means. The annual arithmetic mean is normally larger than the annual geometric mean.

b. Allowable increase over baseline for Class II areas.

c. The indicated pollutant concentrations represent average concentration values expected to result from production shaft releases. These concentration estimates are based on 1 year of onsite meteorological measurement, and an assumed D stability.

be expected to stay far below Federal and state ambient standards. The data presented in these tables also indicate that ambient contributions from the surface mining activities can be expected to be much less than the allowable Class II significant deterioration increments.

Annual-average meteorological conditions were also used in estimating radiological impacts from surface mining operations (Section 2.8.2). Annual-average meteorological assumptions used in radiological impact assessment of underground mine shaft releases are identified in the subsection on underground mining. The meteorology used in the radiological impact estimation consisted of an assumed E stability and the onsite wind information presented in Table 2.7.1.4-2.

Fugitive Dust - Preoperational information on fugitive dust from the planned mining operation is limited. Fugitive dust is expected from four major sources: (1) construction, (2) ore and waste rock storage, (3) vehicular travel on roads, and (4) surface mining.

Construction - Fugitive dust during the project construction phase will be associated with land clearing, ground excavation, cut and fill operations, and equipment traffic over access roads. The EPA has presented an emission factor of 2.7 t/ha/month (1.2 ton/acre/month) for fugitive dust during moderate construction activity.[24] This emission factor was developed from data collected around construction sites in Las Vegas, Nevada, and Maricopa County, Arizona, and is applied to particles less than about 30 μm in diameter.[24] Particles of this size have the potential for remaining airborne beyond project boundaries.

Surface construction activities for this project are expected to be less extensive than those for which this emission factor was developed and to be of short duration (about 6-9 months). In addition, overburden removal activities which have a potential to release substantial amounts of fugitive dust are already 70 percent complete at the Spencer-Richardson mine. The total anticipated surface disturbance for all new mine sites over the life of the mining operation will be about 35 ha (90 acre). An effective mitigation program is estimated to reduce construction-related fugitive dust by up to 50 percent.

Unpaved Roads - On the average, fugitive dust from unpaved roads with no mitigation applied have the following particulate size characteristics:

Particle Size Diameter	Weight Percent
< 30 μm	60
≥ 30 μm but < 100 μm	40

Particles larger than 100 μm are not considered in fugitive dust estimations from unpaved roads. Studies indicate that with mean wind speeds of 4.4 m/s (10 mi/h) or less,[24] these particles are likely to settle out within 6 to 9 m (20-30 ft) from the edge of the road. Particles with diameters in the 30 to 100 μm range are likely to settle out within a few hundred feet of the road depending on atmospheric turbulence. Thus, only about 60 percent of the fugitive dust from uncontrolled roads has a potential of remaining suspended. The fugitive dust will be carried away and dispersed by turbulent mixing. Resultant impacts are expected to be relatively minor and localized.

Based on EPA-recommended procedures for estimating fugitive dust from unpaved roads,[24] the estimated emission factor for vehicle travel on unpaved roads in the project area is about 3.30 kg/vehicle-km (11.72 lb/vehicle-mi). Approximately 1.98 kg/vehicle-km (7.03 lb/vehicle-mi) is expected to remain suspended.

It is estimated that chemical treatment or frequent watering of unpaved roadways can reduce fugitive dust by up to 50 percent.[24] Continuous watering of frequently traveled roads will be performed as ground and weather conditions require. Thus, the expected fugitive dust emission rates presented in the preceding paragraph will be substantially reduced, and resultant impacts should not be significant.

Ore and Waste Rock Storage - Fugitive dust associated with ore and waste rock storage piles can be divided into the contributions of several distinct source activities: (1) loading onto storage piles, (2) equipment traffic in storage areas, (3) wind erosion, and (4) loadout of ore and waste rock for processing or transportation. Approximate percentages of the total ore and waste rock storage dust emissions for each of these four activities are 12, 40, 33, and 15 percent, respectively.[24] Using EPA recommended procedures, an emission factor for fugitive dust of 0.66 kg/t (1.63 lb/ton) of ore and waste rock placed in storage was estimated for the project area.

Topsoil storage piles associated with the project will be seeded to prevent wind erosion (see Section 3.5). Initially, mined ore for the most part will be moist, so dust control during loading operations should not be necessary. However, sprinkling will be provided to prevent dust releases from ore and waste rock storage piles, if conditions warrant such action. The potential for dust in the storage areas from equipment traffic will be controlled by watering as ground and weather conditions require.

2.7.3.3 Air Pollution Control - Control methods for nonradiological air pollutants applicable to this project will depend primarily on the types or combinations of mining methods chosen. The primary pollutant caused by surface activity is likely to be fugitive dust. This problem will be mitigated to a large extent by revegetation of waste dumps, stockpiles and other disturbed areas and by watering of haulage roads as weather and ground conditions require. Combustion emissions from above-ground vehicles are regulated by EPA. Applicable emission standards depend on the year of vehicle manufacture.

Emissions from diesel engines used in underground mining and the operation of shaft heaters will be controlled in order to maintain underground pollutant concentrations below applicable MSHA standards (Table 2.7.3.1-1). The amount of fugitive dust generated by underground operations depends to a large extent on the moisture content of the material to be mined. High moisture contents are expected in the Burdock mine, so fugitive dust amounts released from underground shafts should be small. As previously mentioned, lower moisture contents are expected in the Runge East underground mine, so some fugitive dust may be released through its mine shafts. However, these amounts should also be small because of the limited nature of the Runge East operation.

2.7.3.4 Cumulative Project Air Quality Impacts - Nonradiological air quality impacts from simultaneous operation of the underground and surface projects will primarily result from fugitive dust attributed to surface mining, vehicular travel on largely unpaved roads, and wind erosion of stockpiles, waste piles, and disturbed lands. With the planned mitigation, fugitive dust impacts can be held to a minimum and should only result in a small impact on the project area's air quality. Nonradiological air emissions from fossil-fuel combustion will also result in some degradation of the local air quality. However, cumulative concentrations from all mining operations should stay well within Federal and state ambient air quality standards because the sources are small, will be widely dispersed, and will have different release characteristics. Increased turbulence associated with the intervening topography is also expected to reduce additive concentrations.

2.7.4 - Nonradiological Air Quality Monitoring - An air quality monitoring program will be performed at the mining site to conform with the requirements of the appropriate regulatory agencies. What is considered to be an adequate monitoring program is described below. However, the actual program would differ somewhat based upon the requirements of the regulatory agencies. Additional monitoring will be carried out as necessary.

At least one year prior to ore production, air quality monitoring will commence to establish background concentrations for particulates. The monitoring station will be maintained by the mine operator and will consist of a high-volume sampler collecting 24-hour samples once every 6 days. A site-specific meteorological facility, located at the old mill site in Edgemont, is presently collecting wind speed, wind direction, temperature, relative humidity, and precipitation information. The air quality monitoring station will be located in such a manner as to preclude significant interference from mine development activities.

Operational air quality monitoring will be conducted at locations where the maximum particulate impact from the mining project is expected. The preproduction information will be analyzed to determine the number of monitoring stations required for the operational program.

Samples from the high-volume monitors will be analyzed for particulate mass. Analysis for radionuclide concentrations are discussed in Section 2.8.3.

Results of the operational monitoring program will be evaluated periodically to determine if changes in the program are appropriate.

2.7 References

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2.8 Radiological

2.8.1 Description of the Existing Environment - Sampling of environmental media for background radioactivity levels was begun in July 1975. Samples of surface and ground waters, sediment, soil, and vegetation have been taken in various seasons of the year and returned to TVA's Radioanalytical Laboratory for analysis. These data establish a baseline on the distribution of background radioactivity in the environment within the project area and may be used in determining the impact of mining operations on the environment. The results from samples collected to date are listed in Tables 2.8.1-1 through 2.8.1-5.

Uranium concentrations were determined by fluorimetry and thorium concentrations (reported as thorium-230) were determined by chemical separation of thorium followed by alpha counting. Beginning in May 1976, radium-226 concentrations were determined by the radon emanation technique.

The available results for bismuth-214 and those results for radium-226 obtained through the use of gamma spectroscopy must be viewed and used with caution. These results were determined by use of gamma scans using lithium-drifted germanium detector systems. The interpretation of a gamma spectrum from such a gamma scan, to identify and quantify some of the uranium isotopes and their progeny, is extremely difficult because of the presence of overlapping peaks. To obtain the reported values, radium-226 was considered to be in equilibrium with bismuth-214 when each of the spectra was interpreted. Consideration also must be given to potential contributions by background and other radionuclides to the reported radium and bismuth concentrations.

2.8.2 Radiological Impacts - Atmosphere - Small amounts of radioactive materials will be released to the atmosphere as a result of mining operations. These releases will result in small exposures to man and other biota from both external and internal sources. Doses from external sources include doses from submersion in gaseous effluent and doses from exposure to soil on which very small amounts of radioactive material have been deposited. Doses to area organisms from radionuclides deposited internally are believed to be larger than the doses from external sources of radiation. These internal exposures result primarily from radionuclides ingested with food and from the inhalation of airborne radioactivity. Taking into consideration the land use characteristics in the project area and the belief that radionuclides such as radium and lead do not concentrate in plants, doses from the inhalation of airborne radioactivity are likely to be the highest doses which organisms in the area will receive.

Underground mining in the saturation zone will be performed at the Burdock mine; therefore, a high water content in the mined material may be expected. This high moisture content is likely to result in minimal particulate generation. Consequently, effluent releases of radioactive materials associated with particulates from the mining operation may be expected to be very small. However, even if appreciable quantities of particulates were generated, dilution of the original concentrations by the large volume of ventilating air and by natural dispersion in the atmosphere would be expected to result in concentrations at the

Table 2.8.1-1

Radioactivity Levels - Edgemont Project Area

Ground Water (Dissolved Activity)

Sampling Location	Date Collected	Gross α pCi/ℓ	Gross β pCi/ℓ	Natural U μg/ℓ	^{230}Th pCi/ℓ	^{226}Ra Dissolved pCi/ℓ	^{226}Ra Suspended pCi/ℓ	^{210}Pb pCi/ℓ	^{210}Po pCi/ℓ
Francis Peterson Ranch Well	8/16/76	-	-	2.29	0.02 ± 0.07[a]	2.55 ± 0.03			
Burdock Site (Lakota)	8/16/76	-	-	1.12	0.84 ± 0.16	1.55 ± 0.02			
Burdock Well B-1 (Fall River)	11/12/76	-	-	0.87	1.1 ± 0.2	0.55 ± 0.03			
	4/27/77	-	-	0.25	0.04 ± 0.07	0.43 ± 0.03		b	b
	7/21/77	-	-	0.25	0.3 ± 0.2	0.91 ± 0.04			
	11/15/77	-	-	0.41	0.4 ± 0.1	0.35 ± 0.03			
Burdock Well B-2 (Lakota)	11/12/76	-	-	9.49	0.5 ± 0.1	133.2 ± 0.4			
	4/27/77	-	-	0.32	0.06 ± 0.07	80.6 ± 0.3			
	7/21/77	-	-	0.19	0.05 ± 0.10	33.2 ± 0.2		c	33.2 ± 0.2
Burdock Well # 1	2/08/77 (Start of Pump Test)	89.9 ± 8.7	75.7 ± 4.7	6.39	0.2 ± 0.08	111.4 ± 0.4			
	2/21/77 (During Pump Test)	169.9 ± 14.9	94.0 ± 9.6	8.20	0.2 ± 0.09	222.4 ± 0.5			
	2/25/77 (end)	113.8 ± 8.9	84.5 ± 4.9	7.29	0.2 ± 0.09	226.6 ± 0.6			
	4/27/77	76.7 ± 5.9	54.9 ± 2.8	0.51	-0.04 ± 0.04[d]	159.3 ± 0.4		b	b
	7/21/77	-	-	0.10	0.1 ± 0.1	230.1 ± 0.6			
	11/14/77 (Start of Pump Test)	178.9 ± 9.7	133.6 ± 4.1	7.49	0.2 ± 0.1	189.8 ± 0.5	0.64 ± 0.004		
	11/14/77 (3 Hours After Start)	204.0 ± 10.3	154.8 ± 4.5	9.50	0.02 ± 0.06	204.6 ± 0.5	0.70 ± 0.004		
	11/17/77 (End of Pump Test)	377.2 ± 14.8	56.7 ± 3.6	5.85	0.9 ± 0.2	183.0 ± 0.5	0.56 ± 0.004		
Holding Pond for Burdock Well # 1	4/27/77	10.6 ± 2.5	26.2 ± 1.8	5.46	0.4 ± 0.1	29.95 ± 0.20			
	7/21/77	-	-	5.00	0.04 ± 0.06	4.31 ± 0.08		b	b
	11/17/77 (After Pump Test)	141.8 ± 9.0	49.0 ± 3.0	4.66	1.15 ± 0.17	83.7 ± 0.3	30.0 ± 0.2		
Miles Spencer Ranch Well	4/27/77	-	-	0.08	0.04 ± 0.07	1.87 ± 0.05			
Preston Richardson Ranch Well	4/27/77	-	-	0.16	0.01 ± 0.07	4.42 ± 0.08			
Wayne Peterson Ranch Well	4/27/77	-	-	1.00	-0.01 ± 0.06[d]	2.97 ± 0.06			
Glen Peterson Ranch, Well D-27 (Lakota)	4/27/77	-	-	0.48	0.13 ± 0.08	10.36 ± 0.12			
	11/15/77	-	-	0.43	0.10 ± 0.08	9.61 ± 0.11			
Glen Peterson Ranch, Well D-26 (Fall River)	4/27/77	-	-	0.06	0.11 ± 0.08	1.08 ± 0.04			
	11/15/77	-	-	0.11	0.70 ± 0.14	2.95 ± 0.07			
Well D-11	11/15/77	-	-	0.32	0.23 ± 0.09	1.37 ± 0.04			
Well D-17	11/15/77	-	-	1.83	0.28 ± 0.10	2.08 ± 0.05			
Well D-19	11/15/77	-	-	4.00	0.22 ± 0.09	1.73 ± 0.05			
Darrow Well	11/15/77	-	-	5.68	0.28 ± 0.10	97.25 ± 0.35			

a - The error reported is the 1-sigma counting error.
b - Insufficient sample.
c - Sample lost during analysis.
d - Negative value is an artifact of counting statistics and does not infer a negative activity.

Table 2.8.1-2

Radioactivity Levels - Edgemont Project Area - Soil[a]

Sampling Location	Date Collected	Gross α pCi/g	Gross β pCi/g	Natural U μg/g	^{230}Th pCi/g	^{226}Ra pCi/g	^{214}Bi[c] pCi/g	^{137}Cs[c] pCi/g	^{210}Pb pCi/g	^{210}Po pCi/g
Burdock, Southeast; East Central Section 11	7/31/75	0.6 ± 0.1[b]	5.2 ± 0.2	-	-	1.11 ± 0.04[c]	1.0 ± 0.04	0.1 ± 0.01	-	-
	5/5/76	6.9 ± 0.8	-	2.98	3.6 ± 0.4	0.74 ± 0.02	1.3 ± 0.07	0.9 ± 0.03	-	-
	8/25/76	-	-	1.73	2.3 ± 0.2	0.91 ± 0.03	-	-	-	-
	11/12/76	-	-	2.07	2.9 ± 0.3	1.11 ± 0.03	-	-	-	-
	4/27/77	14.6 ± 1.7	-	2.26	1.8 ± 0.2	1.10 ± 0.03	-	-	-	-
	7/21/77	-	-	6.33	1.1 ± 0.2	1.30 ± 0.03	-	-	5.2 ± 0.4	2.9 ± 0.3
	11/15/77	-	-	4.08	0.08 ± 0.08	1.35 ± 0.03	-	-	10.8 ± 0.6	5.2 ± 0.4
Burdock, West; North Central Section 15	5/5/76	7.3 ± 0.8	-	2.67	0.6 ± 0.2	0.85 ± 0.03	0.9 ± 0.03	0.3 ± 0.01	-	-
	8/25/76	-	-	4.42	3.8 ± 0.3	1.36 ± 0.03	-	-	-	-
	11/12/76	-	-	1.82	2.0 ± 0.2	1.09 ± 0.03	-	-	-	-
	4/27/77	10.9 ± 1.5	-	2.07	0.8 ± 0.2	1.03 ± 0.03	-	-	-	-
	7/21/77	-	-	2.34	0.0 ± 0.06	1.35 ± 0.03	-	-	6.7 ± 0.4	4.0 ± 0.3
	11/15/77	-	-	2.40	0.2 ± 0.1	0.71 ± 0.02	-	-	5.6 ± 0.5	5.6 ± 0.3
Pit # 6 Area; Northeast Section 2	5/5/76	8.1 ± 0.9	-	4.78	2.3 ± 0.3	2.15 ± 0.04	1.8 ± 0.07	0.9 ± 0.03	-	-
	8/25/76	-	-	0.64	2.3 ± 0.2	1.08 ± 0.03	-	-	-	-
	11/12/76	-	-	1.50	1.9 ± 0.2	1.07 ± 0.03	-	-	-	-
	4/27/77	24.6 ± 2.1	-	2.35	3.0 ± 0.3	3.20 ± 0.05	-	-	-	-
	7/21/77	-	-	5.36	2.3 ± 0.3	2.07 ± 0.04	-	-	56.7 ± 2.9	14.9 ± 2.7
	11/15/77	-	-	4.37	0.2 ± 0.1	1.81 ± 0.04	-	-	8.9 ± 0.6	10.5 ± 0.4
Runge, East; Central Section 31	5/5/76	4.9 ± 0.7	-	2.94	0.1 ± 0.1	0.97 ± 0.03	1.4 ± 0.05	1.2 ± 0.03	-	-
	8/25/76	-	-	2.70	0.4 ± 0.1	1.55 ± 0.03	-	-	-	-
	11/12/76	-	-	1.86	1.6 ± 0.2	1.38 ± 0.03	-	-	-	-
	4/27/77	9.5 ± 1.4	-	2.28	2.1 ± 0.2	1.97 ± 0.04	-	-	-	-
	7/21/77	-	-	3.11	1.4 ± 0.2	1.37 ± 0.03	-	-	14.1 ± 0.7	11.3 ± 1.2
	11/15/77	-	-	2.46	0.05 ± 0.08	1.30 ± 0.03	-	-	4.7 ± 0.5	3.5 ± [illegible]
Burdock Mill # 1 (West)	11/15/77	-	-	2.41	0.08 ± 0.08	0.74 ± 0.02	-	-	4.7 ± 0.5	4.8 ± 0.2
Burdock Mill # 2 (North)	11/15/77	-	-	1.13	-0.02 ± 0.06[d]	1.00 ± 0.03	-	-	7.4 ± 0.6	6.3 ± 0.3
Burdock Mill # 3 (East)	11/15/77	-	-	3.76	0.11 ± 0.09	1.32 ± 0.03	-	-	4.8 ± 0.5	5.0 ± 0.3
Burdock Mill # 4 (South)	11/15/77	-	-	1.32	0.08 ± 0.08	0.82 ± 0.03	-	-	4.6 ± 0.4	4.9 ± 0.3

a - All results reported on a dry weight basis.
b - The error reported is the 1-sigma counting error.
c - Results obtained by gamma spectroscopy using a Ge(Li) detection system. Analysis for Ra-226 and Bi-214 using this method may produce results which are of questionable reliability.
d - Negative value is an artifact of counting statistics and does not infer a negative activity.

Table 2.8.1-3

Radioactivity Levels - Edgemont Project Area
Vegetation[a]

Sampling Location	Date Collected	Gross α ρCi/g	Gross β ρCi/g	Natural U μg/g	^{230}Th ρCi/g	^{226}Ra ρCi/g	^{214}Bi[c] ρCi/g	^{137}Cs[c] ρCi/g
Burdock, Southeast; East Central Section 11	7/31/75	0.01 ± 0.01[b]	10.1 ± 0.1	-	-	0.30 ± 0.05[c]	0.30 ± 0.05	d
	5/5/76	0.5 ± 0.2	-	0.14	0.17 ± 0.02	0.11 ± 0.01	d	0.2 ± 0.03
	8/25/76	-	-	0.22	0.19 ± 0.03	0.28 ± 0.01	-	-
	11/12/76	-	-	e	e	0.08 ± 0.004	-	-
	4/27/77	-	-	0.14	0.19 ± 0.03	0.12 ± 0.01	-	-
	7/21/77	-	-	0.12	0.00 ± 0.01	0.17 ± 0.02	-	-
	11/15/77	-	-	0.15	-0.002 ± 0.004[f]	0.10 ± 0.001	-	-
Burdock, West; North Central Section 15	5/5/76	0.3 ± 0.2	-	0.07	0.13 ± 0.02	0.19 ± 0.01	d	0.2 ± 0.02
	8/25/76	-	-	0.21	0.19 ± 0.03	0.46 ± 0.02	-	-
	11/12/76	-	-	0.05	0.03 ± 0.01	0.15 ± 0.006	-	-
	4/27/77	-	-	0.17	0.01 ± 0.02	0.11 ± 0.01	-	-
	7/21/77	-	-	0.13	0.01 ± 0.01	1.01 ± 0.04	-	-
	11/15/77	-	-	0.13	0.03 ± 0.02	0.05 ± 0.001	-	-
Pit #6 Area; Northeast Section 2	5/5/76	0.9 ± 0.2	-	0.04	0.03 ± 0.01	0.15 ± 0.01	0.6 ± 0.07	0.2 ± 0.02
	8/25/76	-	-	0.03	0.10 ± 0.01	0.65 ± 0.01	-	-
	11/12/76	-	-	e	e	0.14 ± 0.007	-	-
	4/27/77	-	-	0.24	0.05 ± 0.14	0.17 ± 0.01	-	-
	7/21/77	-	-	0.21	0.01 ± 0.01	0.16 ± 0.02	-	-
	11/15/77	-	-	0.17	0.01 ± 0.02	0.22 ± 0.001	-	-

a - All results reported on a dry weight basis.
b - The error reported is the 1-sigma counting error.
c - Results obtained by gamma spectroscopy using a Ge(Li) detection system. Analysis for Ra-226 and Bi-214 using this method may produce results which are of questionable reliability.
d - None detected.
e - Insufficient sample.
f - Negative value is an artifact of counting statistics and does not infer a negative activity.

Table 2.8.1-3 (Continued)

Radioactivity Levels - Edgemont Project Area
Vegetation[a]

Sampling Location	Date Collected	Gross α ρCi/g	Gross β ρCi/g	Natural U μg/g	^{230}Th ρCi/g	^{226}Ra ρCi/g	^{214}Bi[c] ρCi/g	^{137}Cs[c] ρCi/g
Runge, East; Central Section 31	5/5/76	1.0 ± 0.2	-	0.22	0.14 ± 0.02	0.26 ± 0.01	0.8 ± 0.1	0.4 ± 0.04
	8/25/76	-	-	0.02	0.01 ± 0.01	0.07 ± 0.004	-	-
	11/12/76	-	-	e	e	0.10 ± 0.007	-	-
	4/27/77	-	-	0.90	0.15 ± 0.03	0.34 ± 0.01	-	-
	7/21/77	-	-	0.42	0.01 ± 0.01	0.31 ± 0.02	-	-
	11/15/77	-	-	0.54	0.03 ± 0.01	0.24 ± 0.001	-	-
Burdock Mill #1, West	11/15/77	-	-	0.45	0.01 ± 0.01	0.25 ± 0.001	-	g
Burdock Mill #2, North	11/15/77	-	-	0.13	0.03 ± 0.01	0.08 ± 0.001	-	g
Burdock Mill #3, East	11/15/77	-	-	0.31	0.03 ± 0.01	0.10 ± 0.001	-	g
Burdock Mill #4, South	11/15/77	-	-	0.26	0.03 ± 0.01	0.11 ± 0.001	-	g

a - All results reported on a dry weight basis.
c - Results obtained by gamma spectroscopy using a Ge(Li) detection system. Analysis for Ra-226 and Bi-214 using this method may produce results which are of questionable reliability.
e - Insufficient sample.
g - Analysis not complete.

Table 2.8.1-4

Radioactivity Levels - Beaver Creek Surface Water (Dissolved Activity)

Sampling Location	Date Collected	Gross Alpha pCi/ℓ	Gross Beta pCi/ℓ	Natural U μg/ℓ	^{230}Th pCi/ℓ	^{226}Ra pCi/ℓ
Beaver Creek at Hwy. 85 Bridge	7-31-75	1.1 ± 1.1[a]	5.5 ± 2.5	-	-	-
	5-5-76	-	-	9.8	0.09 ± 0.15	1.11
	8-25-76	-	-	4.0	0.27 ± 0.11	0.17 ± 0.02
	11-12-76	-	-	8.6	0.05 ± 0.05	0.15 ± 0.02
	4-27-77	-	-	5.4	0.17 ± 0.09	0.20 ± 0.02
	7-21-77	-	-	9.7	0.14 ± 0.08	1.09 ± 0.04
	11-15-77	-	-	5.4	0.17 ± 0.09	0.38 ± 0.03
Beaver Creek at Mouth	5-5-76	-	-	10.5	0.24 ± 0.20	0.05
	8-25-76[b]	-	-	-	-	-
	11-12-76	-	-	9.6	0.63 ± 0.13	0.08 ± 0.02
	4-27-77	-	-	6.1	0.17 ± 0.09	0.36 ± 0.03
	7-21-77	0.3 ± 2.0	40.4 ± 3.8	16.5	0.17 ± 0.09	0.25 ± 0.02
	11-15-77	-	-	4.6	0.12 ± 0.08	0.20 ± 0.02
Beaver Creek Control (Upstream)	5-5-76	-	-	11.3	0.16 ± 0.16	0.08
	8-25-76	-	-	5.1	0.97 ± 0.30	0.20 ± 0.02
	11-12-76	-	-	9.7	1.08 ± 0.17	0.10 ± 0.02
	4-27-77	-	-	7.4	0.24 ± 0.10	0.22 ± 0.02
	7-21-77	-	-	10.9	0.29 ± 0.10	0.31 ± 0.03

a - The error reported is the 1-sigma counting error.

b - Sample lost in transit.

Table 2.8.1-5

Radioactivity Levels - Beaver Creek
Bottom Sediment[a]

Sampling Location	Date Collected	Gross Alpha pCi/g	Gross Beta pCi/g	Natural U µg/g	^{230}Th pCi/g	^{226}Ra pCi/g	^{214}Bi[b] pCi/g	^{137}Cs[b] pCi/g	^{210}Pb pCi/g	^{210}Po pCi/g
Beaver Creek at Old Hwy 85 Bridge	7/31/75	0.7 ± 0.1[c]	5.3 ± 0.2	-	-	1.06 ± 0.04[b]	0.93 ± 0.04	1.7 ± 0.01	-	-
	5/5/76	5.4 ± 0.7	-	2.57	0.3 ± 0.2	1.29 ± 0.03	0.75 ± 0.05	0.1 ± 0.02	-	-
	8/25/76	-	-	1.48	1.5 ± 0.2	1.06 ± 0.03	-	-	-	-
	11/12/76	-	-	1.12	2.1 ± 0.2	0.98 ± 0.03	-	-	-	-
	4/27/77	-	-	1.42	0.3 ± 0.1	1.15 ± 0.03	-	-	-	-
	7/21/77	-	-	3.4	-0.05 ± 0.07[d]	0.91 ± 0.03	-	-	-	-
	11/15/77	-	-	0.02	0.8 ± 0.2	0.44 ± 0.02	-	-	3.3 ± 0.4	1.5 ± 0.2
Beaver Creek at Mouth	5/5/76	8.0 ± 0.9	-	2.65	0.06 ± 0.2	1.25 ± 0.03	1.3 ± 0.7	0.6 ± 0.03	-	-
	8/25/76	-	-	2.23	0.4 ± 0.1	1.71 ± 0.04	-	-	-	-
	11/12/76	-	-	0.86	2.6 ± 0.3	0.84 ± 0.03	-	-	-	-
	4/27/77	-	-	0.87	0.2 ± 0.1	1.31 ± 0.03	-	-	-	-
	7/21/77	-	-	4.1	0.5 ± 0.2	2.45 ± 0.05	-	-	-	-
	11/15/77	-	-	0.72	0.2 ± 0.1	0.83 ± 0.02	-	-	5.5 ± 0.5	4.8 ± 0.4
Beaver Creek, Upstream	5/5/76	5.54	-	4.37	0.4 ± 0.3	1.03 ± 0.03	1.4 ± 0.07	0.2 ± 0.03	-	-
	8/25/76	-	-	3.01	0.9 ± 0.2	1.23 ± 0.03	-	-	-	-
	11/12/76	-	-	1.50	2.9 ± 0.3	1.01 ± 0.03	-	-	-	-
	4/27/77	-	-	0.89	0.02 ± 0.07	1.34 ± 0 03	-	-	-	-
	7/21/77	-	-	3.7	0.02 ± 0.08	1.41 ± 0.04	-	-	-	-

a - All results reported on a dry weight basis.
b - Results obtained by gamma spectrometry using a Ge(Li) detection system. Analysis for Ra-226 and Bi-214 using this method may produce results which are of questionable reliability.
c - The error reported is the 1-sigma counting error.
d - Negative value is an artifact of counting statistics and does not infer a negative activity.

project boundary which are insignificant. Because sprinkling will be used as necessary to reduce the potential for dust generation along the main ore transport routes, that potential exposure pathway also should lead to insignificant exposure.

The principal gaseous effluent will be radon-222, resulting from the decay of radium-226, which is an established component of uranium ore. For purposes of calculation, radon-222 and its progeny will be assumed to be vented to the atmosphere from the underground mine exhausts such that the short-lived decay products of radon-222 are present in the following concentrations: ^{218}Po(RaA), 2.0 Bq/l (Becquerel/liter) (5.4 x 10^{-8} μCi/cm^3); ^{214}Pb(RaB), 1.1 Bq/l (3.0 x 10^{-8} μ Ci/cm^3); ^{214}Bi(RaC) and ^{214}Po(RaC'), each at 0.78 Bq/l (2.1 x 10^{-8} μ Ci/cm^3). These decay products are assumed to be released at an approximate composite 50 percent of the secular equilibrium level and are present at a concentration of 0.3 working levels (WL). In this regard one working level may be defined as any combination of short-lived decay products of radon-222 in one liter of air, without regard to the degree of equilibrium, that will result in the ultimate emission of 1.3 x 10^{+5} MeV of alpha-particle energy. The radon-222 concentration in the shaft exhaust then is assumed to be approximately 2.2 Bq/l (6.0 x 10^{-8} μCi/cm^3).

Ventilation characteristics have not been finalized. In accordance with preliminary plans, releases are assumed to be exhausted vertically at a ventilation flow rate of 56.6 m^3/s (2,000 ft^3/s) through each of the first two production shafts (see Figure 1.1.2.1-2). The flow is expected to be continuous (24 hours per day 7 days per week). The total estimated radon-222 emission rate is then approximately 2.5 x 10^5 Bq/s (6.8 Ci/s) or 2.2 x 10^{10} Bq/d (0.59 Ci/d).

Two ore stockpiles are expected to be established in the vicinity of each production shaft. Secular equilibrium through radium-226 is assumed for the ore, as is radon-222 flux (Bq/m^2.s) equal to 0.893 times the radium-226 concentration (Bq/g).[4] For purposes of calculation, one ore pile with an average U_3O_8 grade of 0.11 percent and an area of 8640 m^2 is assumed to exist near each production shaft, leading to a conservatively estimated total release from the ore piles of 1.6 x 10^{10} Bq/d (0.42 Ci/d) of radon-222. This release is assumed to be initially free of the short-lived decay products of radon-222.

Concentrations above background of radon-222 and its short-lived decay products are calculated using the emission information listed above and estimated annual average meteorological conditions (see Section 2.7.3) for the project area of interest in conjunction with a point-source, Gaussian plume model[5] for calculating dispersion of effluents.

Buildup of the short-lived decay products of radon-222 in transit is considered; however, processes for removal of the decay products from the atmosphere are not fully considered. Secular equilibirum values would therefore be calculated at large downwind distances. Such values in composite would probably exceed realistic composite values by a factor ranging from 2 to 5.

Concentrations at specified points of interest near the mining operation at the Burdock mine are presented in Table 2.8.2-1. These locations are generally locations where it is believed that the human occupancy factor is greater than zero; for example, residences. For such locations, indoor concentrations (in WL) and doses are calculated from the listed outdoor concentrations by assuming a ventilation rate of one air change per hour for each residence. Removal processes such as plateout of decay products on furniture are not considered. The calculated disequilibrium conditions (approximately 71 to 96 percent of secular equilibrum values) are therefore expected to exceed realistic disequilibrum conditions (believed to be in the 20 to 50 percent range) by factors ranging from approximately 1.5 to 4.5. The production shaft was used as the reference point for determination of distance and compass sector.

The highest annual average above-background concentration calculated at a known residence is approximately 2.7 x 10^{-4} Bq/l (7.3 x 10^{-12} μCi/cm^3) of radon-222 or approximately 5.6 x 10^{-5} WL of the short-lived decay products. This concentration is less than 1 percent of the maximum permissible concentration (MPC) for radon-222 or is less than 1 percent of MPC for the short-lived decay products of radon-222, as these MPC's are listed in the Code of Federal Regulations, Title 10, Part 20 (10CFR20) for release to unrestricted areas. These MPC's are used here as guidelines in the absence of applicable regulatory limits.

At a project boundary location, the maximum radon concentrations is 1.0 x 10^{-3} Bq/l (2.7 x 10^{-11} μCi/cm^3) or is 1.1 x 10^{-4} WL of the short-lived decay products.

These calculated concentrations can be compared roughly to the approximate average 5.5 x 10^{-3} Bq/l (1.5 x 10^{-10} μCi/cm^3) background concentration for radon-222 or the approximate average 1.0 x 10^{-3} WL background concentration for the short-lived decay products of radon-222.[6] In areas where radon exhalation is naturally high, background concentrations of radon-222 and its short-lived decay products may be significantly in excess of the above figures. The Edgemont area is very likely to be an area with high natural exhalation, and therefore high background concentrations.

Limited data collected for TVA to date suggest that background in the Edgemont, South Dakota, area may be in the range of 1.1 to 3.0 x 10^{-2} Bq/l (3 to 8 x 10^{-10} μCi/cm^3) for radon-222 and 3 to 6 x 10^{-3} WL (outdoors) for the short-lived radon progeny.[7] Limited data collected for the Nuclear Regulatory Commission suggest that appropriate background values for radon-222 may be in the range of 3.0 to 4.4 x 10^{-2} Bq/l (8 to 12 x 10^{-10} μCi/cm^3).[8]

Annual doses to the lungs (segmental bronchi) of adults residing in the project area from the inhalation of radon-222 and its short-lived decay products may be estimated by multiplying the appropriate decay product concentrations by the following dose conversion factors: ^{218}Po (RaA), 16 ram•l/y•Bq (0.6 x 10^9 rem•cm^3/y• μCi); ^{214}Pb(RaB), 27 rem•l/y•Bq (1.0 x 10^9 rem•cm^3/y Ci); and ^{214}Bi(RaC), 46 rem•l/y•Bq (1.7 x 10^3 rem•cm^3/y μCi). The dose conversion factor for ^{214}Po(RaC') is very small in comparison with the above factors. Use of these dose conversion

TABLE 2.8.2-1

RADIONUCLIDE CONCENTRATIONS AND ANNUAL INHALATION DOSES TO BRONCHIAL EPITHELIUM OF LUNGS OF AREA RESIDENTS

Location No.	Distance(m) and Direction[a]		Outdoor Concentrations Rn-222 Conc. (Bq/1)	Po-218 Conc. (Bq/1)	Pb-214 Conc. (Bq/1)	Bi-214 Conc. (Bq/1)	Rn-222 Decay Product Conc. (WL)[b]	Annual Dose (rem)[c]
1	3,660	N	1.9 (-4)	1.9 (-4)	1.5 (-4)	1.1 (-4)	4.5 (-5)	.015
2[e]	21,300	SE	1.2 (-5)	1.2 (-5)	1.2 (-5)	1.1 (-5)	3.1 (-6)	.001
3	1,770	SSE	2.3 (-4)	2.2 (-4)	1.3 (-4)	8.3 (-5)	4.8 (-5)	.016
4	3,220	SSE	1.1 (-4)	1.0 (-4)	7.3 (-5)	5.2 (-5)	2.4 (-5)	.008
5	1,910	SW	1.3 (-4)	1.3 (-4)	9.3 (-5)	6.6 (-5)	3.0 (-5)	.010
6	3,760	SSW	4.4 (-5)	4.4 (-5)	3.7 (-5)	3.0 (-5)	1.1 (-5)	.004
7[f]	4,180	WSW	5.4 (-5)	5.4 (-5)	4.3 (-5)	3.4 (-5)	1.3 (-5)	.004
8	890	W	1.0 (-3)	9.0 (-4)	4.3 (-4)	2.7 (-4)	1.1 (-4)	.038
9[g]	960	W	8.8 (-4)	7.9 (-4)	3.8 (-4)	2.4 (-4)	1.7 (-4)	.057
10	2,420	W	2.7 (-4)	2.6 (-4)	1.6 (-4)	1.1 (-4)	5.6 (-5)	.019
11	3,960	NW	9.1 (-5)	9.1 (-5)	5.9 (-5)	4.1 (-5)	2.0 (-5)	.007
12	3,360	NNW	1.2 (-4)	1.2 (-4)	7.9 (-5)	5.6 (-5)	2.6 (-5)	.009

Note: (1) Releases from shafts 1 and 2 and the associated ore piles are considered.
(2) 1 Curie (Ci) = 3.7×10^{10} Becquerel (Bq).

a. The reference point used for determining location distances and directions is production shaft number 1.
b. "WL" is working level (see text).
c. Doses to area residents are calculated using radon decay product disequilibrium assumptions which are conservative (see text).
d. 1.9 (-4) = 1.9×10^{-4}
e. City of Edgemont.
f. Lease boundary location; occupancy factor near zero.
g. Burdock School; no longer in use.

factors is believed to result in conservative (e.g., by an order of magnitude) estimates of the inhalation dose rates to the lung. Using these factors, the maximum annual average dose, is approximately 0.019 rem to the lung of an individual continuously occupying the "worst" known residence. The population dose to the lung for the city of Edgemont, with an assumed population of 2000 is estimated to be 2 person-rem. Doses due to natural background concentrations of the radionuclides of interest are likely to be in the range of hundreds of millirem per year and are here assumed to be approximately 0.35 rem/y per individual. The subsequent natural background population dose to the lung for Edgemont is therefore approximately 700 person-rem. The estimated population dose due to mining operations is therefore approximately 0.3 percent of the background lung dose for the nearest population center. If, as previously suggested, the background dose is higher than that estimated, the impact from mining operations would of course be reduced below the 0.3 percent increment.

Note should be made that a significant discrepancy exists between the doses implied by the figures on percentage of maximum permissible concentration and the doses calculated herein. The implied difference is believed to be primarily attributable to the anatomic lung model and the method of lung dosimetry used by the Nuclear Regulatory Commission (NRC) in determining the MPC for radon-222, as compared to the lung model and dosimetry used herein. In general, radon dosimetry is a very complex problem, and presentation of the many factors involved in radon dosimetry is beyond the scope of this statement. However, use of apparent NRC models would reduce the highest calculated doses by approximately a factor of 5.

Calculated concentrations for radon-222 and its short-lived decay products are much less than the maximum permissible concentrations used herein as guidelines. Also, the calculated annual average concentrations are significantly less than the assumed background concentration. The small number of persons continually occupying known residences in the immediate vicinity of the shafts may receive doses which range up to 5 percent of the assumed background dose.

A third production shaft may be sunk at the Burdock mine at some time subsequent to the sinking of the initial production shaft. The postulated location of this third shaft is 760 m (2500 ft) E of the second shaft. Because the location has not been finally determined, an accurate assessment of potential radiological impacts due to mining operations at this shaft site is not possible. However, an assessment was performed, considering releases from the postulated shaft and an adjacent ore pile, with doses determined at the same residence locations previously considered. Source terms for the shaft and ore pile are assumed to be the same as those used for each of the initial production shafts. Results of the calculations are presented in Table 2.8.2-2.

In addition to the Burdock mine, other mining operations are planned for the Edgemont area. Two "underground" mines are the Darrow and Runge East mines, located approximately 4,000 m (13,120 ft) NE and 16.4 km (10.2 mi) ESE of the Burdock No. 1 shaft, respectively. Assuming the same configuration, source

TABLE 2.8.2-2

RADIONUCLIDE CONCENTRATIONS AND ANNUAL INHALATION DOSES TO BRONCHIAL EPITHELIUM OF LUNGS OF AREA

RESIDENTS - POSTULATED RELEASES FROM SHAFT NO. 3

Location No.	Distance(m) and Direction[a]		Outdoor Concentrations: Rn-222 Conc. (Bq/l)	Po-218 Conc. (Bq/l)	Pb-214 Conc. (Bq/l)	Bi-214 Conc. (Bq/l)	Rn-222 Decay Product Conc. (WL)[b]	Annual Dose (rem)[c]
1	3,660	N	4.5 (-5)[d]	4.4 (-5)	2.8 (-5)	2.0 (-5)	9.7 (-6)	.003
2	21,300	SE	4.9 (-6)	4.9 (-6)	4.7 (-6)	4.6 (-6)	1.3 (-6)	.0004
3	1,770	SSE	4.0 (-5)	4.0 (-5)	2.9 (-5)	2.0 (-5)	9.1 (-6)	.003
4	3,220	SSE	3.4 (-5)	3.4 (-5)	2.6 (-5)	1.9 (-5)	7.9 (-6)	.003
5	1,910	SW	3.5 (-5)	3.5 (-5)	2.7 (-5)	2.0 (-5)	6.1 (-6)	.003
6	3,760	SSW	1.8 (-5)	1.8 (-5)	1.6 (-5)	1.4 (-5)	4.5 (-6)	.002
7[f]	4,180	WSW	1.8 (-5)	1.8 (-5)	1.5 (-5)	1.3 (-5)	4.3 (-6)	.001
8[g]	890	W	5.1 (-5)	5.1 (-5)	3.6 (-5)	2.6 (-5)	8.9 (-6)	.003
9[g]	960	W	5.0 (-5)	4.9 (-5)	3.5 (-5)	2.5 (-5)	1.1 (-5)	.004
10	2,420	W	6.7 (-5)	6.7 (-5)	4.7 (-5)	3.4 (-5)	1.5 (-5)	.005
11	3,960	NW	4.1 (-5)	4.1 (-5)	2.8 (-5)	1.9 (-5)	9.1 (-6)	.003
12	3,360	NNW	4.2 (-5)	4.1 (-5)	2.7 (-5)	1.9 (-5)	9.1 (-6)	.003

Note: (1) Release of radon-222 from the assumed ore pile adjacent to shaft No. 3 is also considered.
(2) 1 Curie (Ci) = 3.7×10^{10} Becquerel (Bq).

a. The reference point used for determining location distances and directions is production shaft number 1.
b. "WL" is working level (see text).
c. Doses to area residents are calculated using radon decay product disequilibrium assumptions which are conservative (see text).
d. 4.5 (-5) = 4.5×10^{-5}
e. City of Edgemont.
f. Lease boundary location; occupancy factor near zero.
g. Burdock School; no longer in use.

terms (hence, neglecting particulate generation underground), and meteorology as assumed for one shaft at the Burdock No. 1 mine, potential lung doses incurred by residents due to these mining operations are not expected to exceed 0.007 rem annually. A site identified for surface mining is the Spencer-Richardson site located approximately 4,330 m (14,200 ft) NNE of the Burdock No. 1 mine. No occupied residences have been identified within a 2,000 m (6,560 ft) radius of this site. Doses to occupants of the "worst" known residence near this operation are not expected to exceed approximately 0.008 rem to the lungs, based on release and dispersion characteristics the same as for one shaft at the Burdock No. 1 mine. The lung dose to the population of Edgemont due to all of the additional mining operations is conservatively estimated to be 2.8 person-rem per year; that is, the dose from these operations is likely to be approximately 0.4 percent of the assumed background dose. Based on present estimates of ore reserves, the additional operations are likely to be of short duration; therefore, the estimated dose rates will be applicable only for a short period of time (e.g., less than one year).

Concentrations of radon-222 at receptor locations, resulting from such subsequent underground operations as may be scheduled, would not be expected to exceed those concentrations calculated for the first operation, assuming that effluent concentrations do not exceed the concentrations assumed herein and that venting configurations would be similar.

> Note: Preliminary calculations were made to estimate doses from ingestion of beef and vegetables contaminated with the daughter products of radon-222. For the locations previously considered, the highest doses were found at the unoccupied project boundary location. These hypothetical doses were 0.0026 rem/y to bone and 0.0025 rem/y to kidney via the ingestion pathway. Doses to other organs were smaller than the above numbers. Considering the magnitude of these doses in comparison to the doses to the bronchial epithelium, no further discussion of the ingestion pathway was considered warranted.

Water - Small amounts of radioactive materials are contained in water produced during mining operations. Releases of such water could potentially result in small exposures to man and other biota, principally from the ingestion of waters in which there exist small, above-background concentrations of radionuclides.

No water quality changes are expected to be induced below ground during operations at the Burdock mine because net flow will be toward the mine and its depressuring wells. Depressuring operations will result in a quantity of ground water which will be stored in retention lagoons. Any deliberate discharge from the lagoons or any use of the water as drinking water would be permitted only if the proposed effluent or drinking water, respectively, meets applicable standards (see Table 2.6.1.1-3). The water would be treated, as necessary, to assure compliance with those standards. Periodic monitoring of soils and shallow ground water in any effluent discharge area may need to be conducted, depending on conditions of operation.

Proper design and operation of the rentention (of precipitation, drainage, etc.) lagoons, pipelines, and ore and waste storage pads at all of the mining sites will assure that (a) any effluent released in a planned operation would meet applicable standards, (b) any water to be used as drinking water would meet applicable standards, and (c) inadvertent releases of radionuclides will occur at minimal frequency and that any such release will be of minimal quantity. Appropriate radiological monitoring of area surface and ground waters would be conducted following any inadvertent release of sufficient quantities of radioactive materials to affect significantly radionuclide concentrations in those waters.

After cessation of mining operations at the Burdock mine, the reestablished hydraulic gradient will approach premining conditions. There may be some water quality changes down-gradient from the disrupted ore zone. This would be a result of oxidation and other chemical reactions that could change the solubility of salts and chemicals within an abandoned mine. (See Section 2.6.2.1.) Monitoring of the host aquifer could be continued into the post-mining stage to determine whether a study of ground-water quality in and near the abandoned mine area is necessary.

Considering the water use characteristics in the site areas, no significant exposure from ingestion of water containing above-background concentrations of radioactive materials is expected, due to the mining operations. Radiological surveillance programs will be designed to detect significant changes in radionuclide concentrations in the project areas. Mitigating measures would be instituted and implemented if water supplies are found to contain concentrations of radionuclides which are significantly increased due to project operations.

<u>2.8.3 Radiological Monitoring</u> - Waters generated during the mining operations will be treated, monitored, and discharged in compliance with applicable requirements. The actual effluent monitoring program will be designed by the mine operator to conform with the requirements of the appropriate regulatory agencies. It is anticipated that the program will include monthly sampling of the effluent, with analyses being performed to determine uranium and radium-226 contents. The environmental radiological monitoring program is designed to determine the radiological impact of mining operations on the environment. During the life of the facility, increases in radionuclide concentrations in the environment should exist in no more than trace amounts, with very minor or no impact on the environment. Operational monitoring program details (i.e., sampling locations, equipment, frequencies, etc.) will be determined through evaluation of site topography, meteorology, the preoperational monitoring program, and the requirements of appropriate regulatory agencies.

Preoperational sampling is conducted to establish a baseline of data on the distribution of background radioactivity in the environment. Efforts are made to begin this sampling at least one year prior to operation of the facility, with samples being collected in the various seasons of the year. Results available to date are presented in Section 2.8.1.

The operational-phase monitoring program presently envisioned is described in the paragraphs below.

Ground Water - Samples of ground water will be collected quarterly from at least two locations in the vicinity of the Burdock mining operations. Initial operational monitoring will include analyses for uranium and radium-226 content, and possibly for gross alpha content. Analyses for thorium-230, lead-210, or polonium-210 content may be conducted periodically, and these or other analyses will be conducted as required.

Surface Water and Sediment - Samples of surface water and bottom sediment will be taken quarterly from at least two locations in Beaver Creek. Water will be monitored for uranium and radium-226 content and sediment will be monitored for uranium, thorium-230, and radium-226. Gross alpha analysis may be performed on some samples. Any other analyses required by applicable regulations will also be performed.

Soil and Vegetation - Soil sampling will be conducted at least semi-annually at a minimum of one control and one indicator ("downwind") location around each mine. Uranium, thorium-230, and radium-226 analyses will be performed on all samples, while lead-210 or polonium-210 analyses will be performed on selected samples.

Vegetation will be sampled at least one time per year at a minimum of one control and one indicator ("downwind") location around each mine. Normally, samples will be taken during the growing season. Uranium, thorium-230, and radium-226 analyses will be performed on all samples while lead-210 or polonium-210 analyses will be performed on selected samples.

Air - Samples from the high-volume monitors discussed in Section 2.7.4 will be composited for quarterly analyses for uranium, thorium-230, radium-226, and lead-210 content. Plans are not finalized regarding the collection of samples for determination of radon-222 or radon-222 progeny concentrations. However, it is anticipated that either radon or radon progeny will be determined on a continuous basis for one week each month. Sampling locations for radon or its progeny are expected to be the same as those used for the high-volume sampling. Any sampling and analyses required by applicable regulations would be performed.

Results of the monitoring program will be evaluated periodically and appropriate changes in the program will be made. Such changes may include increasing or decreasing the frequency of sampling or the number of sampling locations, relocating some sampling locations, or discontinuing some sections of the monitoring program if measurements are consistently negligible. Sampling and analyses required by applicable regulations would in any case be performed.

2.8 References

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2.9 Flora and Fauna

2.9.1 Vegetation

2.9.1.1 Description - Surveys to document major vegetation types and floristic elements on the Edgemont project area were conducted for TVA during the period from fall 1975-fall 1976[1]. Three major vegetation regions are transected by the project area: grassland, ponderosa pine, and desert shrub.[2] Grassland vegetation communities are dominated by buffalo grass (*Buchloe dactyloides* (Nutt.) Engelm.), blue grama (*Bouteloua gracilis* (HBK) lag.), western wheatgrass (*Agropyron smithii* Rydb.), Sandberg bluegrass (*Poa secunda* Presl.) and little bluestem (*Andropogon scoparius* (Michx.) Nash). The ponderosa pine (*Pinus ponderosa* Lawson) region extends out of the Black Hills to include a large portion of the project area in both South Dakota and Wyoming. Major species within this zone are ponderosa pine, Rocky Mountain juniper (*Juniperus scopulorum* Sarg.) and sedge (*Carex* spp.). Big sagebrush (*Artemisia tridentata* Nutt.) and black greasewood (*Sarcobatus vermiculatus* Hood. Emory) communities, part of the desert shrub region, cover a major portion of the project area, especially dominating the western half and extending westward into the Powder River basin.

Vegetation on the project area has not extensively deteriorated from livestock use, but intensive overgrazing occurs in some areas (particularly near water). Overgrazed areas can also be found where sheep are being pastured. Although sheep grazing is important in portions of the project area in Wyoming, rangeland use is predominantly by cattle. Other domestic animals on or adjacent to the project area are horses, pigs, and goats. Generally, 2.7 to 3.9 ha (6.6 to 9.5 acre) are required to support one animal unit (a 1,000-pound cow and calf, five sheep or the equivalent) for one year on and near the project area.[3]

Crop production is generally limited to dry land hay or grain. Native hay crops usually yield less than 3,360 kg/ha (1.5 ton/acre). Wheat yields vary, but are generally below 3 m^3/ha (35 bu/acre). Other crops occasionally grown on the project area include dry land corn, barley and oats.

Fourteen major vegetation types were identified on the project areas: (1) abandoned--invaded (orphan mine lands), (2) silver sagebrush, (3) silver sagebrush--big sagebrush, (4) big sagebrush--medium stand, (5) big sagebrush--heavy stand, (6) sand sagebrush, (7) grassland, (8) little bluestem grassland, (9) prairie dog town, (10) rough breaks, (11) black greasewood-- big sagebrush, (12) black greasewood, (13) cottonwood bottom, and (14) ponderosa pine. Variations in species composition occur within most vegetation types as a result of such factors as microclimatic differences, slope aspect, gradient (angle), and length, grazing pressure, and moisture availability.

Of the major communities, those covering the greatest portion of the project area are: (1) sagebrush, (2) ponderosa pine, (3) rough breaks, and (4) grassland, (Table 2.9.1.1-1). In the big sagebrush, medium stand type, vegetative ground cover averaged 23 percent (76 percent of the surface area is litter, rocks and bare ground), of which grasses comprise approximately two-thirds. In the ponderosa pine, understory species average 8 percent ground cover. Grasses, the major life form on the rough breaks, comprise nearly half the total cover of 14 percent. Grassland averages 17 percent ground cover and is dominated by grasses with 12 percent cover. The ten remaining communities range from an average total percent ground cover of 16 percent on little bluestem grassland to 30 percent on silver sagebrush--big sagebrush.

Shrubs, a major portion of the ground cover in three communities (silver sagebrush, big sagebrush, heavy stand and black greasewood), comprise between one-third and one-half of total cover. Shrub density ranges from 50 plants/ha (20/acre) on the grassland to 14,602 plants/ha (5,912/acre) on big sagebrush, heavy stand. Other vegetation types with high shrub densities are black greasewood--big sagebrush, sand sagebrush, and silver sagebrush--big sagebrush. Of the plant species recorded for the project area, approximately 60 percent are forbs, 20 percent grasses, 10 percent shrubs, and 5 percent grasslike species. Trees, half-shrubs and succulents comprise the remaining 5 percent. Table 2.9.1.1-2 summarizes the 14 plant communities. In the Edgemont area, ponderosa pine stands have increased and encroachment into surrounding grasslands has occurred in the past 50 to 100 years.[4] Fire has occasionally been used to limit seedling invasion into adjacent little bluestem grasslands found along the margins of pine stands.

Ponderosa pine averaged 40.5 trees per hectare (16/acre) across the project area with a range of 21 to 67 trees/ha (9-27/acre). Over 95 percent of all trees had a DBH (Diameter at Breast Height-i.e. 1.6 m (4.5 ft) above ground) less than 33 cm (13 in). Trees with a DBH less than 12.7 cm (5 in) were not included in calculations. Over 80 percent had a DBH less than 20.3 cm (8 in). Pine stands were generally healthy and free of disease, except for an occasional tree infected by fungi or infested with pine bark beetles (<u>Dendroctonus</u> spp.). Timber stands in the area are used locally as a source of wood for firewood, fences, corrals, homesteads, barns, and small bridges.

No threatened or endangered plant species were found on or near the project areas.[5] Two plant species collected in Wyoming during summer 1976 were identified as being new state records. These two species, <u>Dalea enneandra</u> and <u>Triodanis perfoliata</u>, had not been previously collected in Wyoming. Neither species is considered threatened or endangered.

<u>2.9.1.2 Impacts</u> - Approximately 32 ha (80 acre) of shrub land, woodland, and grass land will be directly impacted by the proposed mining activities. Secondary activities such as house construction, road development and upgrading, and other off-site construction activities which will occur primarily in and near Edgemont will result in only minimum surface area disturbance. Table 2.9.1.2-1 lists disturbed areas by habitat type for each mine site.

Most of the 32 ha (80 acre) of vegetation will be displaced by construction of mine shafts, holding ponds, and other attendant facilities. Approximately 0.2 percent of the sagebrush, 0.01 percent of the pine and 0.03 percent of the grassland communities in the lease area will be disrupted by

Table 2.9.1.1-1

Areal Extent of Major Community Types

Community	Approximate Area Hectares (Acres)
Sagebrush	10,570 (26,100)
Ponderosa pine	7,290 (18,000)
Grassland	5,060 (12,500)
Prairie dog town	700 (1,740)
Rough breaks	3,640 (8,980)
Greasewood	490 (1,200)
Cottonwood bottoms	930 (2,300)

Table 2.9.1.1-2

Plant Communities of the Edgemont Project Area

Community	Total Perennial Cover (percent)	Representative Dominant Species
Abandoned-invaded	10.5	buffalo grass, blue grama, sand dropseed, needleandthread western wheatgrass
Silver sagebrush	26.0	silver sagebrush, buffalo grass, western wheatgrass, blue grama, sandberg bluegrass
Big sagebrush, medium stand	23.0	big sagebrush, buffalo grass, blue grama, western wheatgrass, sandberg bluegrass
Silver sagebrush-big sagebrush	30.0	big sagebrush, silver sagebrush, buffalo grass, blue grama, western wheatgrass
Big sagebrush, heavy stand	23.0	big sagebrush, blue grama, buffalo grass, sandberg bluegrass, western wheatgrass
Sand sagebrush	21.0	sand sagebrush, big bluestem, sandseed, plains prickly pear, threadleaf sedges, blue grama
Grassland	17.0	buffalo grass, blue grama, sandberg bluegrass, threadleaf sedge
Little bluestem	16.0	little bluestem, needle leaf sedge, wild buckwheat, prairie sandreed, Louisiana sagewort
Prairie dog town	17.0	buffalo grass, blue grama, plains prickly pear, scarlet globe mallow
Rough breaks	14.0	big sagebrush, wild buckwheat, blue grama, buffalo grass, side oats grama
Black greasewood-big sagebrush	19.0	black greasewood, big sagebrush, western wheatgrass, blue grama, alkali sacaton
Black greasewood	18.5	black greasewood, blue grama, sand dropseed, buffalo grass, western wheat grass
Cottonwood bottoms	16.5	plains poplar, western wheatgrass, buffalo grass, yellow sweet clover, common dandelion
Ponderosa pine	8.1	ponderosa pine, skunkbush sumac, blue grama, buffalo grass, western wheatgrass, big sagebrush, fringed and Louisiana sagewort

mining activities. These will be lost for the life of the mine or until reclamation practices are implemented. While these areas will be reclaimed, it is not likely that revegetated areas will closely resemble the existing plant species composition and diversity (i.e., it will be impossible to reintroduce all species lost). Disturbed areas that are not promptly revegetated will be susceptible to wind and water erosion (see Chapter 3).

Dust and gases resulting from construction and operation at mines may adversely affect some species of vegetation, especially near haul roads. Mine waste material generated as a result of underground and open pit mining may contain toxic materials. All toxic material will be handled in compliance with applicable regulations. If it is buried, it will be covered with material suitable for revegetation.

At the Burdock mine site, a layer of impermeable shale 87 m (285 ft) thick lies between the shallowest aquifer and the ground surface. For this reason, depressuring of the aquifers will result in no adverse impacts to vegetation.

The water from the underground Burdock mine will cause a temporary change in vegetation composition along the discharge waterway. After being treated (see Section 2.6.3), the water will be discharged in a natural drainage for approximately 2.4 km (1.5 mi) before entering Beaver Creek near the Cheyenne River. This relatively small flow of water will cause a slight shift along a narrow meandering course from arid to wetland vegetation for the life of the mine. After the mining activity ends and the water flow ceases, the vegetation in the drainage area will revert to a species composition similar to what is presently existing.

No threatened or endangered plant species or unique plant communities are known in the project area.

Due to the relatively small acreage of vegetation that will be impacted by the project and mitigation efforts employed, impacts to vegetation should not be of a significant adverse nature.

2.9.1.3 Mitigation - Vegetation impact mitigating measures will consist of the reclamation measures discussed in Chapter 3, the watering of roads to decrease dust problems, and the use of existing roads which will reduce the need for new road construction thereby reducing the amount of habitat disturbed.

2.9.2 Wildlife

2.9.2.1. Description - Wildlife investigations for this project were conducted during the period from fall 1975-fall 1977. The investigations were coordinated with personnel of the South Dakota Department of Game, Fish and Parks; Wyoming Game and Fish Department; U.S. Fish and Wildlife Service; and the U.S. Forest Service. The purpose of these investigations was to document important wildlife resources of the project area to allow assessment of future mining and reclamation activities.

Table 2.9.1.2-1

Area Disturbed Due to Mining

Mine Site	Plan Community — Area Disturbed in Hectares (Acres)					
	H[1]	M	G	A	GB	P
Burdock No. 1	8 (20)	4 (10)	2 (5)	-	-	-
Burdock No. 2	-	13 (33)	-	-	1 (2)	-
Spencer Richardson	-	-	-	-	-	-
Runge East	-	1 (3)	-	2 (4)	-	1 (3)
Darrow	-	-	-	-	-	-
Subtotal	8 (20)	18 (46)	2 (5)	2 (4)	1 (2)	1 (3)

Total = 32 hectares (80 acres)

H = Big sagebrush, heavy stand
M = Big sagebrush, medium stand
G = Grass land
A = Abandoned-invaded
GB = Black greasewood-big sagebrush
P = Ponderosa pine

The plant community complex described in Section 2.9.1 supports a diverse fauna. Numerous species of mammals, birds, reptiles, and amphibians are known to occur in the Black Hills and outlying areas.[6,7,8,9] A number of these species are important hunting resources while others have high esthetic and ecological value.

Wildlife field investigations for the most part were performed in conjunction with vegetation field studies during the period from fall 1975-fall 1976. These investigations were qualitative evaluations aimed at documenting the existance of critical wildlife habitats (e.g. threatened or endangered species, important big game wintering areas, sage grouse (Centrocercus urophasianus) strutting grounds, trout water, etc.).

After the Burdock underground mining site was located, it was discovered that the surface facilities will destroy a few acres of an existing prairie dog (Cynomys ludovicianus) town. For this reason, after consultation with the U.S. Fish and Wildlife Service and the South Dakota Department of Game, Fish, and Parks, TVA conducted an extensive black-footed ferret (Mustela nigripes) survey on the project area prairie dog town in September 1977 and found no evidence of ferrets.[14,15]

The Wyoming and South Dakota game and fish agencies consider the following habitat types to be of critical importance to wildlife in the project area: (1) aquatic habitat, (refer to Section 2.9.3.2) (2) riparian habitat, (3) shrublands, (4) rimrocks and canyons, and (5) ponderosa pine.[10,11,12]

Riparian habitat is found along permanent and emphemeral stream courses. Due to structure, composition and increased density of riparian vegetation, it serves as important nesting, spawning, resting, and escape cover area. Riparian habitat in the lease area is heavily used by turkey (Meleagris gallopavo) and mule deer (Odocoileus hemionus) and whitetailed deer (Odocoileus virginianus). White-tailed deer are primarily restricted to cottonwood bottoms along the Cheyenne River.[11,12]

Shrublands, particularly sagebrush, are extremely important to numerous species, especially antelope (Antilocarpa americana) and mule deer. Shrublands provide important winter feeding areas and in the case of sagebrush, strutting grounds for the sage grouse.

Ponderosa pine affords yet another habitat type and is utilized by a number of species for feeding, nesting, and escape cover. Wild turkey, raptors (hawks and owls) and mule deer utilize pine stands extensively.

A significant niche of rimrock and canyon habitat in the project area is that occupied by birds of prey which heavily use this habitat for feeding and nesting. Eleven species of hawks, owls, and vultures are considered common in the area and 22 species have been recorded.[9] Not all of these species intensively use rimrock and canyon areas but many nest and feed in these areas. This habitat also supports small birds, small mammals, deer, turkey, and reptiles and provides a rich food source for many predator species.

Due to moderate climate in the project area, big game species such as mule deer and antelope do not move to winter ranges but utilize the same habitat throughout the year. Off the project area to the north and east at higher elevations (Elk Mountain), big game species move to lower elevations during winter.

Hunting on and near the project area is primarily for antelope, deer, and turkey.[11,12] Since white-tailed deer are restricted to river bottom habitat along the Cheyenne River, hunting for mule deer is more common. Due to existing land use conditions, there is limited habitat for sharptail grouse (Pedioecetes phasianellus) and ring-necked pheasant (Phasianus colchicus). Sage grouse inhabit the South Dakota project area but there is no season for this species. In Wyoming, pheasant, chukar (Alectoris graeca), sage grouse, sharptail grouse and dove (Zeneidura macroura) are hunted. Waterfowl hunting on area streams and reservoirs is popular and significant numbers of migrating ducks and geese pass through the area. Cottontail rabbits (Sylvilagus spp.) also provide important small game hunting opportunities.

Predator red fox (Vulpes fulva), bobcat (Lynx rufus), coyote (Canis latrans)) and varmint (prairie dog) hunting is also popular in the area.[11,12] Mountain lion (Felis concolor) and bear (Ursus americanus) are not considered game species by South Dakota and therefore are not hunted. Bear are hunted in Wyoming but due to lack of suitable habitat, would not be expected on the Wyoming portion of the project area. The mountain lion is considered a trophy game animal in Wyoming and may be expected on the project area. Trapping for beaver (Castor canadensis), muskrat (Ondatra zibethica), and predators such as coyotes, red fox, and bobcat occurs in the area.[11,12]

The project area could provide potential habitat for the following threatened or endangered species:[13]
- Peregrine falcon (Falco peregrinus - endangered)
- Southern bald eagle (Haliaeetus leucocephalus endangered)
- Blackfooted ferret (Mustela nigripes - endangered)

None of these species were seen on or near the site during field investigation.

The peregrine is known to inhabit the Black Hills and conceivably could occur on or near the project area. The southern bald eagle could be found in the area during winter as a transient. The ferret is not known to be in the area but potential exists because of the presence of suitable habitat conditions (prairie dog towns). Black-tailed prairie dog towns provide habitat for the endangered ferret which preys on prairie dogs. After consultation with the U.S. Fish and Wildlife Service and the South Dakota Department of Game, Fish, and Parks, TVA conducted a ferret survey on the project area prairie dog towns in September 1977 and no found evidence of ferrets.[14,15]

2.9.2.2 Impacts - As shown in Section 2.9.1, 32 ha (80 acre) of habitat will be lost for the life of the mines. The bulk of the disturbance will occur at the Burdock shaft sites since these will cause new habitat disruption. The Spencer Richardson and Darrow mines are existing open pits for which the surface disturbance should not be significantly increased; and no further habitat disturbance should occur. The Runge East mine is an existing underground mine that will be reopened, but little further surface disturbance will occur at this site.

Of a total of 32 ha (80 acre) of habitat lost, 26 ha (66 acre) will be sagebrush. This will result in the reduction of food and cover for a number of wildlife species. Antelope, in particular, are an important game species which heavily depend upon sagebrush habitat. Impacts to, less mobile species such as small mammals, reptiles and amphibians will be more severe due to their small home range and their inability to relocate. Due to the vast area of sagebrush, grassland, and pine found on or near the project area, loss of 32 ha (80 acre) of habitat should not cause significant adverse impacts to wildlife species (see discussion in Section 2.9.1.2).

Two or three holding ponds will be developed at the Burdock No. 1 shaft. Water will be released from the pond into an adjoining natural drainage (ephemeral stream) and will be suitable for livestock and wildlife use. Dewatering operations will not adversely affect streams or reservoirs.

The bald eagle and peregrine falcon should not be adversely affected by this project since habitat critical to their survival will not be impacted. They could be impacted by harrassment and illegal shooting. Efforts to control this potential impact are discussed in Section 2.9.2.3).

Construction at the Burdock shaft sites will destroy several acres of prairie dog towns but field investigations indicated ferrets were not present.

As discussed in Section 2.10, employment growth as a result of the project will amount to 160 people. Based upon this growth, it is estimated that the total population increase in the region attributable to this project will be about 565 persons (refer to Section 2.10). Increased road traffic of commuters and the influx of new people will cause additional stresses to the wildlife resource of the region. By using the percentage of the population in the State of South Dakota who hunt (23 percent), it is estimated that approximately 130 hunters will move into the area as a result of the project.[16] Illegal hunting and harrassment of wildlife constitute a potentially significant impact, particularly to big game species and the diverse raptor fauna of the region. It is difficult to quantify the magnitude of these potential impacts. Mitigation measures are discussed below.

2.9.2.3 Mitigation - Attempts to minimize impacts to wildlife will be made through reclamation and conducting a wildlife ecology information and education program for project employees. The reclamation program will ensure that all disturbed areas are revegetated (Chapter 3). Revegetated areas will not closely resemble existing plant communities in species composition and diversity, (e.g., shrublands will probably more closely resemble grasslands after reclamation). Even though vegetation composition on the reclaimed areas will be different from existing cover, the small amount of disturbance from mining (underground and extraction from existing pits) will cause only very local changes that are insignificant to regional wildlife populations.

In an effort to help mitigate impacts to wildlife populations from the influx of additional people into the region, a condensed education program will be prepared by TVA in cooperation with Wyoming and South Dakota Fish and Game personnel. The objective of this program is to create in project employees an appreciation and awareness of regional fish and game values. The program will stress the need and importance of fish and game laws and notify employees that disregard of these laws may be cause for disciplinary action in addition to the penalty prescribed by law.

2.9.3 Aquatic Biota

2.9.3.1 Nonfish

2.9.3.1.1 Sampling: Sites and Frequency - Surface waters flowing through the Edgemont project area were sampled in September 1975 and in June 1976 to document the composition and diversity of indigenous aquatic communities during dry and wet seasons, respectively. Sampling sites were selected based on the following criteria: (1) the need to delineate preoperational conditions in the vicinity of potential mining activities*, and (2) the need to delineate the biota indigenous to each of the representative habitat types (riffles, pools, vegetative areas) and each of the major substrates (silt, clay, detritus, cobble, submerged and emergent aquatic plants). Two sites, Pass Creek and an unnamed pond near Burdock No. 1 shaft were sampled only in 1976 because they were not identified as being in the vicinity of mining activities until after the 1975 survey was completed. The upper two stations on Beaver Creek (Wyoming) were not sampled in 1976 because of flooding. Biological sampling stations and their proximity to the proposed mining sites are illustrated on Figure 2.9.3.1-1.

2.9.3.1.2 Description of Habitat and Stream Classification - Surface waters of the Edgemont project area provide habitats suitable for a variety of aquatic biota. Habitats range from dry stream courses which contain water only during or after heavy precipitation to streams which contain some flow throughout the year. The majority of the streams have intermittent and/or interrupted flows, being subject to alternate periods of drying and flooding. The effects of variable discharge upon habitat are significant as such discharges may deposit quantities of silt at one time and then scour the substrate at another.[17] Variable discharge also affects the habitat when periods of extremely low flow exist, since much of the benthic substrate can be exposed and subjected to rapid drying.

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*Based on information available at that time

There are five aquatic systems which occur near or on the Edgemont project area. These are: Beaver Creek and its major tributary, Stockade Beaver Creek (State of Wyoming Class I waters), Pass Creek (State of South Dakota--intermittent stream), Unnamed Pond (holding pond for mine dewatering), Cheyenne River (State of South Dakota--warm water semi-permanent fish life propagating waters, limited contact recreation, wildlife and stock watering, and irrigation), and Cottonwood Creek (perennial stream). Representative riffle pool habitats characterize the creeks and the Cheyenne River. The unnamed pond provides habitat for aquatic organisms for only a portion of the year.

2.9.3.1.3 - Description of Indigenous Fauna and Flora - The flora and fauna of the aquatic habitats in the site vicinity are representative of aquatic environments in semi-arid climates. Wide fluctuations in species diversity and numbers occurred and are expected due to frequent changes in habitat availability. No rare, threatened or unique species were identified from any of the site visits. Similarly, no unique habitats were identified. Detailed descriptions of the fauna and flora are available in a TVA report.[18]

2.9.3.1.4 Potential Impacts to Indigenous Faunal and Floral Communities Posed by Mining at this Site - Ecological populations of intermittant streams are transient and/or ephemeral. Recolonization of temporary dried areas is accomplished through surface water drift, survival of desicant resistant eggs, new egg deposition, and groundwater migration of larvae or adults. Water released from ponds will meet all NPDES requirements for the protection of aquatic life; thus, the primary impact of mining operations will be an increase in habitat, stream flow, and flow duration; and thus an increase in aquatic biological populations. The only undesirable aspect associated with such a population increase would be the corresponding increase in the population numbers, and perhaps the number of species of biting (pest) arthropods. These pests would most likely include mosquitos, black flies, horseflies, and deer flies. A secondary impact would involve compositional changes in the biota as a result of increased flow and/or physiochemical alterations. These compositional shifts would probably be insignificant with regard to most, if not all, of the biota because (1) they would be temporary (only during mining operations), and (2) the organisms would remain in surrounding areas and could recolonize affected areas as soon as mining ceased. Unusual or special precautions should not be necessary for protection of the area's nonfisheries biotic communities.

2.9.3.1.5 Mitigation - General mitigative measures which will be employed to the extent practical to prevent or reduce possible impacts include: (1) construction of dikes and ditches before other major surface construction and during the dry season to reduce suspended solids runoff during periods of heavy rainfall, (2) the initial release of pond effluents will be gradual so that any potential scouring of the streambeds will be minimized, (3) strict adherence to provisions stipulated within the NPDES permit.

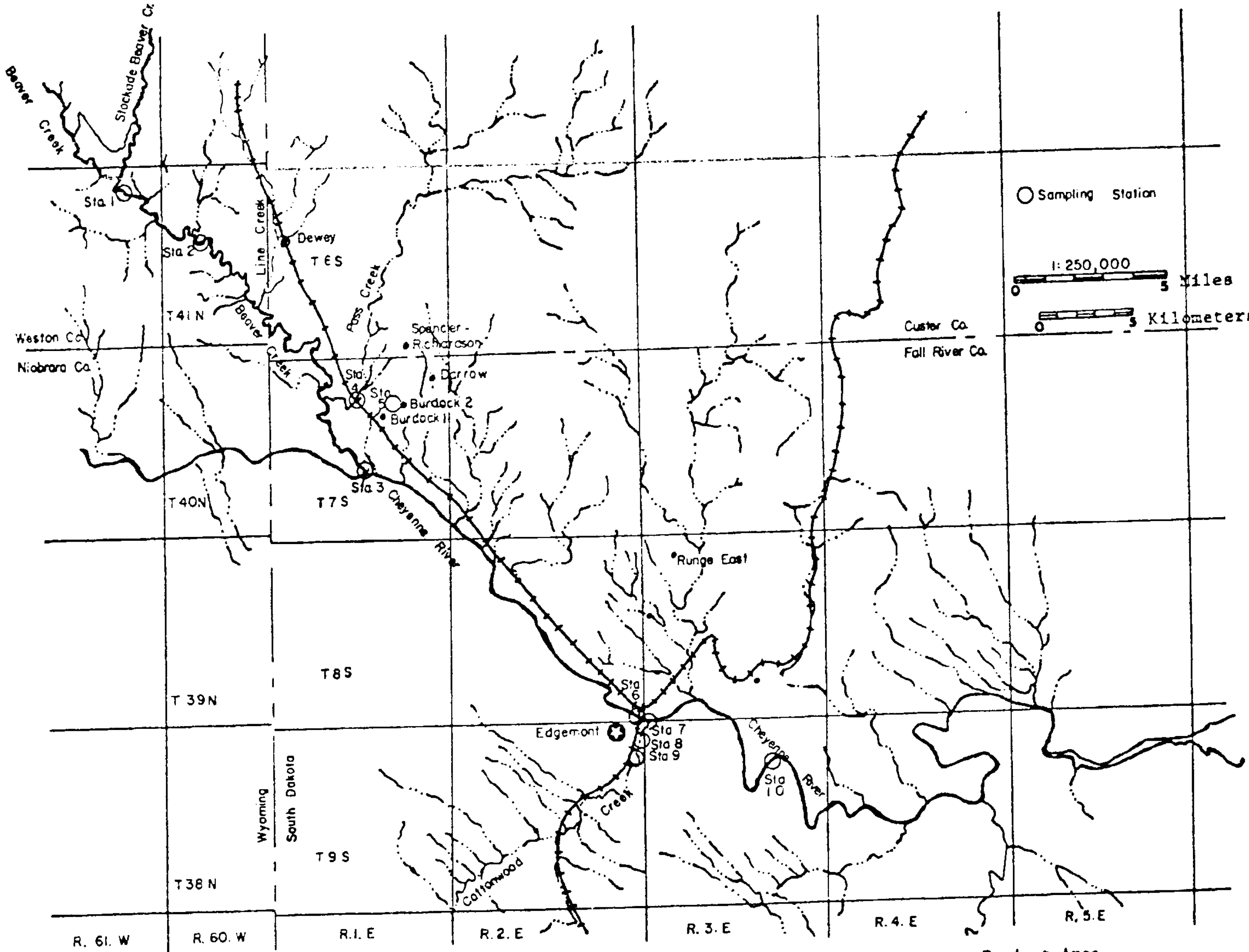

Figure 2.9.3.1-1 Biological Sampling Stations and Potential Mining Sites on the Edgemont Project Area

2.9.3.2 Fish

2.9.3.2.1 Description - As discussed in Section 2.9.2.1, the Wyoming and South Dakota game and fish agencies consider the aquatic habitat as one type of habitat to be of critical importance to wildlife in the project area.

Due to the arid regional climate, surface water (aquatic habitat) is extremely important. Table 2.9.3.2-1 lists fishery resources found on or adjacent to the project area.

Permanent streams and warm water reservoirs support such species as channel catfish (*Ictalurus punctatus*), bluegill (*Lepomis macrochiris*), carp (*Cyprinus carpio*), and numerous nongame species (plains top minnow (*Fundulus sciadicus*), plains minnow (*Stybognathus placitus*), black bullhead (*Ictalurus Melas*), and plains killifish (*Fundulus kansae*)). Cold water streams and reservoirs are stocked with trout. Aquatic habitat provides valuable watering areas for big game, turkey, and important nesting and feeding area for waterfowl and shorebirds.

2.9.3.2.2 Impacts - Two or three holding ponds will be developed at the Burdock No. 1 shaft. Water will be released from the pond into an adjoining natural drainage (ephemeral stream) and will be suitable for livestock and wildlife use. Dewatering operations will not adversely affect surface water streams or reservoirs.

As previously discussed in Section 2.9.2.2, employee growth as a result of the project will amount to 160 people with an estimated total population growth of 565. The influx of new people will cause additional stresses to the fish resource of the region. It is difficult to assess the magnitude of these potential impacts. Measures to be taken to ensure mitigation of these potentially severe impacts are discussed below. By using the percentage of the population in the State of South Dakota who fish (24 percent) it is estimated that approximately 135 fishermen will move into the area as a result of the project.[16] Careful planning and coordination between TVA, its operator, and the various state and federal agencies, will be necessary to reduce impacts.

2.9.3.2.3 Mitigation - The condensed education program discussed in Section 2.9.2.3 is applicable to help mitigate impacts to fish populations.

Table 2.9.3.2-1

Fishery Resources on and Adjacent to Edgemont Property

Water Body	Status[1]	Fishing
Streams		
Cheyenne River	P	Catfish
Beaver Creek	P	Catfish
Cascade Creek	P	Trout
Pass Creek	E	-
Plum Creek	E	-
Piney Creek	E	-
Red Canyon Creek	E	-
Cottonwood Creek	P	Catfish
Hat Creek	P	Catfish
Stockade Beaver Creek	P	Catfish
Reservoir		
Stock Ponds	P	Bass, bluegill
MW Reservoir	P	Trout
LAK Reservoir	P	Trout, bass, yellow perch
McMaster Reservoir	P	Trout

1. E=Ephemeral, P=Permanent

2.9 References

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2.10 Socioeconomic Considerations

2.10.1 Socioeconomic Environment - Projects creating increases in an area's basic employment (such as mining) have many positive effects but also have the potential for disrupting communities by overloading their public and private services and facilities. The net effect is contingent upon many factors including the existing capabilities of a community to absorb the projected additional growth. This section presents information regarding the capabilities of the governmental entities likely to absorb portions of the population increase.

2.10.1.1 Definition of the Impact Area - Examination of the regional map (see Figure 1.1.1-1) for the project area makes the definition of the impact area relatively straightforward. While uranium miners are willing to commute long distances 82 to 107 km (51-67 road mi)[1], they are unlikely to locate that far away if they are moving into an area with communities closer to the project. In this case, two communities--Edgemont and Hot Springs--are close enough to the project area to serve as potential locations for new residents. Also, they are both in Fall River County in which the project is located.

2.10.1.2 Impact Area Characteristics - Community profiles for Edgemont and Hot Springs are discussed in sections 2.10.1.2.1 and 2.10.1.2.2, respectively. These profiles contain a brief description of the status of community development, the facilities and services presently available, and the outlook for community growth and expansion. This information forms the basis for evaluating the potential for impacts created by the population influx presented in section 2.10.2.

2.10.1.2.1 Edgemont

Population and Employment - Since 1960, population and employment have undergone significant shifts in Edgemont. In 1960, the population was about 1,800 but by 1970, this had decreased to about 1,200 as a result of the closing of the Black Hills Army Depot in 1967. Although some small industries have located near Edgemont, the community reverted to essentially a small trade and service center for the surrounding agriculture-based population. However, the advent of major energy-related development in the west has begun to alter the situation. The biggest change has been the expansion of Burlington Northern Railroad's operation in Edgemont. As a result of coal activities in Wyoming, Burlington Northern's employees have increased from 20 in 1968 to about 200. This increase has included both construction employees for upgrading the tracks and train crews. As a result, Edgemont has reached an estimated population between 1,800 and 2,000.

The decrease in population because of the earlier loss of job opportunities resulted in another important characteristic of the county--a very low unemployment rate. From 1970 to 1974, it never exceeded 2.5 percent while the South Dakota rate stayed around 4 percent.

Education - Edgemont Independent School District No. 23-1 serves all but the eastern part of Fall River County.

Enrollment in the spring of 1977 totaled 432 students. Edgemont has consolidated all schools into one large structure, but has divided it up for administrative purposes. The enrollments and capacities are:

	Enrollment	Maximum Capacity
High School	109	159
Junior High	67	107
Elementary School	256	304

While physical capacity exists, part of the facility dates back to 1931. Also a large amount of the equipment was acquired from the schools in Igloo which were closed when the army depot closed.

Transportation - U.S. Highway 18 is the major highway through Edgemont. It runs through Hot Springs [43 km (27 mi)] to the east and into Wyoming to the west. This highway is presently being upgraded in the Edgemont Area. Already mentioned is the Burlington Northern Railroad which offers freight service. Bus service is provided by Continental Trailways with connections to Rapid City in the north and Denver, Colorado, to the south. The Edgemont area is also served by a sod runway which accommodates small private aircraft.

Utilities - Communications - Privately provided utilities include Black Hills Power and Light (electricity) and Peoples Telephone and Telegraph Company (telephone). The city provides water, sewer, and solid waste collection.

Water supply is obtained from wells with a flow estimated to be adequate for a population of 10,000. Present storage is 2.6 x 10^6 l (700,000 gal) which corresponds to the peak daily use. Although the quantity of the supply is adequate, the water is very hot (53° C, 128° F) and high in minerals which is damaging to water mains and valves. Recently a $150,000-Local Public Works grant was approved to finish a partially completed reservoir. The reservoir will have a capacity of about 23.8 x 10^6 l (5.3 x 10^6 gal) and will also serve as a cooling pond to lessen the adverse effects on the distribution system.

Wastewater treatment is provided by a single stabilization lagoon. Based on limited sampling, the facility does not meet the requirements of the National Pollutant Discharge Elimination System (NPDES) permit. Priority for funding the design of proposed improvements to the facility is 66 out of 117 towns in the state.

Solid waste disposal is contracted by the city with a private operator. The operator provides once-a-week pickup and also operates the city-owned and state approved landfill.

Housing - The recent surge in population growth has placed a great deal of pressure on the existing housing. From 1962 to 1976 only three houses were built, but the railroad expansion has resulted in 16 being built in the last year. Plans have also been made to build two 8-unit apartments, a 25-unit trailer park, and 10 to 12 modular units which are on order. In addition, a senior citizens unit is expected to release about 18 older homes for purchase or rent. Expansion of the water and sewer distribution and collection systems is a constraint on any large-scale housing development.

One developer from Rapid City has plans for a 6.9 ha (17 acre) development containing a mixture of dwelling types and some commercial establishments. This scale of development is also contingent upon the emergence of a significantly expanded market.

Health, Police and Fire Protection - There are two dentists and one optometrist in Edgemont. One physician has established an outpatient clinc with services available on weekday afternoons. Most medical services must be obtained in Hot Springs, 43 km (27 mi) away. Ambulance service is provided by the volunteer fire department. About 10 members have completed an 81-hour emergency medical technician course.

Twenty-four-hour police protection is provided by four full-time and one part-time patrolmen. The department has two patrol cars and two persons serving as dispatchers. The local department is supported by a local deputy sheriff based in Edgemont.

Fire protection is provided by a 40-member volunteer fire department. Its equipment consists of two pumpers, one a 3,785 l (1,000 gal) pumper, two 4-wheel drive rural service trucks with 530 l (200 gal) capacity each, a salvage truck with smoke extractor, and a 16,000 l (6,000 gal) tanker used for water supply for rural fires. The insurance classification of Edgemont is eight [on a scale of 1 (best) to 10 (worst)].

Recreation - Volunteers presently operate the recreation program although local officials have indicated plans for hiring a recreation director to organize activities. There are two tennis-basketball courts, and the high school has a football-baseball complex. Activities in the summer include softball and hardball leagues for all ages and the city leases the motel swimming pool for public use during certain hours. In the winter, there are a few men's basketball teams.

2.10.1.2.2 Hot Springs

Population and Employment - Hot Springs underwent a small population decline from 1960 to 1970 dropping from 4,943 to 4,434. Since this period, the population has increased to approximately 4,800.

Employment in the government sector is one of the major reasons for the relative stability of the population. The Veterans Administration Center which employs about 500 people contains 232 general hospital beds and 511 domiciliary care beds. At the State Veterans Home, about 100 people are employed caring for about 69 patients. Since Hot Springs serves a very large trade area, trades and services employment constitutes the other major employment sector.

Education - Hot Springs Independent School District No. 23-2 covers the northeastern part of Fall River County. Enrollment in the spring of 1977 totaled 1,162 distributed among four elementary schools, one middle school and one senior high school. However, three of the elementary schools are rural schools and would not serve children of persons moving to Hot Springs. Thus, the relevant enrollments and capacities are:

	Enrollment	Maximum Capacity
High School	381	420
Middle School	312	270
Elementary School	427	500

Overcrowding exists in the middle school while excess capacity is available in both the high and elementary school.

Transportation - Bus service is provided by Continental Trailways and the Omaha-Rapid City bus line. Continental Trailways provides a direct connection with Rapid City to the north and Denver (through Edgemont) to the south. The Omaha-Rapid City bus line also connects with Rapid City but goes to Chadron, Nebraska, and other stops across Nebraska.

Rapid City offers the nearest commercial airline connection. However, there is a municipal airport in Hot Springs which serves light aircraft. This airport has a 1,372 m (4,500 ft) asphalt runway and 1,158 m (3,800 ft) sod runway and two hangars with fuel availability. Lights are operable by radio control.

Utilities - Communication - Private utilities include Black Hills Power and Light (electricity) and Peoples Telephone and Telegraph Company (telephones). The city provides water, sewer, and solid waste disposal service.

Water supply is from groundwater sources which are adequate for the existing population. Additional sources exist which can be tapped to serve population growth. Improvements are planned which include expanding storage capacity by 9.5×10^6 l (2.5×10^6 gal) and building a new water collection gallery from which water is pumped to the central storage reservoir.

Wastewater treatment facilities are old and provide inadequate treatment. Improvements have been designed which would provide treatment capacity for 6,500 people. Priority for funding these improvements is 16 in the state which is expected to result in construction beginning in 1978.

Housing - Conventional housing is in short supply, but market response to increased demand should be assisted by the large availability of building lots in the city. Construction on these lots could make use of existing utility lines thus eliminating both the time and expense associated with developing new unserved areas. Mobile homes supplement conventional housing with about 15 mobile home parks containing about 300 spaces. The individual vacant building lots are not available for placement of mobile homes because community regulations restrict mobile homes to approved mobile home parks.

Health, Police and Fire Protection - The Southern Hills General Hospital is the only civilian hospital in the area. It contains 50 beds and is operating at about 30 percent occupancy. Further, the auxiliary facilities already in the hospital are sized to serve 150 beds. Thus, it has a great deal of capacity to serve additional needs. Four doctors, one surgeon, and three general practitioners are in the community and utilize the hospital. There are also two dentists and two optometrists in Hot Springs. In addition to the general hospital, there is a 50-bed nursing home which is operating at capacity.

The police department which provides 24-hour protection has six patrolmen, three desk sergeants, and a dispatcher shared with the county. There is a new city-county jail and the department has two patrol cars.

Fire protection is provided by a volunteer department consisting of 57 men. Facilities include two 1,892 l (500 gal) pumpers, a ladder truck, smoke extractor, two rural service pumper trucks and an emergency ambulance.

Recreation - A full range of community recreation facilities is available. Swimming is available at the Evans Plunge and Larive Lake. Tennis courts are located at the high school and at Butler Park. The high school also has a football field and baseball facilities are available at the VA center. There is a nine-hole golf course at the country club and another under construction at Butler Park. Recreation activities are sponsored by various civic organizations such as the American Legion, Jaycees, VFW and Elks.

2.10.2 Socioeconomic Impacts

2.10.2.1 Introduction - This section discusses potential socioeconomic impacts of this project in the context of all known energy-related development in the area. This analysis is based on a set of assumptions which TVA considers reasonable in light of present information. However, methodology and results are presented in some detail to enable the effects of variations to be easily assessed.

2.10.2.2 Magnitude and Distribution of Impacts - A number of energy-related developments are occurring or expected in the Edgemont area. These include expansion of railroad and related activity, the proposed project, and another small uranium mining operation. Based on present plans, the total energy-related employment is expected to increase from about 200 in 1975 to 1,155 in 1981. TVA's operator employed about 40 people in the Edgemont area in 1975. Employment for the Edgemont mining project and associated exploration and milling will level off at 200 in 1981. Thus, employment growth from 1975 to 1981 totals 955 with the project accounting for 160.

Increases in basic employment such as mining and transportation will eventually result in increases in secondary employment such as clerks, barbers, etc. In 1973, the ratio of secondary to basic employment in Fall River County was about one. Assuming this ratio to hold through 1981, 955 secondary employment opportunities will be created with 160 due to this project.

Estimating the employee influx associated with the employment increase took into account the size of the present population within commuting distance, the unemployment rate, the types of skills required, etc. The new employees for the Edgemont project will consist primarily of underground miners and supervisory personnel which are skills generally in short supply. The other mining activity will face a similar situation. The railroad-related activities will use skills more generally available or more easily developed than underground mining. However, Fall River County had an unemployment rate of about 2 percent from 1970 through 1974 which indicates a lack of available individuals in the area. Considering these factors, an employee influx rate of 90 percent was used for energy-related development.

Secondary employment is made up largely of positions filled by women or young people. Thus, as new mining employees move in with their families, they will create a pool of potential secondary employees. Based on these considerations, a secondary employee influx rate of 50 percent was used.

Converting the employee influx into a population estimate was based on 75 percent of the employees having families and 25 percent being single. Family size was based on national trends and averages because these employees would be drawn from a multi-state area. The family size used was three. Applying the various rates and factors to a basic employment increase of 955 results in a population increase of about 3,350. For the project, the 160 new jobs result in a population increase of 565. Of the total population influx, 755 were school age (0.75 school-age child per family) with 125 due to the project.

To evaluate the potential impacts on community facilities, the total population increase was distributed between the towns of Edgemont, Hot Springs, and Igloo-Provo (see Table 2.10.2.2-1). Igloo-Provo is not considered as part of the project impact area because no significant portion of the project employees are expected to locate there. However, Igloo is the location of one of the railroad-related projects and could be expected to absorb a portion of the associated population increase. Some employees may scatter among the small settlements in the area or in isolated individual dwellings. However, this is expected to be only a small fraction (less than 5 percent) and is not subtracted from the total allocated to the impact communities. Based on factors such as community size, distance from the work location, employee characteristics, and other judgments, Edgemont was projected to receive 600 of the basic employee influx and Hot Springs, 240.

Secondary employee distribution is expected to follow a different pattern because of the predominant role played by Hot Springs in this sector. A total of 480 secondary employees were distributed with 360 to Hot Springs and 120 to Edgemont. The total employee influx to each community was 720 to Edgemont and 600 to Hot Springs. This produces an estimated population influx of 1,800 to Edgemont and 1,500 to Hot Springs. Of the total population influx, the project accounts for 340 (19 percent) in Edgemont and 225 (15 percent) in Hot Springs.

Table 2.10.2.2-1 summarizes the employment and population influx discussed above and presents projections of the school-age influx and projected housing demand.

One general and fundamental conclusion can be drawn from just the total population influx projections. Edgemont is faced with the prospect of very rapid growth while Hot Springs should be able to accommodate the growth with no significant problems. Generally, communities can absorb indefinitely annual population growth rates of 5 percent or less without special fiscal or administrative actions. Growth rates between 5 and 10 percent require special efforts to maintain adequate service levels and facilities over an extended period, but it is generally possible and feasible. At growth rates greater than 10 percent, for periods exceeding 5 years, the demand for services and facilities calls for additional expenditures at a much faster rate than additional revenues are generated so that facilities and service levels often deteriorate[2]. Edgemont is projected to grow at an average annual rate of about 17 percent and Hot Springs at about 5 percent. Even without the proposed project, Edgemont's growth rate would still be about 14 percent which could still create a very stressful situation.

These projections are subject to an important qualification. Rapid growth in Edgemont could create conditions which would cause some of the influx projected for Edgemont to locate in Hot Springs. However, there is no information upon which to quantify this possibility. Also, it would not occur until the situation in Edgemont had deteriorated to unacceptable levels. Thus, projections of impacts for specific community facilities and services will be based on the projections as presented.

2.10.2.3 Impacts on Schools - Edgemont school system is projected to receive 415 additional students and Hot Springs, 340. By continuing to use present facilities up to their rated capacity, Edgemont would have to provide additional space for 277 students or about 10 classrooms. Hot Springs would require space for an additional 230 students (about 8 classrooms) if the present level of overcrowding were to continue. If the overcrowding was to be relieved, space would be required for 272 students (about 10 classrooms).

There are no plans in either school system to expand facilities. In the immediate future, the excess capacity can be used to accommodate the students. If permanent facilities are expected to meet future needs, the lead time required to plan, locate, design, and construct a school means that efforts should be undertaken very soon. If present school sites are adequate, portable classrooms can be purchased and placed in use in a much shorter time. However, if the latter alternative is to be a conscious decision rather than one forced by future enrollments, planning should begin very soon.

2.10.2.4 Impacts on Housing - On the average, 105 new dwelling units per year will be required in Edgemont and 90 in

Table 2.10.2.2-1

Edgemont Uranium Mining Project
Selected Socioeconomic Impact Indicators
Comparison of Project to Total in the Area

	Edgemont		Hot Springs		Igloo-Provo	
	Total[1]	Project[2]	Total[1]	Project[2]	Total[1]	Project[2]
Employee Influx						
Basic	600	115	240	30	20	0
Secondary	120	20	360	60	0	0
Total	720	135	600	90	20	0
Population Influx	1,800	340	1,500	225	50	0
School-Age	405	75	340	50	10[3]	0
Housing Demand	630	120	525	80	20	0

1. Total due to all energy-related development including the TVA project.
2. Amount due to TVA project alone.
3. Included in the Edgemont school district.

Hot Springs. In Edgemont, there may be approximately 70 additional dwellings by mid-1978 plus the potential of one small 6.9 ha (17 acre) development. In Hot Springs, there are no announced plans for new housing developments. Thus, it will be very difficult for new residents to find a place to live, let alone find the type of dwelling they prefer. Given the high level of demand, the cost and length of time to construct conventional homes, most of the new dwellings will likely be mobile homes plus some modular dwellings. Planning for this growth is important so that the needed development in the near future provides a sound basis for longer-term development.

2.10.2.5 Impact on Water and Sewer Systems - Water supply capacity does not create a constraint to achieving the projected population growth in either Edgemont or Hot Springs. Hot Springs' distribution system is extensive and undergoing improvement which should enable the water to be provided where needed without major additional extensions. In Edgemont, water line extensions required by new development could become a constraint. Financing could be one significant problem but use of a mix of available mechanisms--bonds, grants, loans, rate structure, agreements with developers, etc.--could provide the necessary funds. Just as important are the extension plans so that lines are located and sized to meet long-term development without duplication or undersized lines. This planning should begin soon in order to provide the basis for proposing financing.

In Edgemont, the population growth could further overload the present sewage treatment system until the planned improvements are made. However, the improvements are based on a future population of 2,000. Thus, it appears that the design should be adjusted to take into account the new growth. An alternative to tying into the sewer system is to use septic tanks, because soils in the vicinity of Edgemont are generally suitable.

Hot Springs is faced with a situation similar to Edgemont in that, until planned improvements are made, more population growth could further overload the existing sewage treatment system. In addition, the improvements are planned to serve a population of 6,500. Based on the projections in this analysis, the population of Hot Springs will be approximately 6,300 in 1981 so some thought should be given to revising the design in order to extend the time until expansion is required. Septic tanks may offer an alternative to tying onto the sewer system in the Edgemont area but soil characteristics in the Hot Springs area essentially prohibit this alternative.

2.10.2.6 Impact on Medical Services - Most of the demand for medical services in Edgemont will probably transfer to Hot Springs. If this occurs, the demand for emergency medical services could essentially double. The increased population could also make feasible the establishment of a satellite clinic from the hospital in Hot Springs.

In Hot Springs, the Southern Hills General Hospital is fully adequate to meet the needs of the total population influx. Based on Department of Health, Education, and Welfare criteria for a physician shortage (one physician to 1,500 people), the eight doctors already in Hot Springs would also be adequate to serve the total influx. However, that would likely result in a lessened level of service based on the present physician to population ratio of 1 to 1,050. Using the existing ratio, three more physicians would be required.

2.10.2.7 Other Impacts - Population increases on the order of those projected for Edgemont and Hot Springs will create a need to expand most other public services and facilities such as police protection, solid waste disposal, fire protection, and recreation. In Edgemont, the doubling of population indicates a probable doubling of all of these aspects of government. In Hot Springs, the increase is about 30 percent which indicates that certain elements might be capable of accommodating without a proportional expansion. Depending on the pattern of new development, it might be possible that existing fire protection equipment and personnel would be completely adequate. It is also possible that recreation and police protection will have some ability to absorb additional demand without either expansion or significant reduction in the level of service. On the other hand, solid waste pickup and disposal would be more directly proportional to increases in population.

2.10.3 Socioeconomic Mitigation - Mitigation of the potentially adverse impacts described in section 2.10.2 will take place through a combination of three types of actions. The first which could possibly take place is direct action by the project; for example, providing funds for a planning program. The second is indirect action by the project such as payment of taxes by the project and its employees. The third is external action by others such as Federal loans or grants. All three types of actions function within a legislative framework set forth by the state and Federal government. The degree to which mitigation occurs depends upon how well existing legislation works and the extent to which new state and Federal legislation is enacted which would supplement the existing revenue flow.

Direct actions by the companies impacting the area could take many forms, but the most likely is in the area of housing in order to attract and keep employees. However, there are no announced plans at this time. TVA is prepared to cooperate with other companies in the area to work with the communities to provide direct assistance for other purposes. One purpose for which assistance already has been requested is a planning program for Edgemont. This planning program would work toward the timely provision of the additional services and facilities required by the rapid population growth. TVA is presently evaluating funding this program in cooperation with other impacting industries and the city of Edgemont.

For operating expenses local governmental entities rely heavily on gross receipts tax, gasoline tax, property tax, state redistributions and revenue sharing. Gross receipts tax, gasoline tax and most redistribution follow very closely changes in population and income and do not lag very far behind. To specifically aid energy-impacted areas, South Dakota amended its severance tax act to increase the rate and provide partial redistribution to the counties in which the minerals are produced. The new rate is 4.5 percent and until the end of 1979, two-thirds of the collected tax will go to the producing county and one-third to the State. From 1980 on, the split will be 50 percent for the county and 50 percent for the State until the county receives $300,000 over which amount the State retains everything. At the county level, the board of county commissioners is responsible for allocating the funds "for school, roads, law enforcement and municipal purposes to offset social, economic or physical impacts, either direct or indirect, resulting from the extraction of severed energy minerals in the county." Property tax revenue and revenue sharing can lag up to two years behind increases in population.

School districts with children whose parents are working at TVA's mill may qualify for operating funds from the Federal government under P.L. 81-874. The funding varies directly with changes in membership, but some lag could occur if the membership is growing rapidly. State support for school operating funds functions in a similar manner.

Local funding of major capital expenditures is generally through bonds. The level and life of the projects affecting the impact area should provide a strong basis for revenue bonds. Bonds subject to tax rate and assessment limits may be more difficult to float on a timely basis due to the lag in new development being listed on the tax rolls.

Other support for capital expenditures comes from Federal grants and loans. Extensive use of this mechanism is already in evidence in the area for such things as water and sewer system improvements. In the future, areas with high rates of growth due to energy development may qualify for higher priorities, larger projects, smaller local shares, etc.

Housing is generally expected to be developed and financed by conventional means. The source of funds for large-scale development is nationwide and the number and duration of employment opportunities should indicate a sound investment opportunity. However, some initial reluctance may be encountered which could result in the direct project participation described above.

Interest in mitigating energy-related socioeconomic impacts is quite high at the Federal level. The U.S. Senate is considering a bill (S. 1493) to assist energy-impacted states, local governments, and Indian tribes. The bill proposes a program of grants and loans for planning and implementation of actions to mitigate impacts arising from energy-related development.

2.10 References

1. Kiner, Phil and Dobbs, Thomas. "Location Aspects of a Rural Work Force: The Wyoming Uranium Industry," contributed paper for the AAEA/CAES/WAEA Joint Annual Meetings, Edmonton, Canada, August 8-11, 1973.

2. Gilmore, John S. Presentation to the First Annual Economics of Energy Workshop sponsored by the Association for University Business and Economic Research, Snowbird, Utah, August 23, 1977.

2.11 Natural, Scenic, and Cultural Resources

2.11.1 Scenic and Natural Features

Description - The topographic variety of the Edgemont project area provides a number of features of scenic and natural interest, principally canyon formations and Ponderosa pine-covered hills interspersed with the grass and sagebrush-covered plains which comprise the majority of the project area. Distinctive natural and scenic features on or in the vicinity of the project site are identified in Figure 2.11.1-1. Although the characteristics and variety of these features provide aesthetic appeal, none are unique to the area.[1]

The only feature in the project vicinity proposed for special scenic designation is Red Canyon-Fourmile Creek Drive extending from U.S. Highway 18 east of Edgemont to U.S. Highway 16 west of Custer. This area is proposed by the South Dakota Department of Transportation for inclusion in the Federal scenic roads and parkways plan.[2] The Red Canyon segment of the route passes in a north-south direction between the central and southern blocks of the project area and intersects one disjuncted 6 ha (15 acre) parcel under lease. The proposed Runge East mine site is located approximately 1.9 km (1.2 mi) west of the route at the nearest point.

Major regional scenic resources and tourism associated with these attractions are discussed in Section 2.11.4.

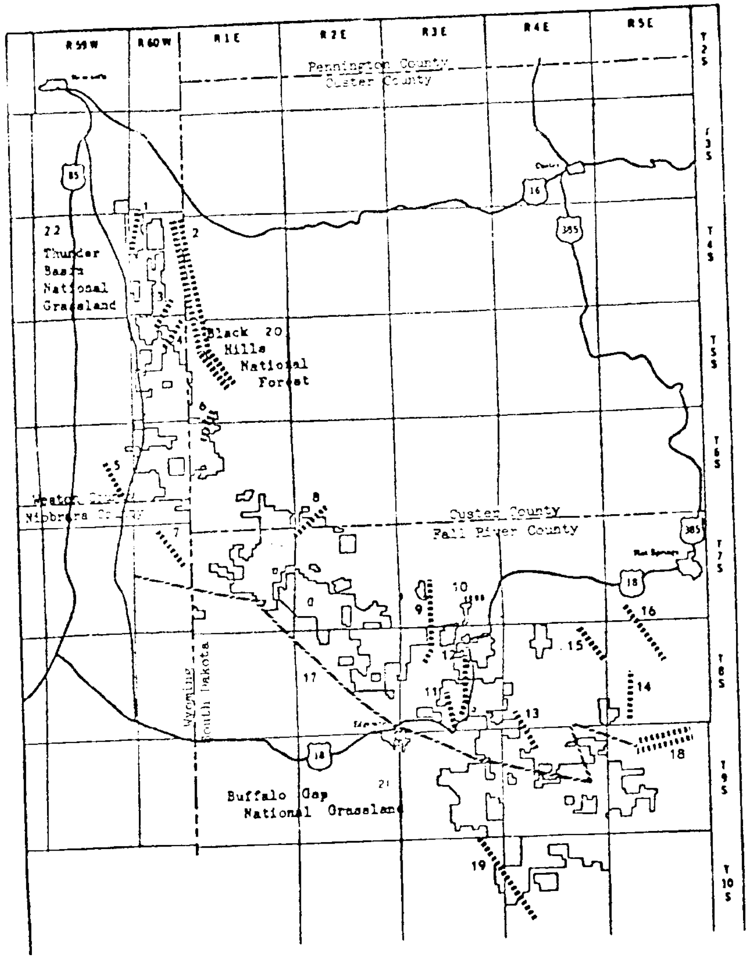
Impacts - Surface disturbance from mining operations will be very limited. The reclamation program will ensure that such alterations eventually blend with the existing landscape.

Intervening topography between the Runge East mine site and the proposed scenic road through Red Canyon precludes viewing of the site from the route. Primary access to the Runge East mine is from existing roads to the west, and these routes will be used as haul roads. Thus, the project will not adversely affect the proposed scenic road, or other scenic and natural features.

2.11.2 Historical Resources

Description - A historical and cultural site survey of the Edgemont Project area was conducted.[1] An archaeological survey of portions of Fall River and Custer Counties, South Dakota, done for TVA by the South Dakota Archaeological Research Center also addressed historic sites. The Historic Sites Survey included the documentation of essentially all habitable structures, structure remains, and manmade improvements existing within or on the immediate fringe of the Edgemont project area. These were plotted on maps and accompanied by both written and pictorial descriptions of features. Copies of these materials have been furnished to the State Historic Preservation offices of Wyoming and South Dakota.

Using these inventory records as a guide, a field review was conducted to evaluate significance of sites and assess potential impacts. Since the majority of the project area and sites in question were located in Fall River and Custer Counties, South Dakota, representatives of the South Dakota Historic Preservation



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Distinctive natural features on or adjacent to the project area:

1. Whoopup Canyon
2. Elk Mountains
3. Clifton Canyon
4. Carr Canyon
5. Rattlesnake Ridge
6. Plum Canyon
7. Twentyone Divide
8. Bennett Canyon
9. Red Canyon
10. Matias Peak
11. Sheep Canyon
12. Dead Horse Canyon
13. Chilson Canyon
14. Cascade Spring and Falls
15. Lindsey Canyon
16. Arabaugh Canyon
17. Cheyenne River
18. Angostura Reservoir
19. Unnamed Ridge
20. Black Hills National Forest
21. Buffalo Gap National Grassland
22. Thunder Basin National Grassland

Figure 2.11.1-1 Natural Features on or in the Vicinity of the Edgemont Uranium Mining Project

Office participated in the field review, which also included the project area in Weston County, Wyoming. In a subsequent meeting, these representatives reviewed the results of the field analysis.

No sites currently listed in the National Register of Historic Places are located within the project area. Other than the route of the Cheyenne and Deadwood Stage which passes through the town of Edgemont, no Register sites are located within 8 km (5 mi) of the project area boundaries. One potential Register site, the Whoop-up Canyon Petroglyph, is located at the northern extremity of the project area in Weston County, Wyoming. This site appears in the State Register of Historic Places and is proposed for nomination to the National Register. The petroglyphs, appearing on both sides of the narrow canyon, are contained in a section extending over perhaps 27-37 m (30-40 yd).

Six of the approximately 600 "ghost towns" recorded(1) in the Black Hills region are within the vicinity of the project area, along with three sidings of the Chicago, Burlington, and Quincy Railroad. Two of these "towns" containing the remains of a few buildings are on the fringe of the project area itself and the rail sidings (little remains except ruins) are within the area. These sites were generally poor and were judged to have no historical or architectural significance.

The S&G (Sturgis and Goddell) Ranch Site (extant 1870's) may represent one of the first permanent pioneer settlements in the region. It is located at the edge of the project area near the site of the former town of Dewey (new buildings now exist on the rail siding at this postal station). Little remains of the ranch site except foundation stones, a few logs, and a cellar. Scattered domestic debris was noted. Further photographic documentation of this site and the site of two abandoned ranch buildings at other locations is being done for the South Dakota Historic Preservation Office by TVA for purposes of completing their research. These sites are privately owned.

No other features of interest were noted in the evaluation and field review. Other than the site of the S&G Ranch, no additional sites or structure eligible or potentially eligible were judged to exist within or immediately adjacent to the project area.

Impacts - The proposed mining activity will not directly or indirectly impact any sites or structures with architectural or historical significance. No such sites or structures are on lands proposed to be mined nor are any found within the fenced compounds associated with mining activity. Sites with any identified potential are located at considerable distances from the proposed mining so that indirect impact is of no consequence. Knowledge gained from the inventory and the evaluation process associated with this proposal should measurably add to the states' information about cultural resources in the counties involved.

The State Historic Preservation officers of South Dakcta and Wyoming are in general agreement with the impact analysis contained herein.

Because of this, TVA believes that no adverse effect from the proposed project will occur to any historic site or structure now in or potentially eligible for inclusion in the National Register of Historic Places.

2.11.3 Archaeology - Archaeological reconnaissances and surveys were performed intermittently in the project area from March 1975 until August 1977 by the State of South Dakota's Archaeological Research Center. One hundred twenty-six (126) archaeological sites and seventy-five (75) archaeological loci were encountered. The sites range in time from Paleo to Plains Villages and consist of pictograph and petroglyph sites to small resource exploitation sites to large habitation sites occupied for extended periods of time. Although no sites listed in the National Register will be affected by the project, National Register eligibility status for the surveyed sites is currently being evaluated by the State of South Dakota.

No archaeological sites are located in the 1/4 section with either the Burdock shafts or the Darrow Extensions. One site is located in the 1/4 section with the Spencer-Richardson mine, and two sites are located in the 1/4 section with the Runge East mine.

Archaeological site avoidance was maintained during the exploration phase of the project, and site avoidance is the continued goal during development and mining. Where required, sites in the area of mining activity will be fenced. If during the course of mining it becomes necessary to adversely impact a site that has been determined eligible for the National Register appropriate mitigation of the impact will be implemented through consultation with the Advisory Council on Historic Preservation and the State Historic Preservation Office.

Mining personnel will be made aware that archaeological resources exist in the project area. Known archaeological sites will be delimited, and if a new site is discovered, the state archaeologist will be notified and the site protected, pending investigation.

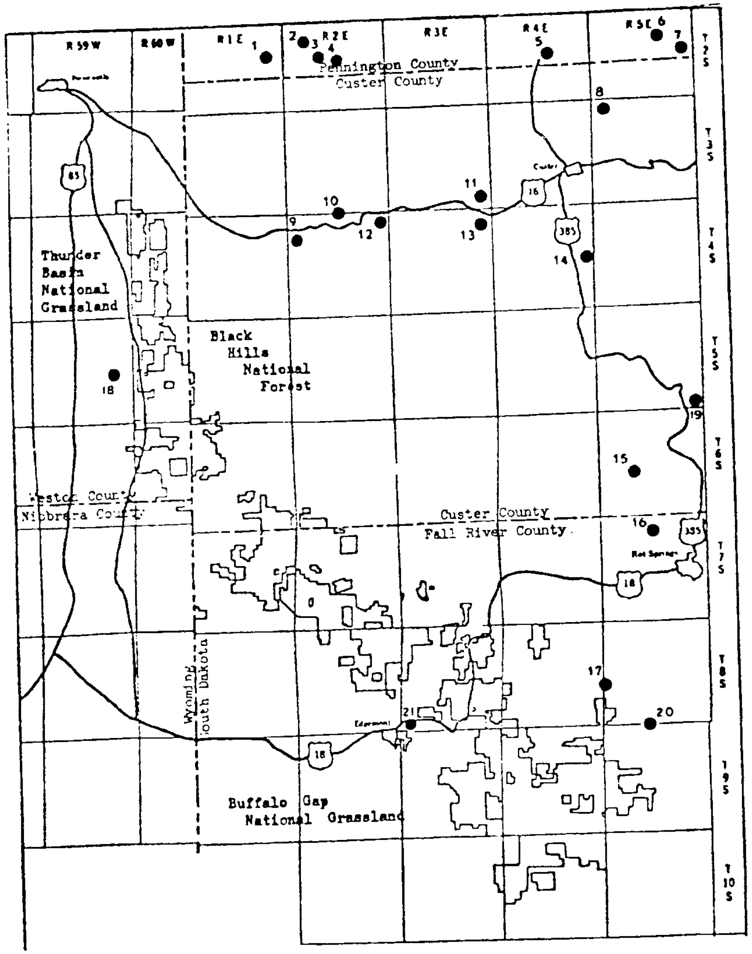
2.11.4 Recreation

Description - No existing recreation facilities are located on the Edgemont project area. As discussed in Section 2.11.1, the project area and vicinity possess a number of scenic features which have some potential recreation value, including a proposed scenic road through Red Canyon. Fringe areas of the Black Hills National Forest are located within the project area, but these areas have no developed facilities and potential use is limited further by poor accessibility.

Recreational activity in the project vicinity is associated chiefly with tourism and hunting. Because of the proximity of the project area to the Black Hills and other western South Dakota-eastern Wyoming attractions, the project vicinity is exposed to more tourist activity than other regions of these states. Hunting activity is discussed in Section 2.9.2. Due to low flows and turbid water conditions, fishing and other water-based recreation activity on project vicinity streams is very limited.

Major regional recreation areas and attractions include Buffalo Gap and Thunder Basin National Grasslands, Wind Cave National Park, Jewel Cave National Monument, Mt. Rushmore National Memorial, Custer State Park, and Angostura State Recreation Area as well as the Black Hills National Forest. These and other regional facilities are identified in Figure 2.11.4-1. A wide variety of public and commercial recreation facilities and services are associated with these areas.[2,3]

Impacts - The Edgemont project will not result in significant impacts to recreational activity in the project area. Project-related impacts will be negligible. No mining is currently planned on National Forest lands, and any future proposals for mining on these lands would be subject to the continuing review and approval of the U.S. Forest Service. Portions of the project area are visible from scenic overlooks located south and southeast of the properties on U.S. Highway 18 and South Dakota Highway 89, respectively; but the proposed mining activities are removed from highways. As noted in Section 2.11.1, the proposed scenic road through Red Canyon would not be affected visually or by traffic associated with mine operations at the nearby Runge East mine. Thus, impacts will be confined essentially to increased use of regional recreation facilities and pressure on wildlife resources from in-moving project employees. Within the context of overall regional development, cumulative recreation impacts from in-movers associated with this and other mining projects become more important because of limited state, county, and municipal recreation lands and facilities in this area.[3] However, project-related effects on regional recreation opportunities are expected to be minor. (See Section 2.10 for information related to community recreation and the project's relationship to regional development patterns and cumulative socioeconomic impacts).



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Recreation areas in the vicinity of the project area:

1. Rogers Lake
2. Ice Cave
3. Bear Trap Cave
4. Igloo Cave
5. Oreville Campground
6. Pine Creek Natural Area
7. Mt. Rushmore National Memorial
8. Sylvan Lake - Custer State Park - The Needles
9. Teepee WC
10. Jasper Cave
11. Harry Mills Campground
12. Jewel Cave National Monument
13. Comanche Park Campground
14. Beecher Rock
15. Onyx Cave
16. Cold Brook Reservoir
17. Cascade Springs
18. MW Lake
19. Wind Cave National Park
20. Angostura Reservoir and State Recreation Area
21. Cheyenne River Campground

Figure 2.11.4-1 Location of Recreation Areas in the Vicinity of the Edgemont Uranium Mining Project

2.11 References

1. Mine Reclaimation Consultants, Historical Resources in the Edgemont Lease Area. Unpublished Manuscript. TVA. Norris, Tennessee.

2. South Dakota Division of Parks and Recreation. South Dakota Comprehensive Outdoor Recreation Plan. 1975.

3. University of Wyoming, Division of Business and Economic Research. Outdoor Recreation in Wyoming. Vol 1-3, 6-7. 1969-72.

2.12 Other Considerations

2.12.1 Liquid Wastes

2.12.1.1 Underground Mine Water - Of the three underground mine areas identified, only the Burdock area is expected to require significant depressuring. Depressuring will be accomplished by pumping two or three wells located around the periphery of each mine shaft and by the mine's subsurface drainage system. Each of the peripheral dewatering wells at Burdock No. 1 shaft will be pumped at an average rate of 14.2 l/s (225 gal/min), beginning prior to shaft construction and lasting for as long as needed during the mining. The subsurface drainage system routes infiltrated water to each shaft's mine sump for pumping to the surface. This flow for the Burdock No. 1 shaft is estimated to be 42.6 l/s (675 gal/min).

This mine water, if contaminated, will be temporarily retained in impervious holding ponds before release into the local drainages. The pond effluents must comply with the applicable limitations which will be established in the NPDES permit for the mining operations. Other than suspended solids, it is anticipated that radium-226 and possibly uranium will be the only constituents that may occur in sufficiently high concentrations to require treatment before discharge. If radium removal is necessary, a barium chloride coprecipitation process will probably be used in conjunction with the impervious, settling pond system. Any uranium removal necessary will be by ion exchange. No significant adverse water quality impacts are anticipated from the discharge of the mine waters into the local drainage.

The rate of water discharge associated with depressuring at Burdock No. 2 shaft is not known at this time but will be less than that identified for shaft No. 1. Little or no water is expected from the Darrow and Runge East mines. The water from each of these mines will be managed in a similar manner as described for Burdock No. 1 shaft, if necessary.

2.12.1.2 Surface Mine Water - Ground water is not expected to be encountered at the Spencer Richardson surface mines. Any water accumulated in the open pit will be managed in a manner similar to the underground mines, if necessary (see Section 2.12.1.1).

2.12.1.3 Runoff - Area runoff outside the boundary of the mining operations will be diverted around the areas disturbed by mining. Runoff from overburden storage, topsoil storage, revegetated areas, and other disturbed areas will be controlled as necessary by a system of dikes, trenches, ponds or other appropriate measures. Except for ore-storage runoff, which may be controlled separately, any runoff at the mine sites contaminated by radioactive constituents will be routed to the mine water treatment facilities described in section 2.12.1.1.

2.12.1.4 Sanitary Wastes - The sanitary wastes at the Burdock mine will be treated by conventional, state-approved systems, consisting probably of a combination of septic tanks, and/or sewage lagoons. At the other proposed mines, portable toilet facilities will be provided. All systems will be operated in accordance with state and Federal requirements.

2.12.2 Solid Waste - All solid waste, by defined as Public Law 94-580, generated by the mining and associated activities will be stored, collected, and disposed of in accordance with applicable solid waste management regulations (local, state, or federal). Municipal-type solid waste will be generated at a rate of approximately 1.8 kg (4 lb) per worker per day. This solid waste will consist primarily of paper, cans, bottles, rags, wrappers, containers, packing materials, oil filters, and garbage. At the peak employment of 140 people, about 252 kg (560 lb) of solid waste will be generated per day. Since this is a relatively small quantity of waste, the most economical method of disposal will be to use a local, approved sanitary landfill.

Scrap wood will be offered to the general public for salvage (firewood or other use). Residue from public salvage will be burned and/or buried on-site, or disposed of off-site with the "domestic-type" solid waste. The recoverable resource portion of domestic-type solid waste (metals, rubber, etc.) will be recovered for sale if feasible.

All potentially hazardous wastes (as defined by P.L. 94-580) will be stored in suitable labeled containers on-site until they can be transported to an approved hazardous or chemical waste disposal facility.

2.12.3 Noise - A survey of onsite baseline noise was conducted May 2, 1978, at the proposed mining sites on the Edgemont properties. Weather conditions during daytime measurements consisted of partly cloudy skies and wind speeds relatively constant in a range between 22 to 33m/s (10-15 mi/h) with gusts up to 67 m/s (30 mi/h). Wind screens were used to minimize the wind effects. Nighttime values were taken under clear skies and low wind speeds of 0 to 11 m/s (0-5 mi/h). Baseline noise levels were recorded for approximately 15 min at each of the locations during both day and night. These measurements were used to calculate the L_{eq}, L_d, L_n, and L_{dn}. The L_{eq} is an equivalent steady state noise level which in the stated period of time would contain the same noise energy as the time varying noise measured during the same time period. The day/night equivalent sound level (L_{dn}) is a L_{eq} for a 24-hour period with a 10 dB weighting applied to nighttime values. A daytime equivalent (L_d) is a L_{eq} for the daytime period (0700-2200 hours) and nighttime equivalent (L_n) is a L_{eq} for the nighttime period (2200-0700 hours).

At the proposed mining sites, baseline noise levels are low compared to EPA guidelines.[1] The major sources of noise at these locations are the proximity of railroad tracks and wind noise through nearby vegetation (pines). Other noise sources are birds and other animals, both domestic and wild, and some vehicle traffic on nearby roads. There are 35-40 coal-hauling trains per day, each consisting of 100-110 cars. It is estimated that as many as 80 such trains per day will pass along this route by 1980.

Construction Noise - Noise radiated from the mining areas during construction will have minimum impact on residents of the area. The area is scarcely populated with only 25 people living in nine residences within the vicinity 3.2 km (approximately 2 mi) of the mines. Noise radiated during construction will originate from the use of heavy construction equipment located above ground. Federal noise regulations covering noise emissions from construction equipment, such as crawler tractors, portable compressors, and medium and heavy duty trucks, will be met.

Operational Noise - Operational noise from the mining operations will originate from ore hauling equipment and pumps; surface-mounted equipment such as ventilation fans and compressors; and other heavy equipment as listed in Tables 1.1.2.1-1 and 1.1.2.2-1. Mine ventilation equipment and compressors are expected to operate 24 hours per day while other equipment will operate only 8 hours per day with the possible exception of truck operations for 16 hours per day. Noise levels at the site boundaries are not expected to exceed 60 dB(A) during daytime hours and 55 dB(A) during nighttime hours. The nearest residence is approximately 1.8 km (1.1 mi) from a proposed underground mining site. The average baseline-noise level for the area is approximately 66dB (I_{dn}). With a property line sound level of 60 dB(A), impact from mining operations at that residence will be insignificant. This sound level should be well within the EPA guideline values. There are no known noise ordinances near the mine sites.

When mining operations begin a survey will be made to determine site boundary noise levels. Operation of these mines shall conform with all applicable noise regulations.

2.12 References

1. U.S. Environmental Protection Agency Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety, Report No. 550/9-74-004. March 1974.

3. Reclamation

Purpose: The objective of this reclamation plan is to outline the procedures which will be used to return lands disturbed during mining and associated operations to a self-sustaining and productive vegetation. This reclamation plan is flexible and designed to take advantage of the most appropriate procedures for each site to be reclaimed. Inasmuch as the proposed plan of reclamation is written to comply with state and federal regulations, it is standard procedure for the area. As individual sites are identified, this reclamation plan will be supplemented with a detailed plan covering only the immediate area of disturbance. In South Dakota, specific reclamation objectives and procedures will be established after consultation between TVA and the surface landowners. Since the land is primarily used for livestock grazing, reclamation for livestock grazing will be the primary objective. The South Dakota Department of Wildlife, Fish, and Parks; the South Dakota Conservation Commission; and other appropriate Federal and state agencies will be consulted when the surface owner has other land-use objectives. There is no mining planned on the Wyoming property. If mining is extended into Wyoming, however, affected land will be reclaimed to a use equal to or greater than its highest previous use. Standards adopted by the Wyoming Department of Environmental Quality, Land Quality Division, will be followed and the reclamation goal will be to establish the vegetative cover on the affected land such that it will be capable of renewing itself under natural conditions.

Successful reclamation requires the use of (1) proven water conservation and wind and water erosion prevention practices; (2) soil and plant species compatibility; (3) proper time, depth, rate of seeding and transplanting techniques; (4) topsoil or other material identified as suitable for a plant growth medium; and (5) experienced personnel who can make on-the-spot judgments on the adequacy of the seedbed, moisture, and other physical conditions of the soil on the area to be revegetated.

3.1 Topsoil and Overburden Stockpiling

Since most of the planned mining will be underground, surface disturbance will be limited. Topsoil will be removed from all areas affected by mining activities (see Section 1.1), segregated from other overburden materials, and marked in accordance with the applicable regulations. Where feasible, stockpiles will be located on leeward slopes of existing hills and away from existing drainages to protect them from prevailing winds and from water erosion. If the stockpiled topsoil is not to be used for as long as six months, it will be seeded to provide temporary cover.

3.2 Surface Preparation

If new open pits are developed, they will be backfilled with overburden. Extended surface mining from old pits and other surfaces disturbed by mining activities will be graded and contoured to blend in with the surrounding undisturbed topography and covered with topsoil or suitable subsoil (see Section 3.4). If final placement and shaping of overburden material results in excessive compaction, the top 46 to 61 cm (18-24 in) will be ripped while the material is relatively dry so that better shattering will be obtained.

Haul roads that are abandoned will be ripped and covered with topsoil. Shafts in the underground mine areas will be sealed in accordance with applicable Federal and state regulations. Procedures described in Section 3.4 through 3.7 will be implemented.

3.3 Placement of Overburden Containing Undesirable Materials

Underground mine waste will be tested for toxic materials. If toxic concentrations are encountered, the stockpiled material will be covered with an impermeable layer of nontoxic overburden (according to the appropriate state requirements) and compacted to minimize release into surface and subsurface water or, some other approved method of handling will be used. Upon permanent disposal, no toxic material will be placed into the subsurface hydrologic system nor within 2.4 m (8 ft) of the surface. Results of the overburden analysis[2] from the Spencer Richardson mine show that overburden materials should not pose a revegetation problem. Both the topsoil and subsoil at the Spencer Richardson mine have chemical and physical properties which make them suitable for use as a surface covering. Other overburden ranges from moderately to highly saline, but will be covered with at least .3 m (1 ft) of subsoil and topsoil prior to revegetating.

3.4 Topsoil Preparation

Fifteen to 22 cm (6-9 in) of topsoil will be spread over the shaped and prepared surfaces. Care will be exercised to avoid movement of topsoil when it is wet, particularly heavy, fine-textured material. If periods occur when permanent cover cannot be established, topsoil will be graded to provide a rough surface to minimize wind and water erosion. Before seeding, the need for surface modification (such as scarification) for water conservation will be determined and implemented.

3.5 Species, Seeding Rates, and Methods of Application

Table 3.5-1 lists the species and rates suggested for the various soil conditions. The species listed are adapted to the climatic and soil conditions existing in the area and are highly palatable to livestock, tolerant to grazing, and available for year-round use by livestock. The seed mixtures are designed to yield the maximum number of seedlings that the area can support. If other land use objectives are sought by the surface land owners, appropriate governmental agencies will be consulted for advice on seeding mixtures. Modification of the seeding mixtures will be considered throughout the period of reclamation if onsite performance of the species indicates that changes are needed.

Drill seeding will be used where practical. Seeding will be on the approximate contour so drill furrows will trap moisture and prevent excessive erosion of the newly seeded areas. If slopes are too steep for drill equipment, the seed mixture will be broadcast at approximately twice the rate given in Table 3.5-1 and followed by brush drag or similar treatment to ensure seed coverage, or seed may be applied by other acceptable methods such as hydroseeding.

TABLE 3.5-1

Recommended Seeding Rates
of Pure Live Seed kg/ha (lb/acre)*

Species	Ordinary Uplands	Heavy Soils Depressions	Sandy Soils	Wet or Subirrigated Areas
Agropyron smithii Rosana	4(4.5)	6(6.7)		4(4.5)
Agropyron dasystachyum Critana	3(3.4)	3(3.4)		
Agropyron riparium Sodar		2(2.2)	3(3.4)	3(3.4)
Bouteloua curtipendula Pierre or Butte	2(2.2)			
Calamovilfa longifolia			1(1.1)	
Schizachyrium scoparium Blaze	2(2.2)	2(2.2)	2(2.2)	
Oryzopsis hymenoides			3(3.4)	
Stipa viridula Lodorm			2(2.2)	
Agropyron elongatum Alkar or Orbit				4(4.5)
Astragalus cicer				3(3.4)
Atriplex canescens**			2(2.2)	

*Rates indicated are for drilled stands.
**Add to mixture if a palatable shrub is desired by landowner.

3.6 Time of Seeding and Protection of Seeded Areas

Due to the low annual precipitation (see Section 2.7), seeds must be sown when maximum moisture is present for germination and seedling establishment. Fall seeding will be done from October 1 until the ground freezes, about December 1. Spring seeding will be done between March 15 and May 1.

To ensure optimum plant establishment, seeded areas will be protected by fencing, herding, or similar approved animal control techniques, for two growing seasons or until the vegetation cover becomes self-sustaining. TVA will seek the cooperation of the surface owners to achieve successful reclamation. Weed control should not be needed once the desired plant species become established.

3.7 Planting of Trees and/or Shrubs

Areas which are to be reclaimed for tree and shrub production will receive the same preparation as those for grazing. A good stand of desirable grasses will provide understory cover and prevent invasion by weeds as well as help control erosion.

The trees to be transplanted will be placed in depressions approximately 18.6 dm^2 ($decimeter^2$), (2.0 ft^2) to trap additional moisture and aid in establishment. The depressions will be made after the grass seeding to minimize competition between the new transplants and grasses. Ponderosa pine or a mixture of ponderosa pine and Rockymountain juniper will be planted on the dry upland sites.

3.8. Previously Mined Pits

On the project area there are several unreclaimed pits and adits left by previous owners of the mineral rights. These mines date back as far as 1951 and were developed prior to effective regulations on reclamation. Where TVA will extend existing mines, new surface disturbed areas will be reclaimed in accordance with the procedures described in the preceding sections. As a minimum, this will consist of reclamation to a condition equivalent to that existing before mining by TVA.

3.9 Reclamation Schedule

As mining and associated activities are completed on any area, reclamation as described in Sections 3.2 thru 3.7 will be implemented. If the former activities cease during a seeding and planting season, reclamation procedures will be implemented immediately. If not, the procedures will be implemented the following season.

3.10 Alternative to the Proposed Reclamation

Reclamation alternatives will be governed by mining; i.e., in the event of mining and/or associated activities, the most site specific reclamation information available will be followed. However, roads and buildings or other structures may be retained by the surface owners for uses after mining activities have ceased. This would be reported to the South Dakota State Conservation Commission (or the Wyoming Land Quality Division in the case of Wyoming property), and these facilities would then become the responsibility of the surface owner.

3.11 Reclamation Monitoring

An onsite revegetation monitoring program will be conducted. TVA will work with the South Dakota Conservation Commission and/or the Wyoming Land Quality Division and other agencies suggested by them to develop a program with acceptable monitoring techniques.

3. References

1. TVA, Division of Forestry, Fisheries, and Wildlife Development. Reclamation plan, Edgemont lease. January 1977. In TVA Files.

2. Colorado School of Mine Research Institute. Chemical and Physical properties of Edgemont topsoil. May 1977. In TVA Files.

4. Alternatives to the Proposed Actions

In developing this proposal, TVA considered the following alternatives:

1. No Action - TVA has a statutory obligation to supply an ample amount of electricity at the lowest feasible cost to the area TVA serves. Since by 1986 nearly half of TVA's installed capacity of 48 x 10^6 kw will be nuclear fueled, an adequate supply of uranium must be made available on a timely basis. Not participating in the proposed action would require TVA to obtain an equal amount of uranium from other sources. TVA has identified no advantages, environmental or other, which would accrue from adoption of this alternative. Pursuing this course would impair TVA's ability to provide the required power without incurring substantially higher costs. Therefore, no action is considered to be an unacceptable alternative.

2. Purchase of Uranium - TVA has the largest commitment to power production from nuclear sources of any electric generating system in the United States. This large commitment requires a stable, long-term, ensured supply of uranium fuel. This objective is best met through a diversity of sources; therefore, it is unwise to depend entirely on purchases of uranium for the only source of supply. In addition, the present market conditions for the purchase of uranium are not favorable. The supply-demand imbalance has created a situation in which many uranium producers are able to sell their product at a premium without regard to cost of production. It is, therefore, to TVA's benefit and that of the utility industry as a whole, to take steps to increase uranium production. To this end, TVA has begun mineral rights acquisition activities to provide a stable long-term supply and to allow the acquisition of uranium at a lower cost than that which would be possible through purchases on the open market.

3. Mining Other Properties - TVA is also considering participating in mining ventures at other locations. However, substantial lead times are required in order to properly plan, develop, and achieve production from an uranium mine. Although exploration and planning for other mining ventures are continuing, this does not preclude the necessity for the proposed project. Moreover, a decision by TVA to abandon this proposal in favor of mining at other locations would not preclude the development of these properties by someone else. Furthermore, mining at other locations would likely result in similar types of impacts of equivalent magnitude.

4. Alternative Mining Techniques - Alternative mining techniques were considered before choosing the methods outlined herein. In TVA's opinion, the planned mining techniques represent the best balance among environmental, economic, technical, and other factors. Mining techniques will be continually reevaluated with the above factors in mind and as additional minable reserves are discovered.

5. Delay in Mining Schedule - Although delay in the proposed mining for several years might allow the incorporation of future technological advances in mining techniques which would result in reduced environmental impacts, we have identified none which are expected to be available during the life of the project. The timing of uranium production from the Edgemont project is critical because this production is needed to fuel TVA's reactors during the early 1980's. In the event production is delayed, it would be necessary to obtain substitute fuel from other sources which would be mined by present technology and probably at greater cost to TVA. Since TVA has identified no significant environmental or other benefits from a delayed mining schedule, the cost of delayed production dictates the rejection of this alternative.

6. Conclusions - The alternatives of no action, of purchasing uranium or of mining at other locations do not avoid the types of environmental impacts which will result from the proposed Edgemont mining project, nor would these alternatives prevent development in the proposed project area because the identified ore deposits would most probably be mined by other producers. Moreover, each of the alternatives considered would result in higher economic cost to TVA than the proposed action.

5. Adverse Environmental Effects Which Cannot Be Avoided

Mine-water discharge will cause a temporary depression of ground water levels in the Lakota Formation and to a lesser extent, in the Fall River Formation in the vicinity of the mines, and water levels in wells in the area will decline. Many artesian wells that now flow within the affected area will cease to do so after mining operations begin; however, the aquifers will remain saturated and water will still be available by pumping except possibly in the immediate vicinity of the mine.

The increase in population due to the project will place additional pressure on the surrounding communities and counties to provide needed community services.

There will be a minor alteration of specific topographic features near the shaft sites due to the mine waste piles. However, the land surface will be reclaimed to blend with the natural topography.

There will be a temporary minor degradation of air quality in the immediate vicinity of the mining operations due to fugitive dust and exhaust emissions from combustion-driven mining and support vehicles and equipment and releases of radon and short-lived radon progeny from the shafts and ore piles. This degradation is not expected to exceed air quality standards and will cease after the project is completed.

There will be a loss of plant and animal species from mined areas. Reclamation will mitigate impacts to flora and fauna, but it is unlikely that reclaimed communities will closely resemble existing species composition and diversity.

There will be a temporary change in land use from rangeland and forest to mineral extraction during the life of the project. However, since the operation is primarily underground mining, surface disturbance will be minimal. No surface subsidence is anticipated.

Depending on the mill location chosen, there will be an increase in vehicular emissions resulting from the transport of the uranium ore to the mill, an increase in vehicular traffic, and associated increased wear and tear on public roads.

6. Irreversible and Irretrievable Commitments of Resources

The principal irreversible and irretrievable commitment of resources will, of course, be the use of the mined uranium for energy production. It is estimated that a minimum of 1.9 x 10^6 kg (4.3 x 10^6 lb) of U_3O_8 will be extracted. As much as 10 percent of the underground minable ore will be left in the ground. About 8.5 x 10^6 l (2.2 x 10^6 gal) of petroleum fuels will also be expended plus a yet to be determined amount of electricity. Some of the materials used in the mine and support buildings and equipment will also be unrecoverable.

7. Relationship Between Local Short-Term Uses Of The Environment Versus Long-Term Productivity

There will be no significant long-term effects on the environment due to the proposal. During the proposed mining, approximately 32 ha (80 acre) would become unavailable for other uses. Virtually all of this new disturbance would be reclaimed after mining (see Chapter 3) and would then be available for essentially the same purposes as before mining. Differences in aquifer water levels attributable to aquifer depressuring for mining should be insignificant relative to premining levels about 10 years after completion of the project.

8. Milling

Plans for milling of the Edgemont ores are in the early stages of development. Alternative locations, processes, and capacities are being evaluated. A maximum capacity is expected to be 680 t/d (750 ton/d), and the following analysis is based upon this capacity. Process parameters used in this analysis are from one process under study, but should not differ significantly if an alternative process is selected.

A design feed of 0.12 percent U_3O_8 and 0.18 percent V_2O_5 ore will provide a daily mill input of 817 kg (1,800 lb) U_3O_8 and 1,226 kg (2,700 lb) V_2O_5. Probable extraction efficiencies will be 98 percent for uranium and 80 percent for vanadium.

The mill site fenced area should be about 80 ha (200 acre). Additional land may be purchased around the fenced site as a buffer zone and to allow for future expansion should ore reserves be expanded greatly.

Tailings disposal facilities will be of two types. A pond of about 16 ha (40 acre) will be required for disposal of solid tailings for ten years of mill operation, assuming that the thickness of tailings does not exceed 12 m (40 ft). A lined evaporation pond will also be required for waste effluent. This pond should not exceed 8 ha (20 acre) in size.

All of the non-recoverable U_3O_8 is expected to be released to the solid tailings disposal pond. Approximately 20 percent of this U_3O_8 is expected to be dissolved in the residual liquid in the solid tailings. Practically all of the non-recoverable V_2O_5 will also be released to the solid tailings. Only about 3 percent of this should be dissolved in the interstitial liquid. Less than 1 percent of the lost V_2O_5 is expected to be released to the evaporation pond.

Water consumption for the entire process should be about 246,000 l/d (65,000 gal/d). Annual fuel consumption is expected to be 159,000 l (42,000 gal) propane, 5,110,000 l (1,350,000 gal) No. 6 fuel oil, and 350,000 l (92,400 gal) No. 2 fuel oil. In addition, approximately 933 kW of electrical power will be required to operate the mill.

It is believed the following sections provide a reasonable discussion on a generic basis of the potential environmental impacts of a uranium milling facility of the type and capacity anticipated to be required. However, the impacts could be somewhat different depending on advances in the state-of-the-art in uranium milling techniques and the details of the final mill design. When milling arrangements have been agreed upon, a more detailed environmental assessment of the proposed mill and mill site will be developed in the context of the application for the mill license.

In summary, no unacceptable environmental impacts associated with building and operating a mill were identified in this generic assessment.

8.1 Air

Operation of the Edgemont mill facility will result in increased ambient concentrations of gaseous pollutants (sulfur oxides, nitrogen oxides, hydrocarbons, and carbon monoxide) and suspended particulate matter. Fugitive dust and fossil fuel combustion emissions will both contribute to the increase in ambient concentrations.

Fugitive dust releases will result from construction and hauling activities; tailings piles, ore piles, and stockpiles; and other disturbed land surfaces associated with the milling operation. However, mitigative procedures are expected to reduce the potential for significant nonradiological air quality impacts due to fugitive dust releases. Estimates of the emission rates of dust discharged to the atmosphere from the dust control equipment are presented in section 8.2 of this chapter.

The combustion of fossil fuels will release pollutants to the atmosphere. It is estimated (based on the annual fuel consumption rates presented in preceding section) that approximately 42 l/h (11 gal/h) of No. 2 fuel oil, 19 l/h (5 gal/h) of propane and 855 l/h (226 gal/h) of No. 6 fuel oil will be consumed, producing approximately 18.3 g/s (145 lb/h) of sulfur oxides, 1.25 g/s (10 lb/h) of particulates, 0.15 g/s (1.2 lb/h) of carbon monoxide, 0.03 g/s (0.2 lb/h) hydrocarbons, and 1.8 g/s (14 lb/h) of nitrogen oxides. The use of gasoline-powered vehicles will generate additional combustion emissions.

These combustion products will be emitted from multipoint sources at varying locations and with different release characteristics. Therefore, detailed assessment of the air quality impacts which can be expected to result from these emissions is not possible until more specific design information becomes available. However, the Edgemont mill facility will meet all applicable ambient air quality standards and air pollution control regulations.

8.2 Radiological

During operation of a uranium mill, small amounts of radioactive materials are released to the atmosphere and ground and surface waters. These releases may result in exposure of area residents to above-background concentrations of radioactive materials, primarily through inhalation of air and ingestion of food or water. Of importance in some cases, may be direct irradiation by materials confined on the mill site.

For conventional drying and packaging, discharges to the atmosphere from dust control equipment will consist of the off-gas from the ore dryer, the effluent from two baghouses on the crushing circuit, and the effluent from the scrubber serving the yellowcake finishing circuit. The ore dryer will operate at about 6,800 l/s (14,400 ft^3/min) with the off-gas at a temperature of 70° C (160° F). With two cyclones in series in the offgas stream, ore dust will be emitted at a rate of about 20 kg/h (45 lb/h). The baghouses will include a large baghouse operating at about 7,900 l/s (16,800 ft^3/min) and emitting less than 2.3 kg/h (5 lb/h) ore dust and a small baghouse operating at 520 l/s (1,100 ft^3/min) and emitting less than 0.5 kg/h (1 lb/h) ore dust. The yellowcake finishing circuit scrubber will be essentially 100 percent efficient with no detectable quantities of yellowcake dust expected in the effluent stream.

Radioactive particles may also be suspended into the atmosphere as a result of wind action on exposed ore stock piles and mill tailings. Radon-222 and its short-lived decay products also will be released to the atmosphere from the mill building, the tailings retention system, and ore stock piles. Releases to area waters will result from leakage, if any, from the tailings ponds. With proper design, construction, and operation of the mill, concentrations of radioactive materials released to the environment will be below applicable regulatory limits. The health and safety of the public should not be impaired either by the planned releases or by accidental or short-term releases. Further, direct radiation is not expected to be an important exposure pathway for a mill. The releases would be significantly reduced if the yellowcake is shipped as a slurry rather than undergoing conventional drying and packaging processes.

8.3 Water

Impacts on water quality resulting from the proposed uranium mill should be minimized by utilizing proper design, construction, and operation procedures. However, impacts could result from nonradiological liquid effluents produced in the milling process.

The uranium mill will be designed to prevent the release of radioactive liquid effluent directly to the surface water as required by Federal Regulations.* Liquid discharge from the mill is to tailings ponds. The liquid waste streams contain natural uranium, thorium-230, and radium-226, as well as nonradiological waste products (kerosene, amine, alcohol, and waste resins) of the leaching and precipitation process.

The liquid phase of the tailings contains a portion of the organic phase from the solvent-extraction step. Chemical laboratory waste and runoff from the ore storage areas during heavy precipitation will also be routed to the tailings pond. Contamination of the ground water might occur due to seepage both vertically and horizontally from the tailings pond; however, the tailings ponds will be designed to minimize this seepage.

Hazardous or toxic materials will be handled and stored to prevent accidental releases to the environment.

*40 CFR Part 436 (1976)

8.4 Land

Impacts of the uranium mill to land use will probably include removal of range land from grazing and wildlife usage for the mill facilities and tailings ponds estimated at 80 ha (200 acre). The locating of the mill and facilities will be done with a knowledge of any historical or archaeological sites in the area so impacts to these sites can be minimized. Land disturbance in relation to transportation could include the construction of new roads and upgrading of existing roads, the extent of which depends on the specific location of the mill.

Impacts to the soil will be localized within the mill site area. General impacts will include disruption of the soil forming processes, mixing of existing soils, and destruction of the soil which will have an effect on vegetation and subsequently wildlife. Because of the limited amount of area to be disturbed by a mill operation, these impacts will not be significant in terms of regional land use.

Effects to vegetation and wildlife include the disturbance to the land and vegetation in the area of the mill. Destruction of some animals may occur due to increased traffic on local roads. Hunting pressure on local populations of game species would probably increase.

8.5 Socioeconomic

Construction of a new uranium mill can impact communities in several ways. An increased number of employees associated with the mill has the potential for impacting a community's public and private facilities and services. The trend in mill design is toward increased automation. In the future, a mill of this capacity could probably be operated with about 60 employees. Increased traffic will result from commuters and operation of construction vehicles. Resulting impacts would be an increased accident frequency, possible inconvenience to local residents due to increased traffic, and increased wear and tear on the roadways. Because of the small amount of current traffic and relatively small amount of traffic generated by the mill, the impacts due to increased traffic should not cause unacceptable conditions.

Section 2.10 discusses other socioeconomic impacts arising from population influx due to the mill.

8.6 Safety

The environment may be affected by accidents associated with the milling of uranium. The occurrence of accidents related to the mill operation will be minimized through proper design, manufacture, and operation, as well as through a quality assurance program designed to establish and maintain safe operations. A detailed analysis of potential accidents will be addressed in the required environmental assessment when mill location, design and operating procedures are known.

8.7 Transportation

The mode of transport of ore to the mill has not been determined but in all probability will be by heavy-duty diesel-powered trucks. The impact associated with the transport of this ore will relate primarily to the generation of increased air pollutants and an increase in vehicular congestion. There is the possibility of other similar operations in the area contributing to the generation of increased air pollution and traffic. The actual transportation impacts of this mill and others cannot be accurately determined at this time.

Accidents during transportation of yellowcake to a UF_6 conversion facility could result in releases of this material to the environment. Yellowcake is conventionally packaged at the mill in 208 l (55 gal), sealed steel drums containing about 360 kg (800 lb.). According to published statistics,[1,2] the probability of truck accidents involving shipment of the yellowcake occuring is in the range of 2.6 to 4.2 x 10^{-6}/km (1.6 to 2.6 x 10^{-6}/mi). Only a small fraction of the accidents would result in the release of the contents of the shipping container. A recent accident (September 1977) involving a shipment of yellowcake resulted in a spill of 6,800 kg (15,000 lb) on the ground and truck trailer. It was estimated[4] that approximately 56 kg (123 lb) of U_3O_8 would be released to the atmosphere. The consequence for the accident area with a population density of 5.52 people/km^2 (2.13 people/mi^2) would be a 50 year dose commitment of 0.146 man-rem. Natural backround results in a 50 year integrated lung dose of 19 man-rem. Even for a large spill, cleanup of the released material and contaminated soils would be readily accomplished, thus further reducing the risk of significant radiation exposures. Another method which could be used is shipping yellowcake slurry in a tanker truck. In the event of an accident, the release of radionuclides would be reduced, and cleanup of the released material and contaminated soil could be more readily accomplished than cleanup of a dry spill.

8. References

1. Environmental Survey of Transportation of Radioactivity Materials to and from Nuclear Plants; U.S. Atomic Energy Commission. Directorate of Regulatory Standards. WASH-1238. December 1972.

2. An Assessment of the Risk of Transporting Plutonium Oxide and Liquid Plutonium Nitrate by Truck. Battelle Northwest Laboratories Report BNWL-1046. August 1975.

3. Clarke, R. K. et al. "Severity of Transportation Accidents". Sandia Laboratory Report SLA-74-0001, Vol. I-IV. Unpublished.

4. U.S. Nuclear Regulatory Commission. Draft Environmental Statement Related to the Operation of Moab Uranium Mill, Atlas Mineral Division Atlas Corporation. Office of Nuclear Materials Safety and Safeguards. Docket No. 3453. November 1977.

Appendix A

The Associated Soil Series Interpretations and Estimated Engineering Properties of the Edgemont Project Area Soils

APPENDIX A

TABLE A-1 SOIL INTERPRETATIONS FOR USE AS TOPSOIL AND SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH

MAP SYMBOL	SOIL SERIES	SLOPE (PERCENT)	COMPOSITION (PERCENT)	THICKNESS OF "A" HORIZON IN INCHES	SUITABILITY AS TOPSOIL[1]	REMARKS	DEPTH TO BEDROCK IN INCHES	SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH[2]	REMARKS
10	PITS, MINE	---	95	---	---	---	---	POOR	TOO ROCKY
16	HISLE-SLICKSPOTS COMPLEX	0-6							
	HISLE PART		65	2	POOR	THIN LAYER, EXCESS SODIUM, DENSE COMPACT SUBSOIL	20-40	POOR	EXCESS SODIUM
	SLICKSPOTS PART		25	---	---	---	---	---	---
19B	SATANTA LOAM	2-6	85	9	GOOD	---	>60	GOOD	---
19C	SATANTA LOAM	6-9	85	9	GOOD	---	>60	GOOD	---
40B	NORKA SILT LOAM, SANDSTONE SUBSTRATUM	2-6	85	7	FAIR	BEDROCK BELOW 30 INCHES	>30	FAIR	THIN LAYER
42D	BUTCHE-BONEEK LOAMS	3-15							
	BUTCHE PART		60	4	POOR	THIN LAYER	<20	POOR	THIN LAYER
	BONEEK PART		25	6	FAIR	THIN LAYER, SLOPE, TOO CLAYEY	>40	FAIR	TOO CLAYEY, SLOPE
42E	BUTCHE-ROCK OUTCROP COMPLEX	15-30							
	BUTCHE PART		60	4	POOR	THIN LAYER, SLOPE	<20	POOR	SLOPE, THIN LAYER, ROCKS
	ROCK OUTCROP PART		25	---	---	---	---	---	---
49B	TUTHILL FINE SANDY LOAM	0-6	85	15	GOOD	---	>60	GOOD	---
69B	**NORKA SILT LOAM**	**2-6**	**90**	**6**	**GOOD**	---	**>60**	**GOOD**	---

TABLE A-1 (Continued)

76D	MINNEQUA-MIDWAY SILTY CLAY LOAMS	6-25							
	MINNEQUA PART		50	13	POOR	SLOPE	20-40	POOR	SLOPE
	MIDWAY PART		40	8	POOR	SLOPE, THIN LAYER	< 20	POOR	SLOPE, THIN LAYER
79F	SHINGLE-PENROSE-ROCK OUTCROP COMPLEX	15-40							
	SHINGLE PART		55	9	POOR	THIN LAYER, SLOPE	< 20	POOR	THIN LAYER, SLOPE
	PENROSE PART		20	6	POOR	THIN LAYER	< 20	POOR	THIN LAYER
	ROCK OUTCROP PART		15	—	---	---	---	---	—
86	DEMAR SILTY CLAY LOAM	0-2	90	3	POOR	THIN LAYER, TOO CLAYEY	>40	POOR	TOO CLAYEY
90	GRUMMIT-SNOMO CLAYS	3-15							
	GRUMMIT PART		55	6	POOR	TOO CLAYEY	<20	POOR	TOO CLAYEY, THIN LAYER
	SNOMO PART		30	7	POOR	TOO CLAYEY	>40	POOR	TOO CLAYEY
91	GRUMMIT-ROCK OUTCROP COMPLEX	3-40							
	GRUMMIT PART		60	6	POOR	TOO CLAYEY, TREES	<20	POOR	TOO CLAYEY, THIN LAYER
	ROCK OUTCROP PART		30	—	—	---	---	—	—
95A	KYLE CLAY	0-2	90	4	POOR	TOO CLAYEY	> 60	POOR	TOO CLAYEY
95B	KYLE CLAY	2-6	85	4	POOR	TOO CLAYEY	> 60	POOR	TOO CLAYEY
96B	PIERRE CLAY	2-6	85	4	POOR	TOO CLAYEY	20-40	POOR	TOO CLAYEY
97D	PIERRE-SAMSIL CLAYS	6-25							
	PIERRE PART		60	4	POOR	TOO CLAYEY, SLOPE	20-40	POOR	TOO CLAYEY, SLOPE
	SAMSIL PART		25	3	POOR	TOO CLAYEY, SLOPE	< 20	POOR	TOO CLAYEY, THIN LAYER, SLOPE
197D	PIERRE-GRUMMIT CLAYS	6-25							
	PIERRE PART		55	4	POOR	TOO CLAYEY, SLOPE	20-40	POOR	TOO CLAYEY, SLOPE
	GRUMMIT PART		30	6	POOR	TOO CLAYEY	< 20	POOR	TOO CLAYEY, THIN LAYER

1. Suitability for use as topsoils refers generally to the A horizon.

2. The column "Suitability of Soil Material (Mixed) for Plant Growth" refers to suitability of materials to 60 inches or to bedrock that will support vegetation or is a medium of plant growth, based upon general texture, structure, erodibility, available water capacity, soluble salt content, depth, and accessibility or availability.

TABLE A-2 ESTIMATED ENGINEERING PROPERTIES OF SOILS

A-3

MAP SYMBOL (1)	SOIL SERIES (2)	DEPTH TO BED-ROCK (3)	DEPTH TO SEASONAL WATER TABLE (4)	DEPTH FROM SURFACE (5)	CLASSIFICATION DOMINANT USDA TEXTURE (6)	CLASSIFICATION AASHO (7)	LIQUID LIMIT (8)	PLASTIC-ITY INDEX (9)	PERMEA-BILITY (10)	AVAILABLE WATER CAPACITY (11)	REAC-TION (12)	SALINITY (13)	SHRINK-SWELL POTENTIAL (14)	CORROSIVITY UNCOATED STEEL (15)	CORROSIVITY CONCRETE (16)
---	---	IN.	FT.	IN.	---	---	---	---	IN/HR	IN/IN OF SOIL	pH	MMOHS/CM	---	---	---
42E	BONEEK, BEDROCK SUBSTRATUM	40-60	>6.0	0-6	SILT LOAM	A-4, A-6	25-40	5-15	0.6-2.0	0.19-0.22	6.1-7.3	---	LOW	MODERATE	LOW
				6-17	SILTY CLAY LOAM, SILTY CLAY	A-6, A-7	35-50	11-25	0.2-0.6	0.11-0.17	6.1-7.8	---	MODERATE	MODERATE	LOW
				17-50	SILTY CLAY LOAM, LOAM	A-4, A-6, A-7	30-45	5-20	0.6-2.0	0.17-0.20	7.4-9.0	---	MODERATE	HIGH	LOW
				50-60	BEDROCK										
42D	BUTCHE	<20	---	0-4	FINE SANDY LOAM	A-4	20-30	NP-7	0.6-6.0	0.12-0.15	6.1-7.8	---	LOW	MODERATE	MODERATE
				4-9	STONY FINE SANDY LOAM	A-4	20-30	NP-7	0.6-6.0	0.12-0.15	6.1-7.8	---	LOW	MODERATE	MODERATE
				9-12	BEDROCK										
86	DEMAR	40-50	>6.0	0-3	SILTY CLAY LOAM	A-6 A-7	30-45	8-20	0.6-2.0	0.16-0.20	6.1-7.3	<2	MODERATE	HIGH	MODERATE
				3-13	CLAY	A-7	40-60	20-35	<0.06	0.08-0.12	5.1-7.3	<2	HIGH	HIGH	MODERATE
				13-45	CLAY	A-7	40-60	20-35	<0.06	0.08-0.12	<5.0	8-16	HIGH	HIGH	HIGH
				45-60	BEDDED SHALE										
90 91 197D	GRUMMIT	5-20	---	0-9	CLAY	A-7	50-65	20-35	0.6-2.0	0.08-0.12	3.6-5.5	---	HIGH	HIGH	HIGH
				9-60	SHALE										
16	HISLE	20-40		0-29	CLAY	A-7	45-85	20-55	<0.06	0.05-0.12	6.1-8.4	---	HIGH	HIGH	MODERATE
				29-60	SHALE										

TABLE A-2 (Continued)

95A 95B	KYLE	>60	>6.0	0-4	CLAY	A-7	50-75	20-45	<0.06	0.08-0.12	6.6-7.8	---	HIGH	HIGH	LOW
				4-60	CLAY	A-7	50-75	20-45	<0.06	0.08-0.12	7.9-8.4	<4	HIGH	HIGH	LOW
76D	MIDWAY	6-20	---	0-17	SILTY CLAY LOAM	A-6, A-7	45-60	20-35	0.06-0.2	0.17-0.20	7.4-8.4	2-8	HIGH	HIGH	MODERATE
				17-60	SHALE										
76D	MINNEQUA	20-40	---	0-5	SILTY CLAY LOAM	A-4, A-6	30-40	8-15	0.6-2.0	0.19-0.22	7.4-8.4	---	MODERATE	HIGH	LOW
				5-24	SILTY CLAY LOAM, SILT LOAM	A-4, A-6	30-40	5-15	0.6-2.0	0.17-0.20	7.4-8.4	---	MODERATE	HIGH	LOW
				24-60	CHALK AND LIMESTONE										
69B	NORKA	>60	>6.0	0-6	SILT LOAM	A-4	20-30	2-7	0.6-2.0	0.19-0.22	6.6-8.4	---	LOW	LOW	LOW
				6-11	SILTY CLAY LOAM, CLAY LOAM	A-4, A-6	30-40	5-15	0.2-0.6	0.17-0.20	6.6-8.4	---	MODERATE	MODERATE	LOW
				11-60	SILT LOAM, LOAM	A-4	15-25	NP-7	0.6-2.0	0.16-0.20	7.4-8.4	---	LOW	MODERATE	LOW
40B	NORKA, BEDROCK SUBSTRATUM	30-60	---	0-7	SILT LOAM	A-4	20-30	2-7	0.6-2.0	0.19-0.22	6.6-8.4	---	LOW	LOW	LOW
				7-15	CLAY LOAM, SILTY CLAY LOAM	A-4, A-6	30-40	5-15	0.2-0.6	0.17-0.20	7.4-8.4	---	MODERATE	MODERATE	LOW
				15-30	CLAY LOAM, SILTY CLAY LOAM, SILT LOAM	A-4, A-6	30-40	5-15	0.6-2.0	0.17-0.20	7.4-8.4	---	LOW	MODERATE	LOW
79F	PENROSE	10-20	---	0-6	LOAM, CLAY LOAM	A-4	15-30	NP-10	0.6-2.0	0.16-0.18	7.9-8.4	---	LOW	HIGH	LOW
				6-14	SHALY CLAY LOAM	A-4	15-25	NP-10	0.6-2.0	0.14-0.17	7.9-8.4	---	LOW	HIGH	LOW
				14-16	LIMESTONE										

TABLE A-2 (Continued)

963 197D	PIERRE	20-40	---	0-29	CLAY, SILTY CLAY	A-7	50-75	22-45	<0.06	0.08-0.12	6.6-8.4	---	HIGH	HIGH	MODERATE
				29-34	SHALY CLAY	A-7	50-85	25-60	<0.06	0.08-0.12	6.6-8.4	---	HIGH	HIGH	MODERATE
				34-60	SHALE										
97D	SAMSIL	4-20	---	0-18	CLAY, SHALY CLAY	A-7	50-85	25-60	0.06-0.2	0.08-0.12	7.4-8.4	---	HIGH	HIGH	MODERATE
				18-60	SHALE										
19B 19C	SATANTA	>60	>6.0	0-9	LOAM	A-4, A-6	25-35	2-15	0.6-2.0	0.18-0.20	6.1-7.3	---	LOW	HIGH	LOW
				9-20	LOAM, SANDY CLAY LOAM	A-6, A-7	30-45	11-25	0.6-2.0	0.16-0.18	6.6-8.4	---	MODERATE	HIGH	LOW
				20-60	LOAM	A-4, A-6	20-35	2-15	0.6-2.0	0.16-0.18	7.4-8.4	---	LOW	HIGH	LOW
79F	SHINGLE	10-20	---	0-13	LOAM, SHALY LOAM	A-6	30-40	5-15	0.6-2.0	0.16-0.17	7.9-9.0	---	MODERATE	HIGH	LOW
				13-60	SHALE										
90	SNOMO	40-60	---	0-45	CLAY, SILTY CLAY	A-7	50-70	20-38	0.6-2.0	0.08-0.12	3.6-5.5	---	HIGH	MODERATE	HIGH
				45-60	SHALE										
49B	TUTHILL	>60	>6.0	0-10	FINE SANDY LOAM	A-4	20-35	NP-10	0.6-6.0	0.14-0.17	6.1-7.8	---	LOW	LOW	LOW
				10-24	FINE SANDY LOAM, SANDY CLAY LOAM	A-4, A-6	25-40	5-15	0.6-2.0	0.09-0.18	6.1-7.8	---	MODERATE	MODERATE	LOW
				24-60	FINE SANDY LOAM, SANDY LOAM	A-4	20-30	NP-10	0.6-6.0	0.09-0.15	6.1-8.4	---	LOW	MODERATE	LOW

Appendix B

Archaeological Clearance Material

HISTORICAL
PRESERVATION
CENTER
University of South Dakota
Vermillion, SD 57069
Phone (605) 677 5314

SOUTH DAKOTA Department of
Education and Cultural Affairs

August 30, 1978

Mr. Maxwell D. Ramsey
Recreation Program Coordinator
Tennessee Valley Authority
Norris, Tennessee 37828

Re: Edgemont Uranium Mining Project
Fall River and Custer Counties

Dear Sir:

This office has been notified of your intention to undertake the above federally involved action. To assist your compliance with Section 106 of the National Historic Preservation Act (PL 89-665); Executive Order 11593, Protection and Enhancement of the Cultural Environment; 36 CFR 800; and other laws and regulations pertinent to the protection of historic, archaeological or culturally significant properties, the State Historic Preservation Officer makes the following comment:

The above project has been reviewed and determined to have no effect on significant cultural sites. However, should archaeological, historical or cultural materials be discovered in the course of the undertaking, work disturbing those materials shall cease immediately, and the State Historic Preservation Officer notified of their existence. An immediate assessment of their importance will follow, and appropriate mitigation recommendations issued.

Additional comments:
This office wishes to extend its gratitude to the TVA for its efforts to protect the cultural resources of the area in question.

Your cooperation in this matter is most appreciated.

Yours truly,

Steven L. Rugole

for John J. Little
State Historic Preservation Officer

jla

cc: Robert Alex

The Office of Cultural Preservation of the Department of Education and Cultural Affairs coordinates South Dakota's archaeological research, museums, historical preservation and historical resource in a program designed to preserve our natural and cultural heritage.

From:	Jeffery C. Parsons
To:	Shea, Valois
Cc:	"Roger Flynn"
Subject:	FW: Oglala Sioux Tribe Comment Attachments #5
Date:	Monday, June 19, 2017 5:38:08 PM
Attachments:	TVA Analysis of Aquifer Tests at the Proposed Burdock Uranium Mine Site Boggs and Jenkins.pdf

Email #5

****

Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738

****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:43 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

Email #5

****

Jeffrey C. Parsons
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Western Mining Action Project
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Lyons, CO 80540
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****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:39 PM
To: shea.valois@epa.gov
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

Email #4

****
Jeffrey C. Parsons
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****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:38 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

****
Jeffrey C. Parsons
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****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:37 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

Email #2

****
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From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:36 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: Oglala Sioux Tribe Comment Attachments

Ms. Shea – in support of the comments submitted this day (June 19, 2017) by the Oglala Sioux Tribe, attached are supplemental documents. As there are several such documents, there are likely to be a series of emails to follow. Thank you.

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

Tennessee Valley Authority
Office of Natural Resources
Division of Water Resources
Water Systems Development Branch

ANALYSIS OF AQUIFER TESTS CONDUCTED AT THE PROPOSED BURDOCK URANIUM MINE SITE BURDOCK, SOUTH DAKOTA

Report No. WR28-1-520-109

Prepared by

J. M. Boggs
and
A. M. Jenkins

Norris, Tennessee
May 1980

17289 K

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ABSTRACT

Separate aquifer tests were conducted in two aquifers which may be affected by TVA's proposed uranium mining operation near Burdock, South Dakota. In April 1979, a constant-discharge test was conducted in the Chilson member of the Lakota formation which comprises the principal ore body and an aquifer of regional importance. The hydraulic properties of both the Lakota (Chilson) aquifer and the overlying Fuson shale aquitard were determined. A second test was conducted in July 1979 in the Fall River aquifer which overlies the Fuson. The hydraulic characteristics of the Fall River aquifer and a second estimate of the Fuson aquitard properties were obtained from the test. The test results indicate that the two aquifers are hydrologically connected via (1) general leakage through the Fuson shale, and (2) direct pathways, probably in the form of numerous old (pre-TVA) unplugged exploration boreholes.

The hydraulic properties of the Fall River, Fuson and Lakota units obtained from the aquifer test analyses were incorporated into a computer model of the site geohydrologic system. These parameters were refined in a calibration process until the model could reproduce the drawdown responses observed during the Lakota aquifer test. Results indicate the transmissivity and storativity of the Lakota (Chilson) aquifer are approximately 1400 gallons per day per foot (gpd/ft) and $1.0x10^{-4}$, respectively. The Fall River aquifer has an estimated transmissivity of 400 gpd/ft and a storativity of about $1.4x10^{-5}$. The hydraulic conductivity of the Fuson aquitard is estimated at approximately 10^{-3} foot per day. The specific storativity of the Fuson was not measured but is assumed to be about 10^{-6} feet $^{-1}$.

INTRODUCTION

This report describes the aquifer testing program conducted at the proposed uranium mine site in Burdock, South Dakota. The purpose of the program was to determine the hydrogeologic conditions in the mining area in order-to predict mine dewatering requirements and impacts.

The Fall River formation and the Chilson member of the Lakota formation comprise the principal aquifers in the vicinity of the proposed mine. These aquifers are separated by the Fuson shale member of the Lakota formation which acts as an aquitard. The uranium deposits to be mined lie within the Chilson unit.

Two unsuccessful aquifer tests were conducted at the site prior to those described in this report. The first test was conducted at the Burdock test well in February 1977. Pumping took place from both the Fall River and Lakota aquifers during the 14-day test. The test results were invalidated by questionable well discharge measurements and by mechanical difficulties with a deep-well current meter used to measure the quantity of water pumped from each aquifer. A second test lasting three days was performed in November 1977. Pumping was restricted to the Lakota aquifer during the test in order to determine the potential for leakage through the Fuson shale from the overlying Fall River aquifer. The results of the test were inconclusive because (1) five observation wells used in the test were subsequently found to be improperly constructed and (2) pressure gauges used to monitor pumping response at several wells malfunctioned during the test.

The problems associated with the two earlier tests were corrected for the tests described in this report. The defective observation wells were pressure sealed with cement grout and replaced with properly constructed wells. More reliable instrumentation for monitoring potentiometric heads in observation wells was used in subsequent tests.

HYDROGEOLOGY

Regional Setting

The proposed mine site is located in the northwestern corner of Fall River County, South Dakota, less than one mile southeast of the community of Burdock. Geologically, the site is situated on the southwest flank of the Black Hills Uplift (see Appendix, Figure 1). The stratigraphy of the region consists of a sequence of rocks ranging in age from Precambrian to Recent which crop out peripherally to the Black Hills. The Precambrian rocks crop out near the center of the Black Hills, and progressively younger rocks crop out to the southwest. Surficial rocks in the site area range in age from lower Cretaceous to Recent. A generalized stratigraphic column for the site is shown in Table 1.

The major structural features of the region are the southwesterly-trending Dewey and Long Mountain structural zones. Faults, fractures and breccia pipes in these zones are believed to affect the ground-water water regime.

Aquifers

The principal aquifers in the region are the alluvial deposits associated with the Cheyenne River and its major tributaries, the Fall River formation, the Lakota formation, the Sundance formation, and the Pahasapa (or Madison) formation. Except for the alluvium, these aquifers crop out peripherally to the Black Hills where they receive recharge from precipitation. Ground-water movement is in the direction of dip, radially from the central Black Hills. In most instances, ground water in these aquifers is under artesian conditions away from the

TABLE I: GENERALIZED STRATIGRAPHIC COLUMN FOR SITE REGION (FROM KEENE, 1973)

PERIOD	FORMATION NAME	SYMBOL	COLUMN	LITHOLOGIC DESCRIPTION	THKNS. IN FEET	HYDROLOGIC CHARACTERISTICS
Quaternary	Alluvium	Qal		Gravel, sand, and silt floodplain deposits. Alluvial terraces and windblown material.	1-30	Good to excellent aquifer along floodplains; terraces generally non-productive except for scattered springs.
Cretaceous	Pierre Fm.	Kp		Dark gray shale, weathering brown or buff and containing many fossiliferous concretions. Scattered concretions which form "teepee buttes". Black fissile shale, cone-in-cone concretions.	1000+	Relatively no value as an aquifer; locally large diameter wells in stream valleys may yield small amounts of highly mineralized water during wet seasons.
	Niobrara Fm.	Kn		Gray calcareous shale, weathering yellow and impure chalk with Ostrea Congesta.	100-225	No known wells.
	Carlile Fm. (Turner sand; Wall Creek sand)	Kcr		Light gray shale with large concretions. Gray shale with thin sandstone layers. Bed of impure limestone. Thin sandstone.	520-540	Relatively impermeable; possible small yields from Turner and Wall Creek sands.
	Greenhorn Lms.	Kg		Thin bedded hard limestone, weathering creamy white, contains Inoceramus Labiatus.	50	Too thin and dense to be an aquifer.
	Graneros Group (Belle Fourche Fm.; Mowry Shale; Newcastle sand; Skull Creek Shale)	Kgs		Light gray shale, bentonite, large concretions. Light gray siliceous shale. Thin brown-to-yellow sandstone. Black shale.	870	Newcastle sand may yield water, permeability is variable.
	Fall River Fm.	Kfr		Interbedded red-brown massive sandstone and Carbonaceous shales.	30-165	Largest producer in the area. Yields up to 60 gpm of highly mineralized water (flow). Water quality generally poor, sometimes yields hydrogen sulfide.
	Fuson Shale			Gray-to-purple shale, thin shales.	0-180	
	Minnewasta Lms.			Light gray massive limestone.	0-25	
	Lakota Fm.	Klk		Coarse, hard, cross-bedded sandstone, buff-to-gray, coal beds locally near base.	130-230	Relatively good aquifer from the lower Chilson member, up to 30 gpm artesian flow.
Jurassic	Morrison Fm.	Km		Green-to-maroon shale, thin sandstone.	0-125	No known wells, possible aquifer.
	Unkpapa Fm.	Ju		Fine grained, massive, vari-colored sandstone.	0-240	No known wells, possible aquifer.
	Sundance Fm.	Jsd		Alternating beds of red sandstone and red-to-green marine shales.	250-450	Produces small amounts of water from the sands suitable for domestic use.
Triassic	Spearfish Fm.	₹s		Red silty shale, limestone, and anhydrite near the top. Redbeds. Gypsum locally near the base.	400	Poor producer, small yields of sulfate water.
?						
Permian	Minnekahta Lms.	Cmk		Pale brown, to gray dense, crystalline limestone.	50	Locally secondary fracture porosity.
	Opeche Fm.	Co		Red thinly bedded sandstones and shales, purple shale near top.	100	No known wells.
?						
Pennsylvanian	Minnelusa Fm.	Cml		Converse sand, red-to-yellow cross bedded sand. Red marker, thin red shale near middle. Leo sands, series of thin limestones. Dolomite at bottom with basal laterite zone.	755-1040	Permeability variable; tremendous flows of warm mineralized water recorded near the perifery of the Black Hills. Excellent potential.
Mississippian	Pahasapa Fm.	Cps		Massive, light colored dolomite and limestone, cavernous in upper 100 feet.	165-465	Most promising aquifer in the area. The 2 wells in this aquifer produce large amounts of water suitable for domestic use.
Precambrian	Metamorphic and Igneous rocks	P€		Granite, schists, quartzite, and slates.	---	No potential.

outcrop area, and water flows from numerous wells in the area at ground surface.

The Fall River and Lakota formations which form the Inyan Kara Group are the principal aquifers in the region. The alluvium is used locally as a source of domestic and stock water. The Sundance formation is used near its outcrop area in central and northwestern Fall River County. The Pahasapa (Madison) formation is locally accessible only by very deep wells and is the source for five wells in the city of Edgemont.

The Fall River and Lakota aquifers are of primary concern because of the potential impact of mine dewatering on the numerous wells developed in these aquifers in the vicinity of the mine. At the proposed mine site, the Fall River consists of approximately 120 feet of interbedded fine-grained sandstone, siltstone and carbonaceous shale. The Fall River aquifer is overlain by approximately 250 feet of the Mowry and Skull Creek shales unit, which act as confining beds. Twenty-six domestic and stock-watering wells are known to be developed in the Fall River formation within a four-mile radius of the mine site. Many of these are flowing at the surface.

The Fall River formation is underlain by Fuson shale member of the Lakota formation. Thickness of the Fuson is on the order of 60 feet in the site vicinity. The Fuson acts as a leaky aquitard between the Fall River and Lakota aquifers. A physical examination of undisturbed core samples of Fuson indicates that the shale itself has a very low permeability. However, aquifer tests suggest a direct connection through the Fuson which may be the result of some as-yet-unidentified structural features or old unplugged exploration holes.

The Chilson member of the Lakota formation is the second most widely used aquifer in western Fall River County, as the source for some 23 wells within a four-mile radius of the mine site. It is also the uranium-bearing unit to be mined. The Chilson consists of about 120 feet of consolidated to semi-consolidated, fine-grained sandstone and siltstone. It is underlain by the Morrison formation consisting of inter-bedded shale and fine-grained sandstone. Regionally, the Morrison is not considered an aquifer. Under conditions of groundwater withdrawal from the Chilson, the Morrison is expected to act as an aquitard.

Recharge to the Fall River and Lakota aquifers is believed to occur at their outcrop areas. Bowles (1968) has theorized that re-charge to these aquifers may also be derived from the upward movement of ground water along solution collapses and breccia pipes from the deeper Minnelusa and Pahasapa aquifers. The solution collapse and breccia pipe features lie within the Dewey and Long Mountain structural belts.

AQUIFER TEST DESIGN

The objective of the aquifer testing program was to obtain sufficient quantitative information about local hydrogeologic conditions to enable prediction of mine dewatering requirements and impacts to both the Fall River and Lakota aquifers. Since the two aquifers involved are separated by the Fuson aquitard, two distinct pumping tests were required to obtain the necessary information about each formation: one test in which the Lakota aquifer was pumped, and another in which pumping was limited to the Fall River aquifer. During both tests ground-water levels were monitored in observation wells developed in each of the three formations. Data obtained from these tests were then analyzed to obtain estimates of the hydraulic properties of the aquifers and aquitard.

The Burdock test well was constructed approximately 600 feet north of the proposed mine shaft. Total depth of the well is 559 feet. The well is screened in both the Fall River and Lakota aquifers as shown in Figure 2.

Fifteen observation wells were constructed within an approximate one-mile radius of the pumping well as indicated in Figure 3. Seven of these wells are developed in the Fall River formation, five in the Lakota, and three in the Fuson. In addition, there is a single well developed in the Sundance formation located approximately one mile from the test well. This well was not constructed specifically for the aquifer tests, but was monitored periodically during the Lakota aquifer test. Construction details for these wells are given in Table 2.

TABLE 2. Observation Well Construction Details

Well No.	Total Depth (feet)	Casing Diameter (inches)	Depth Interval of Open Borehole or Well Screen (feet)	Distance From Pumped Well (feet)
B-10LAK	550	4	510-550	195
B-10FU	395	4	377-395	255
B-10FR	350	4	300-350	177
B-1LAK	570	4	525-570	405
B-1FU	440	4	420-440	350
B-1FR	376	4	334-376	373
B-11LAK	550	4	504-550	618
B-11FR	360	4	315-360	620
B-9LAK	545	1	503-545	1540
B-9FR	293	1	251-293	1540
B-7LAK	441	1	399-441	2507
B-7FR	252	1	210-252	2540
Sundance Well	880	7 7/8	666-780	4763

Inasmuch as water levels in each hydrogeologic unit will respond differently during pumping tests, it is important that each observation well reflect the potentiometric head in the intended uncased borehole interval. Several observation wells used in previous tests were suspected of leaking along the grout seal placed in the annular space between well casing and borehole wall. As a result, special precautions were taken to ensure proper construction of the observation wells used in the present tests. A geophysical device known as a cemeton logging probe was used to check the continuity of the cement grout seal in each well after construction. All were found to be properly sealed.

The so-called ratio-method of multiple-aquifer test analysis (Neuman and Witherspoon, 1973) requires that the response of water levels in both the pumped and unpumped aquifers and in the intervening aquitard be monitored during the test. Water level responses in these units must be measured in wells located at approximately the same radial distance from the pumped well. To obtain the necessary data, two groups of observation wells were constructed, each group having one well developed in the Fall River, one in the Fuson, and one in the Lakota (Chilson member). The B-10 group was located approximately 200 feet northeast of the pumping well, while the B-1 group was located approximately 375 feet to the southwest. These well groups were located close to the pumped well to ensure response in the aquitard and in the unpumped aquifer, if such responses were to occur at all. The remaining well groups (B-7, B-9 and B-11 series) contain only Fall River and Lakota wells.

Under natural conditions, the test well and all monitor wells except for those of the B-7 group flow at ground surface if not capped. The two previous tests conducted at the site indicated that observation wells in the pumped aquifer located close to the pumping well would become non-flowing at some point during the test. Thus, pressure sensing devices would be required during the early part of the test and depth measuring techniques during later periods. To ensure adequate data records, each flowing well was equipped with two pressure measuring devices. Malfunctions of several pressure gauges on previous tests pointed out the need for a back-up pressure measuring device.

Three types of pressure sensors were used: mercury manometers, electronic pressure transducers, and mechanical pressure gauges. The B-1 and B-10 observation well groups were equipped with mercury manometers and pressure transducers. As the closest wells to the pumping center, the data from these wells are most important in the multiple aquifer analysis and warrant the best instrumentation. Pressure transducers from all wells were wired to a central terminal and could be monitored frequently during the tests. Each well in groups B-9 and B-11 was equipped with a mercury manometer and a mechanical pressure gauge. Electric probes were used to measure water levels in the non-flowing wells of the B-7 group. These devices were also used to measure water levels in other wells which became non-flowing during pumping tests. Potentiometric head in the pumped well was measured with a mercury manometer, an air line and an electric probe.

LAKOTA AQUIFER TEST

Several months prior to the Lakota test, a pneumatic packer was set within the Fuson section of the test well to prevent communication between the Fall River and Lakota aquifers through the well. A submersible pump was set below packer to restrict pumping to the Lakota aquifer. Well-head valves on the test well and other artesian observation wells were closed to prevent flow in order to bring the ground-water system into equilibrium before testing.

Hydrographs for the test well and observation wells prior to test are shown in Figures 4 and 5. These hydrographs typify the basic relationship between the potentiometric heads in the Fall River, Fuson and Lakota, i.e., heads are highest in the Lakota, lowest in the Fall River, and at an intermediate position within the Fuson. The irregular readings recorded during January and February 1979 were due to depressurization of the aquifers during the installation of instrumentation and new wells. The pre-test ground-water level configuration in the Lakota aquifer on April 18 is shown in Figure 6.

Test Procedures and Results

A constant-discharge aquifer test was initiated at 1300 hours on April 18, 1979. Discharge from the well was pumped via pipeline to a stock-watering pond located approximately 0.75 miles from the test well. Pumpage was measured with an in-line flow meter and with an orifice plate and manometer device at the end of the discharge line. The pumping rate varied little during the test ranging from 201 to 205 gpm and averaging 203 gpm. The pumping phase of the test lasted for

73 hours (3.04 days) and was followed by a 30 day period of recovery measurements.

Figure 7 shows a semilogarithmic graph of drawdown (s) versus time (t) for the pumping well (Lakota aquifer). Erratic readings during the first 200 minutes of the test are the result of problems with the airline equipment, and are not due to discharge variations. These difficulties were subsequently corrected, but in general airline measurements are believed to be accurate only to within about ±2 feet.

Semilog graphs for the observation well groups are shown in Figures 8 through 12. Note that a slight initial increase in hydrostatic pressure is indicated in the Fall River and Fuson wells of the B-10 and B-1 well groups. This anomalous trend is more pronounced in the Fuson wells than in the Fall River wells and persists for approximately 90 minutes in B-10FU. The response is believed to be due to an increase in pore pressure resulting from deformation of the matrix of these formations.[1] In any case, the anomalous trend was recorded by both the pressure transducers and mercury manometers, and is not the result of measurement error.

The Jacob straight-line method (see Walton, 1970, pp. 130-133) was applied to the semilog graphs for the Lakota wells to obtain the values of transmissivity (T) and storativity (S) presented in Table 3. In the case of the closer observation wells, two straight-line

[1]During the early stages of pumping, water removed from the Lakota in the immediate vicinity of the well causes compaction of the aquifer. This, in turn, may cause the overlying strata to flex slightly in the area where the underlying support of the Lakota has been reduced. The resulting deformation in the overlying formations causes compressive forces which temporarily increase pore pressures in these materials. Subsequently, the effect of pumping-induced depressurization is transmitted through the overlying materials, gradually lowering the hydrostatic pressure.

TABLE 3. Lakota Aquifer Properties

		Jacob Method				Theis Method				Recovery Method	
Well No.	r (ft)	T_e (gpd/ft)	S_e --	T_ℓ (gpd/ft)	S_ℓ --	T_e (gpd/ft)	S_e --	T_ℓ (gpd/ft)	S_ℓ --	T_e (gpd/ft)	T_ℓ (gpd/ft)
PW-LAK	0.67	1980	--	1260	--	--	--	--	--	--	--
B-10LAK	195	2680	7.6×10^{-5}	1370	3.5×10^{-4}	2530	8.4×10^{-5}	1660	1.6×10^{-4}	2060	1300
B-1LAK	405	2140	4.4×10^{-5}	1340	1.2×10^{-4}	2120	4.8×10^{-5}	1550	8.4×10^{-5}	1970	1240
B-11LAK	620	--	--	--	--	2530	1.1×10^{-4}	1530	1.5×10^{-4}	--	1250
B-9LAK	1540	--	--	--	--	--	--	1370	1.3×10^{-4}	--	1290
B-7LAK	2507	--	--	--	--	--	--	1760	6.5×10^{-5}	--	1500
Average:		2270	6.0×10^{-5}	1320	2.4×10^{-4}	2390	8.1×10^{-5}	1570	1.2×10^{-4}	2015	1270

NOTE: Subscript "e" denotes an aquifer parameter determined using early drawdown (or recovery) data. Similarly, subscript "ℓ" denotes a parameter computed from late data.

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solutions were possible: one using the early data and another using the late data. Note that data for wells B-7L, B-9L and B-11L cannot be analyzed by the Jacob method because data do not satisfy the criterion that $r^2S/4Tt \leq 0.01$ (consistent units), where r is the distance between the pumped well and the observation well.

Logarithmic graphs of drawdown data for all observation wells are given in Figures 13 through 17. Theis curve-matching techniques (Walton, 1970, pp. 209-211) were applied to the Lakota curves to obtain T and S estimates for the Lakota aquifer. As with the Jacob analyses, two curve-match solutions were possible: one using the early, steeply-rising portions of the s-t curves, and another using the later data. Both solutions are given in Table 3.

A semilogarithmic graph of distance versus drawdown (Figure 18) was constructed by plotting the final drawdown in each Lakota well versus its radial distance from the pumped well. The Jacob straight-line techniques were applied to these data to obtain T and S values for the Lakota of 1780 gpd/ft and 7.7×10^{-5}, respectively. However, this type of analysis is applicable only to nonleaky aquifer systems. Since leakage obviously occurred during the test, the results are considered unreliable.

Contour maps of the final drawdown in the Lakota and Fall River aquifers at the end of the test are shown in Figures 19 and 20, respectively. The drawdown cone in both aquifers is slightly elongated in a northwesterly direction. This is probably an indication of anisotropic transmissivity, with the transmissivity in the direction parallel to the axis of elongation being somewhat greater than that in the direction normal to the axis of elongation. The principal direction of transmissivity parallels the strike of a regional fracture-joint set, suggesting a possible explanation for the observed drawdown configuration.

Following the pumping phase of the test, water level recovery measurements were made at all observation wells for a period of 30 days. Attempts were also made to monitor recovery in the pumped well using an airline. However, data collected were highly erratic suggesting a malfunction of the airline equipment. Semilogarithmic graphs of residual drawdown versus t/t' (ratio of time since pumping started to time since pumping stopped) for the observation wells are shown in Figures 21 through 25. Lakota graphs were analyzed using Jacob straight-line techniques to obtain the estimates of transmissivity presented in Table 3. Again, two straight-line fits are possible for the closer Lakota wells. Both are given in Table 3.

Interpretation of Test Results

The drawdown trends recorded in the observation wells indicate some important qualitative information about hydrogeologic conditions at the proposed mine site, in addition to providing a basis for determining hydraulic properties of materials. The relative response of the Fall River, Fuson and Lakota formations as reflected in the B-10 and B-1 groups (Figures 13 and 14), is not typical of the response that would be expected in an ideal leaky multiple aquifer system. Ideally, the s-t curve for the intervening aquitard lies between the curves for the pumped and unpumped aquifers. That is, in a logarithmic plot of s-t data the aquitard (Fuson) curve would lie below the curve for the pumped aquifer (Lakota), and above the curve for the unpumped aquifer (Fall River). However, "ideal" trends are not evident in the observed data until after 300 minutes of pumping in the case of the B-10 group, and not until after 2000 minutes in the case of the B-1 group. The fact that a greater pumping response is observed in Fall River formation than in the Fuson during the early part of the test indicates that direct (though restricted) avenues through the Fuson must exist. This condition was suspected before the test, and is believed to be the result of numerous old, unplugged uranium exploration boreholes in the test site vicinity. The shift to a more ideal relationship among the s-t curves exhibited during the latter part of test possibly indicates that general leakage through the Fuson itself has caught up with leakage through the open boreholes.

The leakage condition which is apparent in the response of the Fuson and Fall River wells is not evident in the Lakota well data. Under ideal conditions, the rate of drawdown in the Lakota observation wells would be expected to gradually decrease and perhaps even level off completely for some period of time. However, the opposite effect is noted in Lakota s-t plots, particularly the semilog graphs for B-10 LAK and B-1 LAK (Figures 8 and 9). The rate of drawdown increases in the latter stages of pumping which might indicate decreasing transmissivity of the Lakota aquifer in the site vicinity. The decrease in transmissivity may be due to aquifer thinning or possibly a facies change to less permeable materials. In any case, it is suspected that the leakage effects in the Lakota drawdown data are masked by the conflicting effect of a decreasing transmissivity in the site vicinity.

In general, the agreement between the Theis and Jacob analyses of s-t data is good. T values computed using early drawdown data average 2390 gpd/ft using the Theis method, and about 2270 gpd/ft using the Jacob method. Early data storativities are also in good agreement averaging 6.0×10^{-5} for the Jacob method and 8.1×10^{-5} for the Theis method. The T values computed from the late data (T_{ℓ}) are significantly lower than those determined from the early data, whereas late storativities are larger. The Jacob method yields T_{ℓ} values which average 1320 gpd/ft and storatitivies averaging 2.4×10^{-4}. The Theis method produced an average T_{ℓ} of 1570 gpd/ft and an average S_{ℓ} of 1.2×10^{-4}. The late Theis T values are somewhat higher than the Jacob T's because the Theis method gives some consideration to the earlier data which the Jacob method does not. Transmissivities estimated by the recovery data average 1270 gpd/ft, and are in close agreement with the late Jacob results, although slightly lower.

Ordinarily, in selecting representative T and S for the pumped aquifer in a leaky multiple aquifer system, more emphasis would be placed on the early data collected in the pumped aquifer at the pumped well and closest observation wells. These data are considered least affected by leakage. However, because of the apparent decrease in transmissivity of the Lakota aquifer during the latter stages of the test, it is believed that Lakota parameters computed from the late data are more representative of aquifer properties under a long-term pumping situation such as mine dewatering. On this basis the average transmissivity of the Lakota is estimated to be 1400 gpd/ft and the average storativity 1.8×10^{-4}.

FALL RIVER AQUIFER TEST

Following completion of recovery measurements associated with the Lakota aquifer test, pumping equipment in the Burdock well was rearranged for the Fall River test. A submersible pump was set within the Fall River section of the well and the pneumatic packer reset below the pump in the Fuson section of the well in order to restrict pumping to the Fall River. A preliminary test of the pump and other equipment lasting less than one hour was conducted on May 29. Unexpectedly, the Fall River aquifer was capable of yielding only about 10 gpm on a sustained basis. Since other Fall River wells in the region yield up to 40 gpm, it was assumed that either the well screen was encrusted or the well was not fully developed, or both. An unsuccessful effort was made to develop the well by pumping. A television camera was subsequently lowered into the well to examine the well screen. Little or no encrustation was observed on the screen. Ultrasonics were used in the well to remove any existing encrustation but the yield of the well was not improved. The low productivity of the well is, therefore, attributed to locally poor water-bearing characteristics of the Fall River formation.

Test Procedures and Results

A constant discharge test commenced at 1100 hours on July 24. Water levels in all geologic units were stable prior to the test, as there was no pumping activity in the site vicinity since the completion of well development on July 3. Discharge was measured with an in-line flowmeter, and checked with a 55-gallon container and stopwatch.

During the test the pumping rate varied from 7.6 to 10.4 gpm, and averaged 8.5 gpm. Ground-water levels were monitored in all observation wells shown in Figure 3. The constant discharge test was terminated at 1200 hours on July 26 after 49 hours of pumping. Subsequently, ground-water level recovery measurements were made for a period of six days.

Semilog graphs of drawdown data recorded at the pumped well and observation well groups B-1, B-10 and B-11 are shown in Figures 26 through 29, respectively. No graphs are presented for B-11LAK or the B-7 and B-9 groups as there was no measureable drawdown in these wells. Except for B-11FR, these graphs exhibit a typical straight-line drawdown trend during the first part of the test, followed by a gradual decrease in slope towards the end of the test. This slope change is the result of leakage from adjacent formations, and/or an increase in aquifer transmissivity at some distance from the pumped well. The Jacob method was applied to the semilog graphs to obtain the transmissivity and storativity values shown in Table 4. The T_e and S_e values were obtained using early drawdown data recorded during approximately the first 500 minutes of the test. T_l and S_l values were computed from data recorded after about 1000 minutes. The only reliable estimates are considered to be those computed for B-1FR and B-10FR. Drawdown data for the pumped well is affected by wellbore storage which is significant in this test because of the relatively low pumping rate. The pumped well drawdown data may also be affected by low well efficiency. The semilog plot for B-11FR cannot be analyzed by the Jacob method because the criterion that $r^2S/4Tt \leq 0.01$ is not satisfied for any of the data.

TABLE 4. Fall River Aquifer Properties

		Jacob Method				Theis Method		Recovery Method	
Well No.	r (ft)	T_e (gpd/ft)	S_e --	T_ℓ (gpd/ft)	S_ℓ --	T_e (gpd/ft)	S_e --	T_e (gpd/ft)	T_ℓ (gpd/ft)
PW-FR	0.67	16.(?)	--	--	--	--	--	11(?)	--
B-10FR	177	140.	$1.8x10^{-5}$	410.	--	150.	$1.7x10^{-5}$	80.	340.
B-1FR	373	150.	$0.8x10^{-5}$	420.	--	150.	$1.1x10^{-5}$	90.	350.
B-11FR	618	--	--	--	--	--	--	--	--
Average:		145	$1.3x10^{-5}$	415.	--	150.	$1.4x10^{-5}$	85.	345.

yields suggests that the Fall River aquifer is less permeable in the mine site vicinity than in certain surrounding areas. The aquifer parameters computed from the early drawdown and recovery data are believed to be representative of the aquifer in the immediate vicinity of the test wells. Parameters obtained from analysis of the late data are probably more representative of regional aquifer characteristics.

FUSON AQUITARD PROPERTIES

The hydraulic properties of the Fuson aquitard were estimated using an analytical technique known as the "ratio method" developed by Neuman and Witherspoon (1973). The method requires (1) a knowledge of the transmissivity and storativity of the pumped aquifer; (2) drawdown data for the pumped and unpumped aquifers and the aquitard measured in wells located at approximately the same radial distance from the pumped well; and (3) the vertical distance between the aquifer-aquitard boundary and the perforated section of each aquitard well (Z). The method yields a value of aquitard hydraulic diffusivity, α', equal to K'_V/S'_S, where K'_V is the vertical hydraulic conductivity of the aquitard and S'_S is the specific storativity of the aquitard. To determine K'_V or S'_S from α', either K'_V or S'_S must first be known. In the following analyses a value of $S'_S = 10^{-6}\ ft^{-1}$ is assumed for the Fuson aquitard. Experience indicates that specific storativities of geologic materials do not vary over as wide a range as do hydraulic conductivities. For this reason, and considering the difficulty and expense of obtaining an accurate measure of S'_S over the site vicinity, it appears justifiable to assume a value of S'_S typical of similar geologic materials.

The first step in the analysis is to compute a value of s'/s at a given radial distance from the pumped well, r, and at a given time, t. Next a value of t_D (dimensionless time for the aquifer equal to tT/r^2S) is determined. The values of s'/s and t_D are used to compute a value for t'_D (dimensionless time for the aquitard equal to $K't/S'_SZ^2$) using a family of type curves given in Figure 3 of Neuman and Witherspoon (1973). The vertical hydraulic conductivity of the aquitard K'_V is then obtained from the following equation:

$$K'_v = t'_D Z^2 S'_s/t \qquad (1)$$

Since separate pumping tests were conducted in the Lakota and Fall River aquifers, it is possible to calculate two independent values of K'_v for each well group. Fuson aquitard properties computed by the ratio method along with certain pertinent parameters used in the calculations are presented in Table 5.

Note that since the Fall River, Fuson and Lakota observation wells in each well group do not lie at exactly the same radial distance from the pumped well, an average radial distance r_{avg} is used in the calculations. The r_{avg} values shown in Table 5 were obtained by averaging the radial distance for the pumped aquifer observation well and the radial distance for the aquitard observation well. Also note that the column labeled "Time Interval" represents the time interval during which K'_v values were computed. Generally, three or four values of K'_v were computed at specific times within this interval. These values were then averaged to obtain the K'_v values shown in Table 5.

The vertical hydraulic conductivity of the Fuson ranges from about 10^{-4} ft/d at the B-1 well group to about 10^{-3} ft/d at the B-10 well group. The agreement between the conductivities computed at each well group site for both tests is good. The reason for the order of magnitude difference between the conductivities at the different well sites is unknown, but may be related to errors caused by differences in the radial distances of observation wells--these differences being somewhat greater for the wells of the B-10 group.

TABLE 5. Fuson Aquitard Properties

Test	Well Group	$r_{avg.}$ (ft)	Z (ft)	Time Interval (min.)	K'_v (gpd/ft^2)	K'_v (ft/d)
Lakota	B-10	225	28	100-393	2.0×10^{-2}	2.7×10^{-3}
	B-1	378	11	100-393	1.0×10^{-3}	1.3×10^{-4}
Fall R.	B-10	216	25	100-300	4.8×10^{-3}	6.6×10^{-4}
	B-1	362	40	1200-2350	1.3×10^{-3}	1.8×10^{-4}

The magnitudes of computed conductivities are slightly higher than expected on the basis of the physical characteristics of the Fuson, although they are still within reason. The presence of open boreholes may have caused a more rapid drawdown response in the Fuson monitor wells than would have occurred otherwise. As a result, the calculated K'_v values are probably larger than the actual conductivity of the Fuson shale. The calculated K'_v values are, however, probably smaller than the effective K'_v of the aquitard in the areas where it is breached by open boreholes.

COMPUTER MODEL SIMULATIONS

The hydraulic properties estimated for the Fall River, Fuson and Lakota formations were incorporated into a computer model of the site geohydrologic system. Simulations of the Lakota aquifer test were performed to see if the model could reproduce the drawdown responses observed during the test. An acceptable match between the measured and computed responses would indicate the validity of the estimated formation properties, and thus enhance the credibility of the model for predicting mine dewatering requirements and impacts.

A finite element numerical model developed by Narasimhan et al. (1978) was used for the aquifer test simulations. The aquifer/well-field system was modeled in three dimensions using axial symmetry. The hydraulic properties of the Fall River, Fuson and Lakota formations obtained from the aquifer test analyses were used as initial input data (see Table 6). Uniform properties were assumed for each hydrogeologic unit. The shale units which lie above the Fall River formation and those which lie below the Lakota were assumed to be impermeable in the model. All simulation comparisons were made for the Lakota aquifer test. The Lakota test stressed a larger portion of the multiple aquifer system than did the Fall River test, and more closely approximates the flow regime expected during mine dewatering.

A comparison of the measured and computed results for the initial simulation run are shown in Figure 38. In general, the agreement between the computed and observed drawdown graphs for the Lakota aquifer are good. However, there are large discrepancies in the Fall River and Fuson responses.

TABLE 6. Parameters Used In Computer Simulations

Formation	Initial Parameters					Final Parameters				
	T (gpd/ft)	S (--)	K_v (ft/d)	K_v/K_h (--)	Ss (ft^{-1})	T (gpd/ft)	S --	K_v (ft/d)	K_v/K_h --	Ss (ft^{-1})
Fall River	150.	$1.4x10^{-5}$	$5.6x10^{-2}$	1/3	$1.2x10^{-7}$	400	$1.4x10^{-5}$	$4.6x10^{-2}$	1/10	$1.2x10^{-7}$
Fuson	0.13	$6.0x10^{-5}$	$1.7x10^{-4}$	1/3	$1.0x10^{-6}$	0.45	$6.0x10^{-5}$	$1.0x10^{-3}$	1/1	$1.0x10^{-6}$
Lakota (Chilson)	1400.	$1.8x10^{-4}$	$5.0x10^{-1}$	1/3	$1.5x10^{-6}$	1400.	$1.0x10^{-4}$	$1.5x10^{-1}$	1/10	$8.3x10^{-7}$

Several attempts were made to improve the match between the computed and observed drawdown responses by trial-and-error adjustment or calibration of model parameters. The most reliable parameters, such as the computed Lakota and Fall aquifer coefficients, were only slightly altered in the calibration process, whereas the least reliable parameters, including the ratio of vertical to horizontal permeability and the Fuson properties, were allowed to vary over a wider (though reasonable) range. The hydraulic properties within each hydrogeologic unit were assumed to be uniform throughout the calibration process.

The set of hydraulic parameters yielding the best agreement between measured and observed drawdown data is given in Table 6. The final parameter set differs only slightly from the original. The largest changes were made in the K_v/K_h terms which were unknown to begin with; and in the Fuson hydraulic conductivity which was increased by a factor of five. Both the early and late Fall River T values computed from the aquifer test analyses (150 and 415 gpd/ft, respectively) were tested during model calibration. The drawdown response of the model was found to be relatively insensitive to the value of T used. A transmissivity of 400 gpd/ft is included in the final parameter set as it is believed to be more characteristic of the aquifer regionally.

The match between the measured and computed drawdown responses, shown in Figure 39, is considered acceptable in light of the fact that uniform aquifer-aquitard properties were used in the model. The apparent discrepancies are believed to be due to the heterogeneity and anisotropy of the actual system. The departures which occur during the early phase of the simulation appear large, but are not significant.

The ability of the model to predict the long-term response of system is more important. Thus, more significance is attached to the agreement between the simulated and observed results for the latter part of the test which, in most cases, is quite good. The final set of aquifer-aquitard properties are considered to represent a valid basis for future predictive modeling.

SUMMARY AND CONCLUSIONS

The aquifer test results indicate that the Fuson member of the Lakota formation is a leaky aquitard separating the Fall River and Lakota aquifers. The hydraulic communication between the two aquifers observed during the tests-is believed to be the result of (1) general leakage through the primary pore space and naturally occurring joints and fractures of the Fuson shale, and (2) direct connection of aquifers via numerous old unplugged exploratory boreholes. Whereas, the former leakage mechanism is a regional characteristic of the Fuson, leakage caused by borehole short-circuiting is probably limited to the relatively small area of intensive uranium exploration in the Burdock vicinity.

The Lakota (Chilson) aquifer has an estimated transmissivity of approximately 1400 gpd/ft and a storativity of about 1.0×10^{-4}. These properties are representative of the Lakota in the area affected by the pumping test, and are consistent with what is known or suspected about the aquifer regionally. The transmissivity and storativity of the Fall River aquifer are estimated at approximately 400 gpd/ft and 1.4×10^{-5}, respectively. Test results indicate that the transmissivity of the Fall River may be considerably less than 400 gpd/ft in the immediate vicinity of the test site. However, the selected transmissivity value is more consistent with regional aquifer characteristics.

The hydraulic conductivity of the Fuson aquitard is estimated at approximately 10^{-3} ft/d. The specific storativity of the Fuson was not measured but is assumed to be about 10^{-6} ft^{-1}. If open boreholes are present at the test site as suspected, the computed hydraulic conductivity is probably higher than the true conductivity of the shale, yet lower than the effective conductivity of the aquitard where short-circuited by open boreholes. For this reason, the selected aquitard conductivity of 10^{-3} ft/d should provide a conservative estimate of mine dewatering impacts. Outside of the relatively small area where the aquitard is breached by boreholes, leakage between the two aquifers will be governed by the true conductivity of the shale which is probably on the order of 10^{-4} ft/d or less.

The hydraulic properties of the Fall River, Fuson and Lakota (Chilson) formations computed from aquifer test data were incorporated into a computer model of the site geohydrologic system. These parameters were refined through repeated simulations of the Lakota aquifer test until the model could reproduce the drawdown responses observed during the test. The agreement between the observed and computed responses indicates the validity of the aquifer-aquitard properties, and should enhance the credibility of future predictive models using these parameters.

REFERENCES

1. Gott, G. B., D. E. Walcott, and C. G. Bowles, "Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits, Southern Black Hills, South Dakota and Wyoming." USGS Prof. Paper 763, 1974.

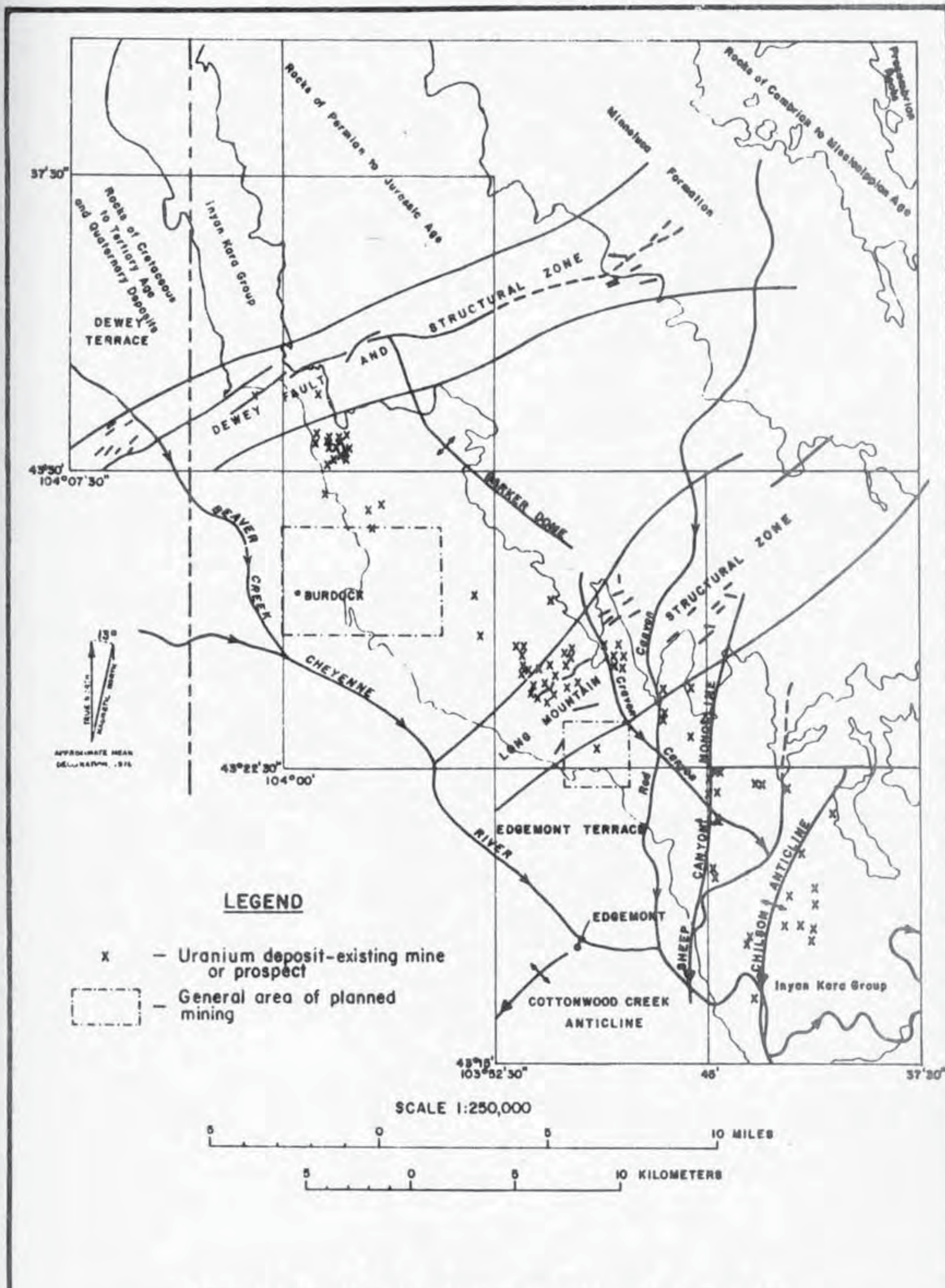
2. Keene, J. R., "Ground-water Resources of the Western Half of Fall River County, South Dakota." Rept. of Inv. No. 109, S. D. Geol. Survey, 1973.

3. Narasimhan, T. N., S. P. Neuman, and P. A. Witherspoon, "Finite Element Method for Subsurface Hydrology Using a Mixed Explicit-Implicit Scheme," Water Resources Research, Vol. 14, No. 5, 1978.

4. Neuman, S. P. and P. A. Witherspoon, "Field Determination of the Hydraulic Properties of Leaky Multiple Aquifer Systems," Water Resources Research, Vol. 8, No. 5, 1973.

5. Walton, W. C., Groundwater Resource Evaluation, McGraw-Hill, New York, 1970.

APPENDIX



(MODIFIED FROM PLATE 4 - USGS PROFESSIONAL PAPER 763)

Figure 1 : Generalized Geologic Map of Site Region

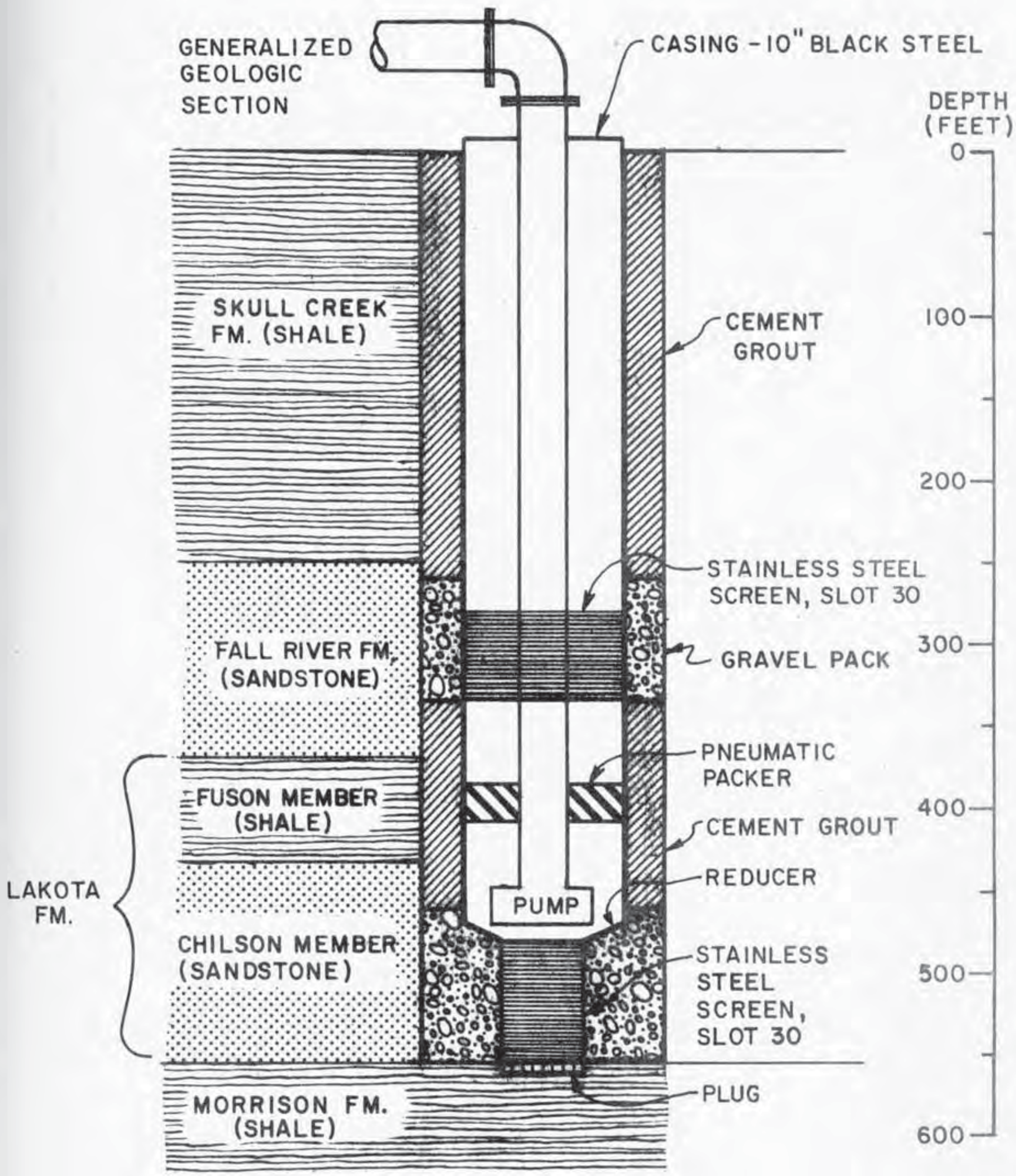


Figure 2 : Burdock Well Profile

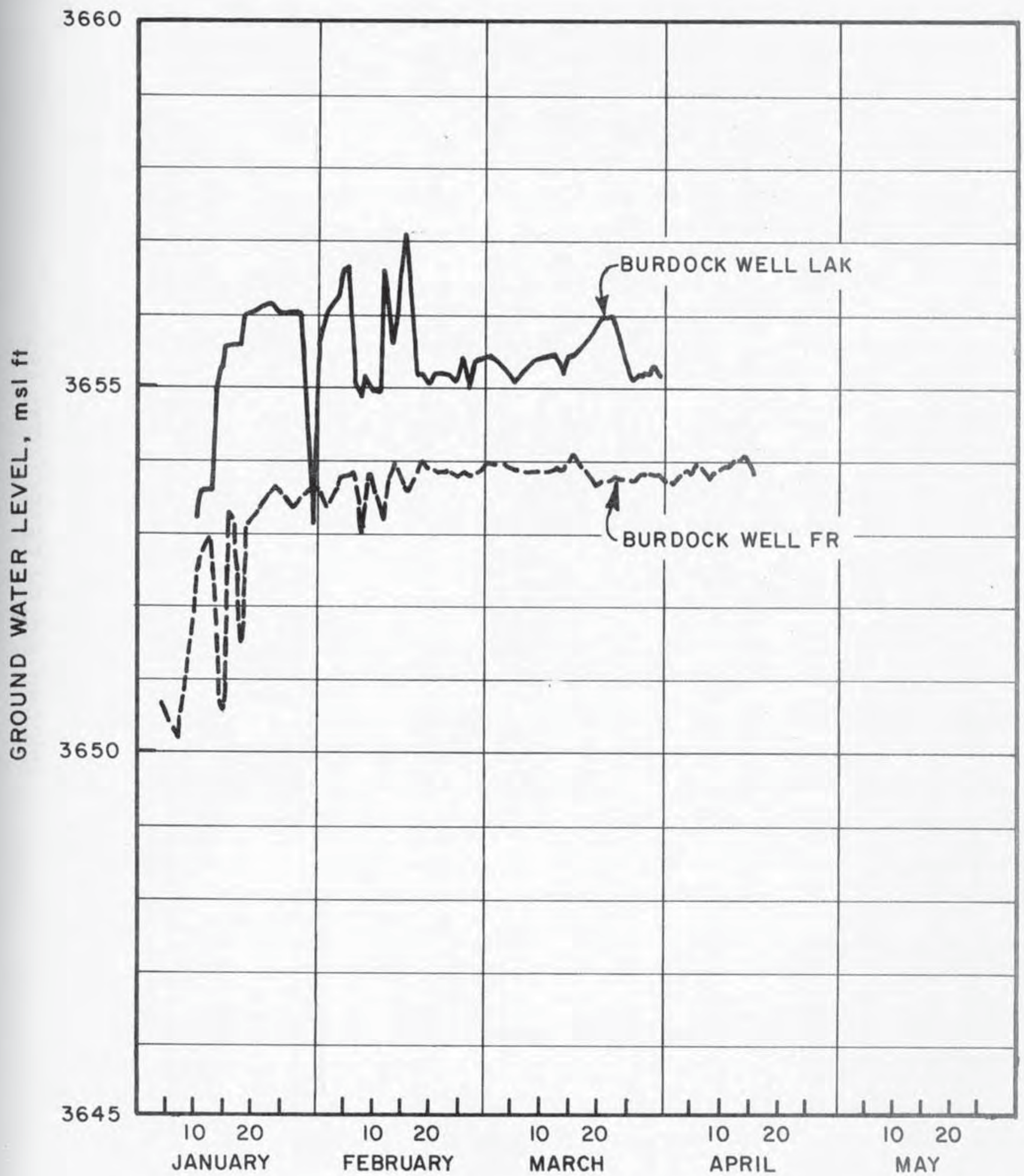


Figure 4 : Hydrographs for Burdock Test Well, January 1 through April 17, 1979

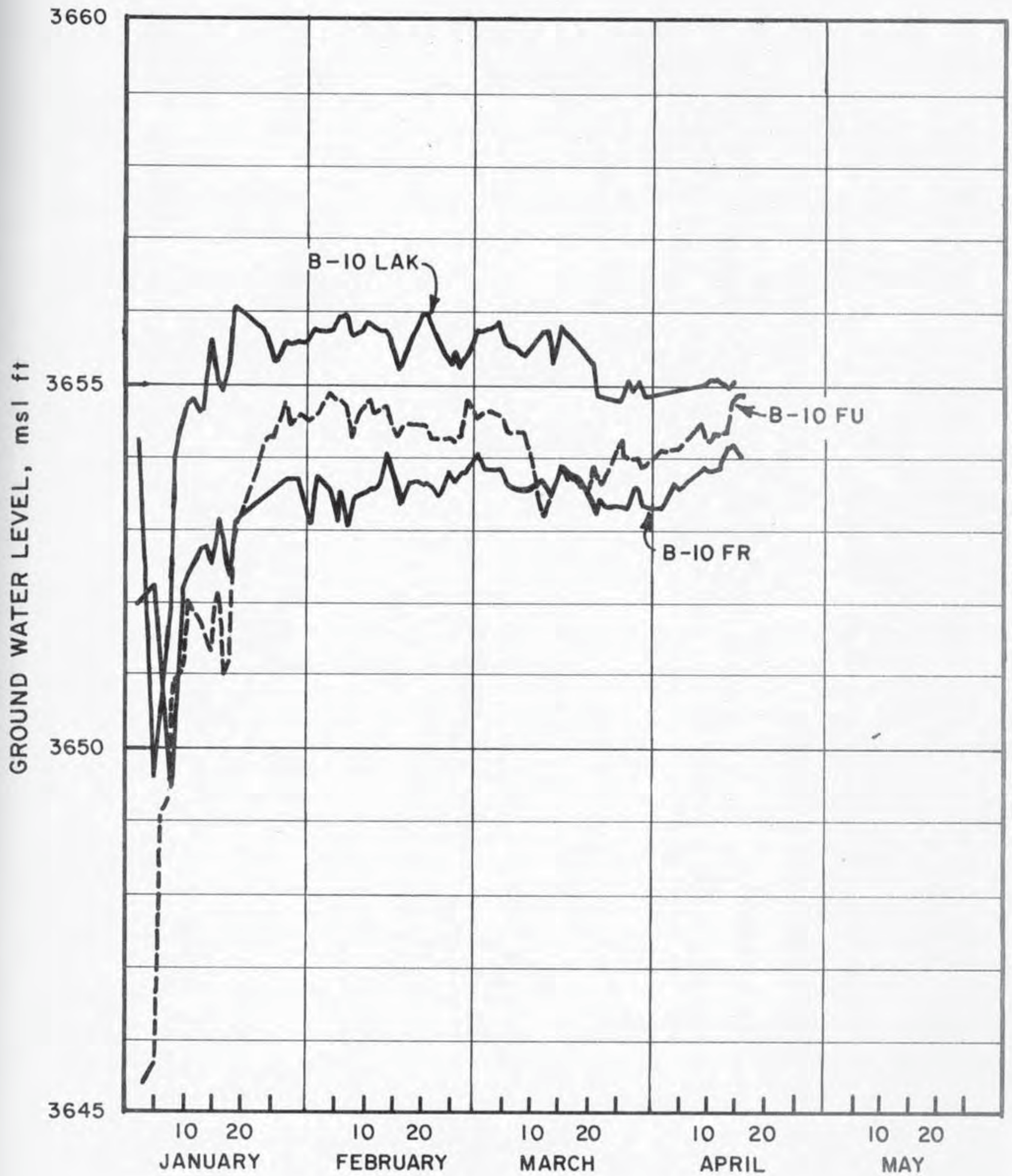


Figure 5 : Hydrographs for B-10 Observation Well Group, January 1 through April 17, 1979

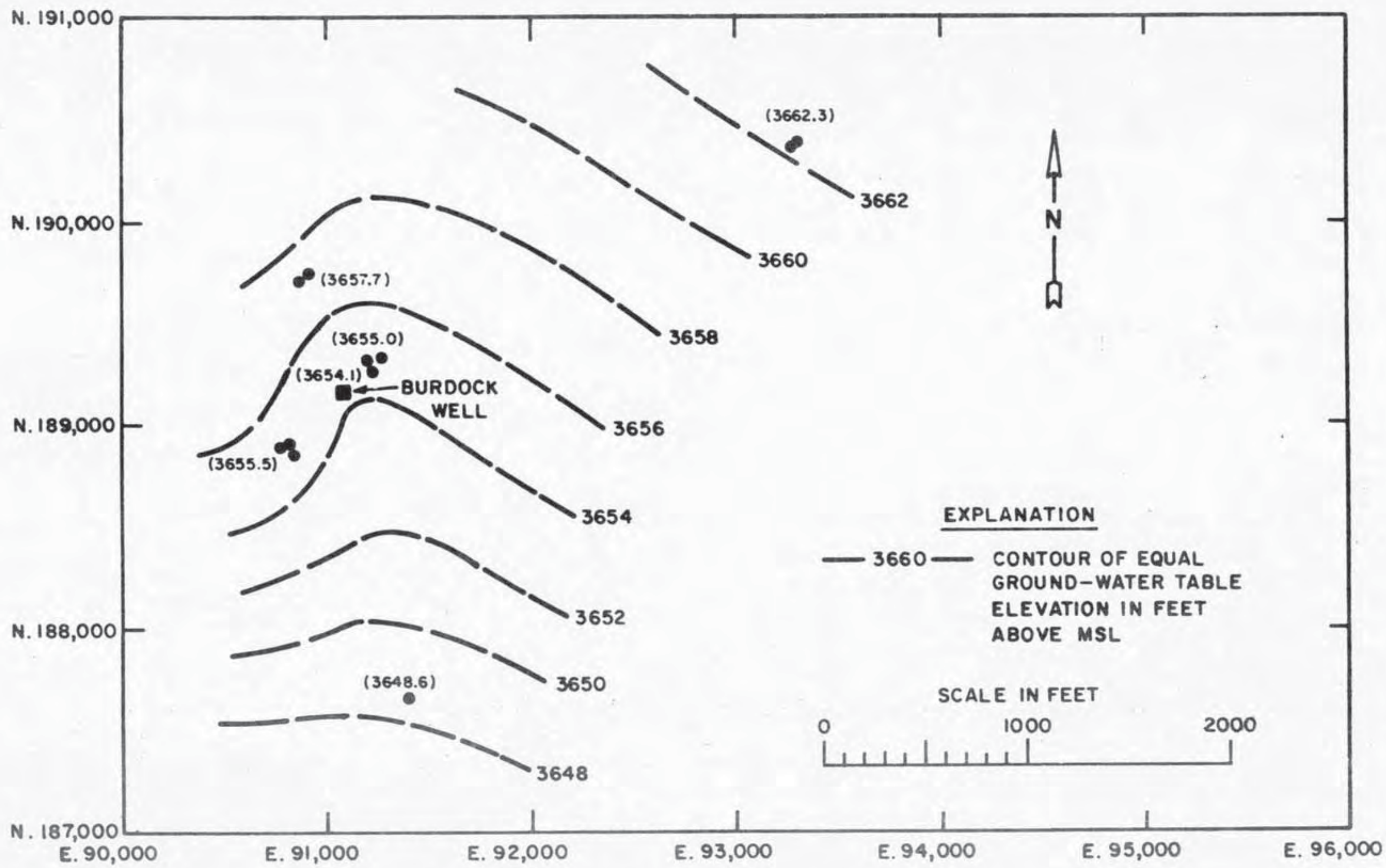


Figure 6 : Pre-Test Ground-Water Level Contour Map for Lakota Aquifer

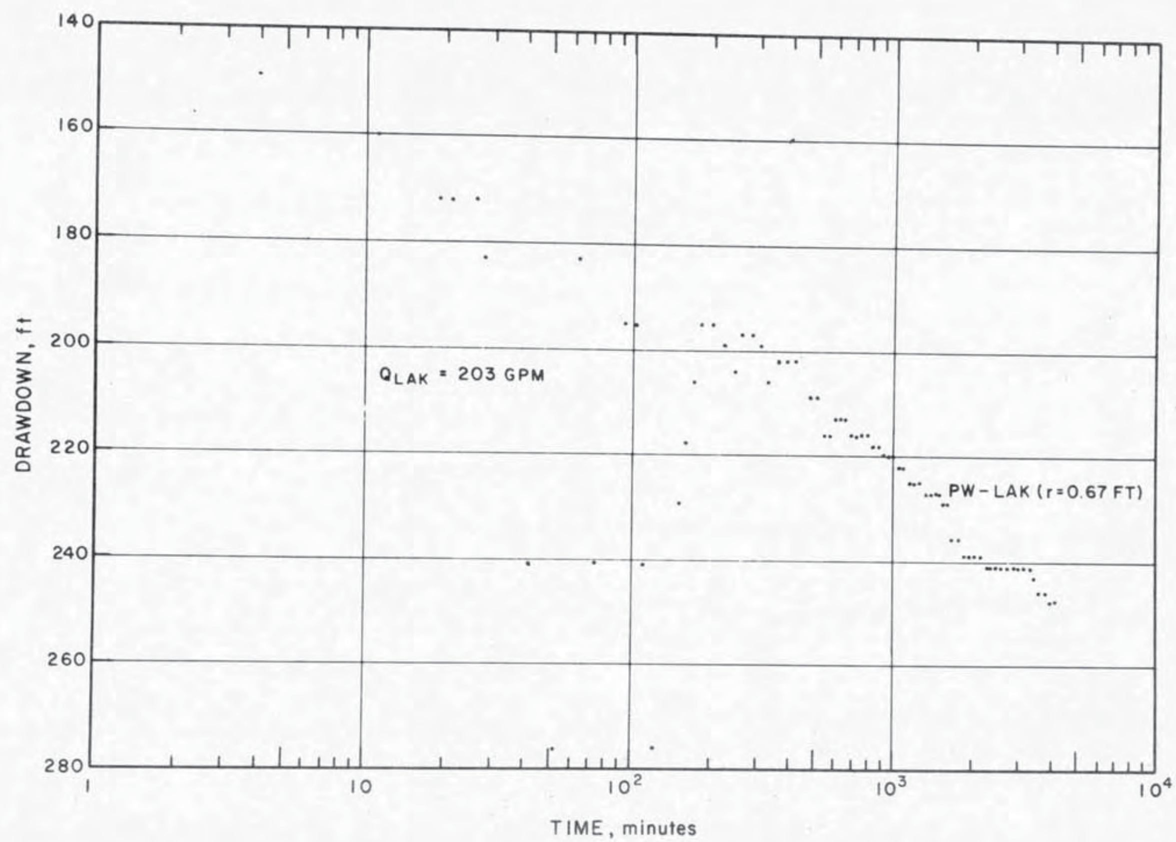


Figure 7: Semilogarithmic Graph of Drawdown for Pumped Well, Lakota Aquifer Test

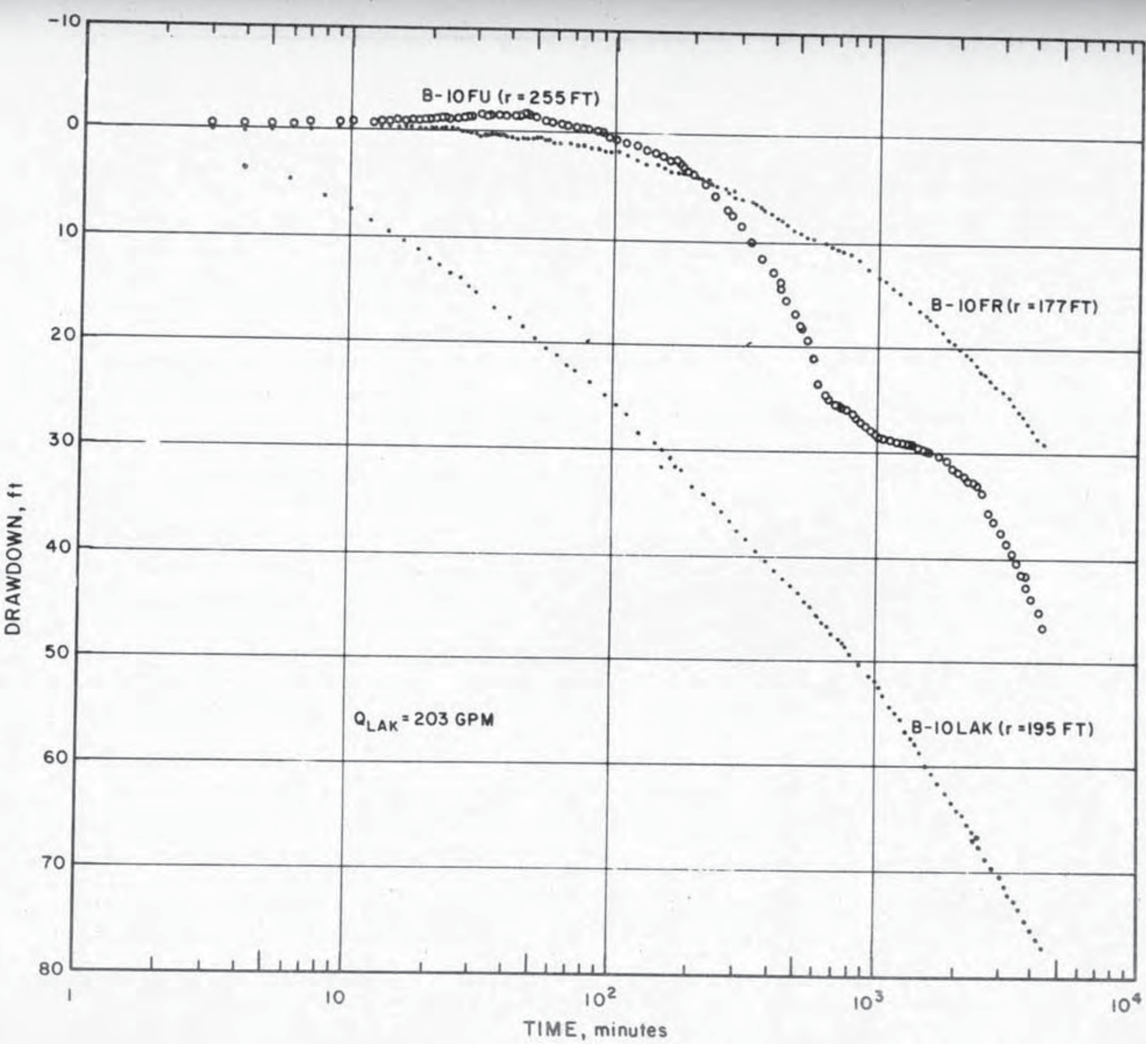


Figure 8 : Semilogarithmic Graphs of Drawdown for B-10 Observation Well Group, Lakota Aquifer Test

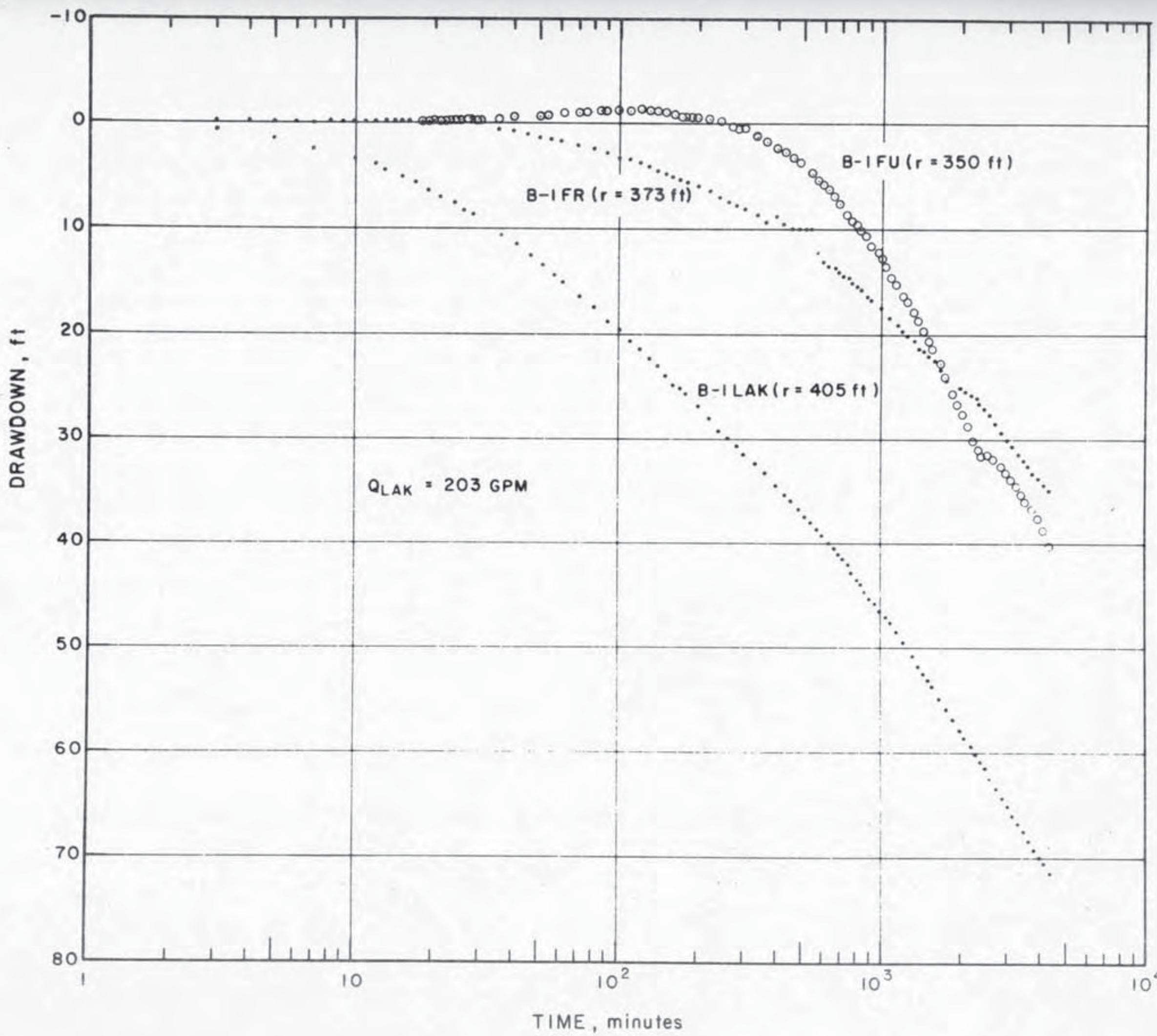


Figure 9: Semilogarithmic Graphs of Drawdown for B-1 Observation Well Group, Lakota Aquifer Test

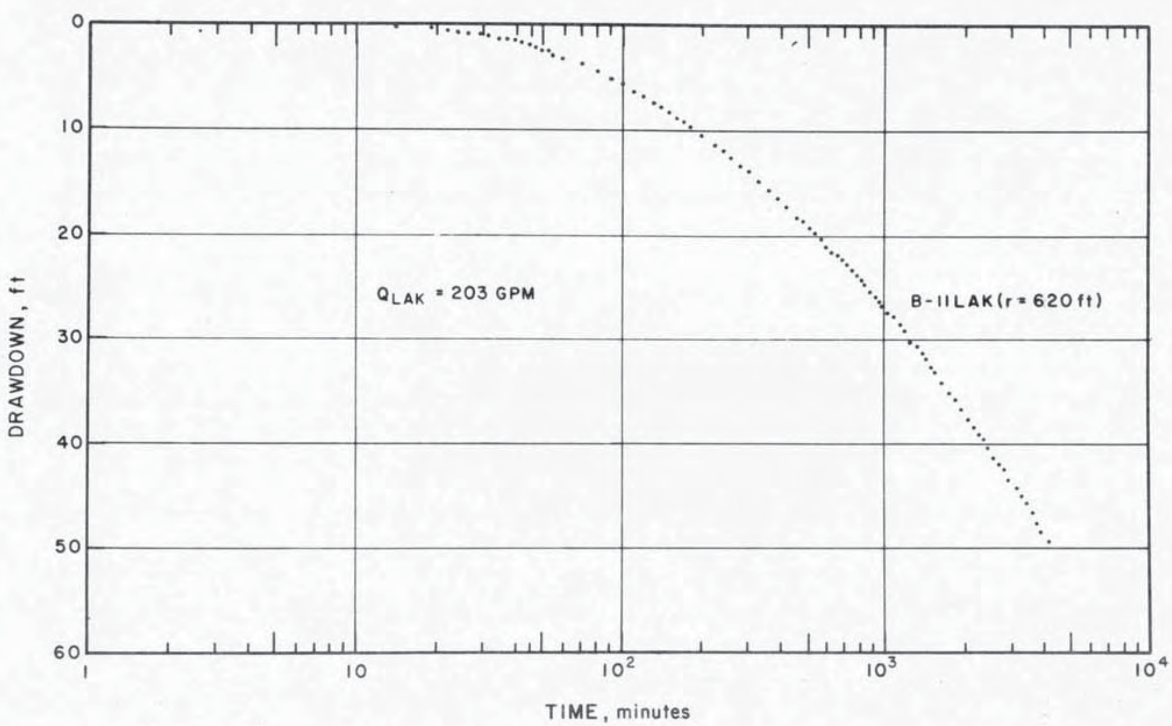


Figure 10: Semilogarithmic Graph of Drawdown for B-11 Observation Well Group, Lakota Aquifer Test

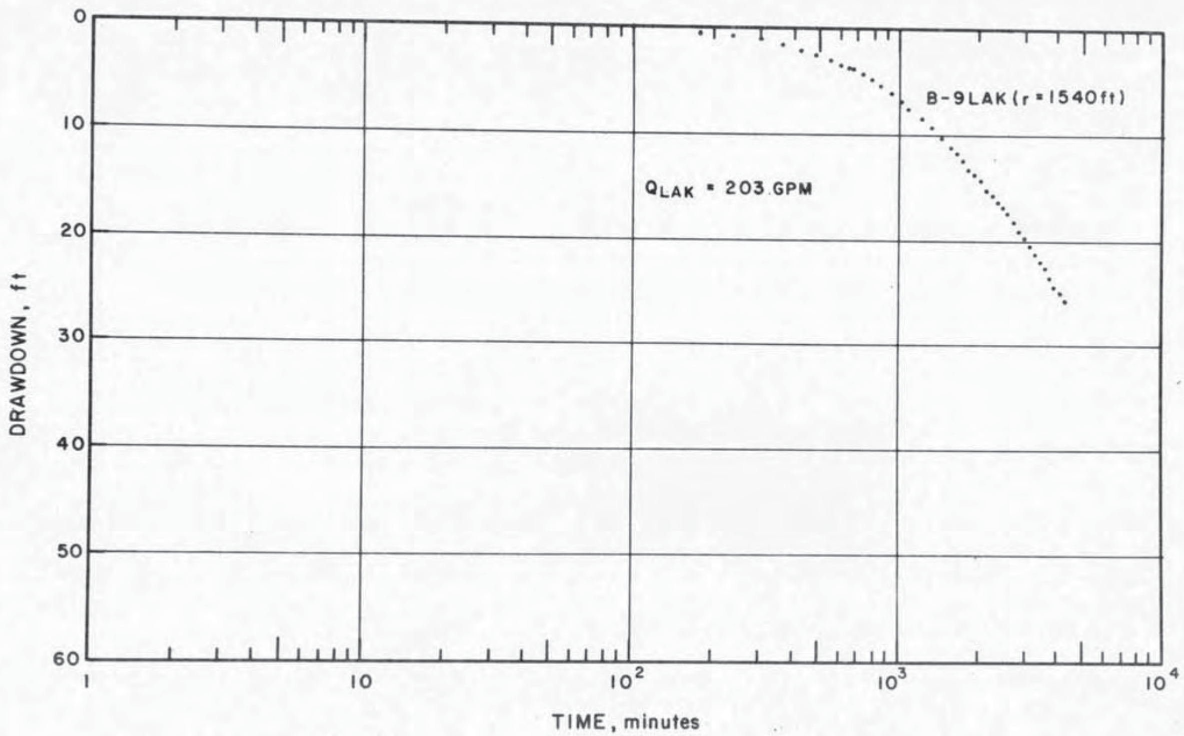


Figure 11: Semilogarithmic Graph of Drawdown for B-9 Observation Well Group, Lakota Aquifer Test

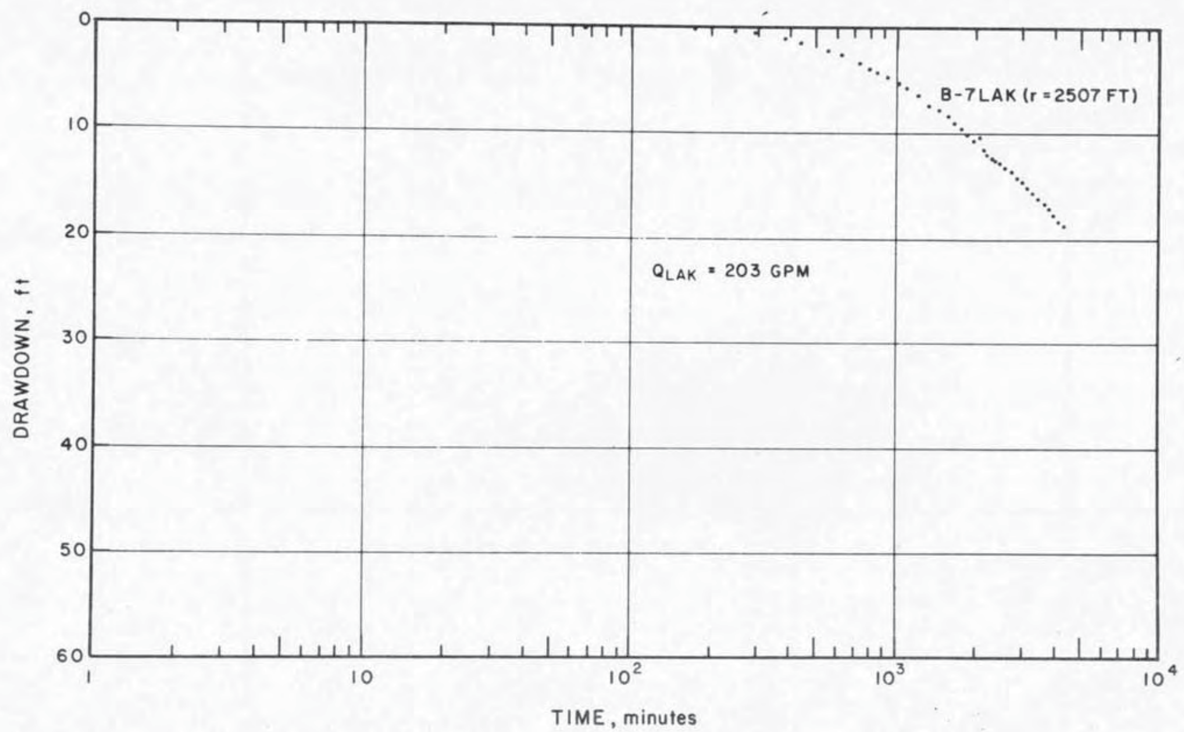


Figure 12: Semilogarithmic Graph of Drawdown for B-7 Observation Well Group, Lakota Aquifer Test

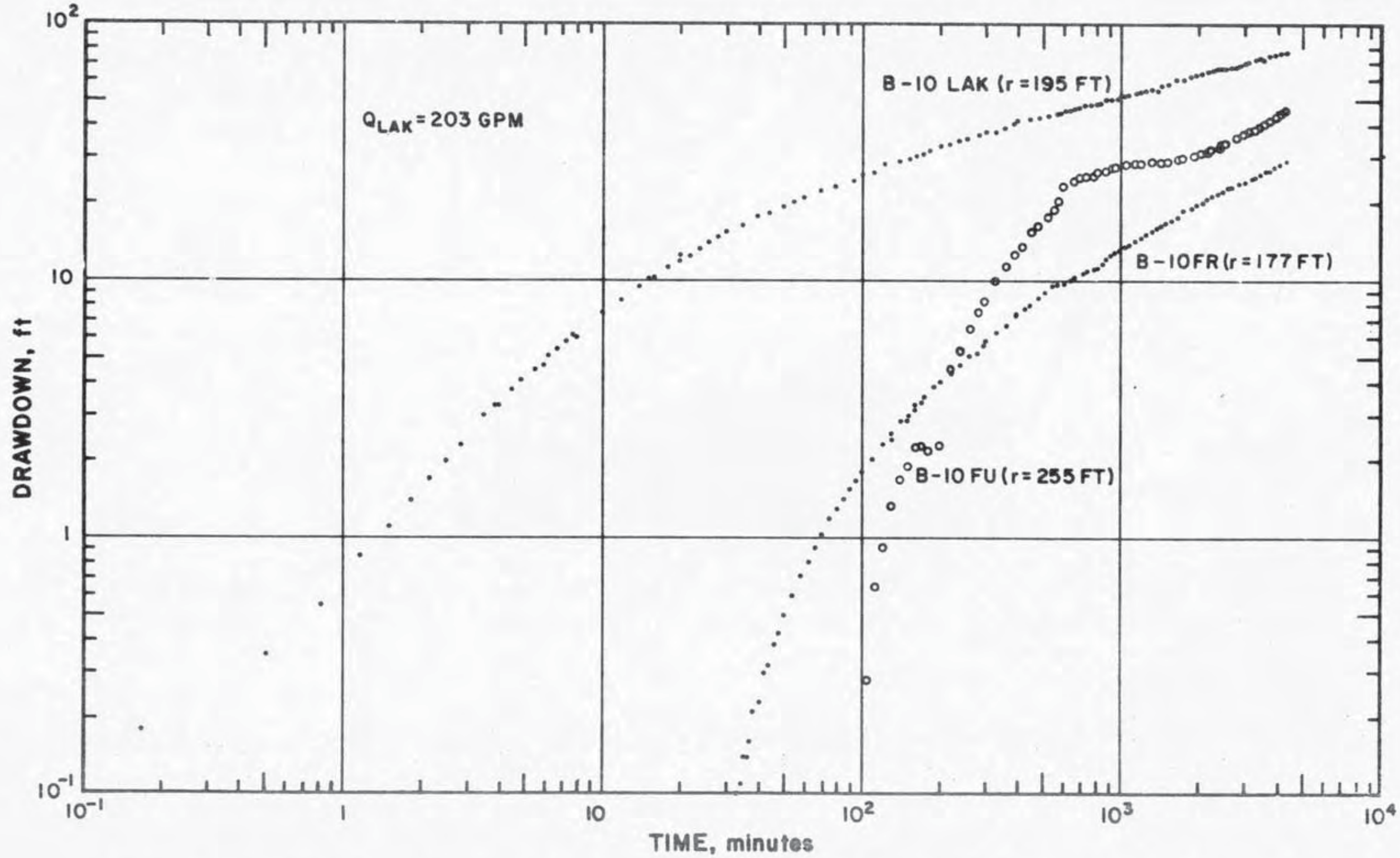


Figure 13 : Logarithmic Graphs of Drawdown for B-10 Observation Well Group, Lakota Aquifer Test

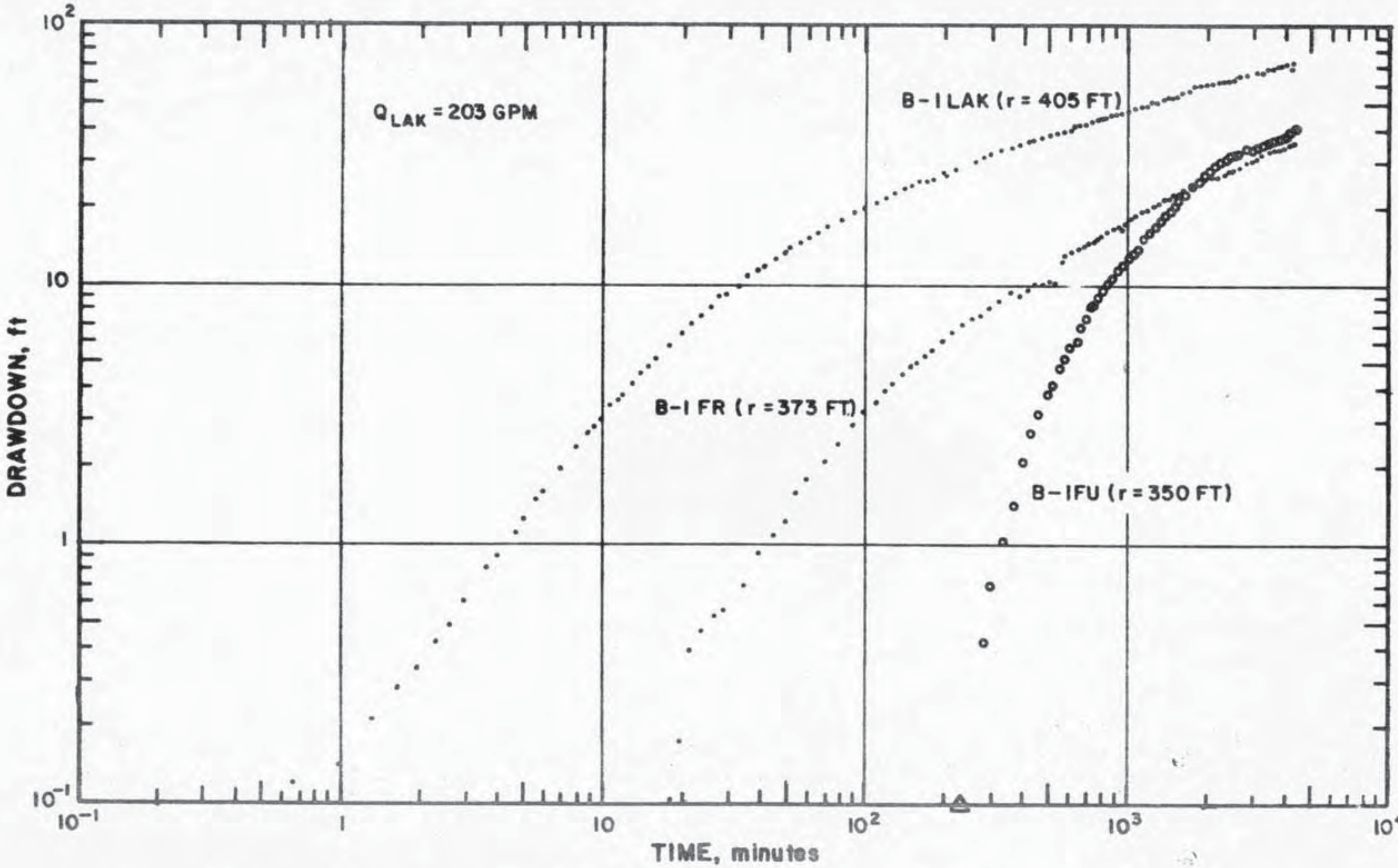


Figure 14 : Logarithmic Graphs of Drawdown for B-1 Observation Well Group, Lakota Aquifer Test

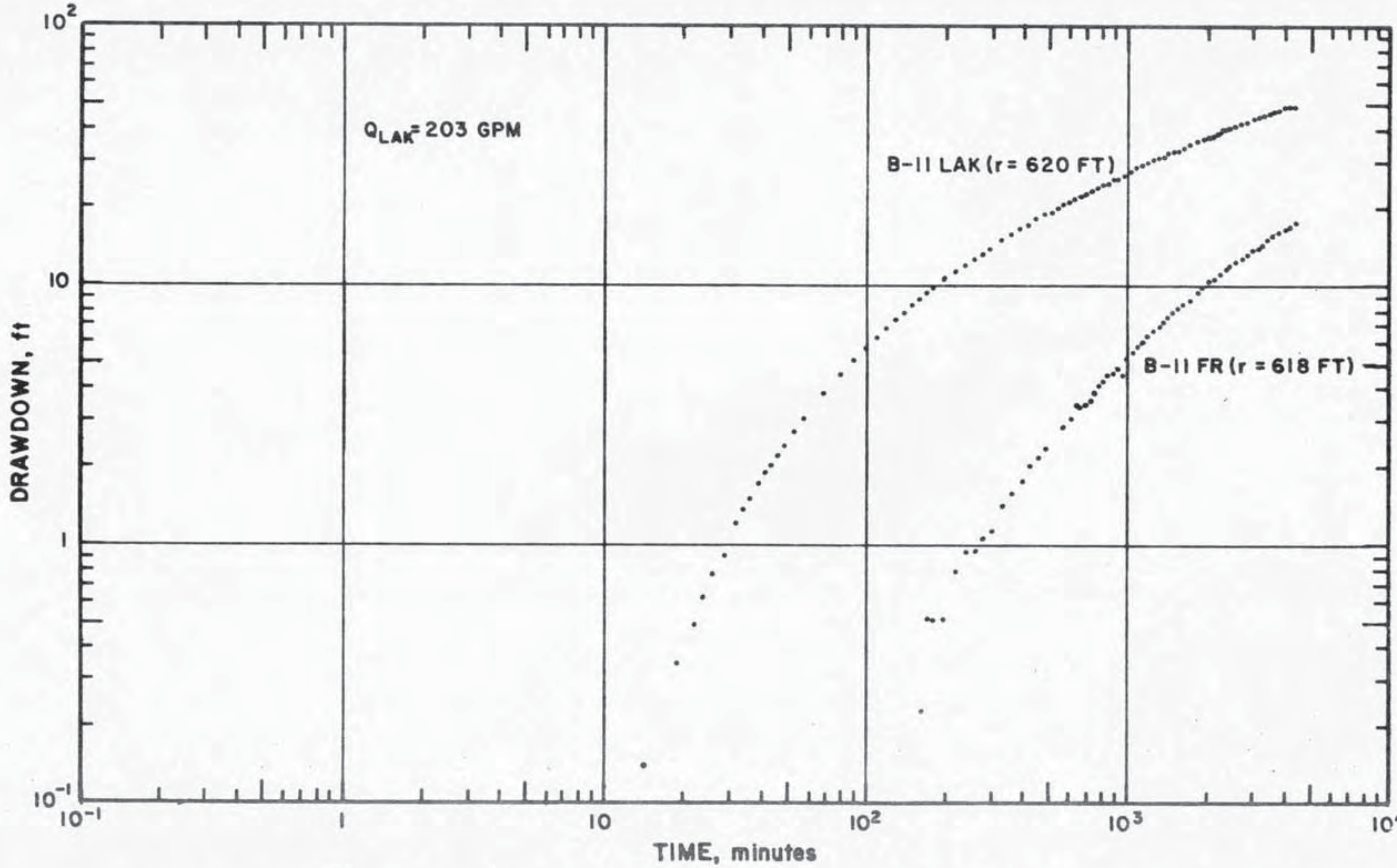


Figure 15: Logarithmic Graphs of Drawdown for B-11 Observation Well Group, Lakota Aquifer Test

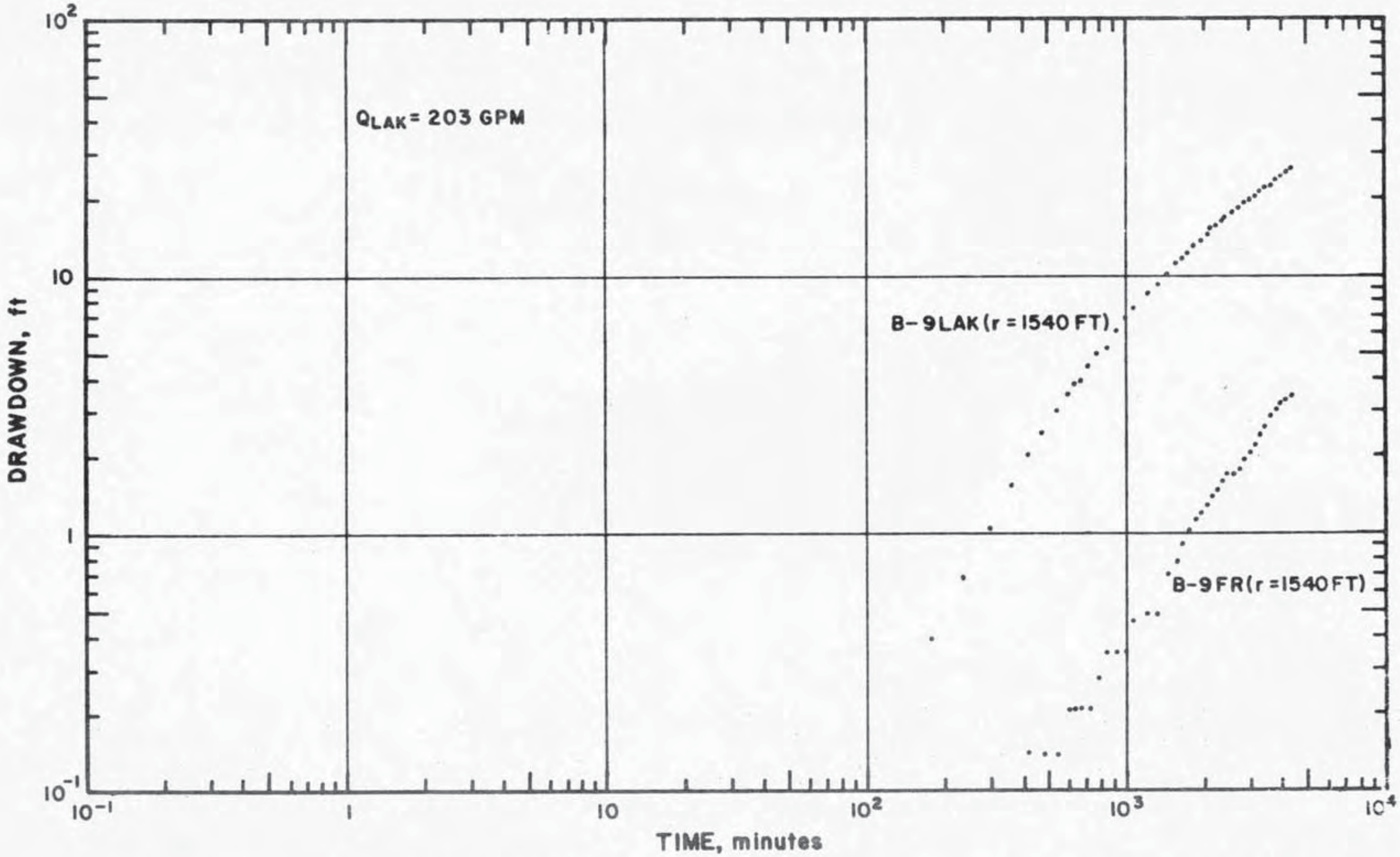


Figure 16 : Logarithmic Graphs of Drawdown for B-9 Observation Well Group, Lakota Aquifer Test

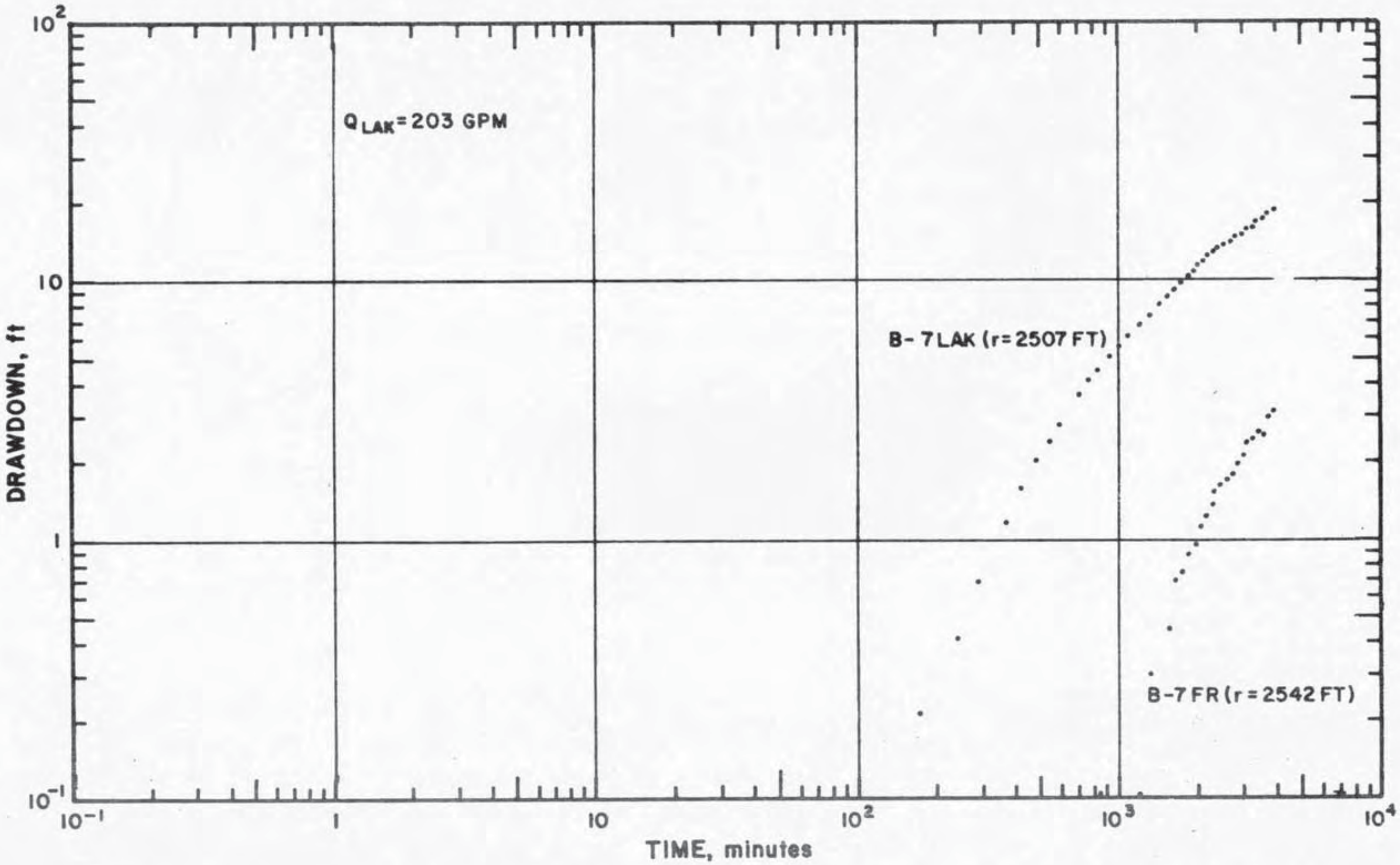


Figure 17 : Logarithmic Graphs of Drawdown for B-7 Observation Well Group, Lakota Aquifer Test

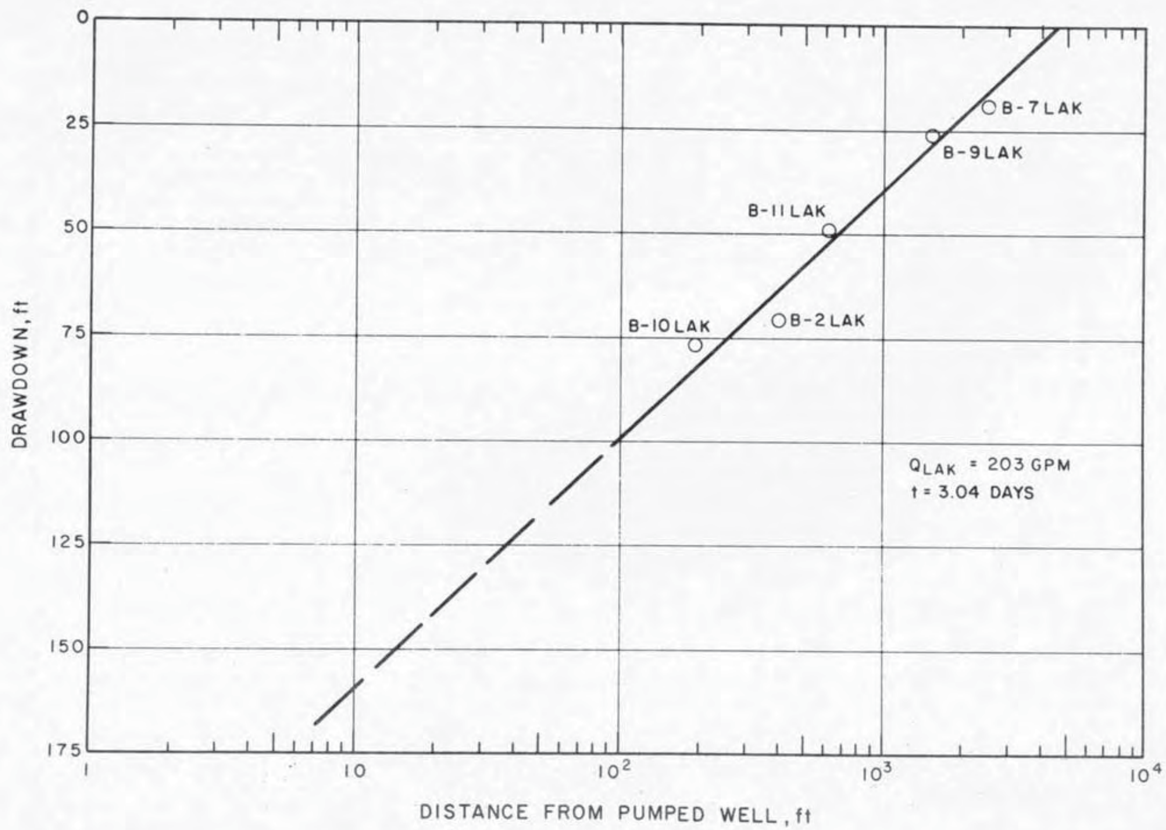


Figure 18 : Semilogarithmic Graph of Distance vs. Drawdown at End of Pumping Test, Lakota Aquifer Test

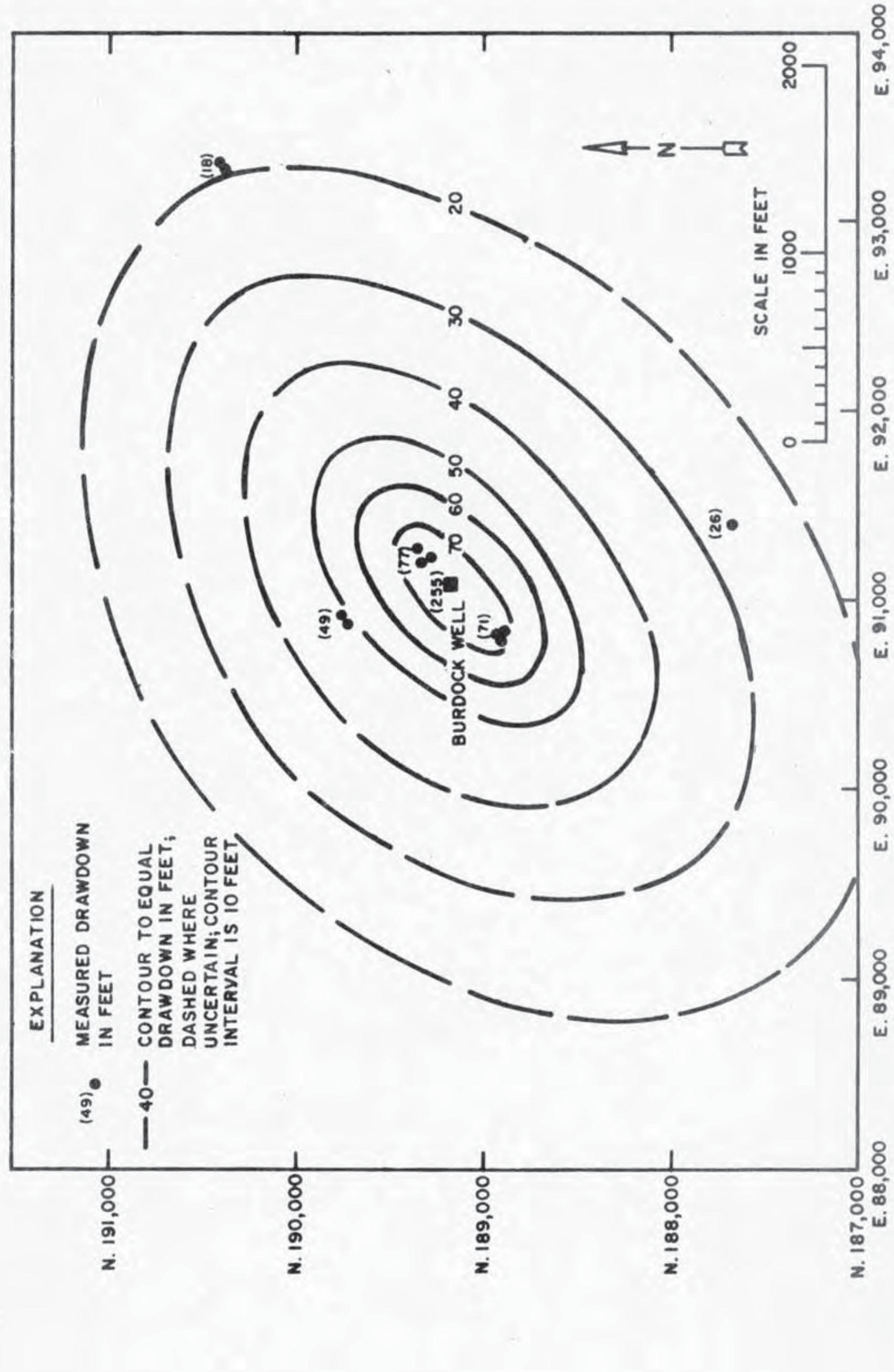


Figure 19 : Drawdown in Lakota Aquifer at End of Lakota Test

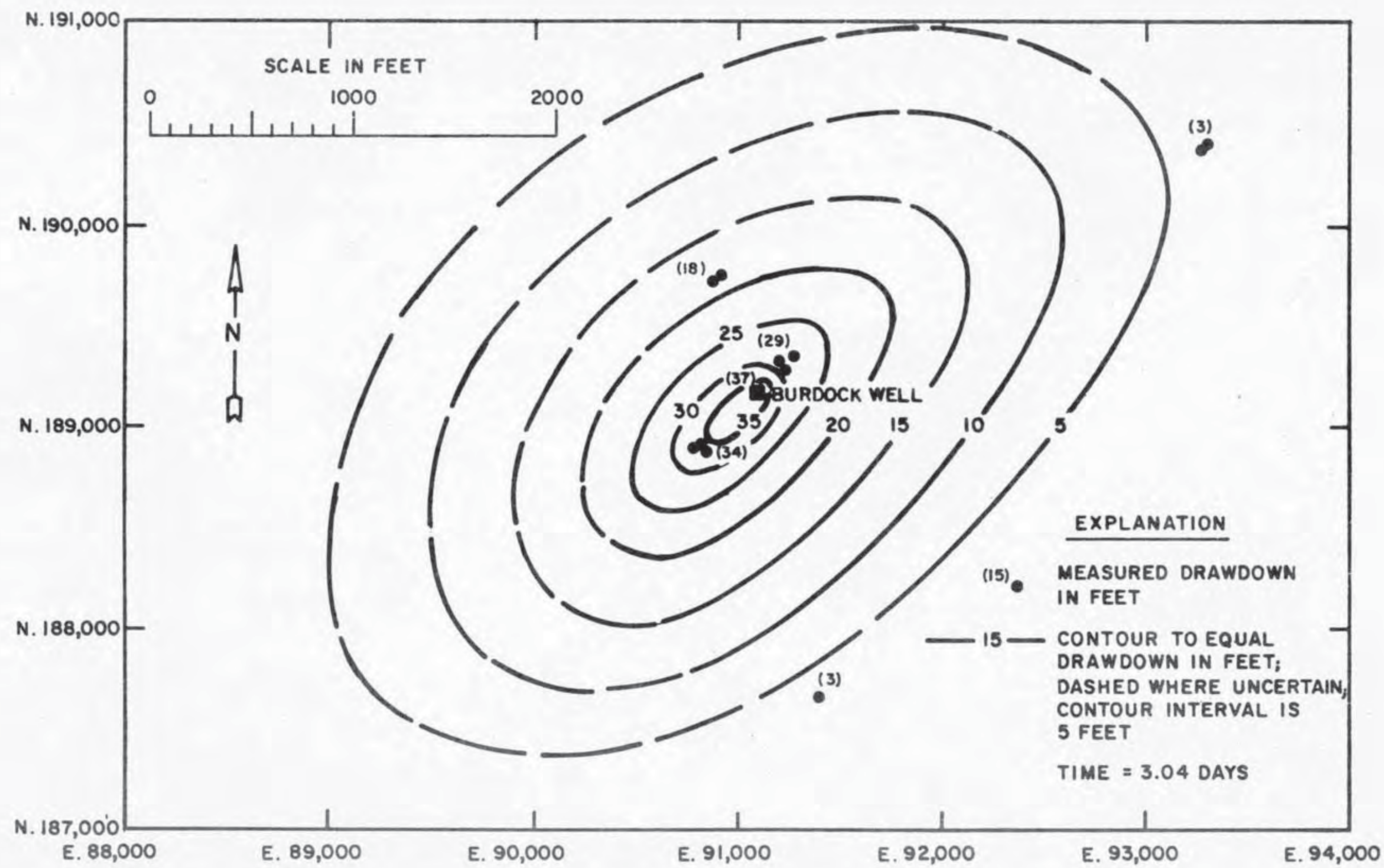


Figure 20 : Drawdown in Fall River Aquifer at End of Lakota Test

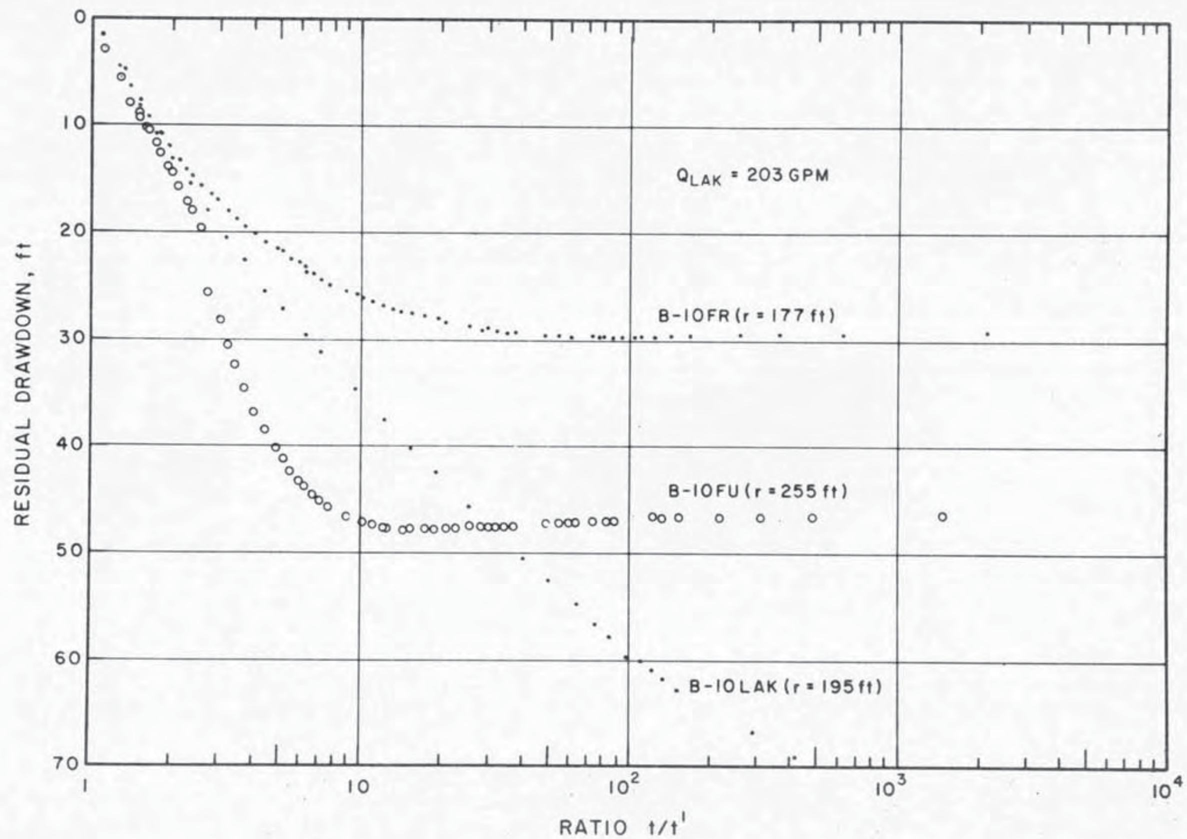


Figure 21: Recovery Graphs for B-10 Observation Well Group, Lakota Aquifer Test

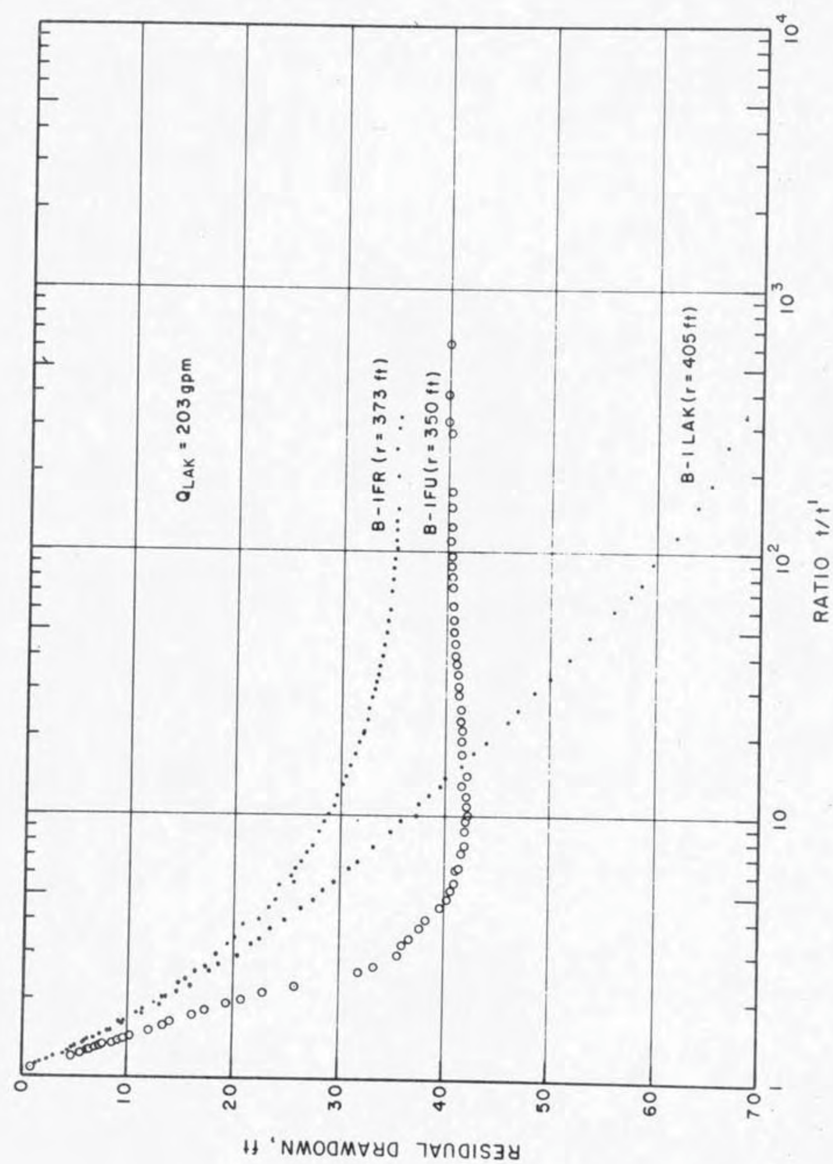


Figure 22: Recovery Graphs for B-1 Observation Well Group, Lakota Aquifer Test

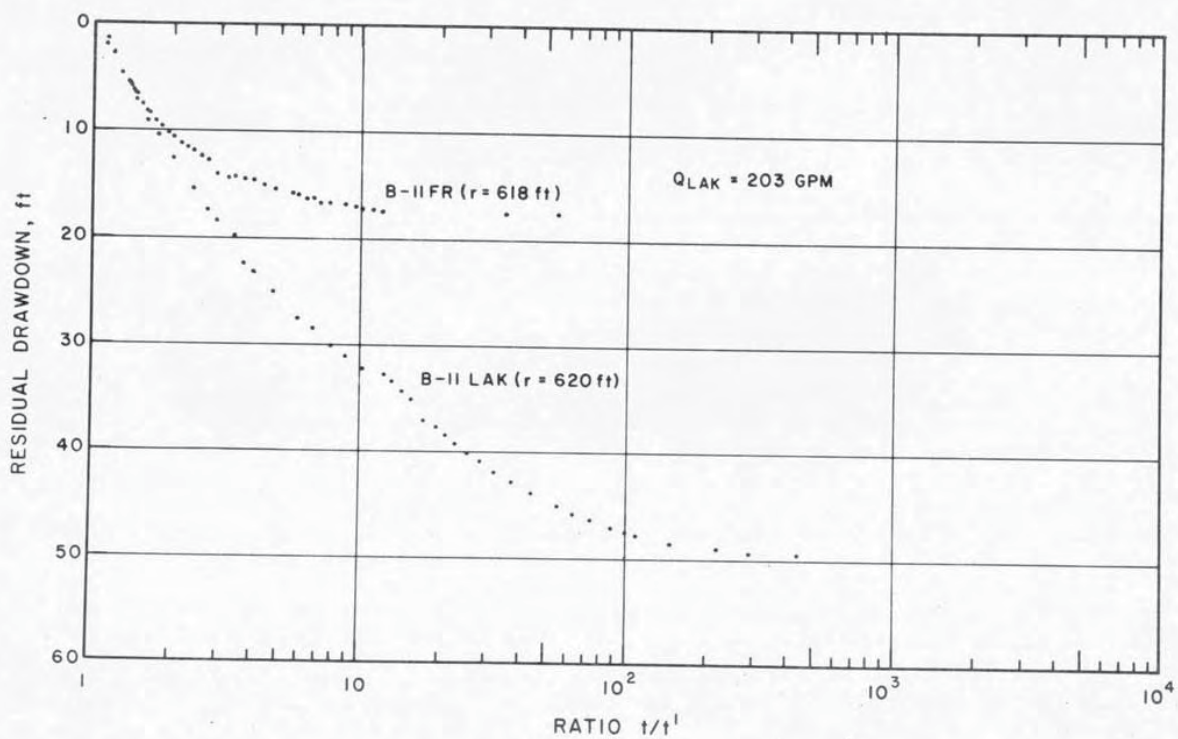


Figure 23: Recovery Graphs for B-11 Observation Well Group, Lakota Aquifer Test

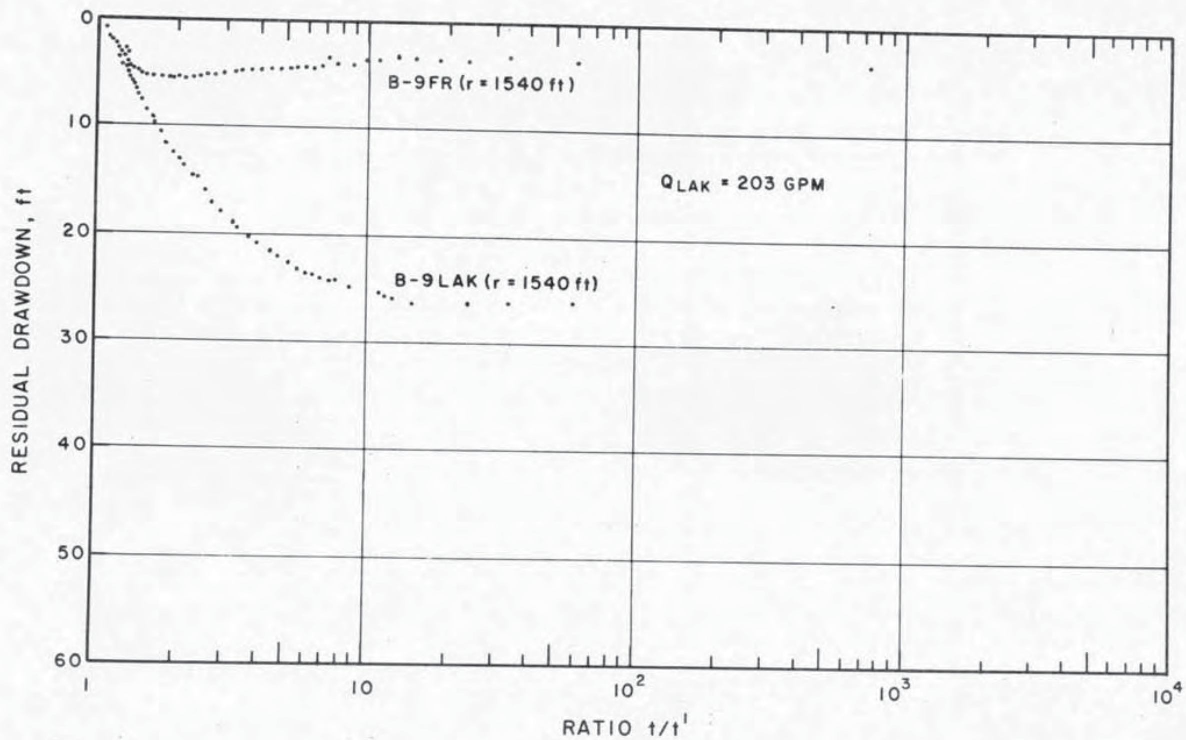


Figure 24: Recovery Graphs for B-9 Observation Well Group, Lakota Aquifer Test

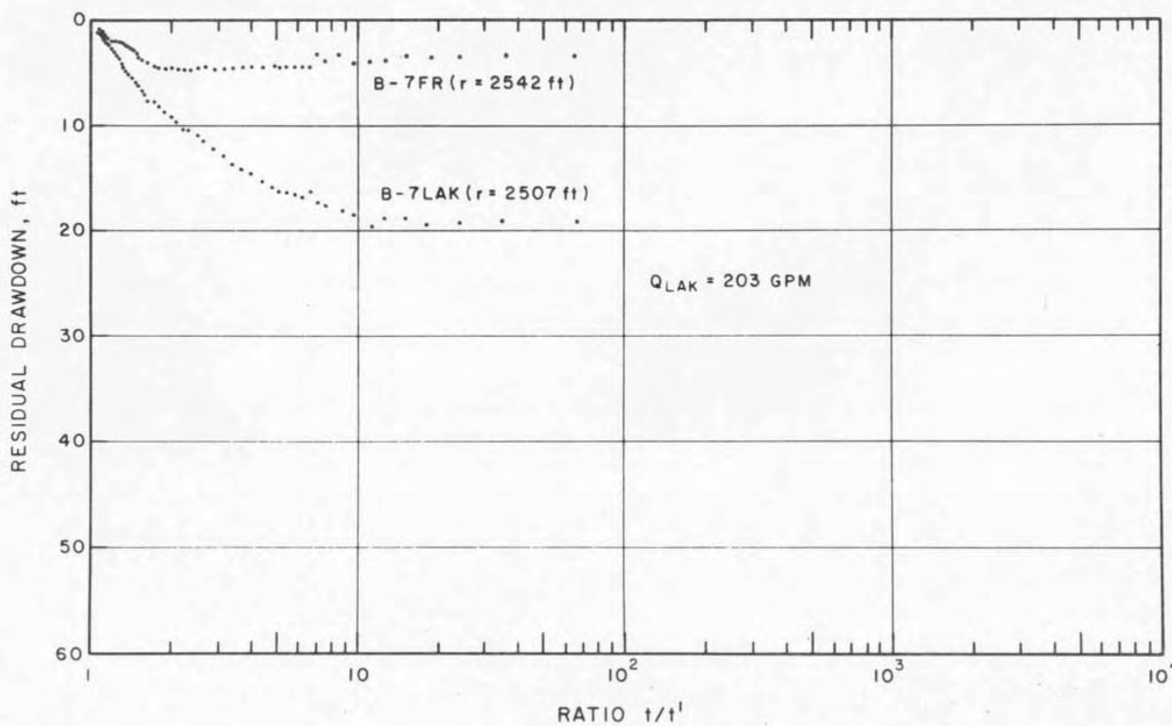


Figure 25: Recovery Graphs for B-7 Observation Well Group, Lakota Aquifer Test

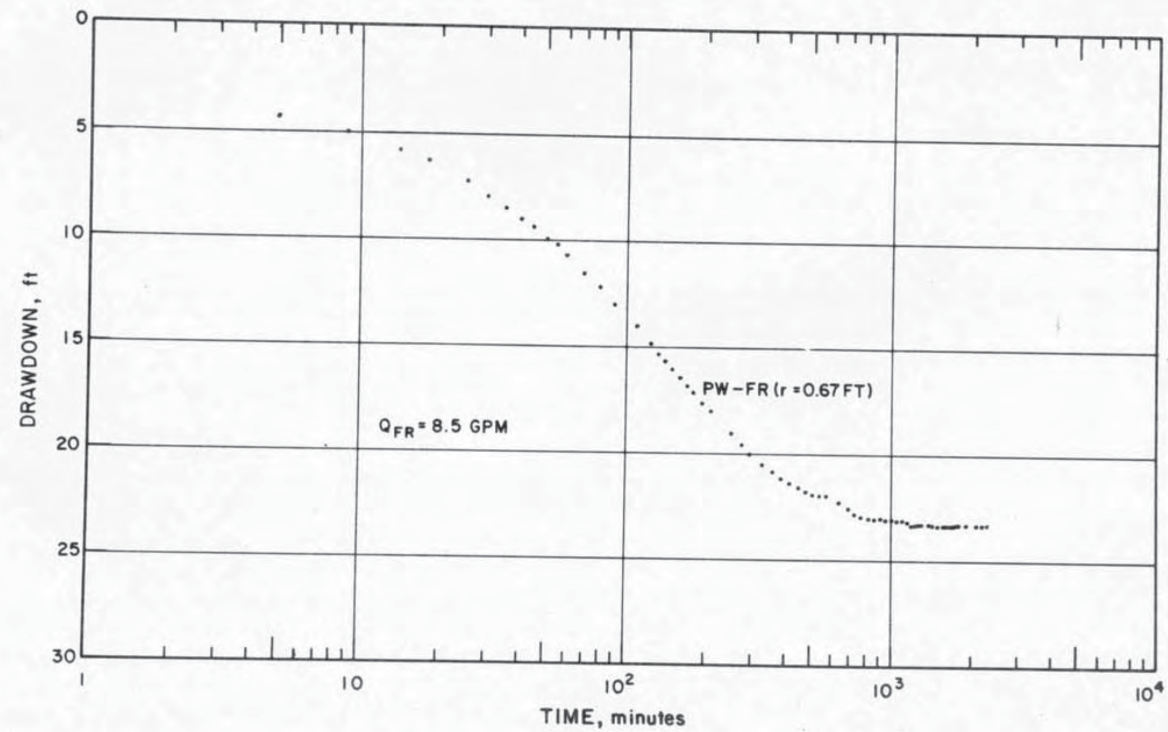


Figure 26: Semilogarithmic Graph of Drawdown for the Pumped Well, Fall River Aquifer Test

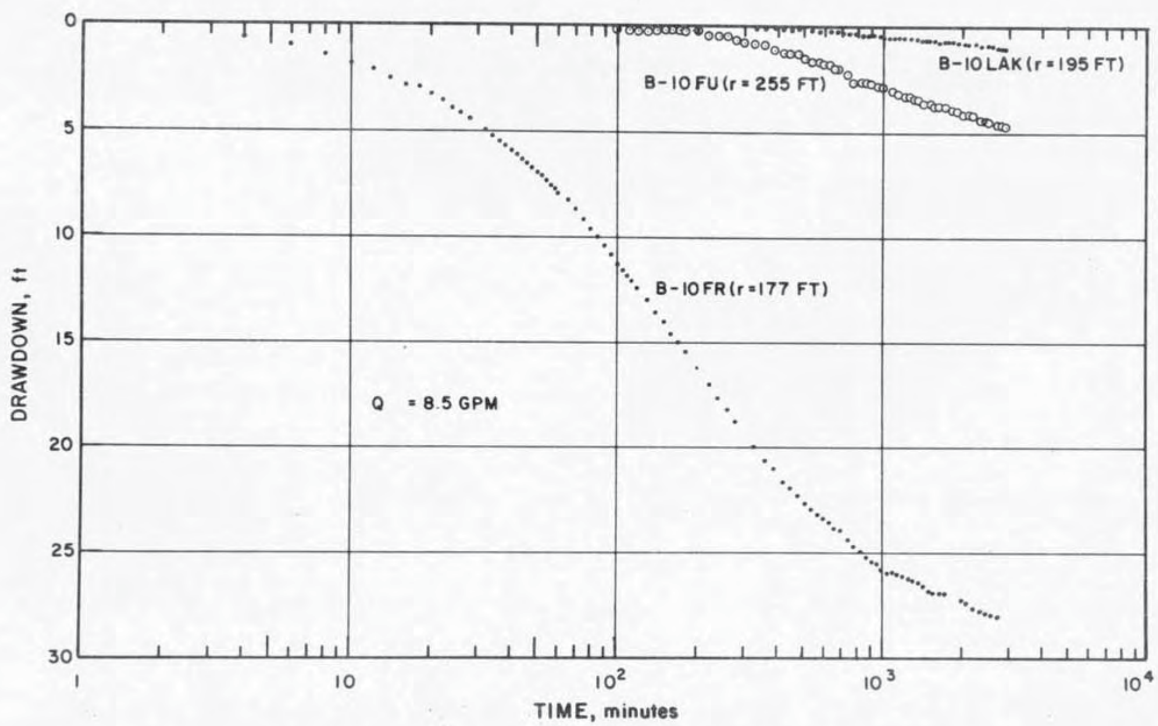


Figure 27: Semilogarithmic Graphs of Drawdown for B-10 Observation Well Group, Fall River Aquifer Test

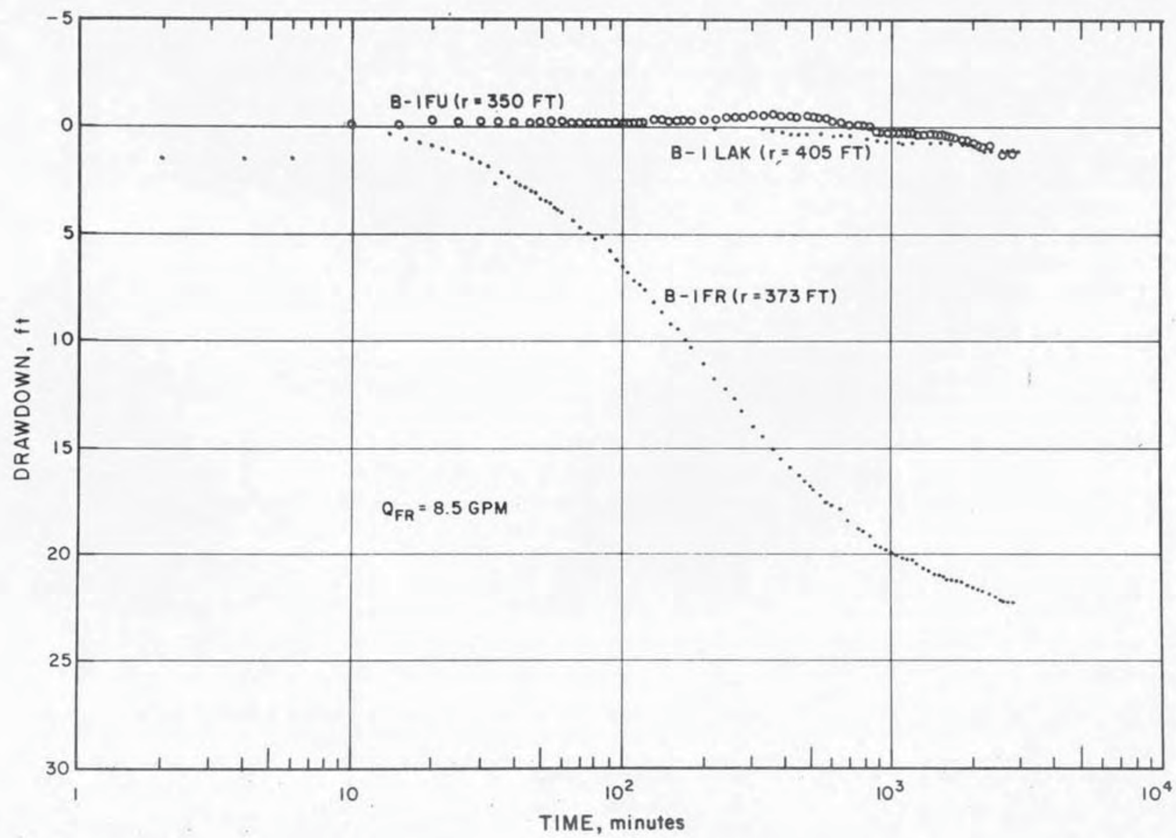


Figure 28 : Semilogarithmic Graphs of Drawdown for B-1 Observation Well Group, Fall River Aquifer Test

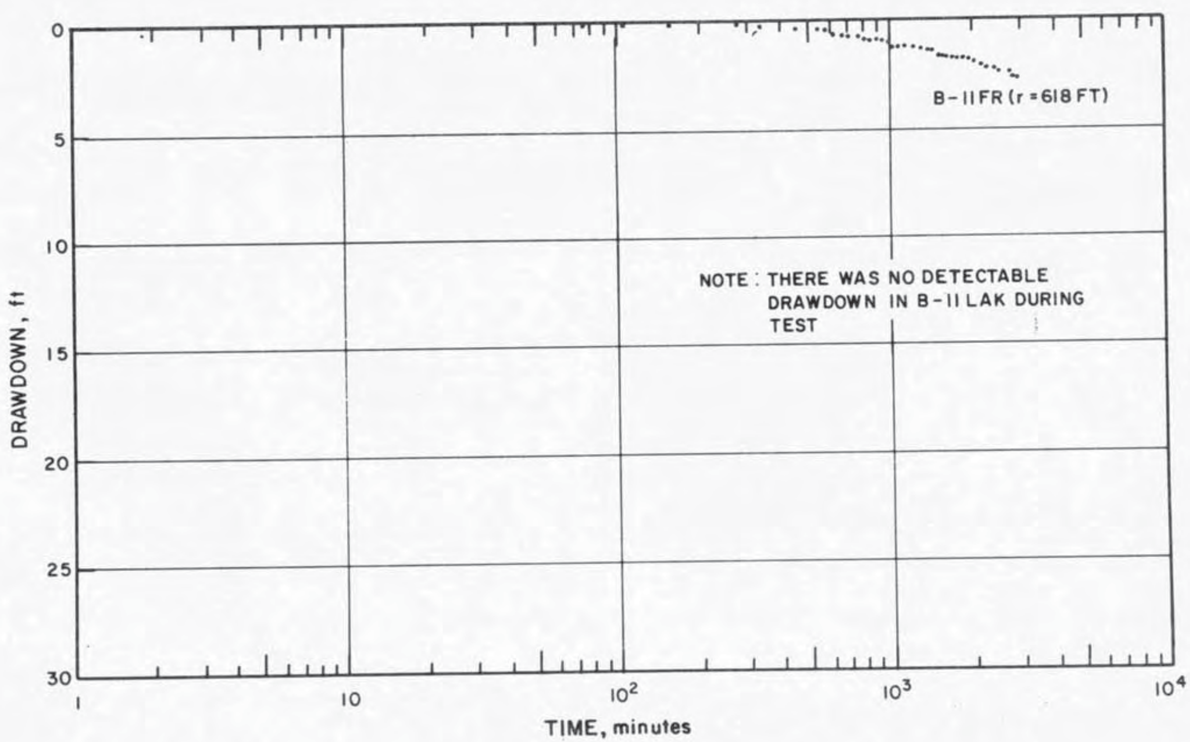


Figure 29: Semilogarithmic Graph of Drawdown for B-11 Observation Well Group, Fall River Aquifer Test

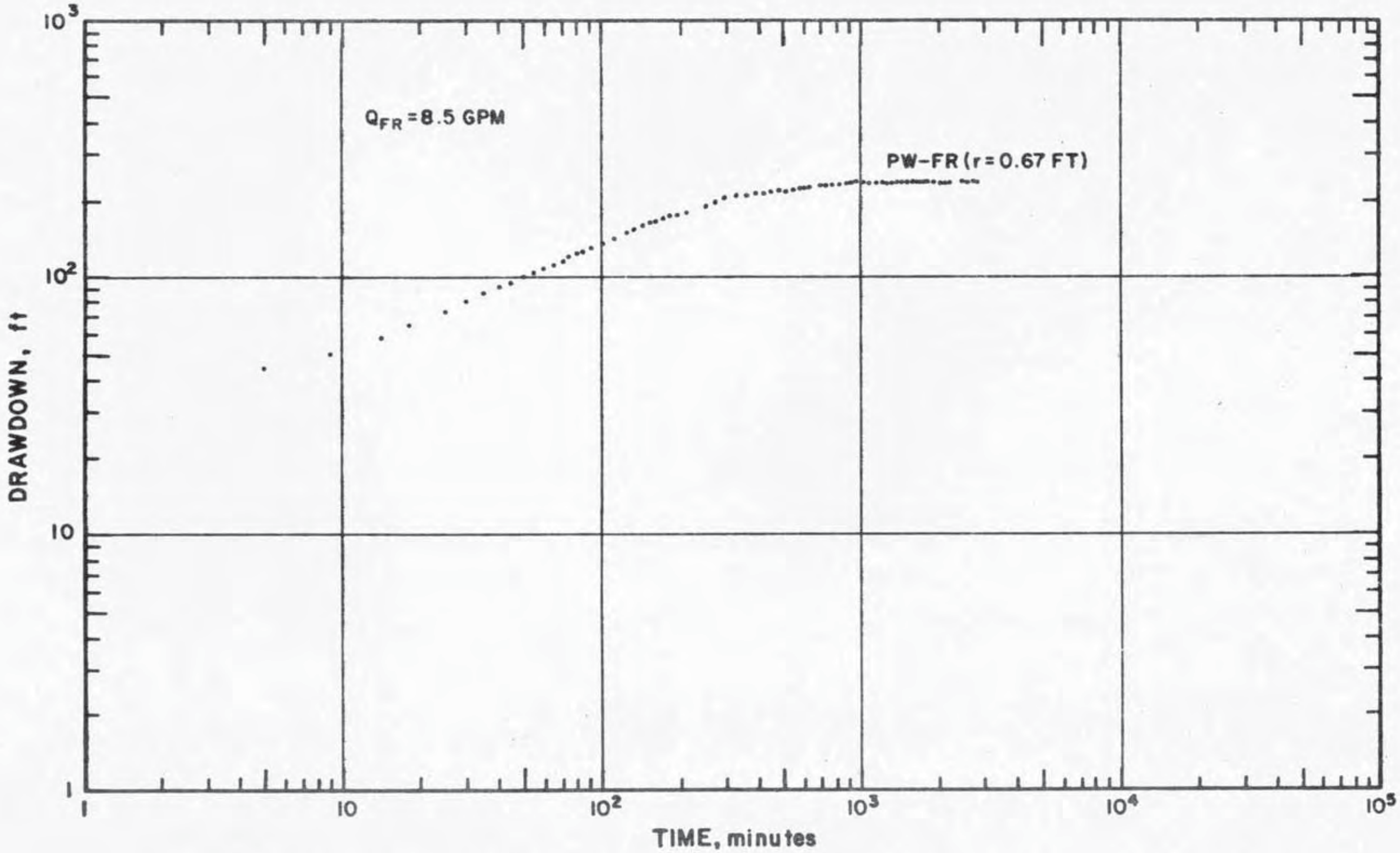


Figure 30: Logarithmic Graph of Drawdown for Pumped Well, Fall River Aquifer Test

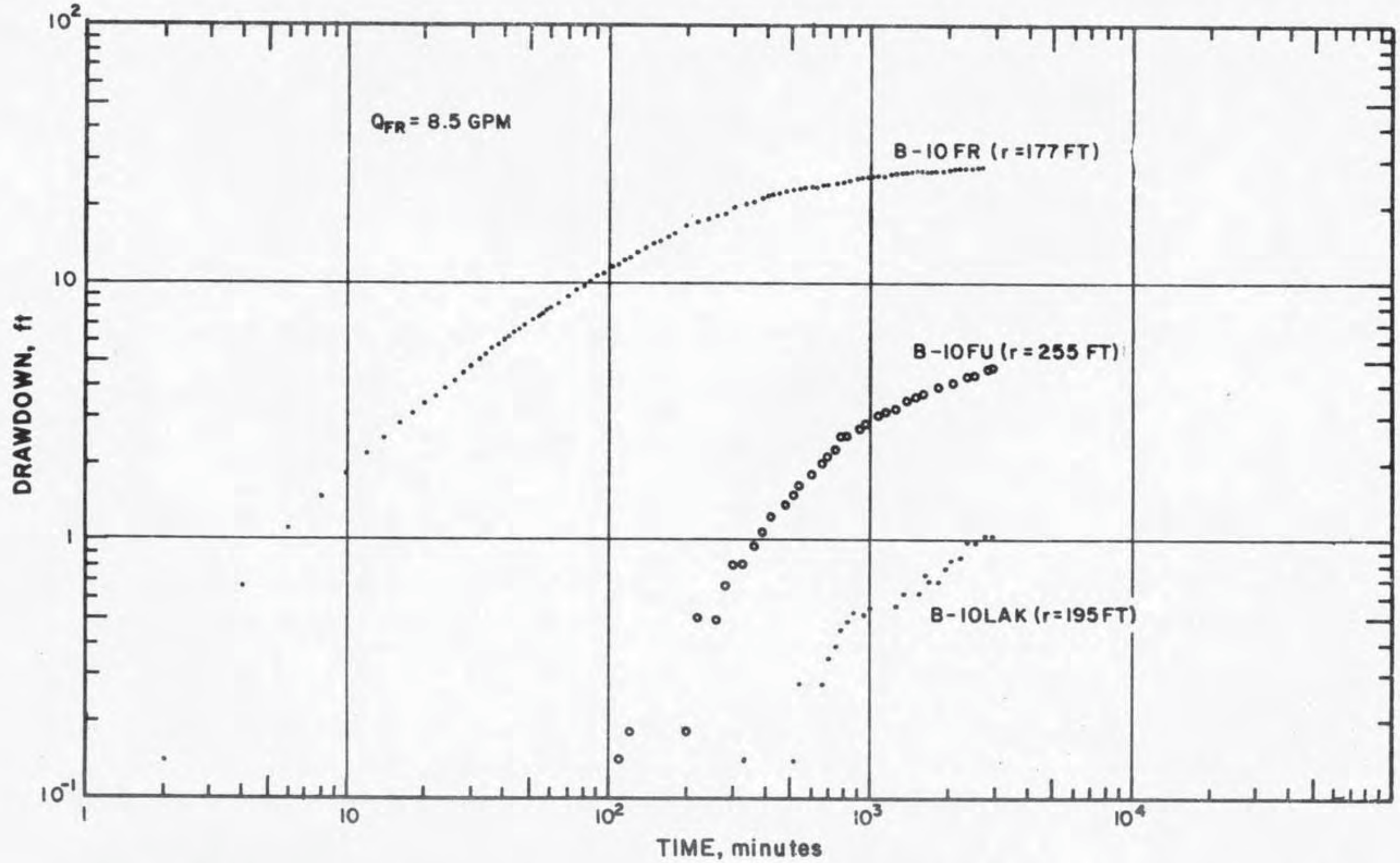


Figure 31: Logarithmic Graphs of Drawdown for B-10 Observation Well Group, Fall River Aquifer Test

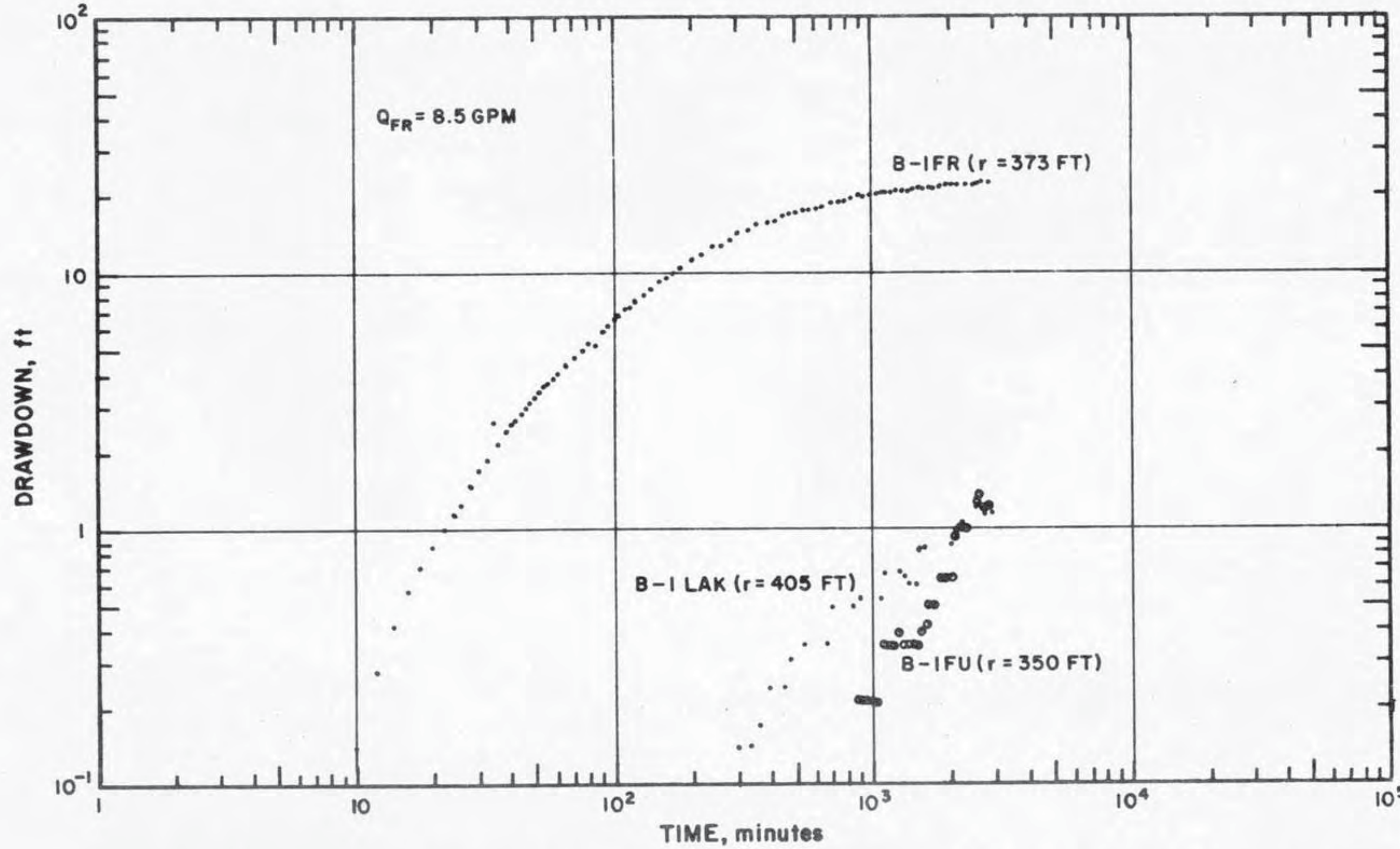


Figure 32: Logarithmic Graphs of Drawdown for B-1 Observation Well Group, Fall River Aquifer Test

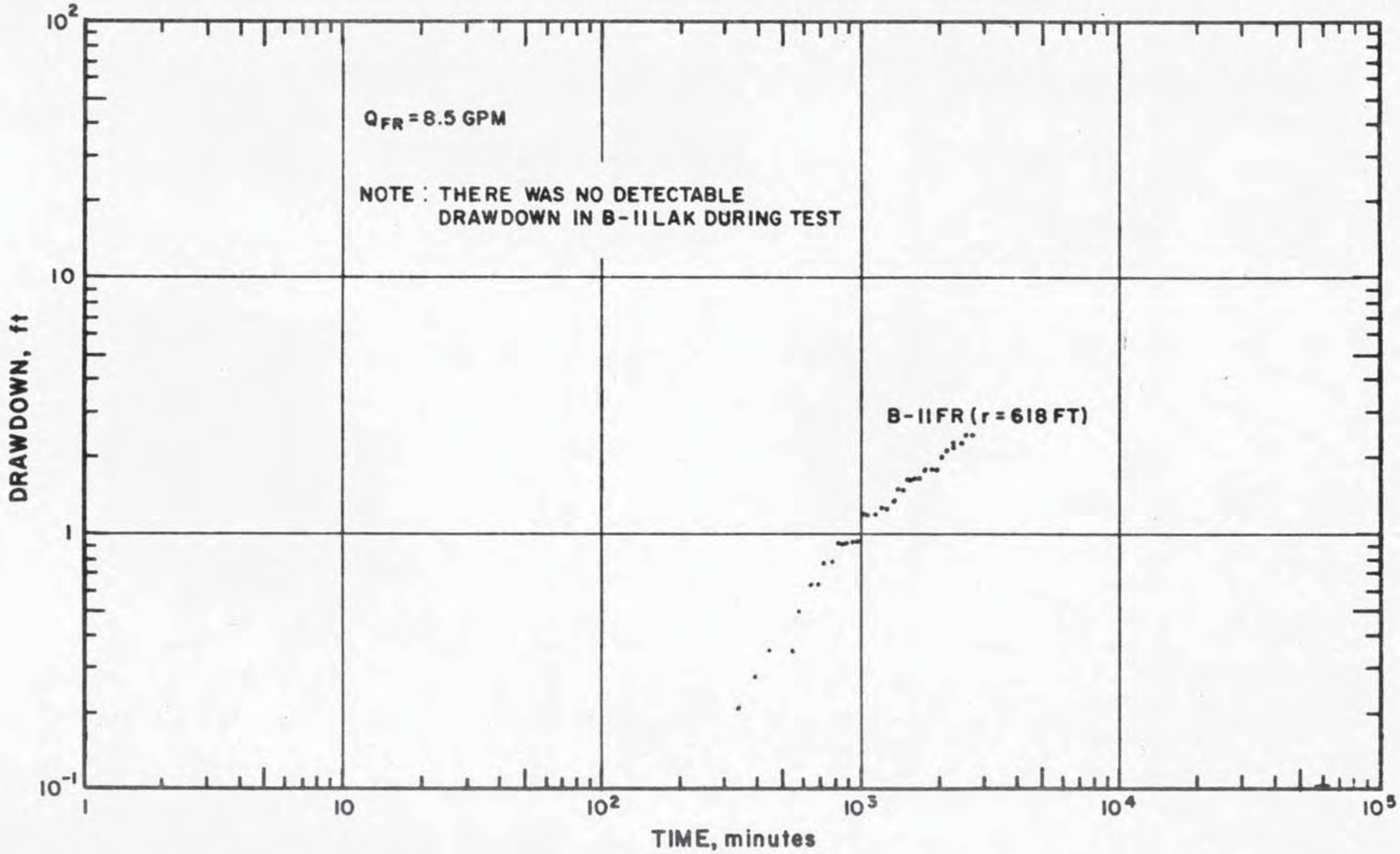


Figure 33: Logarithmic Graphs of Drawdown for B-11 Observation Well Group, Fall River Aquifer Test

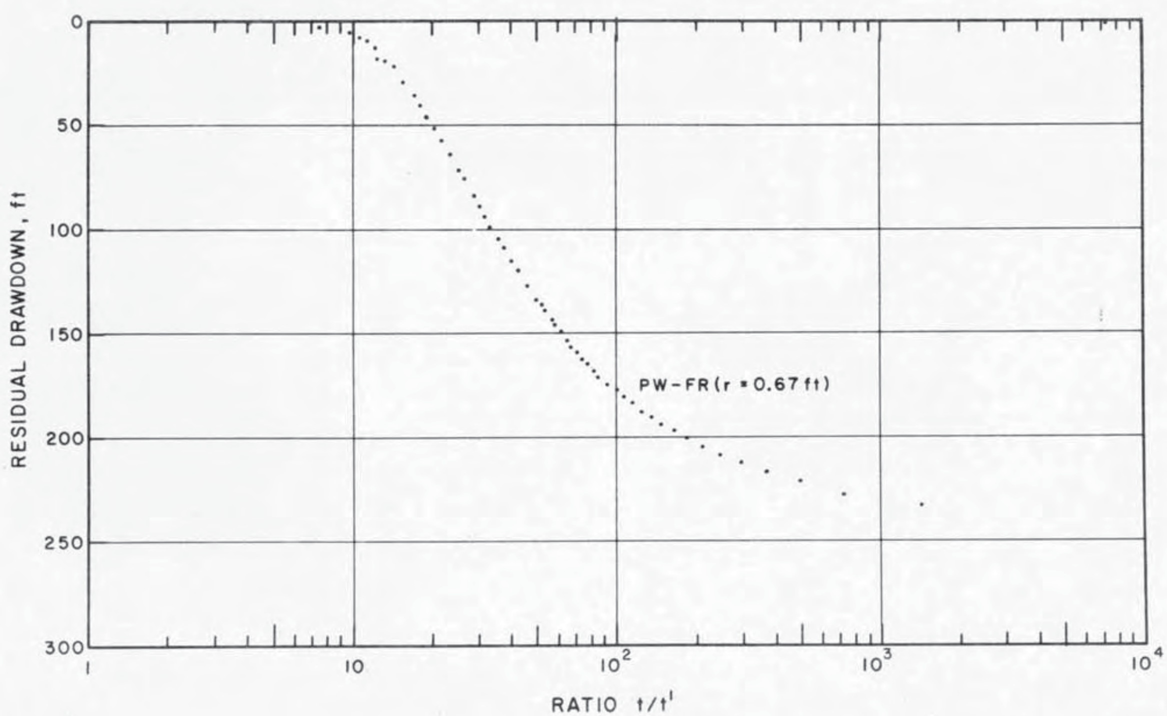


Figure 34: Recovery Graph for Pumped Well, Fall River Aquifer Test

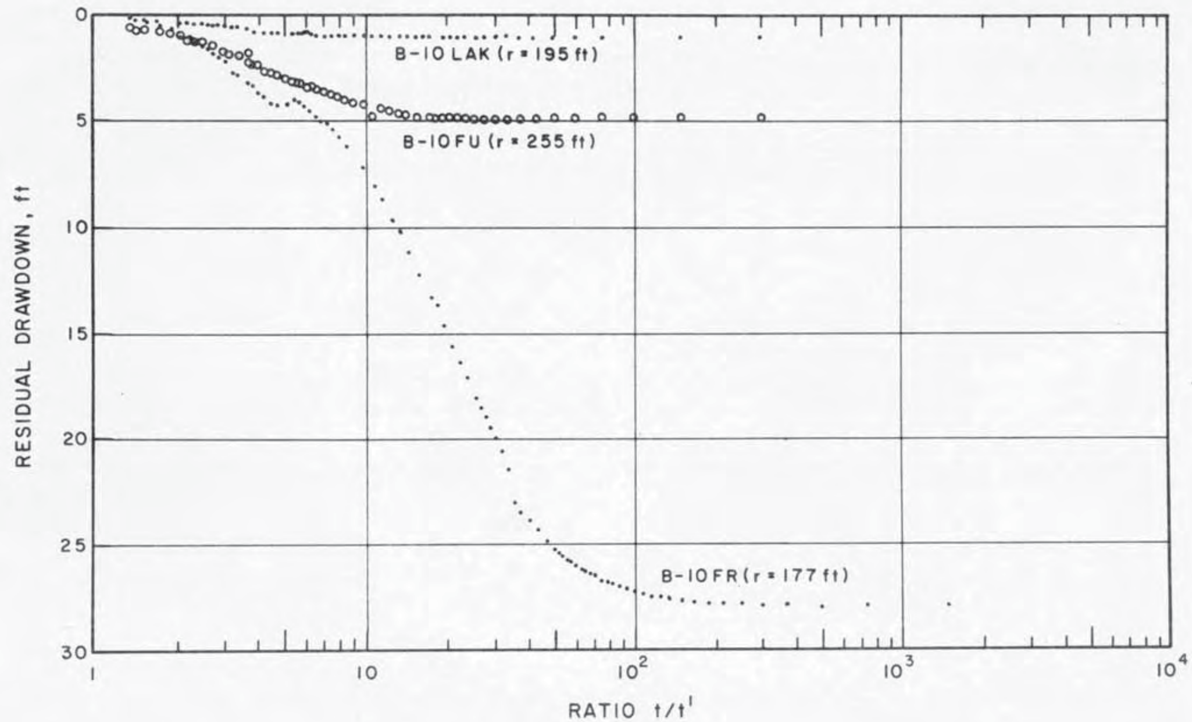


Figure 35: Recovery Graphs for B-10 Observation Well Group, Fall River Aquifer Test

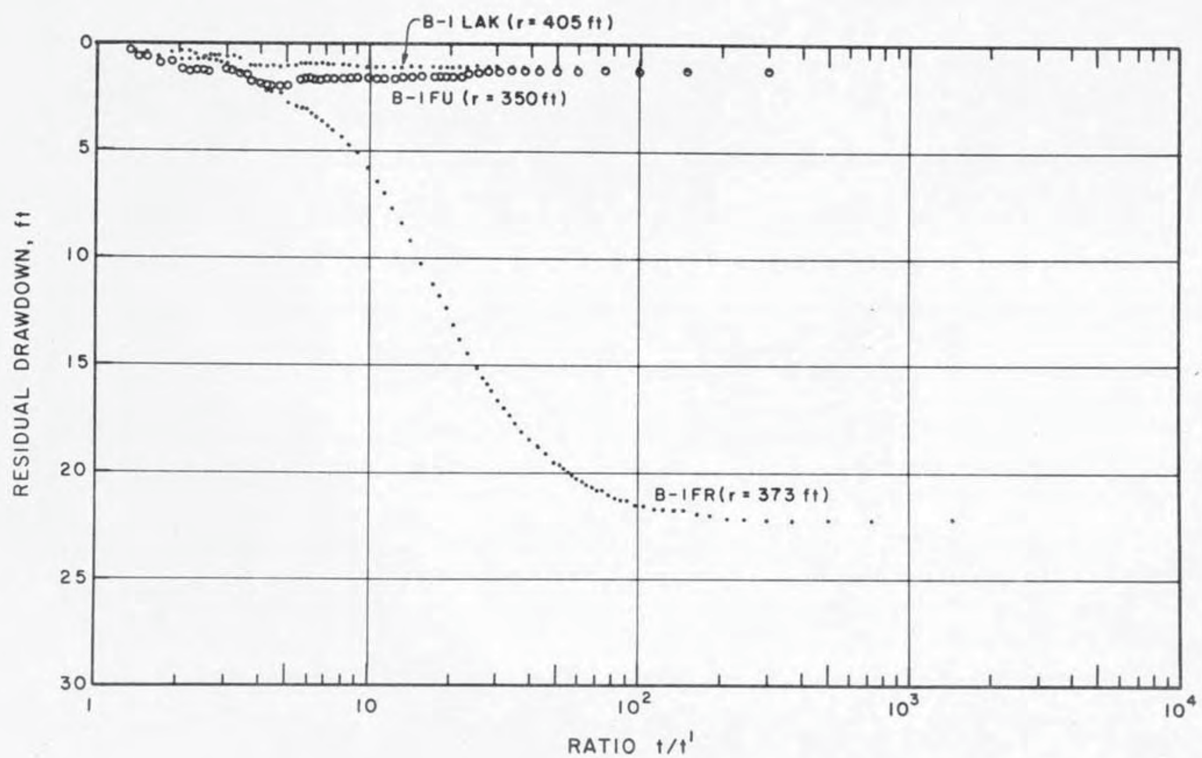


Figure 36: Recovery Graphs for B-1 Observation Well Group, Fall River Aquifer Test

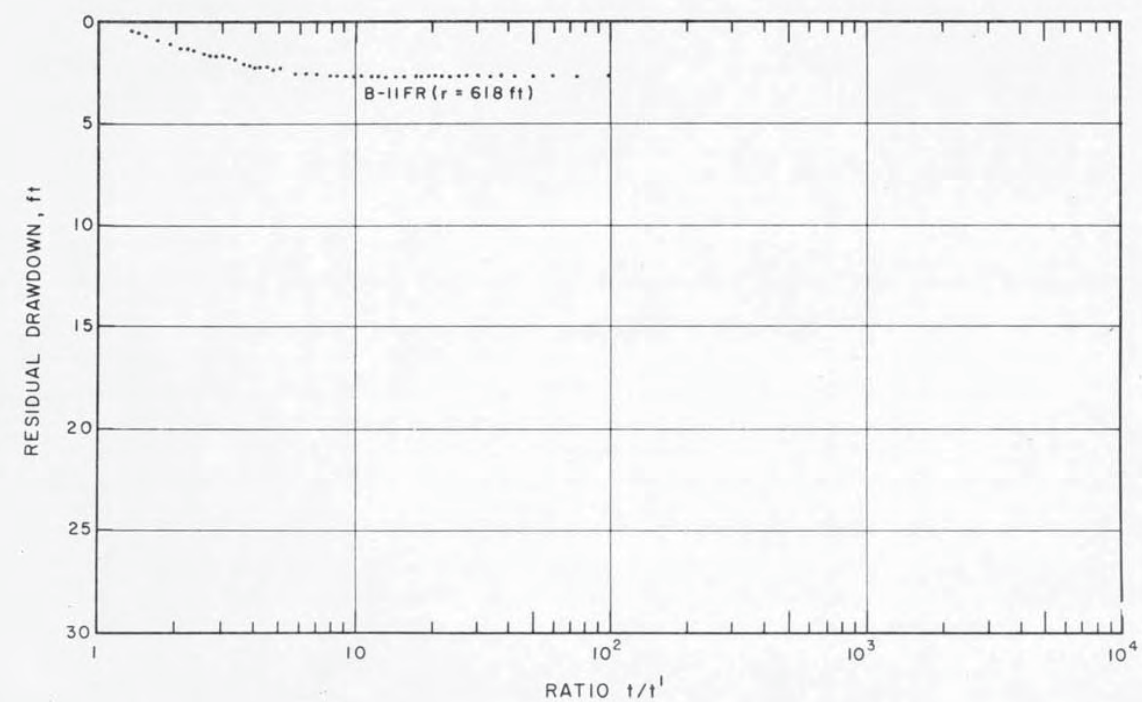


Figure 37: Recovery Graph for B-11 Observation Well Group, Fall River Aquifer Test

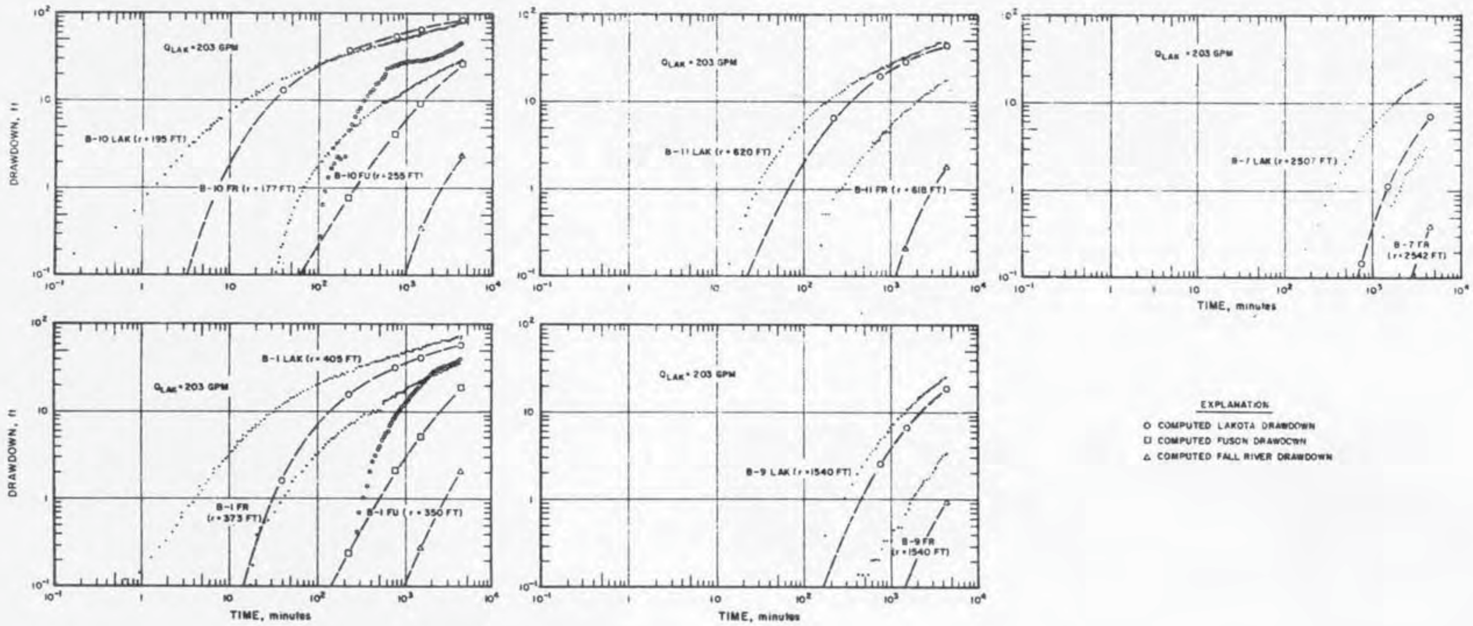


Figure 38 : Results of Initial Lakota Aquifer Test Simulation

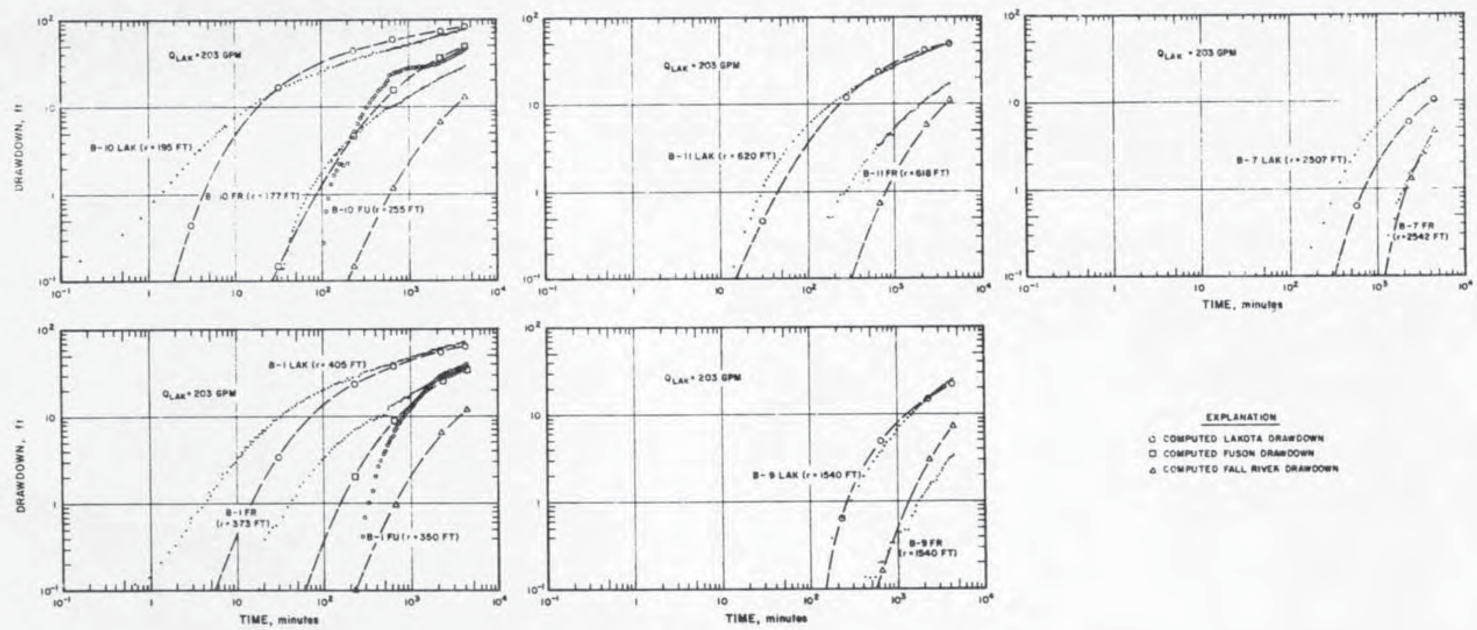


Figure 39 : Results of Final Lakota Aquifer Test Simulation

From: Jeffery C. Parsons
To: Shea, Valois
Cc: "Roger Flynn"
Subject: FW: Oglala Sioux Tribe Comment Attachments #5.1
Date: Monday, June 19, 2017 5:36:04 PM
Attachments: OST-26 Darrow Freezeout Triangle Uranium Mine Site PA Report1.pdf

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Email #5.1

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
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To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

Email #5

****
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Senior Attorney
Western Mining Action Project
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From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:39 PM
To: shea.valois@epa.gov
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

Email #4

****
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From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:38 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

****
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Senior Attorney
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****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:37 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

Email #2

****
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From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:36 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: Oglala Sioux Tribe Comment Attachments

Ms. Shea – in support of the comments submitted this day (June 19, 2017) by the Oglala Sioux Tribe, attached are supplemental documents. As there are several such documents, there are likely to be a series of emails to follow. Thank you.

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

Seagull Environmental Technologies, Inc.

3555 Chase Street
Wheat Ridge, CO 80212
www.seagullenvirotech.com

September 24, 2014

Victor Ketellapper, Site Assessment Team Leader
U.S. Environmental Protection Agency, Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

Subject: Preliminary Assessment Report regarding the Darrow/Freezeout/Triangle Uranium Mine Site near Edgemont, South Dakota
EPA ID: SDN000803095
EPA Region 8 START 8(a) Carve-Out Contract EP-S8-11-05, Task Order 0014
Task Monitor: Victor Ketellapper, Site Assessment Team Leader

Dear Mr. Ketellapper:

Seagull Environmental Technologies, Inc. (Seagull) is pleased to submit the attached Preliminary Assessment report regarding the Darrow/Freezeout/Triangle Uranium Mine site near Edgemont, South Dakota. Please contact the Project Manager via email at rlunt@seagullenvirotech.com or by phone at (720) 459-7874 if you have any questions.

Sincerely,

Ryan M. Lunt

Ryan M. Lunt
Task Order Project Manager

Hieu Q. Vu, PE
EPA Region 8 START 8(a) Program Manager

Enclosures

PRELIMINARY ASSESSMENT REPORT

Regarding the

DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE

NEAR EDGEMONT, SOUTH DAKOTA

EPA ID: SDN000803095

Contract No.: EP-S8-11-05
Task Order No.: 0014

Prepared By:

SEAGULL ENVIRONMENTAL TECHNOLOGIES, INC.
3555 CHASE STREET
WHEAT RIDGE, COLORADO 80202-1129

September 24, 2014

PRELIMINARY ASSESSMENT REPORT APPROVED BY:

Hieu Q. Vu, PE, Program Manager — September 24, 2014 Date

Lynn Parman, PG, CHMM, QA/QC Manager — September 24, 2014 Date

Ryan M. Lunt, CHMM, Task Order Project Manager — September 24, 2014 Date

Victor Ketellapper, EPA Region 8, Site Assessment Team Leader — Sept 24 2014 Date

DISTRIBUTION LIST

U.S. ENVIRONMENTAL PROTECTION AGENCY

Victor Ketellapper (1 Copy)	Site Assessment Team Leader

SEAGULL ENVIRONMENTAL TECHNOLOGIES, INC.

Hieu Q. Vu (1 Copy)	Program Manager, START 8(a) Carve-Out, EPA Region 8
File (1 Copy)	START 8(a) Carve-Out, EPA Region 8

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1.0 INTRODUCTION

Under the U.S. Environmental Protection Agency (EPA) Region 8 Superfund Technical Assessment and Response Team (START) Carve-Out 8(a) Contract (No. EP-S8-11-05), Task Order No. 0014, Seagull Environmental Technologies, Inc. (Seagull) has been tasked to conduct a Preliminary Assessment (PA) of the Darrow/Freezeout/Triangle Uranium Mine site (the Site) near Edgemont, Custer and Fall River Counties, South Dakota. This PA is to determine whether the site poses a threat to human health and the environment and if further investigation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is warranted.

This PA was conducted in accordance with *Guidance for Performing Preliminary Assessments Under CERCLA* (EPA 1994). The Site is listed in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database as EPA ID SDN000803095. The CERCLIS non-National Priorities List (NPL) status of the site as of February 7, 2014, was “Ongoing Preliminary Assessment” (EPA 2014a).

2.0 OBJECTIVES

Objectives of this PA were to:

- Evaluate existing information and analytical data.
- Assess presence, quantity, or absence of uranium-mine-related contaminants at the Site.
- Document any releases to the environment from the Site.
- Acquire information regarding exposure pathways, surrounding population density, and other target data, including environmentally sensitive receptors (wetlands, fisheries, and threatened or endangered species).
- Assess whether the Site warrants further investigation under CERCLA.
- Identify data gaps or limitations of existing data reviewed in this PA.

3.0 SITE LOCATION AND DESCRIPTION

The Site is near Edgemont, in Custer and Fall River Counties, South Dakota. Geographic coordinates at the approximate center of the site are 43.478486 degrees north latitude and 103.962746 degrees west longitude. Currently used primarily for cattle grazing, the Site encompasses approximately 1,426 acres at the southwest edge of the Black Hills uplift approximately 13 miles northwest of Edgemont, South Dakota (see Figures 1 and 2).

The Site lies within the proposed Dewey-Burdock in-situ uranium recovery (ISR) project area. ISR is a means of extracting uranium from underground ore bodies through a series of injection and production wells, and pumping it to the surface for production of nuclear fuel (Powertech Uranium Corporation [Powertech] 2014). In 2009, Powertech submitted the Dewey-Burdock Project Application Technical Report in order to obtain a U.S. Nuclear Regulatory Commission (NRC) Uranium Recovery License for working within the Proposed Action Area (PAA) (Powertech 2009). The PAA boundary encompasses approximately 10,580 acres of mostly private land, including a series of sequentially developed well fields, a satellite ion exchange facility, a central processing plant, and associated facilities to recover and process the final uranium product. The NRC prepared a draft Supplemental Environmental Impact Statement (SEIS) to evaluate potential environmental impacts from proposed construction, operation, aquifer restoration, and decommission of an ISR uranium facility at the proposed site (NRC 2012). The Final Environmental Impact Statement (EIS) was completed in January 2014 (NRC 2014a). The technical report completed by Powertech included results of baseline sampling within the PAA. Sampling data from the area of the Site obtained during that effort were used for this PA to evaluate conditions at the Site. Mining waste remains in abundance at the Site, and is suspected to be a source of radionuclide contamination to nearby streams and groundwater (see Figure 2).

The site is within the Great Plains physiographic province, where vegetation is a mix of short grasses and shrubs typical of semi-arid steppe land, along with Ponderosa Pine forest toward the Black Hills. Most of the surrounding land is used for rangeland (Powertech 2009).

3.1 SITE HISTORY

The Site is an abandoned uranium mine. Uranium was discovered in the Edgemont area in 1952 (Powertech 2009). Early mining of the material was limited to surface deposits; however, later drilling revealed deeper deposits. In the mid-1970s, the Tennessee Valley Authority (TVA) purchased a major interest in the Edgemont area and hired Silver King Mines, Inc., to explore the property. However, in the mid-1980s, the operation was halted due to an economically unsustainable decline in uranium prices. In 1994, Energy Fuels Nuclear (EFN) acquired the property but relinquished it due to low uranium prices. Surface land rights and mineral rights in the site area belong to private owners and the U.S. government (Powertech 2012a, b).

A number of uranium mine sites have been investigated under Superfund authority, as these sites can present potential for (1) public exposure to radon and other radionuclides, (2) contamination of groundwater and surface water supplies (via acid drainage and mobilization of heavy metals), (3) natural habitat disturbance, (4) increased instability of the land via erosion and slope stability failure, and (5) other physical safety hazards. Therefore, these sites may pose a threat to nearby human health and the environment (EPA 2007).

3.2 CURRENT SITE CONDITIONS

During a site reconnaissance on November 5, 2013, Seagull team members and EPA traveled along public roads in the vicinity of the Site in an unsuccessful attempt to identify a vantage point from which to view the Site. Photos of the area of the Site—including drainage areas, historical points of interest, and current conditions of the surrounding area—were taken during this site reconnaissance (see Appendix A). START and EPA visited Edgemont City Hall to meet with local officials to discuss purposes of the PA and to obtain information for the report. Following the meeting with local officials, the City Engineer/Code Administrator of Edgemont accompanied START and EPA to visit areas of interest in and around Edgemont, including the nearby uranium mill tailings repository and location of the former mill. The visit also included travel to current City of Edgemont Public Water Supply (PWS) wells to confirm their locations.

4.0 SITE CHARACTERISTICS

The following sections discuss the geology and hydrogeology, hydrology, and meteorology of the site vicinity.

4.1 GEOLOGY AND HYDROGEOLOGY

The Site is within the Black Hills; soils within the Site's boundaries are generally clayey or silty, with patches of sandy loam on upland areas and clay in or near drainages. The level upland areas have deep soils, and shallow soils are on hills, ridges, and breaks (NRC 2012). Wide areas of unconsolidated alluvial and terrace deposits of Quaternary age overlie the sedimentary rocks of Cretaceous and Jurassic age. The sedimentary rocks include the Cretaceous-age Belle Fourche Shale, Granerous Group (Mowry Shale and Skull Creek Shale), and Inyan Kara Group (Fall River and Lakota Formations). The Fall River Formation consists of sandstone, siltstone, and interbedded sandstone and shale. The Lakota Formation consists of the Fuson Member (shale and siltstone with discontinuous sandstone) and Chilson Member (interbedded shale and sandstone, and a basal mudstone). The Chilson Member is also known as the Lakota Sandstone (Schnabel 1963, NRC 2012).

The Jurassic-age Morrison and Sundance Formations underlie the Inyan Kara Group. The Morrison Formation consists of shale and claystone interbedded with limestone. The Sundance Formation is composed of the Stockade Beaver Member (shale), Hulett Member (sandstone), Lak Member (sandstone, siltstone, and mudstone), and Redwater Member (shale) (Schnabel 1963).

Many occurrences of uranium minerals have been prospected within the Burdock quadrangle. Generally, the ore minerals occur as impregnations in sandstone, siltstone, and mudstone beds, but not consistently in a carbonaceous environment. Uranium and vanadium minerals from these deposits have been identified as uraninite, carnotite, and tyuyamunite. Corvusite and rauvite are probably present in some of the deposits, although these have not been positively identified. The uranium minerals are restricted to the sandstone and sandy or silty facies in the Fall River Formation and the sandstone in the Chilson Member of the Lakota Formation (Schnabel 1963).

Major aquifers in the Black Hills area include (from top to bottom) the Inyan Kara Group, Minnekahta, Minnelusa, Madison, and Deadwood aquifers (see Appendix B). These aquifers are separated by confining layers with low permeability, except where they outcrop (NRC 2012). The Inyan Kara Group aquifer ranges from 250 to 500 feet thick and contains two subaquifers, the Fall River aquifer and Chilson aquifer, which are separated by the Fuson Shale. Aquifer pumping tests have provided data indicating a hydraulic connection between the Lakota and Fall River Formations through the intervening Fuson Shale in the Burdock area (NRC 2012). The Inyan Kara Group aquifer is separated from the Minnekahta aquifer by the Morrison Formation (60 to 140 feet thick), Sundance/Unkpapa aquifer (a minor aquifer), Gypsum Spring Formation, and the Spearfish Formation (320 feet thick). The Minnekahta aquifer ranges in thickness from 25 to 65 feet. Underlying the Minnekahta aquifer is the Opeche Shale (a confining layer) and the Minnelusa aquifer. The Minnelusa aquifer ranges in thickness from 375 to 1,175 feet. Confining layers are present at the base of the Minnelusa Formation; however, locally, these confining layers may be absent or provide ineffective confinement from the underlying Madison aquifer. The Madison aquifer is the most important aquifer in the region, supplying municipal water for numerous communities, including Rapid City and Edgemont, South Dakota. The Madison Formation is 200 to 1,000 feet thick and mainly consists of a dolomite unit characterized by fractures and karst features. The Madison aquifer is separated from the underlying Deadwood aquifer by the low-permeability Whitewood, Winnipeg, and Englewood Formations (NRC 2012). With the exception of Edgemont, which has two municipal wells in the Madison aquifer, the deeper aquifers are not used as a source of water in the area (Powertech 2009).

The hydrogeologic setting in the Black Hills area also involves minor aquifers, which include the Sundance/Unkpapa, Newcastle, and alluvial aquifers. These minor aquifers yield small volumes of water locally for domestic and stock uses. Alluvial aquifers with thicknesses of 0 to 50 feet are along Beaver Creek, Pass Creek, and the Cheyenne River. They are typically unconfined, but may be confined locally. Alluvial aquifers are separated from the underlying Fall River Formation by the low-permeability Graneros Group confining unit. An alluvial drilling program completed in 2012 did not indicate any areas of discharge to the alluvium along Beaver Creek and Pass Creek from the underlying Fall River aquifer (NRC 2012).

Groundwater in the Fall River and Chilson aquifers flows from northeast to southwest. Regionally, groundwater flows radially outward from the Black Hills toward the surrounding plains (NRC 2012).

Groundwater Levels

Regionally, groundwater levels in alluvial aquifers range from 14.4 to 22.5 feet below ground surface (bgs). Groundwater levels in the Fall River aquifer range from 80 to 680 feet bgs. Groundwater levels in the Chilson aquifer range from 196 to 1,000 feet bgs (Powertech 2009).

4.2 HYDROLOGY

The site lies within the Pass Creek sub-watershed, which comprises most of the east-southeast portion of the larger Beaver Creek watershed. The site is drained by Pass Creek and its tributaries. Located adjacent and east of the site, Pass Creek is an intermittent creek with periods of high runoff following major storm events. No permanent stream flow gages are stationed along Pass Creek (Powertech 2009). Pass Creek flows southwest from the northwest boundary of the Site approximately 6 stream miles to Beaver Creek. Approximately 5.5 stream miles southeast of the confluence of Pass and Beaver Creeks, Beaver Creek flows into the Cheyenne River (Google Earth 2013). In 2013, the mean annual discharge from the Cheyenne River was 38.2 cubic feet per second (cfs), according to a gaging station in Edgemont, downstream of its confluence with Beaver Creek (U.S. Geological Survey [USGS] 2014).

4.3 METEOROLOGY

According to the High Plains Regional Climate Center's (HPRCC) station in Edgemont, the average maximum and minimum annual temperatures in the site area are 61.2 and 33.1 degrees Fahrenheit (°F), respectively. The annual average precipitation is 15.79 inches (HPRCC 2014).

5.0 PREVIOUS ANALYTICAL DATA

Analytical data from groundwater, surface water, sediment, soil, and air were collected within the study area by Powertech and were included in the Dewey-Burdock Project Application for NRC Uranium Recovery License Technical Report (Powertech 2009). These data were referenced in the Environmental Impact Statement (EIS) completed by the NRC.

5.1 GROUNDWATER

The following sections address groundwater sampling and results of that sampling.

5.1.1 Groundwater Sampling

According to a well inventory conducted by Powertech, the following wells are within a 4-mile radius of the Site boundary: one domestic well and five stock wells are within the Site boundary; one domestic well is within 0.25 mile of the Site; one domestic well and four stock wells are between 0.25 and 0.50 mile of the Site; one domestic well and six stock wells are within 0.50 and 1 mile of the Site; 12 stock wells are between 1 and 2 miles of the Site; eight domestic wells, 10 stock wells, and one irrigation well are between 2 and 3 miles of the Site; and six domestic and 10 stock wells are between 3 and 4 miles of the Site (Figure 3).

Powertech conducted groundwater sampling of wells at the proposed Dewey-Burdock ISR project area from October 2006 through February 2009 (see Figure 4). Groundwater samples were collected from domestic, stock, irrigation, monitoring, and temporary wells, the majority of which were downgradient of the Site. Groundwater samples were collected from wells in various aquifers: 17 wells were in the Fall River Formation, 19 wells were in the Lakota Formation (Chilson Member), two wells were in the Inyan Kara Group, three wells were in the Unkpapa Formation, two wells were in unknown aquifers, one well was in the Sundance Formation, and five wells were in alluvium. Generally, groundwater samples were collected for analysis for water quality parameters: major ions; metals, including mercury (total, suspended, and dissolved); and radionuclides (total, suspended, and dissolved).

USGS also conducted groundwater sampling in the Dewey-Burdock area during June 2011. USGS collected 28 groundwater samples from monitoring wells in and around the Dewey-Burdock site that were screened in multiple aquifers.

During July 2012, American Engineering and Testing, Inc. installed additional alluvial groundwater monitoring wells in the area of the Site to supplement the groundwater monitoring results included in the initial application submitted to NRC by Powertech. The additional wells were compliance point wells within the alluvial aquifers along Beaver Creek and Pass Creek (see Figure 5). The wells were sampled monthly by Powertech from July 2012 to June 2013. Most of the samples were analyzed for water quality measurements, metals (including mercury), and dissolved radionuclides.

5.1.2 Groundwater Analytical Results Summary

Groundwater sampling results indicated that in 36 of 49 samples, at least one analyte exceeded the Maximum Contaminant Level (MCL). Of 38 groundwater samples collected from the proposed ore-bearing aquifer, 28 contained analyte concentrations exceeding at least one MCL for drinking water (NRC 2012). The designated crossgradient background well (Well 650) contained concentrations of the contaminants of concern, including total and dissolved radium-226 (Ra-226) (3.2/2.7 picocuries per liter [pCi/L]), total and dissolved uranium (0.4/1.9 micrograms per liter [µg/L]), and dissolved gross alpha (13.1 pCi/L). None of these background concentrations exceeded its MCL.

Samples collected from Wells 615, 684, and 3026, which were screened within the Chilson aquifer, exceeded the MCL for arsenic (0.01 milligram per liter [mg/L]); Wells 650 and 689, also within the Chilson aquifer, exceeded the EPA action level for lead (0.015 mg/L). Samples from Well 622 in the Fall River aquifer and from Wells 676 and 679 in alluvial aquifers along Pass Creek exceeded the MCL for arsenic and EPA action level for lead. Samples from Wells 681 and 688 in the Fall River aquifer exceeded the MCL for arsenic. The MCL for uranium (30 µg/L) was exceeded in samples collected from four of five wells sampled in the alluvial aquifers. Samples from Wells 42, 680, 684, and 3026 in the Chilson aquifer and Well 698 in the Fall River aquifer also exceeded the MCL for uranium. No MCLs for other metals were exceeded in any of the groundwater samples (NRC 2012).

Approximately 50 percent of the samples collected from the Fall River and Chilson aquifers for analysis for dissolved Ra-226 exceeded the MCL of 5 pCi/L. Dissolved Ra-226 levels exceeding the MCL ranged between 5.2 and 1,440 pCi/L. Approximately 75 percent of the samples collected from wells in the Fall River, Chilson, and alluvial aquifers for analysis for dissolved gross alpha exceeded the MCL of 15 pCi/L. Gross alpha levels exceeding the MCL in alluvial wells ranged between 18.3 and 129 pCi/L; however, gross alpha levels exceeding the MCL in the Fall River and Chilson aquifers were higher, ranging from 15.1 to 6,730 pCi/L. Samples from wells 16, 619, 680, 688, and 692 contained dissolved Ra-226 ranging from 6.4 to 1,440 pCi/L, and dissolved gross alpha concentrations ranging from 17.3 to 6,730 pCi/L exceeding their respective MCLs; these wells are within a 1-mile radius of the Site boundary, and are crossgradient or downgradient of the Site.

A primary drinking water standard for radon-222 (Rn-222) has not been established; however, EPA has proposed a limit of 300 pCi/L (EPA 2000). Of samples from all the wells tested during baseline groundwater sampling, only the sample from Well 650 (background) did not exceed the proposed EPA limit; Well 650 is screened in the Chilson aquifer, and is crossgradient of the Site (NRC 2012). Concentrations of Rn-222 found to exceed the EPA's proposed limit for Rn-222 ranged from 11,247 to 17,092,120 Becquerels per cubic meter (Bq/m^3) (304 to 462,000 pCi/L). Wells 680 and 42 in the mapped ore bodies in the Chilson aquifer, and Well 681 in the Fall River aquifer, contained the highest concentrations of Rn-222. Well 42 provides water for domestic use and stock water (NRC 2012).

Groundwater samples collected from all domestic wells except Well 8 contained concentrations of at least one analyte that exceeded its MCL. Groundwater samples exceeding MCLs for uranium (total and dissolved), Ra-226 (total and dissolved), dissolved gross alpha, and arsenic, and the EPA action level for lead, are listed in Table 1.

TABLE 1

GROUNDWATER DATA SUMMARY
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE
JULY 2007 THROUGH FEBRUARY 2009

Well ID	Aquifer	Well Description	Ra-226 (Total) (pCi/L)	Ra-226 (Dissolved) (pCi/L)	Uranium (Total) (µg/L)	Uranium (Dissolved) (µg/L)	Gross Alpha (Dissolved) (pCi/L)	Arsenic (mg/L)	Lead (mg/L)
2	Chilson	Domestic/Stock	--	--	--	--	--	--	--
4	Unknown	Stock	--	--	--	--	--	--	--
5	Fall River	Stock	--	--	--	--	--	--	--
7	Fall River	Domestic	--	--	--	--	15.5 – 17.0	--	--
8	Fall River	Domestic	--	--	--	--	--	--	--
13	Chilson	Domestic	--	--	--	--	19.5	--	--
16	Chilson	Domestic	17.4	6.4 – 33.6	--	--	28.3 – 110	--	--
18	Fall River	Domestic	--	5.8	--	--	15.7 – 37.0	--	--
41	Unknown	Stock	--	16.5	--	--	88	--	
42	Chilson	Domestic	79.7	87.6 – 102	--	32.4 – 40	371 – 560	--	--
49	Fall River	Stock	--	--	--	--	--	--	--
615	Chilson	Monitoring	--	7.2	--	--	15.1 – 38.3	0.021 – 0.024	--
619	Chilson	Stock	120	99.7 – 120	--	--	341 – 438	--	--
622	Fall River	Monitoring	--	7.9	--	--	22.6 – 1,470	0.027	0.023 – 0.03
628	Inyan Kara	Stock	6.8	6.1 – 20.7	--	--	29.9 – 83.9	--	--
631	Fall River	Stock	15.2	9.5 – 22.1	--	--	46.5 – 162	--	--
635	Sundance	Stock	--	--	--	--	--	--	--
650	Chilson	Stock (background)	--	--	--	--	--	--	0.05
675	Alluvial	Alluvial	--	--	38.7 – 50.2	30.7 – 49.3	18.3 – 55.2	--	--
676	Alluvial	Alluvial	--	--	59.1 – 68.7	49.4 – 58.6	31.9 – 95.5	0.021	0.06
677	Alluvial	Alluvial	--	--	41.4 – 47.1	40.2 – 45.0	38.7 – 129	--	--
678	Alluvial	Alluvial	--	--	37.9 – 38.7	34.9 – 36.8	18.9 – 54.7	--	--
679	Alluvial	Alluvial (background)	--	--	--	--	18.4 – 22.4	0.011	0.015 – 0.022

TABLE 1 (Continued)

GROUNDWATER DATA SUMMARY
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE
JULY 2007 THROUGH FEBRUARY 2009

Well ID	Aquifer	Well Description	Ra-226 (Total) (pCi/L)	Ra-226 (Dissolved) (pCi/L)	Uranium (Total) (µg/L)	Uranium (Dissolved) (µg/L)	Gross Alpha (Dissolved) (pCi/L)	Arsenic (mg/L)	Lead (mg/L)
680	Chilson	Test Well	--	1,110 – 1,440	54.1	30.3 – 172	4,090 – 6,730	--	--
681	Fall River	Test Well	--	258 – 445	--	--	656 – 2,220	0.024	--
682	Chilson	Monitoring	--	--	--	--	50.3	--	--
683	Fall River	Monitoring	--	--	--	--	--	--	--
684	Chilson	Monitoring	--	543	336	66.7	1890	0.04	--
685	Fall River	Monitoring	--	--	--	--	23.8	--	--
686	Chilson	Monitoring	--	--	--	--	--	--	--
687	Fall River	Monitoring	--	25.7	--	--	114	--	--
688	Fall River	Test Well		6.7 – 7.9	--	--	17.3 – 29.8	0.015	--
689	Chilson	Test Well	--	5.4 – 7.9	--	--	23.9 – 64.3	--	0.017
690	Unkpapa	Monitoring	--	--	--	--	--	--	--
691	Fall River	Monitoring	--	--	--	--	--	--	--
692	Chilson	Monitoring	--	484	--	--	1450	--	--
693	Unkpapa	Monitoring	--	--	--	--	--	--	--
694	Fall River	Domestic	--	--	--	--	20.2 – 23.9	--	--
695	Fall River	Stock	--	5.2–6.3	--	--	15.9 – 52.2	--	--
696	Chilson	Domestic	--	--	--	--	15.1 – 25.9	--	--
697	Chilson	Stock	--	5.6	--	--	18.2 – 21.7	--	--
698	Fall River	Weather Station	--	347 – 429	101 – 132	99.8 – 119	36.3 – 2,110	--	--
703	Unkpapa	Domestic	--	--	--	--	42.6	--	--
704	Chilson	Monitoring	--	--	--	--	--	--	--
705	Chilson	Monitoring	--	--	--	--	--	--	--

TABLE 1 (Continued)

**GROUNDWATER DATA SUMMARY
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE
JULY 2007 THROUGH FEBRUARY 2009**

Well ID	Aquifer	Well Description	Ra-226 (Total) (pCi/L)	Ra-226 (Dissolved) (pCi/L)	Uranium (Total) (µg/L)	Uranium (Dissolved) (µg/L)	Gross Alpha (Dissolved) (pCi/L)	Arsenic (mg/L)	Lead (mg/L)
706	Fall River	Monitoring	--	--	--	--	20.5 – 56.3	--	--
3026	Chilson	Stock	--	9.5 – 10.4	32.2	--	15.4 – 116	0.022–0.044	--
4002	Inyan Kara	Stock	62.7	52.3 – 63.6	--	--	120 – 314	--	--
7002	Chilson	Stock	6.3	8.0 – 8.8	--	--	29.5 – 91.4	--	--
MCL			**5**	**5**	**30**	**30**	**15**	**0.01**	**0.015[a]**

Source: Powertech 2012c

Notes:

[a] EPA action level
-- Below the MCL or not analyzed
ID Identification
MCL Maximum Contaminant Level
mg/L Milligrams per liter
pCi/L Picocuries per liter
Ra-226 Radium-226
µg/L Micrograms per liter

Samples collected by USGS from Wells 676 and 678 (also sampled by Powertech), which were screened in the alluvial aquifer along Pass Creek, exceeded the MCL for uranium. Additionally, a sample collected from Well 698 (also sampled by Powertech), screened in the Fall River aquifer and immediately downstream of runoff from the Site, also exceeded the MCL for uranium (Johnson 2012).

Samples collected by Powertech from monitoring wells in 2012 and 2013 contained concentrations of gross alpha that exceeded its MCL (15 pCi/L). Well BC1, downgradient of the Site, was the only well that contained a concentration of uranium above its MCL. As previously mentioned, a primary drinking water standard for Rn-222 has not been established; however, EPA has proposed a limit of 300 pCi/L (EPA 2000). All groundwater samples collected from the alluvial monitoring wells contained concentrations of Rn-222 that exceeded 300 pCi/L. A summary of groundwater results from the alluvial monitoring wells in the area of the Site is in Table 2 below.

TABLE 2

MONITORING WELL SUMMARY DATA
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE
2012-2013

Well ID	Sample Location	Ra-226 (pCi/L)	Uranium (pCi/L)	Gross Alpha (pCi/L)
BC1	Pass Creek watershed	--	75.7 – 111	50.1 – 108
BC2	Pass Creek watershed	--	--	20.0 – 38.9
BC3	Pass Creek watershed	--	--	19.3 – 43.5
DC1	Beaver Creek watershed	--	--	15.9 – 88.7
DC2	Beaver Creek watershed	--	--	20.7 – 41.7
DC3	Beaver Creek watershed	--	--	--
DC4	Beaver Creek watershed	--	--	16.5 – 29.6
MCL		**5**	**30**	**15**

Source: Powertech 2013

Notes:
-- Below the MCL or not analyzed
ID Identification
MCL Maximum Contaminant Level
pCi/L Picocuries per liter
Ra-226 Radium-226

5.2 SURFACE WATER AND SEDIMENT

The following sections address analytical data from surface water and sediment samples collected at the study area. Sample locations are shown on Figure 6.

5.2.1 Surface Water Sampling

Surface water samples were collected monthly between July 2007 and June 2008 from perennial and ephemeral streams near the area of the Site. The perennial streams, Beaver Creek and the Cheyenne River, were each sampled at two locations. The ephemeral streams included Pass Creek, Bennett Canyon, and an unnamed tributary (see Figure 6). Passive samplers were installed at the ephemeral stream locations to collect samples during flow events. Two sample locations were on Pass Creek, while samples were to be collected at one location each at Bennet Canyon and the unnamed tributary (Powertech 2009). The Bennet Canyon sample location was absent of water during both sampling periods.

Surface water samples were also collected at impoundment locations in the area of the Site during 2007-2008. In all, 48 impoundments had been identified on aerial photographs and topographic maps prior to field activities and were subsequently field-verified. A subset of 11 impoundments were chosen from the total of 48, based on presence of water during sampling activities and spatial distribution of the impoundments. The locations included the Darrow Pit, Triangle Pit, and nine other impoundments (see Figure 6). Some of the impoundments on the site meet the definition of "surface impoundment" described in Hazard Ranking System (HRS) Table 2-5, indicating they could also be evaluated as potential sources of contamination for HRS scoring purposes (EPA 2011).

5.2.2 Surface Water Analytical Results Summary

Total gross alpha concentrations were detected at all seven sample locations and ranged from 1.9 to 65.8 pCi/L. The highest concentration was detected in a sample collected at the downstream Beaver Creek location. Total and dissolved uranium were detected in every sample except the one collected from the unnamed tributary. The highest concentrations of total uranium (37.8 µg/L) and dissolved uranium (36.8 µg/L) were in a sample collected at the downstream Cheyenne River location. Total and dissolved Ra-226 were detected at concentrations ranging from 0.2 to 5.1 pCi/L. The highest detections occurred in samples collected at the downstream sample locations on Beaver Creek and the Cheyenne River. Total and dissolved Pb-210 were detected at concentrations up to 35 pCi/L. The highest concentration was detected at the upstream sample location on Beaver Creek.

Samples collected at downstream locations on Beaver Creek and Pass Creek met observed release criteria by containing analytes that exceeded three times background concentrations. The sample collected downstream on Pass Creek contained elevated concentrations of gross alpha (8.8 pCi/L), and total and dissolved uranium (25.2/5.0 µg/L), meeting observed release criteria. The sample collected downstream on Beaver Creek contained elevated concentrations of gross alpha (65.8 pCi/L); however, the concentration did not meet observed release criteria. Additionally, a sample collected at the downstream location on the Cheyenne River contained an elevated concentration of Pb-210 (22.0 pCi/L) that met observed release criteria. However, that downstream sampling location on the Cheyenne River was beyond the 15-mile Target Distance Limit (TDL).

Analytical results from surface water samples are listed in Table 3 (Powertech 2012). To summarize the surface water data, the highest downstream detections of each analyte are listed with the corresponding upstream sample results from the same sampling event. For example, the highest concentration of total gross alpha at the downstream Beaver Creek location was detected in a sample collected on November 19, 2007 (65.8 pCi/L at BVC01). Therefore, the total gross alpha concentration detected in the upstream Beaver Creek sample collected on November 19, 2007 (34.7 pCi/L at BVC04), is also listed in the table. The date on which concentrations of Pb-210 were detected at the Cheyenne River downstream location had no counterpart date of Pb-210 data acquisition at the upstream location; thus data obtained on the date of upstream data acquisition closest to the date of data acquisition at the downstream location were used for the comparison. No Superfund Chemical Data Matrix (SCDM) benchmarks have been established for radionuclides in surface water.

TABLE 3

RADIOLOGICAL DATA FOR SURFACE WATER SAMPLES DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE 2007-2008

Sample Location	Sample Description	Gross Alpha Total (pCi/L)	Uranium (µg/L)		Ra-226 (pCi/L)		Pb-210 (pCi/L)	
			Total	Dissolved	Total	Dissolved	Total	Dissolved
BVC04	Beaver Creek–upstream	34.7	6.1	5.6	2.2j	-0.06j	35	26
BVC01	Beaver Creek–downstream	65.8	26.2	26.9	5.1	2.0	14.0	11.0
CHR01	Cheyenne River–upstream	35.3	32.0	30.8	4.1	0.06j	<1	<1
CHR05	Cheyenne River–downstream	29.9	37.8	36.8	5.1	1.4	22.0	<1
PSC02	Pass Creek–upstream	1.9	5.7	0.7	<0.2	NM	0.0j	1.7j
PSC01	Pass Creek–downstream	8.8	25.2	5.0	0.7	NM	3.0j	2.2j
UNT01	Unnamed Tributary	6.1	0.9	ND	0.3	0.2	NA	NA

Source: Powertech 2012d

Notes:

Shaded result indicates the value exceeds three times the background (upstream) level (or above the detection limit if non-detect in the background sample).

<	Less than
ID	Identification
j	Not detected above minimum detectable concentration
NA	Not analyzed
ND	Non detect
NM	Not measured in field/not requested for analysis from laboratory
Pb-210	Lead-210
pCi/L	Picocuries per liter
Ra-226	Radium-226
µg/L	Micrograms per liter

Samples collected from the Darrow Pit (Sub06) and the Triangle Mine Pit (Sub02) contained the highest radionuclide concentrations of the 11 impoundment samples. Total gross alpha was detected at 8,750 pCi/L at location Sub06 and 199 pCi/L at location Sub02. Total and dissolved uranium were detected at 7,380 and 7,840 pCi/L, respectively, at location Sub06, and at 190 and 177 pCi/L, respectively, at location Sub02. In addition, samples collected at Sub01, Sub03, Sub04, Sub09, and Sub10 contained concentrations of total gross alpha ranging from 15.9 to 19.9 pCi/L. Samples collected from Sub01, Sub06, and Sub08 through Sub11 contained concentrations of total Pb-210 ranging from 1.1 to 8.2 pCi/L. Samples collected from Sub02, Sub08, and Sub11 contained concentrations of dissolved

Pb-210 ranging from 1.5 to 4.6 pCi/L. Maximum results for each surface water impoundment in the area of the Site are listed in Table 4.

TABLE 4

**RADIOLOGICAL DATA FOR SURFACE WATER IMPOUNDMENT SAMPLES
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE
2007-2008**

Sample Location	Sample Description	Gross Alpha Total (pCi/L)	Uranium (µg/L)		Ra-226 (pCi/L)		Pb-210 (pCi/L)	
			Total	Dissolved	Total	Dissolved	Total	Dissolved
Sub01	Stock pond	16.2	2.0	0.3	1.2	0.5	-1.4 j	0.7
Sub02	Triangle Mine Pit	199	190	177	0.6	0.7	0.5	0j
Sub03	Mine dam	19.9	3.1	2.3	4.0	4.5	-3.8j	-3.0j
Sub04	Stock pond	13.6	2.4	2.1	3.5	3.4	-3.0j	-2.1j
Sub05	Mine dam	NS	NS	NS	NS	NS	NS	NS
Sub06	Darrow Mine Pit - Northwest	8,750	7,380d	7,840	2.0	4.3	3.1	-0.6j
Sub07	Stock dam	5.8	1.3	2.4	0.8	0.8	-0.8j	-1.4j
Sub08	Stock pond	14.1	2.3	2.8	0.5	0.5	5.3	4.6
Sub09	Stock pond	15.9	2.3	5.6	0.5	0.1	3.6	-0.9j
Sub10	Stock pond	16.3	3.3	2.7	1.2	0.2	5.3j	0.1
Sub11	Stock pond	9.4	1.6	33.6d	0.9	0.7	8.2	3.2

Source: Powertech 2012d

Notes:

<	Less than
d	Reporting limit increased due to sample matrix interference
ID	Identification
j	Not detected above minimum detectable concentration
NS	Not sampled because no water present
Pb-210	Lead-210
pCi/L	Picocuries per liter
Ra-226	Radium-226

5.2.3 Sediment Sampling

Sediment samples were collected by Powertech at collocated surface water sample locations previously cited in Section 5.2.1 (see Figure 6). At each location, four sample aliquots were collected by use of a plastic hand trowel to a depth of 5 centimeters (cm), along a transect spanning the width of the channel in areas where sediment had been deposited. The aliquots were then composited into a single sample to represent the average radionuclide concentration across the channel (Powertech 2009).

Additional sediment samples were collected in the area of the Site from on-site impoundments described in Section 5.2.1. At each location, a single sample was collected by use of a trowel to a depth of 5 cm. Samples were collected near the edge of the water at locations appearing relatively undisturbed. At dry impoundments, sediment samples were collected within areas determined likely to be submerged if water would be present (Powertech 2009). The sediment samples were analyzed for natural uranium, Ra-226, thorium-230 (Th-230), and Pb-210 (Powertech 2009).

5.2.4 Sediment Analytical Results Summary

Samples collected at the downstream Pass Creek location (PSC01) exceeded three times background concentrations for all analytes, thereby meeting observed release criteria. Additionally, a sample collected at the downstream Cheyenne River location (CHR05) exceeded three times the background level for uranium, thereby meeting observed release criteria. Table 5 summarizes analytical results from sediment samples collected at locations on Pass Creek, Beaver Creek, the Cheyenne River, Bennet Canyon, and an unnamed tributary.

TABLE 5
RADIOLOGICAL DATA FROM STREAM SEDIMENT SAMPLES
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE
2008

Sample Location	Sample Description	Sample Date	U-nat Total (mg/kg-dry)	Ra-226 Total (pCi/g-dry)	Pb-210 Total (pCi/g-dry)	Th-230 Total (pCi/g-dry)
BEN01	Bennet Canyon	6/23/2008	1.8	0.6	2.3U	0.6
		8/21/2008	2.4	0.6	2.0	0.5
BVC04	Beaver Creek-upstream	6/17/2008	2.0	1.5	1.9U	0.7
		8/21/2008	2.0	1.0	1.8	1.0
BVC01	Beaver Creek-downstream	6/17/2008	2.0	1.3	0.5U	0.8
		8/21/2008	2.0	0.6	2.6	1.2
CHR01	Cheyenne River-upstream	6/17/2008	1.7	1.0	0.2U	0.6
		8/21/2008	2.7	0.9	1.7	1.4
CHR05	Cheyenne River-downstream	6/17/2008	6.2	2.1	1.7U	1.9
		8/21/2008	1.2	0.6	1.3	0.5
PSC02	Pass Creek-upstream	6/17/2008	1.1	0.6	1.2U	0.4
		8/21/2008	1.0	0.4	0.4U	0.4
PSC01	Pass Creek-downstream	6/17/2008	3.9	2.9	4.7	2.0
		8/21/2008	6.5	1.8	4.0	4.1
UNT01	Unnamed Tributary	6/23/2008	2.0	0.8	2.2U	0.5
		8/21/2008	2.5	0.7	1.7	1.0

Source: Powertech 2009

Notes:

Shaded result indicates the value exceeds three times the background (upstream) level (or above the detection limit if non-detect in the background sample).

ID	Identification
mg/kg	Milligrams per kilogram
NE	Not established
Pb-210	Lead-210
pCi/g	Picocuries per gram
Ra-226	Radium-226
Th-230	Throium-230
U	Analyte not detected at or above the reporting limit
U-nat	Natural uranium

Uranium concentrations in samples from the Darrow Mine Pit – Northwest (Sub06) and Triangle Mine Pit (Sub02) ranged from 18 to 37 mg/kg. Samples from two mine dams (Sub03 and Sub05) and one stock pond (Sub04) contained concentrations of uranium ranging from 4.2 to 8.5 mg/kg. Samples collected from Sub02, Sub05, and Sub06 contained concentrations that exceeded three times background concentrations of uranium, Ra-226 and Th-230, meeting observed release criteria. The sample collected at location Sub03 also contained a concentration of Ra-226 that exceeded three times background, meeting observed release criteria. The sample quantitation limit (SQL) for Pb-210 could not be confirmed through laboratory data information, and therefore the data could not be used to establish an observed release. Table 6 summarizes analytical results from sediment samples collected at impoundment locations throughout the area of the Site.

TABLE 6

**RADIOLOGICAL DATA FOR IMPOUNDMENT SEDIMENT SAMPLES
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE
2008**

Sample Location	Location Description	Sample Date	U-nat Total (mg/kg-dry)	Ra-226 Total (pCi/g-dry)	Pb-210 Total (pCi/g-dry)	Th-230 Total (pCi/g-dry)
Sub01 (background)	Stock pond	6/18/2008	2.2	1.2	0.5U	0.7
		8/21/2008	3.3	1.1	1.0U	1.0
Sub02	Triangle Mine Pit	6/18/2008	18	3.9	2.8U	2.9
		8/21/2008	19	1.3	3.1	6.8
Sub03	Mine dam	6/18/2008	7.2	4.1	3.9	2.1
		8/21/2008	4.2	1.1	3.2	1.9
Sub04	Stock pond	6/17/2008	6.5	2.5	1.2U	0.9
		8/21/2008	5.1	0.7	2.1	1.8
Sub05	Mine dam	6/18/2008	8.5	4.2	4.2	2.4
		8/21/2008	6.0	3.0	2.8	2.3
Sub06	Darrow Mine Pit – Northwest	6/23/2008	37	8.6	9.6	7.8
		8/21/2008	32	5.2	4.0	5.9
Sub07	Stock dam	6/23/2008	1.7	0.7	0.6U	0.5
		8/21/2008	2.2	0.4	1.9	0.9
Sub08	Stock pond	6/23/2008	1.2	0.6	0.6U	0.4
		8/21/2008	1.9	0.4	1.7	0.8
Sub09	Stock pond	6/23/2008	2.4	1.0	1.5U	0.7
		8/21/2008	2.3	0.6	1.7	0.9
Sub10	Stock pond	6/23/2008	1.5	0.8	1.5U	0.7
		8/21/2008	2.1	0.6	0.9U	0.7
Sub11	Stock pond	6/23/2008	2.7	0.8	2.1U	0.5
		8/21/2008	1.8	0.6	1.5	0.8

Source: Powertech 2009
Notes:

Shaded result indicates a concentration that exceeds three times the background level (sample results from June 18, 2008)

ID Identification
mg/kg Milligrams per kilogram
Pb-210 Lead-210
pCi/g Picocuries per gram
Ra-226 Radium-226
Th-230 Thorium-230
U Analyte not detected at or above the reporting limit
U-nat Natural uranium

5.3 SOIL

The following sections address soil sampling and analytical results from soil sampling.

5.3.1 Soil Sampling

Powertech conducted soil sampling within the proposed Dewey-Burdock permit area, which included the area of the Site. Surface soil samples were collected from the top 15 cm by use of a hand shovel. All of the soil samples were analyzed for Ra-226. In all, 25 samples were collected at the area of the Site (Powertech 2009).

5.3.2 Soil Analytical Results Summary

Samples SMA-B01 through SMA-B29 (not consecutive) were collected at the area of the Site (see Figure 7). Sample SMA-B01 was the designated background sample. The sample results were compared to SCDM cancer risk (CR) screening levels for ingestion of soil, and the health-based standard of 5.0 pCi/g for Ra-226 in surface soil (15 pCi/g for subsurface soil) based on the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978. That standard was developed for cleanup of radiation-contaminated soil, specifically uranium mill tailings sites. An EPA memorandum dated February 12, 1998, clarifies use of the UMTRCA soil cleanup standard for CERCLA sites (EPA 1998). The purpose of the standard was to limit risk from inhalation of radon decay products in houses built on mine tailings, and to limit gamma radiation exposure to people using contaminated land. The standard was developed to control the hazard from gamma radiation; therefore, this standard may be appropriate and relevant to CERCLA sites (EPA 1998).

Samples SMA-B03, -B07, -B09, -B10, -B11, -B13, -B14, -B15, -B19, -B21, and -B23 through -B30 contained concentrations of Ra-226 that exceeded the SCDM CR screening level of 1.0 pCi/g. Samples SMA-B26 through -B30, collected near the Triangle Mine Pit area and the Darrow Mine Pit, contained concentrations exceeding both the SCDM CR benchmark for Ra-226 and the UMTRCA standard for surface soil for Ra-226 of 5.0 pCi/g. Samples SMA-B07, -B23, -B26, -B28, and -B30 contained concentrations of Ra-226 at or above three times background (0.9 pCi/g), meeting observed release criteria. The exact location of sample SMA-B28 could not be confirmed from the source map produced by Powertech. In addition, samples SMA-B27 and -B29 contained concentrations of natural uranium (U-nat), Pb-210, and Th-230 at concentrations exceeding three times background, also meeting observed release criteria. Table 7 summarizes the surface soil sample analytical results.

TABLE 7

RADIOLOGICAL DATA FROM SURFACE SOIL SAMPLES DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE 2012

Sample ID	Sample Date	Ra-226 (pCi/g)	U-nat (pCi/g)	Pb-210 (pCi/g)	Th-230 (pCi/g)
SMA-B01(background)	9/24/2007	0.9	1.2	0.6	0.5
SMA-B03	9/24/2007	**1.5**	-	-	-
SMA-B04	9/24/2007	1.0	-	-	-
SMA-B07	9/24/2007	**3.2**	-	-	-
SMA-B09	9/24/2007	**1.2**	-	-	-
SMA-B10	9/25/2007	**1.4**	-	-	-
SMA-B11	9/24/2007	**2.3**	-	-	-
SMA-B13	9/25/2007	**1.7**	-	-	-
SMA-B14	9/24/2007	**1.4**	-	-	-
SMA-B15	9/24/2007	**1.6**	-	-	-
SMA-B16	9/24/2007	0.8	-	-	-
SMA-B17	9/24/2007	0.9	-	-	-
SMA-B18	9/25/2007	0.5	-	-	-
SMA-B19	9/24/2007	**1.2**	-	-	-
SMA-B20	9/27/2007	0.9	-	-	-
SMA-B21	9/24/2007	**1.4**	-	-	-
SMA-B22	9/24/2007	0.8	-	-	-
SMA-B23	9/24/2007	**2.7**	-	-	-
SMA-B24	9/24/2007	**1.3**	-	-	-
SMA-B25	9/24/2007	**1.1**	-	-	-
SMA-B26	9/28/2007	**11**	-	-	-
SMA-B27	9/28/2007	**40**	**67**	30	**30**
SMA-B28	9/29/2007	**6.4**	-	-	-
SMA-B29	9/28/2007	**29**	**16**	20	**20**
SMA-B30	9/28/2007	**34**	-	-	-
SCDM Cancer Risk (ingestion)		**1.0**	**3.7***	**NE**	**3.0**
UMTRCA Standard for Surface Soil		**5.0**	**30***	**NE**	**NE**

Source: Powertech 2009

Notes:

Bold result indicates a concentration that exceeds the SCDM or UMTRCA benchmark.
Shaded result indicates a concentration that exceeds three times the background level.

*	Uranium-238 concentration	pCi/g	Picocuries per gram
-	Not analyzed	Ra-226	Radium-226
ID	Identification	SCDM	Superfund Chemical Data Matrix
NA	Not applicable	Th-230	Thorium-230
NE	Not established	UMTRCA	Uranium Mill Tailings Radiation Control Act
Pb-210	Lead-210	U-nat	Natural uranium

Powertech conducted baseline radiological surveys and sampling in the area of the Site between August 2007 and July 2008 to characterize and quantify radiation levels and radionuclide concentrations in soils. Within the surface mine area, external gamma exposure rates ranged from 5.9 to 324 microroentgens per hour (µR/hr). Elevated readings were associated with the abandoned open pit mines, waste rock, and drainages in the surface mine area (Powertech 2009). Background external gamma exposure rates near the Site were approximately 5.0 µR/hr (USGS 1993). Gamma exposure rates within the area of the Site exceeded three times the background, meeting observed release criteria. Table 8 summarizes gamma exposure rates in surface soil in the mine area.

TABLE 8

EXTERNAL GAMMA EXPOSURE RATES IN SURFACE SOIL IN MINE AREA DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE

2007-2008

Parameter	Gamma-Ray Count Rate (µR/hr)
Mean	13.8
Standard Deviation	18.4
Median	10.9
Minimum	5.9
Maximum	324.1
Background	**5.0***

Sources: Powertech 2009, USGS 1993

Notes:

* Approximate
µR/hr Microroentgens per hour

5.4 AIR

The following sections address air sampling and analytical results from air sampling.

5.4.1 Air Sampling

Powertech conducted air monitoring and sampling within the area of the Site during three monitoring periods: August 18, 2007 to February 4, 2008; February 4 to May 17, 2008; and May 17 to July 17, 2008. Ambient exposure rates were measured by use of thermo luminescent dosimeters (TLD) placed at eight locations throughout the Dewey-Burdock site; however, five of the TLDs deployed were lost due to suspected disturbance by livestock in the area.

In addition, Radtrak passive track etch detectors were placed at each of those air monitoring locations, and at an additional eight biased locations to measure radon-222 (Rn-222) concentrations in air. The measurement events were separated into four quarterly periods as follows: August 14 to September 27, 2007; September 27, 2007, to February 1 through 12, 2008; February 1 through 12, 2008, to May 17, 2008; and May 17 to July 17, 2008 (Powertech 2009).

5.4.2 Air Sampling Results Summary

The associated annualized dose rates ranged from 114 to 323 mrem/yr. Typical ranges of average worldwide exposures are 60 to 160 mrem/yr (Powertech 2009).

Ambient radon monitoring results were as follows: Period 1 concentrations ranged from 1.0 to 9.8 pCi/L, with an average of 2.4 pCi/L; Period 2 concentrations ranged from 0.4 to 1.8 pCi/L, with an average of 1.2 pCi/L; Period 3 concentrations ranged from 0.4 to 3.3 pCi/L, with an average of 1.8 pCi/L; Period 4 concentrations ranged from 0.5 to 0.8 pCi/L, with an average of 0.5 pCi/L. In terms of effluent limits, the measured values exceeded the 10 *Code of Federal Regulations* (CFR) Part 20 limit of 0.1 pCi/L for Rn-222 with daughters present (Powertech 2009).

6.0 SOURCES OF CONTAMINATION AND WASTE CHARACTERISTICS

The source areas at the Site were geo-referenced to establish an approximate boundary and area of the four mine waste piles within the site boundary (see Figure 8). Waste Pile #1 (approximately 941,651.45 ft^2) is near the Triangle Mine Pit in the northwest portion of the site. Waste Pile #2 (approximately 11,037.49 ft^2) is 0.25 mile east of Pile #1. Waste Pile #3 (approximately 1,372,012.21 ft^2) is in the north central portion of the site. Waste Pile #4 (approximately 8,552,514.66 ft^2) is near the Darrow Mine Pit in the southeast portion of the site. The combined area of the waste piles is approximately10,877,215 ft^2 (see Figure 8). Radionuclides are the contaminants of concern, including natural uranium, Ra-226, Th-230, and Pb-210. Natural uranium is uranium containing the following relative concentrations of isotopes found in nature: uranium-235 (0.7 %), uranium-238 (99.3 %), and uranium-234 (trace amounts) (NRC 2014b). These radionuclides are present across the area of the Site, and migration of these off site into nearby surface water bodies has been documented. Surface soil samples near the open pits and mine waste piles have contained significantly elevated concentrations of radionuclides, exceeding UMTRCA standards and three times background concentrations.

Uranium, radium, and radon are naturally occurring. Chronic (long-term) inhalation exposure to uranium and radon in humans has been linked to respiratory effects such as chronic lung disease, while radium exposure has resulted in acute leukopenia, anemia, necrosis of the jaw, and other effects. Cancer is the major effect of concern from exposure to radium via oral exposure, which is known to cause bone, head, and nasal passage tumors in humans. Uranium may cause lung cancer and tumors in lymphatic and hematopoietic tissues (EPA 2000).

7.0 PATHWAY ANALYSIS

This section discusses contaminant migration pathways evaluated under the HRS. A CERCLA Eligibility Checklist (Appendix B) and a Potential Hazardous Waste Preliminary Assessment Form (Appendix C) have been completed for the PA. Additionally, site risks and pathways of concern have been presented in a Conceptual Site Model (Appendix D).

7.1 GROUNDWATER PATHWAY AND TARGETS

Radiological results from samples indicate that groundwater in the area of the Site contains concentrations of radionuclides that exceed MCLs for uranium, Ra-226, and gross alpha. In addition, some wells contain concentrations of lead and arsenic that exceed the EPA action level for lead and MCL for arsenic. The majority of the samples exceeding these standards were collected from the Inyan Kara Group aquifer. This aquifer ranges from 250 to 500 feet thick and contains two subaquifers—the Fall River aquifer and Chilson aquifer—which are separated by the Fuson Shale. Data from aquifer pumping tests indicate a hydraulic connection between the Lakota and Fall River Formations through the intervening Fuson Shale in the Burdock area (NRC 2012). Samples collected from the alluvial aquifer in the area of the Site have also contained elevated concentrations of radionuclides. Minor aquifers also occur within the Black Hills, including the Sundance/Unkpapa, Newcastle, and alluvial aquifers. These minor aquifers yield small volumes of water locally for domestic and stock uses. Alluvial aquifers with thicknesses of 0 to 50 feet are along Beaver Creek, Pass Creek, and the Cheyenne River. They are typically unconfined, but may be confined locally. Alluvial aquifers are separated from the underlying Fall River Formation by the low-permeability Graneros Group confining unit. An alluvial drilling program completed in 2012 did not indicate any areas of discharge to the alluvium along Beaver Creek and Pass Creek from the underlying Fall River aquifer (NRC 2012).

Groundwater in the Fall River and Chilson aquifers flows from northeast to southwest. Regionally, groundwater flows radially outward from the Black Hills toward the surrounding plains (NRC 2012). The Site is not within a wellhead protection area (South Dakota Department of Environment and Natural Resources [SDDENR] 2013).

According to a well inventory of the area of the Site conducted by Powertech, the following water wells are within a 4-mile TDL of the Site boundary (see Figure 9): one domestic well and five stock wells are within the Site boundary; one domestic well is within 0.25 mile of the Site; one domestic well and four stock wells are within 0.25 and 0.50 mile of the Site; one domestic well and six stock wells are within 0.50 and 1 mile of the Site; 12 Stock wells are within 1 to 2 miles of the Site; eight domestic wells, 10 Stock wells, and one irrigation well are within 2 to 3 miles of the Site; and six domestic and 10 stock wells are within 3 to 4 miles of the Site. The Site is on the border of Custer and Fall River Counties; the average persons per household in Custer County is 2.17, and the average persons per household in Fall River County is 2.12. Based on the number of domestic wells and the average number of persons per household, approximately 15 people could obtain their water from private wells in Custer County within the 4-mile TDL. Approximately 23 people could obtain their water from private wells in Fall River County within the 4-mile TDL. Table 9 summarizes the drinking water target population in the area of the Site. This estimated population differs slightly from the data obtained for the 2010 census, which indicated fewer (approximately 29) people live within 4 miles of the approximate center of the Site (Mable/Geocorr12: Geographic Correspondence Engine with Census 2010 Geography [Mable/Geocorr] 2014).

TABLE 9

**DRINKING WATER TARGET POPULATION
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE**

Distance From Site	Number of Wells Within TDL	Population Served
On Site	1	2.12
0 to .25 mile	1	2.12
0.25 to 0.5 mile	1	2.17
0.5 to 1 mile	1	2.12
1 mile to 2 miles	0	0
2 miles to 3 miles	8	16.96
3 miles to 4 miles	6	13.02
Total	18	38.51

Source: Mable/Geocorr 2014

Notes:

TDL Target distance limit

7.2 SURFACE WATER PATHWAY AND TARGETS

Hydrology associated with the Site is discussed in Section 4.2. The primary surface water bodies associated with the 15-mile TDL are Pass Creek, Beaver Creek, and the Cheyenne River (see Figure 8).

According to SDDENR, no potable water intakes are on Pass Creek, Beaver Creek, or the Cheyenne River within the 15-mile TDL. Beaver Creek and the Cheyenne River are used by recreational anglers;

however, documentation of the extent of use of the water bodies as fisheries is not available. All surface water bodies within the 15-mile TDL are used for fish and wildlife propagation, recreation, and stock watering. Pass Creek has been designated for irrigation use; however, because the stream is intermittent, insufficient data are available to determine whether Pass Creek actually has been used for irrigation. Beaver Creek, from its headwaters to the Cheyenne River, has been determined to be impaired or threatened due to potential impacts of detrimental specific conductance, total dissolved solids, and salinity in these waters on warm water semi-permanent fish life, fish and wildlife propagation, recreation, stock watering, and irrigation. In addition, the Cheyenne River, between its confluence with Beaver Creek and Cascade Creek, has also been found to present threats to fish and wildlife propagation, recreation, stock watering, irrigation, and warm water semi-permanent fish life because of detrimental specific conductance, total dissolved solids, total suspended solids, and salinity in those waters stemming from runoff from nearby livestock grazing areas, feeding operations, and/or crop production (SDDENR 2012b).

Wetlands have been identified within the area of the Site and downstream of the Site along Pass Creek within the 15-mile TDL. The wetlands within the area of the Site are primarily designated as Palustrine Emergent (PEM) or Palustrine Unconsolidated Shore (PUS), with modifiers identifying the wetlands as seasonally or temporarily flooded and excavated or diked/impounded features. In addition, the Triangle Mine Pit area includes a Palustrine Unconsolidated Bottom (PUB) intermittently exposed excavated feature. Downstream from the Site along Pass Creek are Palustrine Aquatic Bed (PAB) and PEM wetlands that are semi-permanently flooded (U.S. Fish and Wildlife Service [USFWS] 2014). The wetlands within the area of the Site do not meet actual shoreline (frontage) qualifications to be evaluated for HRS scoring (EPA 2013).

The segment of Beaver Creek downstream of its confluence with Pass Creek does not contain identified wetlands until its confluence with the Cheyenne River, where Riverine Lower Perennial Unconsolidated Bottom semi-permanently flooded (R2UBF) and Palustrine Emergent temporarily flooded (PEMA) wetlands exist. Along the Cheyenne River, classified wetlands include Riverine Lower Perennial Unconsolidated Shore temporarily flooded (R2USA), seasonally flooded (R2USC), R2UBF, and PEMA (USFWS 2014). PEMA wetlands on the Cheyenne River approximately 1.7 miles downstream of its confluence with Beaver Creek include approximately 0.23 mile of contiguous frontage, meeting eligibility requirements and size criteria to be evaluated for HRS scoring. Additional PEMA wetlands on the Cheyenne River occur approximately 2.9 miles downstream of its confluence with Beaver Creek, where approximately 0.14 mile of contiguous frontage exists, also meeting eligibility requirements and size criteria to be evaluated for HRS scoring. Other R2USA and R2USC wetlands are present along the

Cheyenne River; however, additional information is needed to determine whether these wetlands have been impacted by the Site. The previous downstream sample location on the Cheyenne River was outside of the 15-mile TDL; therefore, data from that location cannot be used to evaluate attribution of contamination to the Site for HRS scoring purposes (EPA 2014).

Threatened and endangered species known or likely to occur in Custer and Fall River Counties are listed in Table 10. Powertech conducted surveys of the proposed PAA (including the area of the Site), including a 1-mile perimeter of the area, for threatened and endangered species, bald eagle winter roosts, all nesting raptors, upland game bird leks, and big game. In addition to the surveys, incidental observations of all vertebrate wildlife species within the PAA were recorded during each site visit during the year-long baseline survey period. Surveys were also conducted within the PAA for other vertebrate species of concern tracked by the South Dakota National Heritage Program (SDNHP), as well as bats, small mammals, lagomorphs, prairie dog colonies, breeding birds, predators, and herptiles (reptiles and amphibians). All the surveys were conducted by qualified biologists using standard field equipment and appropriate field guides. The black-footed ferret and the greater sage-grouse are the only federally listed species known to occur in both Custer and Fall River Counties. No federally listed vertebrate species were documented within the project survey area. Surveys for the black-footed ferret were not required for this project due to a block-clearance issued by the USFWS that includes the entire PAA and vicinity. The only exception to that clearance is in Custer State Park in northern Custer County. Surveys were also conducted by TVA in the general vicinity of the PAA during fall 1977. No ferrets or evidence of their presence were observed during those historical surveys (Powertech 2009). The following federally listed threatened and endangered species listed in Table 10 possibly occur in the two counties or possibly migrate through the counties (USFWS 2013).

TABLE 10

FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE

Common Name	Scientific Name	Status
Whooping Crane	Grus americana	Endangered
Red knot	Calidris canutus rufa	Proposed threatened
Sprague's pipit	Anthus spragueii	Candidate
Black-footed ferret	Mustela nigripes	Endangered
Northern Long-Eared Bat	Myotic septentrionalis	Proposed Endangered
Greater sage-grouse	Centrocercus urophasianus	Candidate

Source: U.S. Fish & Wildlife Service 2013

The State of South Dakota has listed 23 vertebrate species as threatened or endangered. Only one of the species listed was documented within the PAA or 1-mile perimeter during the survey period (mid-July 2007 through early August 2008). One active bald eagle nest was observed within the northwestern portion of the revised permit area (SW ¼, Section 30, Township 6 South, Range 1 East). The nest was in a cottonwood tree along Beaver Creek, and reportedly fledged one young in 2008. The bald eagle was removed from the Federal List of Endangered and Threatened Wildlife on August 8, 2007. However, protection provided to the bald eagle under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act has continued after the species was delisted. The rule change does not affect the bald eagle's status as a threatened or endangered species under state laws, or suspend any other legal protections provided by state laws. In South Dakota, the bald eagle is still considered a threatened species. Bald eagles were repeatedly observed along Beaver Creek in the western portion of the PPA and perimeter during winter roost surveys in late 2007 and early 2008.

7.3 SOIL EXPOSURE AND AIR PATHWAYS AND TARGETS

Standards have been developed for cleanup of radiation-contaminated soil under UMTRCA of 1978 (40 CFR Part 192). The purpose of these standards was to limit risk from inhalation of radon decay products in houses built on mine tailings, and to limit gamma radiation exposure to people using contaminated land. UMTRCA specifies two cleanup standards based on concentrations of Ra-226: (1) surface soil cleanup to 5 pCi/g, and (2) subsurface soil cleanup to 15 pCi/g. An EPA memorandum dated February 12, 1998, clarifies use of these two UMTRCA soil cleanup standards for CERCLA sites (EPA 1998). The surface soil standard of 5 pCi/g for Ra-226 is a health-based standard developed to control the hazard from gamma radiation; therefore, this standard may be appropriate and relevant to CERCLA sites.

Air samples collected within the Site area contained concentrations of Ra-226 that exceeded the 10 CFR Part 20 limit of 0.1 pCi/L for Rn-222 with daughters present (Powertech 2009).

The land within the Site is privately owned and leased. Land use is primarily agricultural and for livestock grazing. Edgemont, the town nearest the Site (approximately 13 miles away), had an estimated population of 774 people in 2010 (U.S. Census 2010). The area surrounding the Site is primarily agricultural. Residents and people farming surrounding land are potential targets. Nobody resides within 200 feet of the Site. No residents are within 1 mile of the Site, and approximately 26 persons reside within the 4-mile TDL (Mable/Geocorr 2014). No daycare centers or schools are within 200 feet of the Site.

8.0 DATA GAPS

Most of the data reviewed for this PA were acquired and reported during the period of approximately 2006 to 2009. Some significant data gaps exist within the information reported. For the PA, source areas were estimated by tracing boundaries of waste piles and surface impoundments by reference to two-dimensional aerial imagery. Soil samples collected by Powertech within the area of the Site (Surface Mine Area [SMA-XX]) were all analyzed for Ra-226. However, of the 25 samples collected, only three were analyzed for additional radionuclides including uranium, Pb-210, and Th-230—the other known contaminants on site. Groundwater samples were collected within the area of the Site from various types of wells; however, lack of groundwater sampling data from near and upgradient of the Site limited availability of reliable background concentrations. Surface water samples were collected from multiple water bodies in the area of the Site, including Pass Creek, Beaver Creek, and the Cheyenne River. However, the downstream Pass Creek surface water sample location was upstream of the probable point of entry (PPE) for surface water migrating from the Site. Additionally, the downstream sample location on the Cheyenne River was beyond the 15-mile TDL (see Figure 8). Therefore, data acquired at that sample point could not be used to evaluate potential surface water impacts from the Site in this PA. Biological samples including fish were collected by Powertech to evaluate potential impacts on surface water bodies including Beaver Creek and the Cheyenne River. Beaver Creek and the Cheyenne River are used by recreational anglers; however, documentation of the extent of use of the water bodies as fisheries is not available. Uranium was detected in all fish collected during July 2008. The detections were interpreted to be the result of increased sample sizes of the species submitted for laboratory analysis. No detections of uranium occurred in samples collected during April 2008; however, the detection limit was higher during that sampling period due to matrix interferences. Pb-210, Th-230, and Ra-226 were detected, but at low concentrations in most samples. Pb-210 was detected in one specimen collected at the downstream Beaver Creek location; however, the precision of the result was questionable due to matrix interferences. Additional data are needed to determine whether the Site is impacting fish in water bodies downstream of the Site.

9.0 SUMMARY

The Site (EPA ID: SDN000803095) is 15 miles from Edgemont, in Custer and Fall River Counties, South Dakota. Geographic coordinates at the approximate center of the Site are 43.478486 degrees north latitude and 103.962746 degrees west longitude. The 1,426-acre Site is used primarily for cattle grazing. ISR is proposed as a possible future use of this site.

Sources

By reference to aerial imagery, approximate areas of mine waste piles were quantified. Surface soil near the mine waste piles has been determined to contain levels of radionuclides exceeding health-based benchmarks and exceeding three times background concentrations, meeting observed release criteria. Additionally, samples collected from impoundments within the area of the Site have contained elevated levels of radionuclides and could also be considered potential source areas for HRS evaluation. Radionuclides are the contaminants of concern, including uranium, Ra-226, Th-230, and Pb-210.

Groundwater Migration Pathway

Sampling results indicate an observed release to groundwater has occurred at the Site. According to results of groundwater sampling and a well inventory conducted by Powertech, 18 domestic wells are within a 4-mile radius of the site boundary. Wells 16 and 42 have contained concentrations of Ra-226 exceeding its MCL and meeting observed release criteria. Concentrations in other wells have been above background levels but have not met observed release criteria; therefore, those wells are subject to potential contamination.

Surface Water Migration Pathway

Sampling results indicate a release of radionuclides has occurred to Pass Creek, Beaver Creek, and the Cheyenne River. There are no known drinking water intakes within the 15-mile TDL. The Cheyenne River and Beaver Creek support fish life and possible food chain targets; however, the extent of use of the water bodies as fisheries is not available. Freshwater emergent and riverine wetlands are present along the riparian areas at the confluence of Beaver Creek and the Cheyenne River and downstream (along the Cheyenne River); however, it is unknown whether these sensitive environments have been impacted by releases from the site. Additional data are needed to properly evaluate the surface water pathway and confirm attribution to contaminants present at the Site.

Soil Exposure and Air Migration Pathways

Surface soil samples collected at the Site have contained elevated concentrations of radionuclides. Additionally, air samples have indicated elevated concentrations of Rn-222 within the area of the Site. However, because of the small number of targets in the immediate vicinity of the Site, those pathways pose limited threat to human health and the environment.

Conclusions

Additional surface soil sampling within the Site appears warranted to better characterize and define source areas. Additional data could be used to quantify source materials within the area of the Site, and volumes of waste piles should be measured more accurately. Additional sampling of surface water and sediment also appears warranted to determine if releases from the Site are impacting downstream sensitive environments (i.e., wetlands and possible fish habitat).

9.1 EMERGENCY RESPONSE AND REMOVAL ACTION CONSIDERATIONS

Based on available data from previous site assessments by Powertech, a removal action appears warranted to address radium-226 contamination in mine waste piles at the Site. Five soil samples collected from the Site contained radium-226 concentrations that exceeded the EPA health-based standard of 5 pCi/g and exceeded three times background concentrations. Emergency response actions do not appear warranted at the Site.

10.0 REFERENCES

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FIGURES

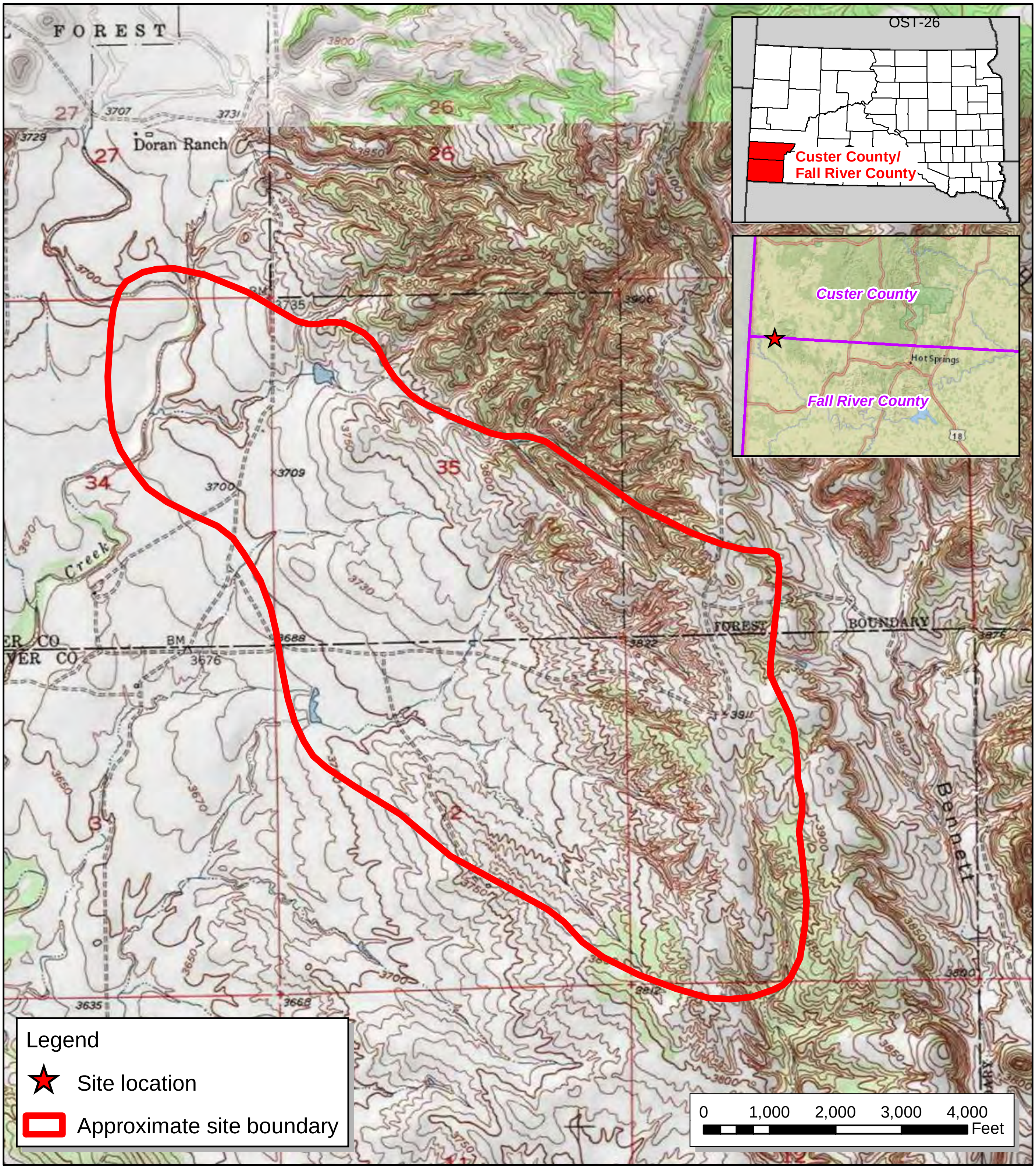

Figure 1
Site Location Map

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

Seagull Environmental Technologies, Inc.

Source: ArcGIS Online, World Imagery, 2011

Date: May 2014

Project No: EPS81105.0014

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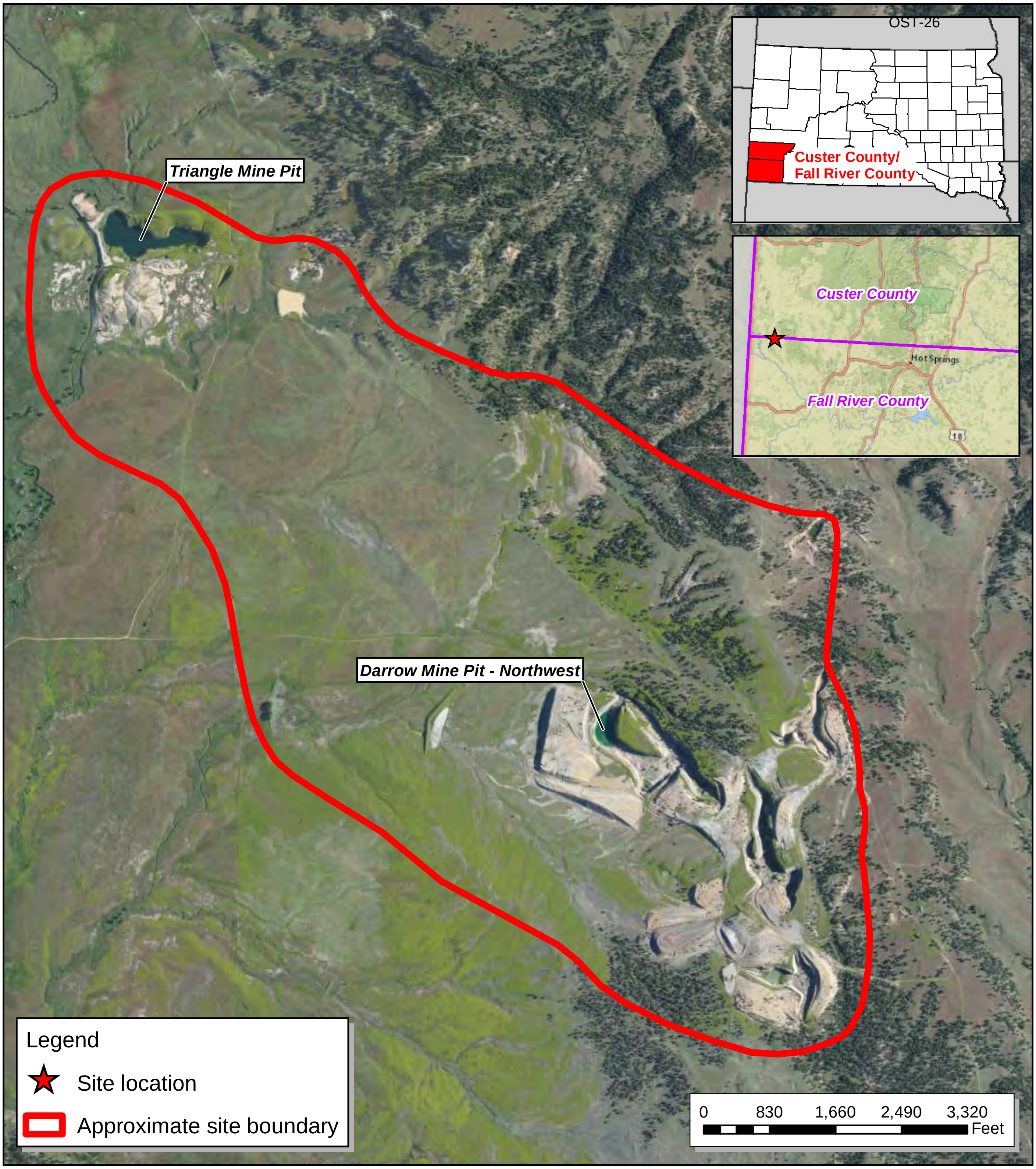

Figure 2
Site Layout Map

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

N W E S

Seagull Environmental Technologies, Inc.

Source: ArcGIS Online, World Imagery, 2011

Date: May 2014
Project No: EPS81105.0014

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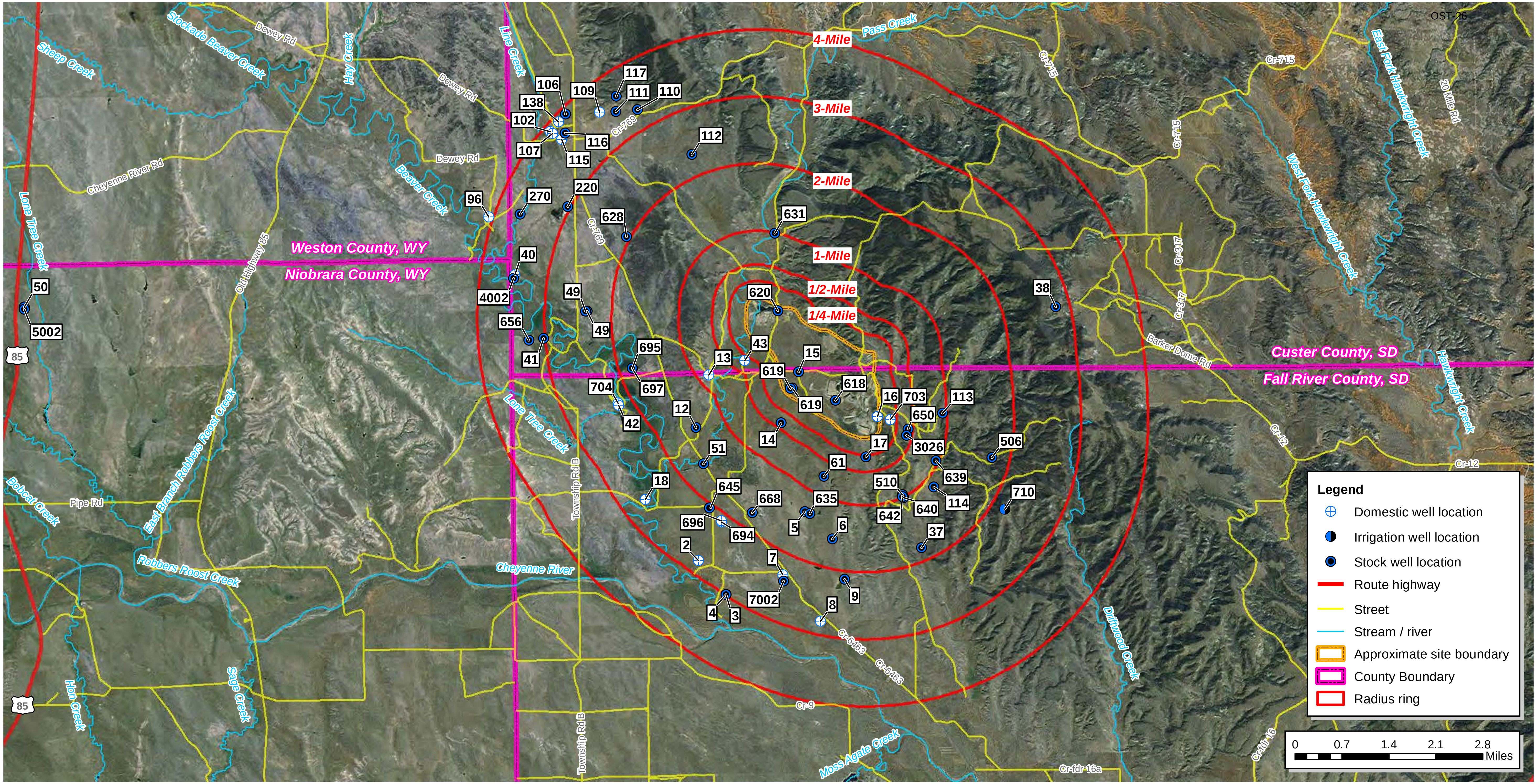

Figure 3
4-Mile Radius Well Locations

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

Seagull Environmental Technologies, Inc.

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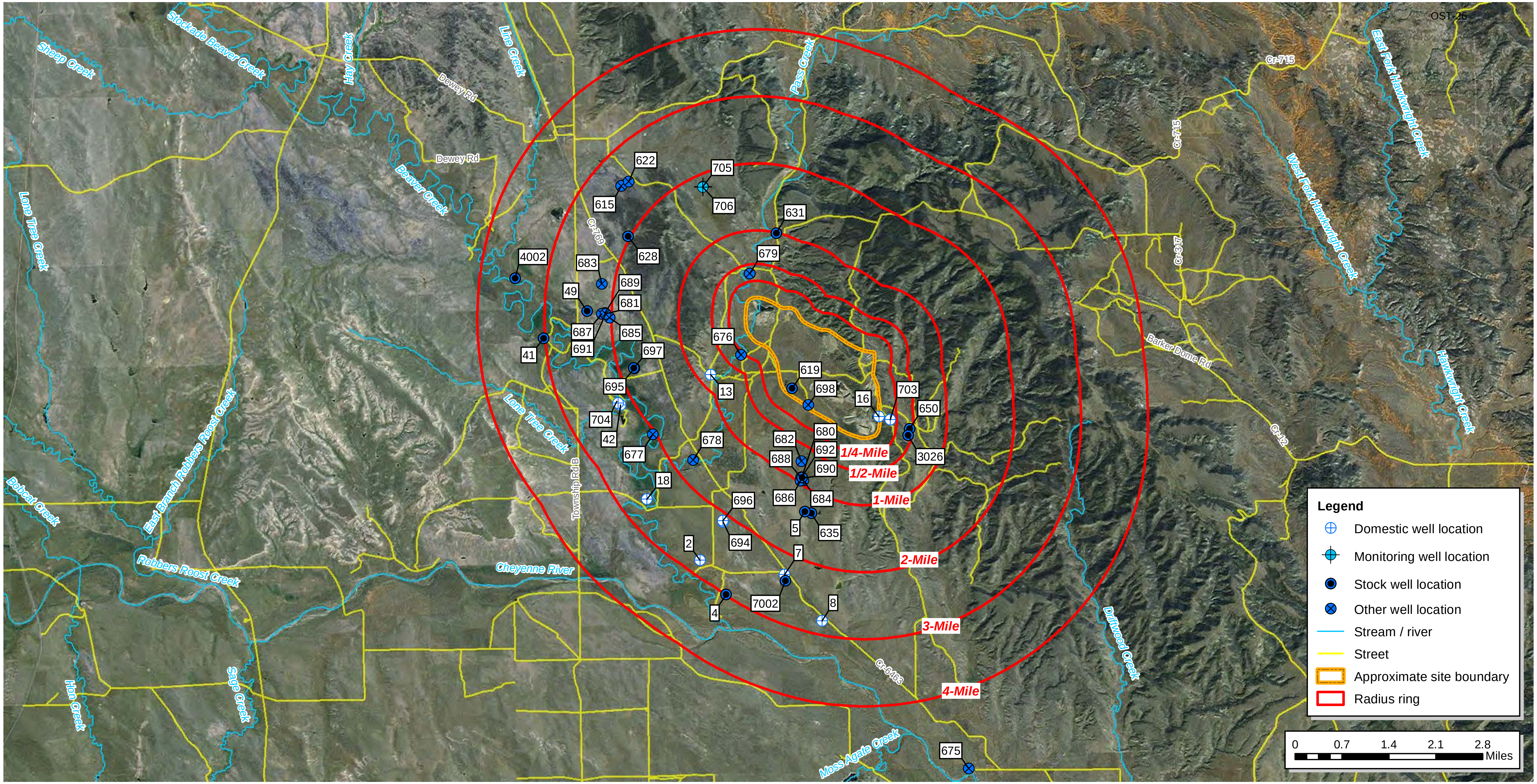

Figure 4
Groundwater Sample Location Map

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

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Seagull Environmental Technologies, Inc.

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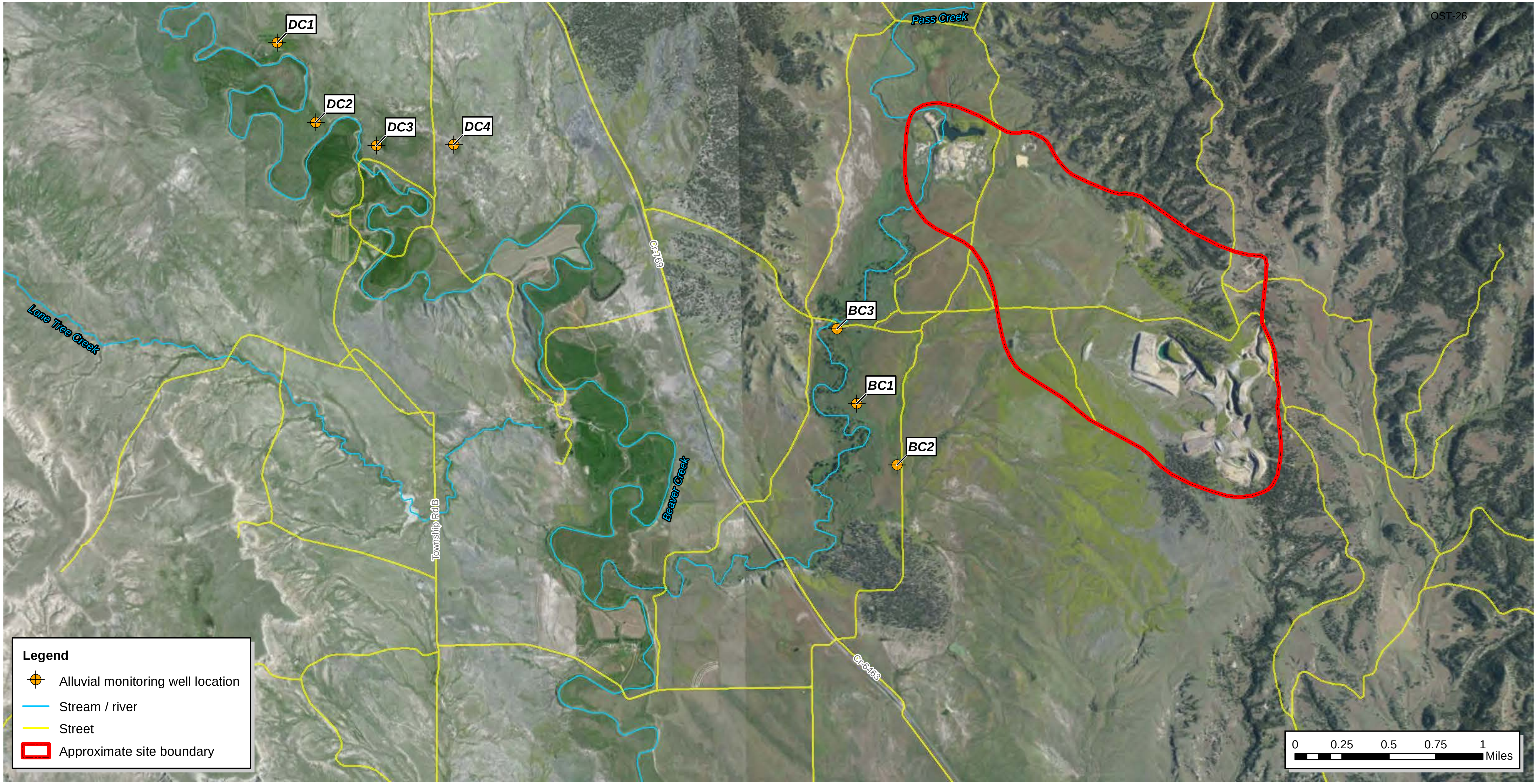

Figure 5
Alluvial Monitoring Well Locations

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

Seagull Environmental Technologies, Inc.

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Date: May 2014 | Source: ESRI, ArcGIS Online World Imagery, 2011; ESRI Data Maps, 2007; HSIP Gold, 2007 | Project No: EPS81105.0014

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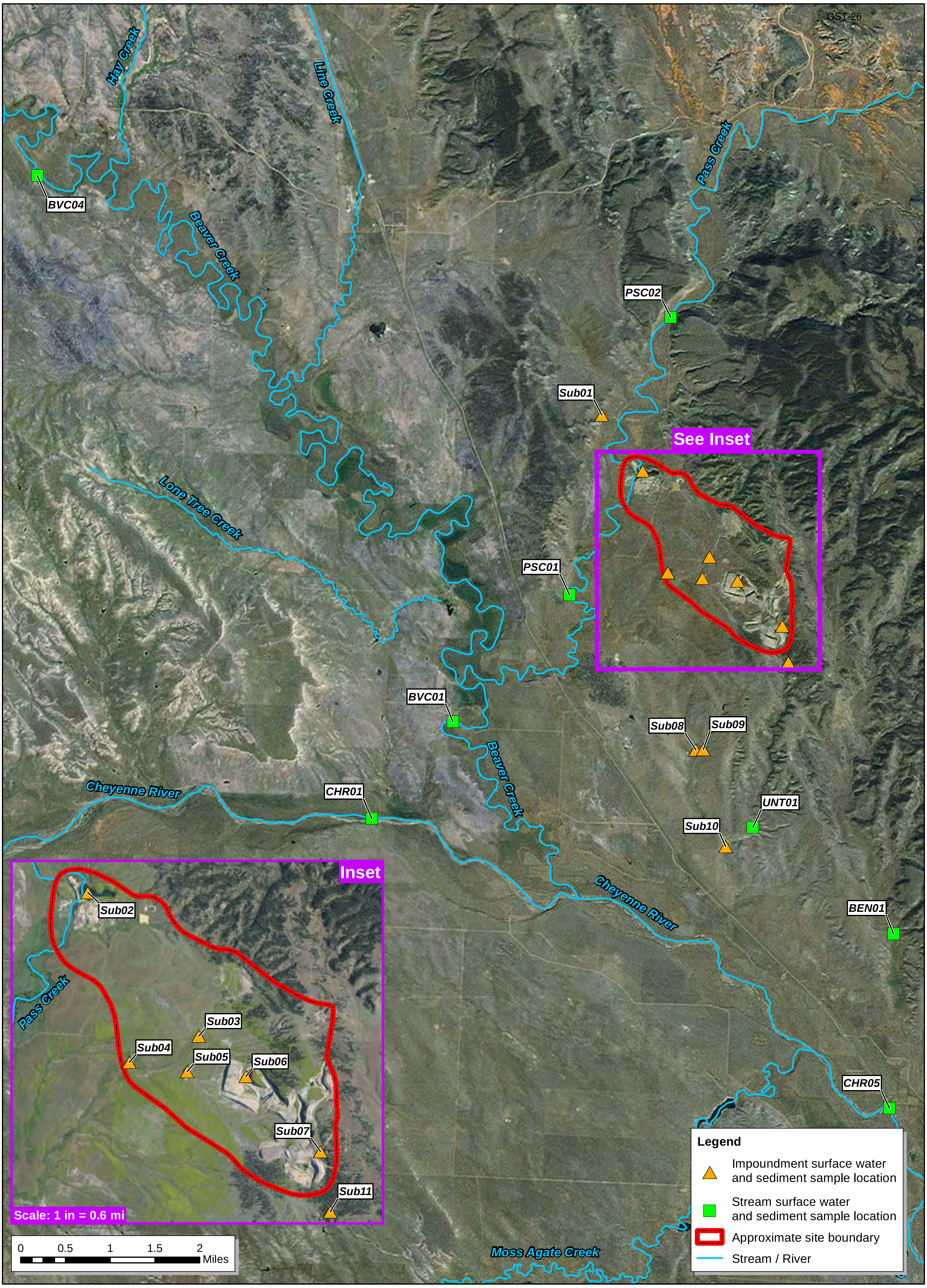

Figure 6
Surface Water and Sediment Sample Locations (Powertech 2008)

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

Seagull Environmental Technologies, Inc.

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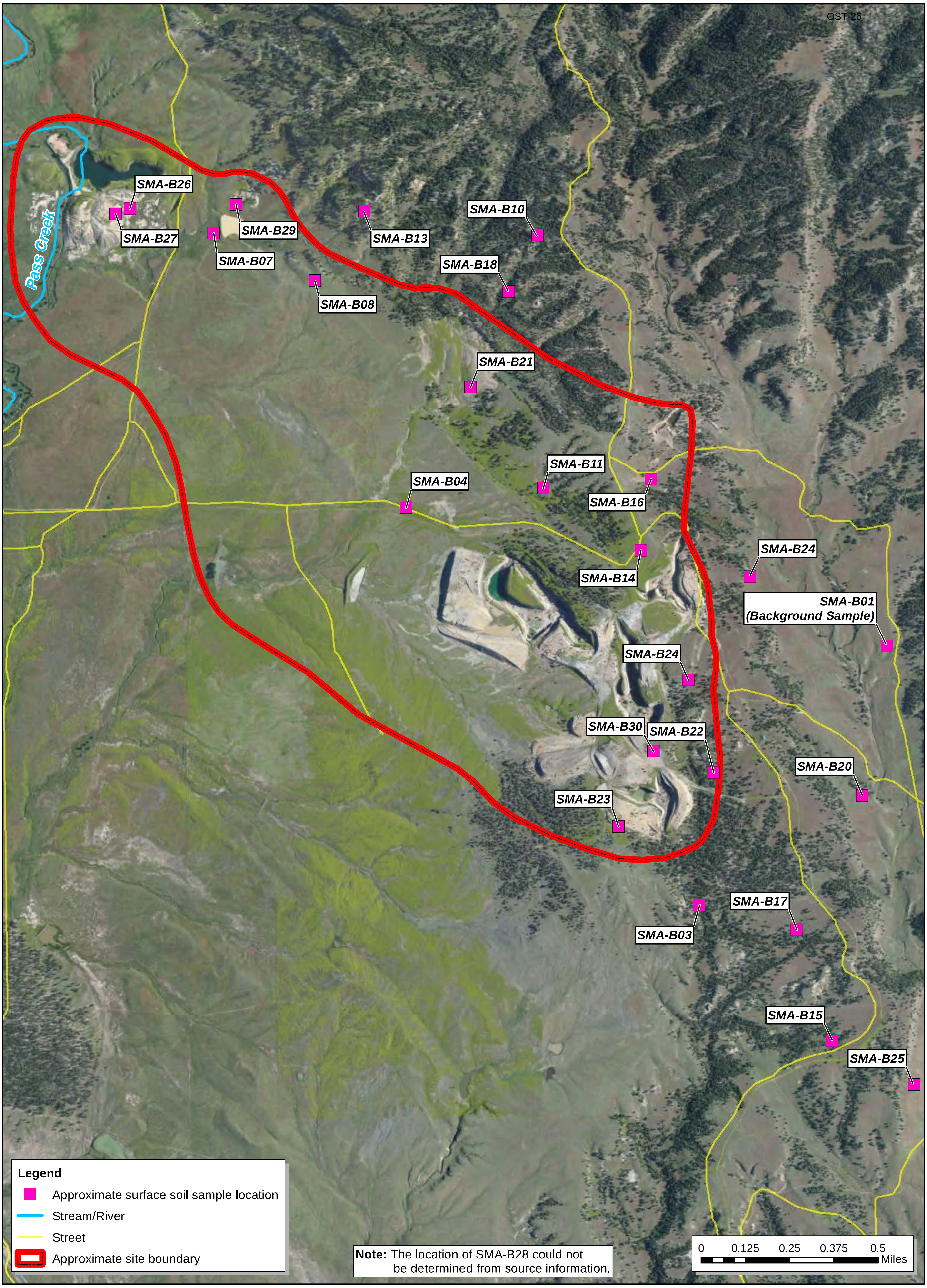

Figure 7
Approximate Surface Soil Sample Locations

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

Seagull Environmental Technologies, Inc.

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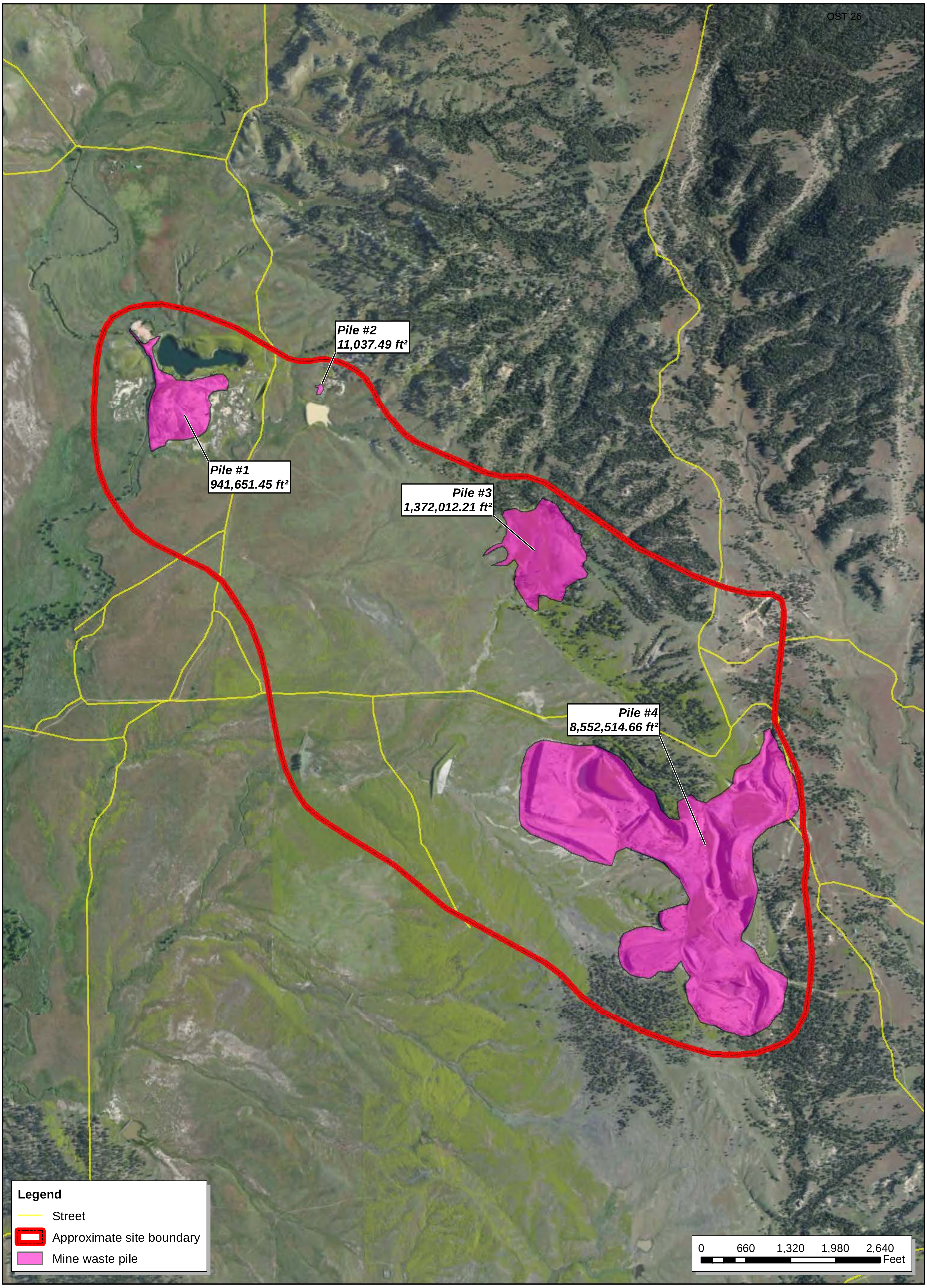

Figure 8
Approximate Source Area Boundaries

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

Seagull Environmental Technologies, Inc.

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Date: May 2014 | Source: ArcGIS Online, World Imagery, 2010; HSIP Gold, 2007; Powertech, 2009 | Project No: EPS81105.0014

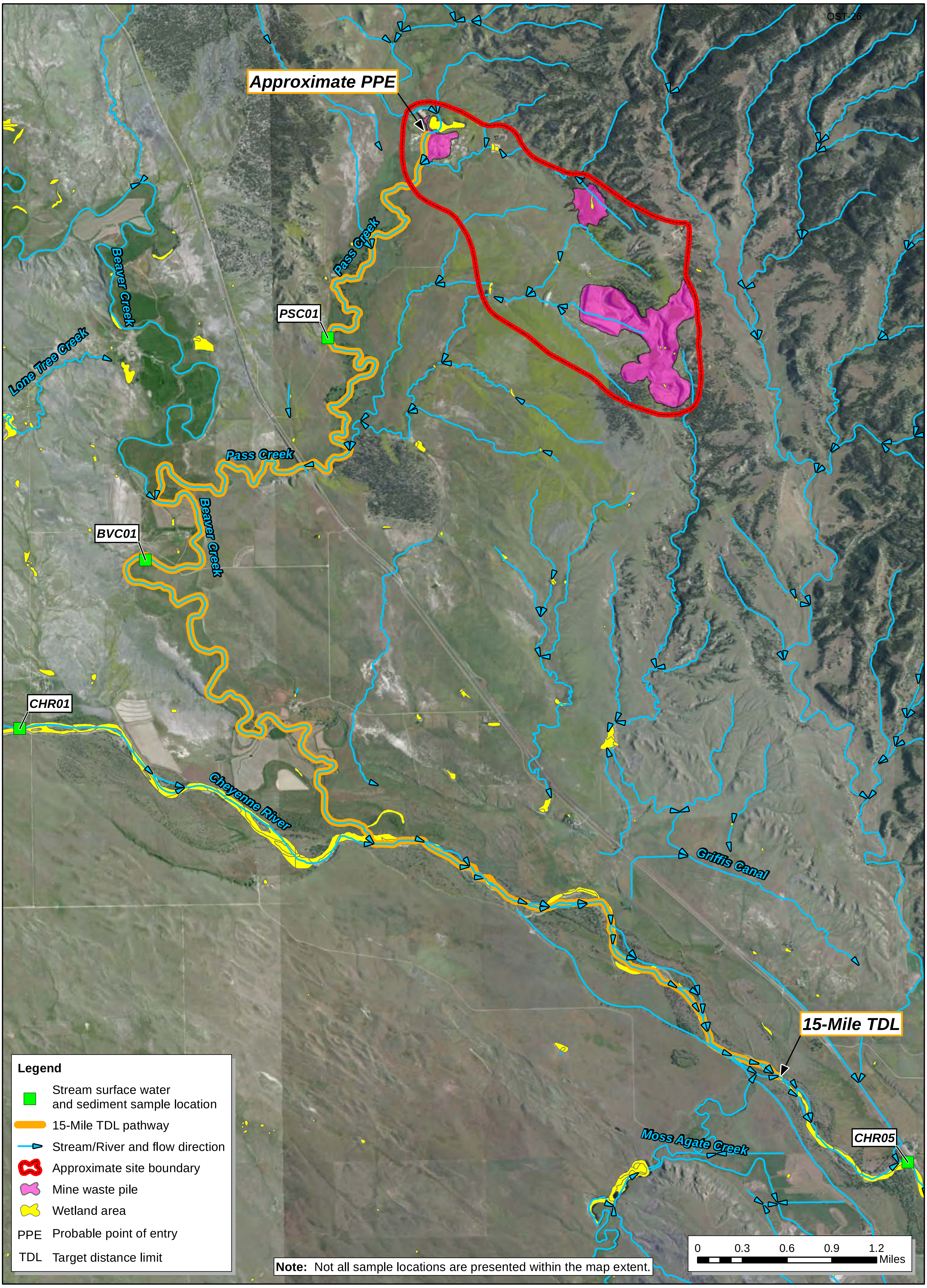

Figure 9
15-Mile Target Distance Limit and Surface Water Sample Locations

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

Seagull Environmental Technologies, Inc.

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Date: May 2014 | Source: ArcGIS Online, World Imagery, 2010; USGS, NHDPlus, 2013; USFWS, NWI, 2013 | Project No: EPS81105.0014

APPENDIX A

SITE RECONNAISSANCE REPORT

Seagull Environmental Technologies, Inc.

3555 Chase Street
Wheat Ridge, Colorado 80212
www.seagullenvirotech.com

May 2, 2014

Victor Ketellapper, Site Assessment Team Leader
U.S. Environmental Protection Agency, Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

Subject: Site Reconnaissance Report regarding the Darrow/Freezeout/Triangle Uranium Mine Site, near Edgemont, Custer and Fall River Counties, South Dakota
EPA Region 8 START 8(a) Carve-Out Contract EP-S8-11-05, Task Order #0014
Task Monitor: Victor Ketellapper, Site Assessment Team Leader

Dear Mr. Ketellapper

Seagull Environmental Technologies, Inc. (Seagull) is pleased to submit this Site Reconnaissance Report regarding the Darrow/Freezeout/Triangle Uranium Mine site near Edgemont, Custer and Fall River Counties, South Dakota. If you have any questions or comments, please contact the Project Manager via email at gdillon@seagullenvirotech.com or by phone at (816) 412-1953.

Sincerely,

Gregory R. Dillon
Task Order Project Manager

Hieu Q. Vu, PE
Program Manager

Enclosures

PRELIMINARY ASSESSMENT REPORT

Regarding the

DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE

NEAR EDGEMONT, SOUTH DAKOTA

EPA ID: SDN000803095

Contract No.: EP-S8-11-05
Task Order No.: 0014

Prepared By:

SETI

SEAGULL ENVIRONMENTAL TECHNOLOGIES, INC.
3555 CHASE STREET
WHEAT RIDGE, COLORADO 80202-1129

May 2, 2014

SITE RECONNAISSANCE REPORT
Darrow/Freezeout/Triangle Uranium Mine Site

DATE/TIME: November 5, 2013, 08:00-17:00.

WEATHER CONDITIONS: Cloudy, snow and rain mixture, calm wind ~26° degrees Fahrenheit (°F).

PARTICIPANTS/AFFILIATION: Gregory Dillon and Jon DeBruine of Seagull Environmental Technologies, Inc.

1.0 INTRODUCTION

Under the U.S. Environmental Protection Agency (EPA) Region 8 Superfund Technical Assessment and Response Team (START) Carve-Out 8(a) Contract (No. EP-S8-11-05), Task Order No. 0014, Seagull Environmental Technologies, Inc. (Seagull) has been tasked to conduct a Preliminary Assessment (PA) for the Darrow/Freezeout/Triangle Uranium Mine (Site) site near Edgemont, Custer and Fall River Counties, South Dakota. As part of the PA, Seagull is submitting this Site Visit Report for activities conducted on November 5, 2013, at the Site. The site visit was conducted to locate previously identified source areas and potential sample locations, and to become familiar with the site layout. The Site is located approximately 13 miles northwest of Edgemont, South Dakota.

2.0 SITE DESCRIPTION

The Site encompasses approximately 1,426 acres and is located primarily on private land. Attempts to gain access to the Site area via letters to private landowners were unsuccessful. During the site reconnaissance, START team members Gregory Dillon and Jonathan DeBruine, and Maple Barnard and Valois Shea of EPA traveled along public roads in the site vicinity in an attempt to attain a vantage point of the Site area. However, the public access roads were inadequate to gain a view of the Site.

Photos of the site area, including drainage areas, historical points of interest, and current conditions of the surrounding area were taken during the site reconnaissance. START and EPA visited Edgemont City Hall to meet with local officials to discuss the purpose of the PA and to obtain information for the report. Following the meeting with local officials, Mr. Mike Koopman, City Engineer/Code Administrator, accompanied START and EPA to visit areas of interest in and around Edgemont. The Edgemont, South Dakota, Uranium Mill Tailings Repository and former mill location were visited during the site reconnaissance. In addition, current City of Edgemont Public Water Supply (PWS) wells were visited to document and confirm their locations.

3.0 AREA DESCRIPTION

The Site is located in Custer and Fall River Counties in the Great Plains physiographic province on the edge of the Black Hills uplift. Land use in the area is primarily agricultural range land for livestock. Surface water from the site drains into tributaries of Pass Creek and Beaver Creek, eventually flowing into the Cheyenne River.

4.0 PHOTOGRAPHIC DOCUMENTATION:

Photographs documenting the site visit are included in Appendix A.

APPENDIX A

PHOTOGRAPHIC DOCUMENTATION

Client: U.S. Environmental Protection Agency	Description: Photograph of the geographic marker at the Edgemont, South Dakota, Uranium Mill Tailings Repository.	Photograph Number: 1
Direction: N/A	Photographer: Gregory Dillon	Date: 11/5/2013

Client: U.S. Environmental Protection Agency	Description: Photograph of no trespassing signage at the Edgemont, South Dakota, Uranium Mill Tailings Repository.	Photograph Number: 2
Direction: East	Photographer: Gregory Dillon	Date: 11/5/2013

57

Client: U.S. Environmental Protection Agency	Description: Photograph of City of Edgemont Municipal Well #2 southwest of town. It is currently an active well for the City's Public Water Supply (PWS).	Photograph Number: 3
Direction: North	Photographer: Jon DeBruine	Date: 11/5/2013

Client: U.S. Environmental Protection Agency	Description: Photograph of City of Edgemont Municipal Well #4 southwest of town. It is currently an active well for the City's PWS.	Photograph Number: 4
Direction: East	Photographer: Gregory Dillon	Date: 11/5/2013

Client: U.S. Environmental Protection Agency	Description: Photograph of an overflow outfall of a City PWS basin and stormwater in the Edgemont City Park. The pond is used for recreational fishing seasonally.	Photograph Number: 5
Direction: South	Photographer: Jon DeBruine	Date: 11/5/2013

Client: U.S. Environmental Protection Agency	Description: Photograph of signage at the boundary of the Black Hills National Forest taken from County Road 16.	Photograph Number: 6
Direction: Northeast	Photographer: Gregory Dillon	Date: 11/5/2013

Client: U.S. Environmental Protection Agency	Description: Photograph of Pass Creek at crossing of County Highway 6463.	Photograph Number: 7
Direction: Southwest	Photographer: Gregory Dillon	Date: 11/5/2013

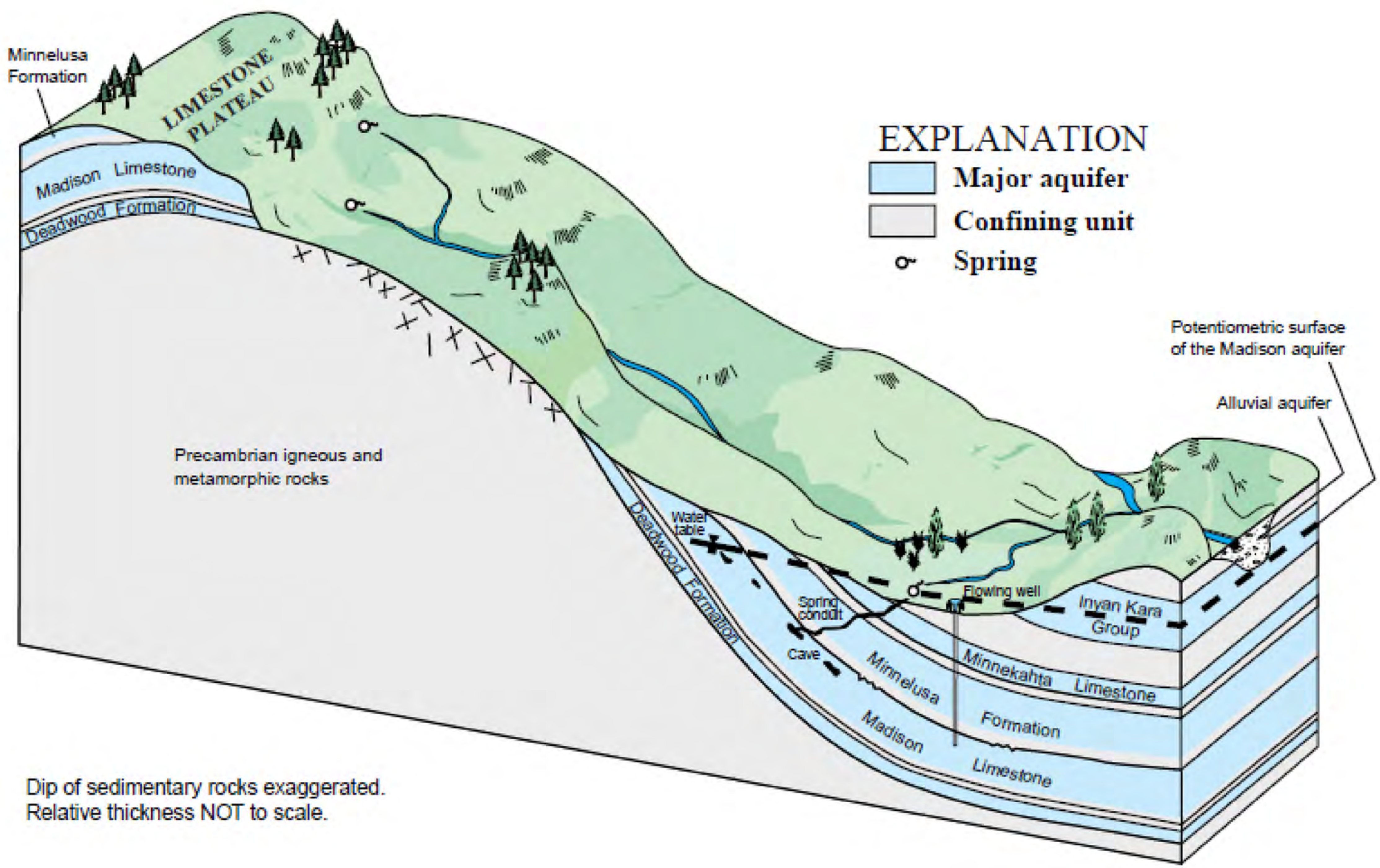
Client: U.S. Environmental Protection Agency	Description: Photograph of Pass Creek at crossing of County Highway 6463.	Photograph Number: 8
Direction: Northeast	Photographer: Gregory Dillon	Date: 11/5/2013

Client: U.S. Environmental Protection Agency	Description: Photograph of the Cheyenne River at the approximate 15-mile Target Distance Limit (TDL).	Photograph Number: 9
Direction: West	Photographer: Gregory Dillon	Date: 11/5/2013

Client: U.S. Environmental Protection Agency	Description: Photograph of the Cheyenne River at the approximate 15-mile TDL.	Photograph Number: 10
Direction: South	Photographer: Gregory Dillon	Date: 11/5/2013

APPENDIX B

DIAGRAM OF HYDROGEOLOGY OF BLACK HILLS AREA



Simplified Hydrogeologic Setting of the Black Hills Area

Darrow/Freezeout/Triangle Uranium Mine
Edgemont, South Dakota

Seagull Environmental Technologies, Inc.

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Date: May 2014 | Source: Driscoll, et al. (2002) | Project No: EPS81105.0014

APPENDIX C

CERCLA ELIGIBILITY CHECKLIST

CERCLA Eligibility Checklist

Site Name: Darrow/Freezeout/Triangle Uranium Mine
Alias:
City: near Edgemont State South Dakota Zip code 57735
EPA ID Number ***(Note - This may be a RCRA or other program ID)*****: SDN000803095**

Note: The site is automatically CERCLA eligible if it is a federally owned or operated RCRA site.

I. CERCLA Authority	Y	N
A. Is the release or threat of release a result of naturally occurring substances in its unaltered form, or altered solely through naturally occurring processes of phenomena, from a location where it is naturally found?		X
B. Is the release or threat of release a result of products that are part of the structure of, and result in exposure within, residential buildings or business or community structures?		X
C. Does the release or threat of release affect public or private drinking water supplies due to deterioration of the system through ordinary use?		X
If YES to A, B, or C, the EPA may not have authority to respond.		
If NO to A, B, or C, the EPA may have authority to respond.		

II. CERCLA Eligibility	Y	N
A. Has this site been previously entered into CERCLIS or is it part of, or adjacent to, an existing CERCLIS site?	X	
B. Is this site part of a National Priority List site?		X
C. Did the facility cease operations prior to November 19, 1980?		X
If YES to A, B, or C, then STOP. The facility is probably a CERCLA site.		
If NO, Continue		
1. RCRA Deferral Factors Did the facility file a RCRA Part A application?		
If YES: a. Does the facility currently have interim status?		
b. Did the facility withdraw its Part A application?		
c. Is the facility a known or possible protective filer? (e.g., filed in error, or never operated as TSDFs)		
d. Does the facility have a RCRA Part B Operating Permit or a post closure permit?		
e. Is the facility a late (after 11/19/80) or non-filer that has been identified by the EPA or the state? (i.e., facility did not know it needed to file under RCRA)		
If all answers to questions a, b, and c are NO, STOP. The facility is a CERCLA eligible site.		
If answer to b or c is YES, STOP. The facility is a CERCLA eligible site.		
If answer to b and c are NO and any other answer is YES, site is RCRA, continue to Part 2.		

CERCLA Eligibility Checklist

2. RCRA Sites Eligible for the NPL Type of facility: Generator____ Transporter___ Recycler_____ TSDF (Treatment/Storage/Disposal Facility)X		
a. Has the facility owner filed for bankruptcy under federal or state laws?		
b. Has the facility lost RCRA authorization to operate or shown probable unwillingness to carry out corrective actions?		
c. Is the facility a TSDF “converter,” i.e., former TSF that did not pursue a RCRA operating permit and have changed status to “generator” or “non-handler”?		
d. Is the facility a non- or late filer?		
If answer to a, b, c, or d is YES, STOP. The facility is a CERCLA eligible site.		
D. Excluded Releases:		
1. Does the CERCLA Petroleum Exclusion apply (CERCLA section 101 (13))?		
2. Does the facility have discharges of CERCLA hazardous substances that are in compliance with federally permitted releases as described in CERCLA section 101 (10)?		
3. Does the facility have a release or threat of release which results in exposure to persons solely within a workplace, with respect to a claim which such persons may assert against their employer as described in CERCLA section 101 (22)?		
4. Does the facility have a release or threat of release which results from emissions from engine exhaust of a motor vehicle, rolling stock, aircraft, vessel, or pipeline pumping station engine as described in CERCLA section 101 (22)?		
5. Does the facility have a release or threat of release which results from source, byproduct or special nuclear material from a nuclear incident subject to section 170 of the Atomic Energy Act; or from any processing site specifically designated under the Uranium Mill Tailings Radiation Control Act of 1978 as described in CERCLA section 101 (22)?		
6. Does the facility have a release or threat of release which results from the normal application of fertilizer?		
If answer to 1, 2, 3, 4, 5, or 6 is YES, the facility is NOT CERCLA eligible.		
If NO, the facility may be CERCLA eligible. (If unknown, answer NO). Please list hazardous substances here. .		

CERCLA Eligibility Checklist

III. Other programs: The site may never reach the NPL or be a candidate for removal. We need to be able to refer it to any other programs in EPA or state agencies which may have jurisdiction, and thus be able to affect a cleanup. Responses should summarize available information pertaining to the question. Include information in existing files in these programs as part of the PA. Answer all that apply.		
A. Is there an owner or operator?		
B. NPDES-CWA: Is there a discharge water containing pollutants with surface water through a point source (pipe, ditch, channel, conduit, etc.)?		
C. CWA (404): Have fill or dredged material been deposited in a wetland or on the banks of a stream? Is there evidence of heavy equipment operating in ponds, streams or wetlands?		
D. UIC-SDWA: Are fluids being disposed of to the subsurface through a well, cesspool, septic system, pit, etc.?		
E. TSCA: Is it suspected that there are PCB's on the site which came from a source with greater than 50 ppm PCB's such as oil from electrical transformers or capacitors?		
F. FIFRA: Is there a suspected release of pesticides from a pesticide storage site? Are there pesticide containers on site?		
G. RCRA (D): Is there an owner or operator who is obligated to manage solid waste storage or disposal units under state solid waste or groundwater protection regulations?		
H. UST: Is it suspected that there is a leaking underground storage tank containing a product which is a hazardous substance or petroleum?		
I. Brownfields: Is there redevelopment/revitalization interest		

Is the site eligible for an assessment under CERCLA authority? Please circle: Yes or No

Site Determination:

Is this site a valid site or incident? Please Circle and explain below

YES or NO

☐ **Enter the site into CERCLIS. Further assessment is recommended (explain below)**

☐ **The site is not recommended for placement into CERCLIS (explain below)**

DECISION/DISCUSSION/RATIONALE:

CERCLA Eligibility Checklist

Regional EPA Reviewer: ______________________________ **Date:** _________________

State Agency Reviewer: ______________________________ **Date:** _________________

APPENDIX D

POTENTIAL HAZARDOUS WASTE PRELIMINARY ASSESSMENT FORM

OMB Approval Number: 2050-0095
Approved for Use Through: OS/T926

EPA Potential Hazardous Waste Site Preliminary Assessment Form

Identification **SDN000803095**	
State SD	Site Number SDN000803095
CERCLIS Discovery Date: March 15, 2013	

1. *General Site Information*

Name: Darrow/Freezeout/Triangle Uranium Mine	Street Address: 13 miles NNW of Edgemont				
City: near Edgemont	State: SD	Zip Code: 57735	County: Custer and Fall River	Co. Code 21 and 27	Cong. Dist: 30
Latitude: 43.478486 Longitude:-103.962746	Approximate Area of Site: _1,426_ Acres _______ Square Miles		Status of Site: ☐ Active X Inactive ☐ Not Specified ☐ NA		

2. *Owner/Operator Information*

Owner: Not Applicable (NA)			Operator:		
Street Address:			Street Address:		
City:			City:		
State:	Zip Code:	Telephone	State:	Zip Code:	Telephone

Type of Ownership:
- ☐ Private
- ☐ Federal Agency Name _______
- ☐ State
- ☐ Indian
- ☐ County
- ☐ Municipal
- ☐ Not Specified
- ☐ Other _

How Initially Identified:
- ☐ Citizen Complaint
- ☐ PA Petition
- ☐ State/Local Program
- ☐ RCRA, CERCLA Notification
- ☐ Federal Program
- ☐ Incidental
- ☐ Not Specified
- ☐ Other __________________

3. *Site Evaluator Information*

Name of Evaluator: Gregory R. Dillon	Agency/Organization: Seagull Environmental Technologies, Inc.	Date Prepared: 04/29/2014
Street Address: 3555 Chase Street	City: Wheat Ridge	State: Colorado
Name of EPA or State Agency Contact: Victor Ketellapper (EPA)	Street Address: 1595 Wynkoop Street	
City: Denver	State: Colorado	Telephone: 303-312-6578

4. *Site Disposition (for EPA use only)*

Emergency Response/Removal Assessment Recommendation: ☐ Yes ☐ No Date _______________	CERCLIS Recommendation: ☐ Higher Priority SI ☐ Lower Priority SI ☐ NFRAP ☐ RCRA ☐ Other ____________________ ☐ Date____________________	Signature: Name (typed): Position:

EPA Potential Hazardous Waste Site Preliminary Assessment Form - Page 2 of 4

CERCLIS Number:

SDN000803095

5. General Site Characteristics

Predominant Land Uses Within One Mile of Site (Check all that apply):

- ☐ Industrial
- ☐ Commercial
- ☐ Residential
- X Forest/Fields
- X Agricultural
- X Mining
- ☐ DOD
- ☐ DOE
- ☐ DOI
- ☐ Other Federal Facility ____________
- ☐ Other ____________

Site Setting:

- ☐ Urban
- ☐ Suburban
- X Rural

Years of Operation:

Beginning Year 1952

Ending Year 1994

- ☐ Unknown

Type of Site Operations (Check all that apply):

- ☐ Manufacturing (must check subcategory)
  - ☐ Lumber and Wood Products
  - ☐ Inorganic Chemicals
  - ☐ Plastic and/or Rubber Products
  - ☐ Paints, Varnishes
  - ☐ Industrial Organic Chemicals
  - ☐ Agricultural Chemicals (e.g., pesticides, fertilizers)
  - X Miscellaneous Chemical Products (e.g., adhesives, explosives, ink)
  - ☐ Primary Metals
  - ☐ Metal Coating, Plating, Engraving
  - ☐ Metal Forging, Stamping
  - ☐ Fabricated Structural Metal Products
  - ☐ Electronic Equipment
  - ☐ Other Manufacturing
- X Mining
  - X Metals
  - ☐ Coal
  - ☐ Oil and Gas
  - X Non-metallic Minerals
- ☐ Retail
- ☐ Recycling
- ☐ Junk/Salvage Yard
- ☐ Municipal Landfill
- ☐ Other Landfill
- ☐ DOD
- ☐ DOE
- ☐ DOI
- ☐ Other Federal Facility ________
- ☐ RCRA
  - ☐ Treatment, Storage, or Disposal
  - ☐ Large Quantity Generator
  - ☐ Small Quantity Generator
  - ☐ Subtitle D
    - ☐ Municipal
    - ☐ Industrial
  - ☐ Converter
  - ☐ Protective Filer
  - ☐ Non- or Late Filer
  - ☐ Not Specified
- ☐ Other ________

Waste Generated:

- ☐ On site
- ☐ Off-site
- X On site and off-site

Waste Deposition Authorized By:*

- ☐ Present Owner
- X Former Owner
- ☐ Present & Former Owner
- ☐ Unauthorized
- ☐ Custer County Roads & Bridges

Waste Accessible to the Public:*

- ☐ Yes
- X No (on site) Unknown if off-site disposal is accessible to public.

Distance to Nearest Dwelling, School, or Workplace:

> 200 Feet

6. Waste Characteristics Information

Source Type: (Check all that apply)	Source Waste Quantity: (Include units)	Tier*:
☐ Landfill		
☐ Surface Impoundment		
☐ Drums		
☐ Tanks and Non-Drum Containers		
☐ Chemical Waste Pile		
☐ Scrap Metal or Junk Pile		
X Tailings Pile	10,877,215.81 ft^2	A
☐ Trash Pile (open dump)		
☐ Land Treatment		
☐ Contaminated Groundwater Plume (unidentified source)		
☐ Contaminated Surface Water/Sediment (unidentified source)		
☐ Contaminated Soil		
☐ Other____________		
☐ No Sources		

* C = Constituent W = Waste stream V = Volume A = Area

General Types of Waste (Check all that apply)

- ☐ Metals
- ☐ Organics
- X Inorganics
- ☐ Solvents
- ☐ Paints/Pigments
- ☐ Laboratory/Hospital Waste
- X Radioactive Waste
- ☐ Construction/Demolition Waste
- ☐ Pesticides/Herbicides
- ☐ Acids/Bases
- ☐ Oily Waste
- ☐ Municipal Waste
- ☐ Mining Waste
- ☐ Explosives
- ☐ Other ____________

Physical State of Waste as Deposited (Check all that apply):*

- X Solid
- ☐ Liquid
- ☐ Sludge
- ☐ Gas
- ☐ Powder

CERCLIS Number:

SDN000803095

EPA Potential Hazardous Waste Site Preliminary Assessment Form - Page 3 of 4

7. *Groundwater Pathway*

Is Groundwater Used for Drinking Water Within 4 Miles?

X Yes
☐ No

Type of Drinking Water Wells Within 4 Miles (Check all that apply):

☐ Municipal
X Private
☐ None

Is There a Suspected Release to Groundwater?

X Yes
☐ No

Have Primary Target Drinking Water Wells Been Identified?

X Yes
☐ No

If yes, Enter Primary Target Population: Approximately 4.24 individuals based on County average populations per household.

List Secondary Target Population Served by Groundwater Withdrawn From:

0 - ¼ Mile * 2.12
> ¼ - ½ Mile * 2.17
> ½ - 1 Mile * 2.12
> 1 - 2 Miles * 0
> 2 - 3 Miles * 14.84
> 3 - 4 Miles * 13.02
Total Within 4 Miles 34.27

Depth to Shallowest Aquifer:

0 to 50 feet below ground surface

Karst Terrain/Aquifer Present:

☐ Yes
X No

Nearest Designated Wellhead Protection Area:

☐ Underlies Site
☐ > 0 - 4 Miles
X None Within 4 Miles

8. *Surface Water Pathway*

Type of Surface Water Draining Site and 15 Miles Downstream (Check all that apply):

X Stream X River X Pond ☐ Lake
☐ Bay ☐ Ocean ☐ Other ______

Shortest Overland Distance From Any Source To Surface Water:*

< 100 Feet
______ Miles

Is There a Suspected Release to Surface Water?

X Yes
☐ No
☐ Unknown

Site is Located in:

☐ Annual - 10-year Floodplain
X > 10-year - 100-year Floodplain
☐ > 100-year - 500-year Floodplain
☐ > 500-year Floodplain

Drinking Water Intakes Located Along the Surface Water Migration Path:

☐ Yes
X No

Have Primary Target Drinking Water Intakes Been Identified:

☐ Yes
X No

If Yes, Enter Population Served by Primary Target Intakes:

0 People

List All Secondary Target Drinking Water Intakes:

Name	Water Body	Flow (cfs)	Population Served

Fisheries Located Along the Surface Water Migration Path:

X Yes
☐ No

Have Primary Target Fisheries Been Identified:

X Yes
☐ No

List All Secondary Target Fisheries:

Water Body/Fishery Name	Flow (cfs)
Beaver Creek	9.9
Cheyenne River	23.0

EPA **Potential Hazardous Waste Site Preliminary Assessment Form - Page 4 of 4**

CERCLIS Number:

SDN000803095

8. Surface Water Pathway (continued)

Wetlands Located Along the Surface Water Migration Path:
X Yes
☐ No
☐ Unknown

Have Primary Target Wetlands Been Identified:
☐ Yes
X No

List Secondary Target Wetlands:

Water Body	Flow (cfs)	Frontage Miles
Cheyenne River (PEMA)	23.0	0.23
Cheyenne River (R2USA)	23.0	0.74
Cheyenne River (R2USA)	23.0	0.27

Other Sensitive Environments Located Along the Surface Water Migration Path:
☐ Yes
X No

Have Primary Target Sensitive Environments Been Identified:
☐ Yes
X No

List Secondary Target Sensitive Environments:

Water Body	Flow (cfs)	Sensitive Environment Type

9. Soil Exposure Pathway

Are People Occupying Residences or Attending School or Daycare On or Within 200 Feet of Areas of Known or Suspected Contamination:*
☐ Yes
X No

If Yes, Enter Total Resident Population:

_________ People (part-time

Number of Workers On Site:*
X None
☐ 1 - 100
☐ 101 - 1,000
☐ >1,000

Have Terrestrial Sensitive Environments Been Identified On or Within 200 Feet of Areas of Known or Suspected Contamination?
☐ Yes
X No

If Yes, List Each Terrestrial Sensitive Environment:

10. Air Pathway

Is There a Suspected Release to Air:
☐ Yes
X No

Enter Total Population On or Within:

On Site	
0 – 1/4 Mile	
>1/4 – 1/2 Mile	
>1/2 Mile - 1 Mile	
>1 - 2 Miles	
>2 - 3 Miles	
>3 - 4 Miles	
Total Within 4 Miles	

Wetlands Located Within 4 Miles of the Site:
X Yes
☐ No
☐ Unknown

Other Sensitive Environments Located Within 4 Miles of the Site:*
☐ Yes
☐ No
X Unknown

List All Sensitive Environments Within 1/2 Mile of the Site:

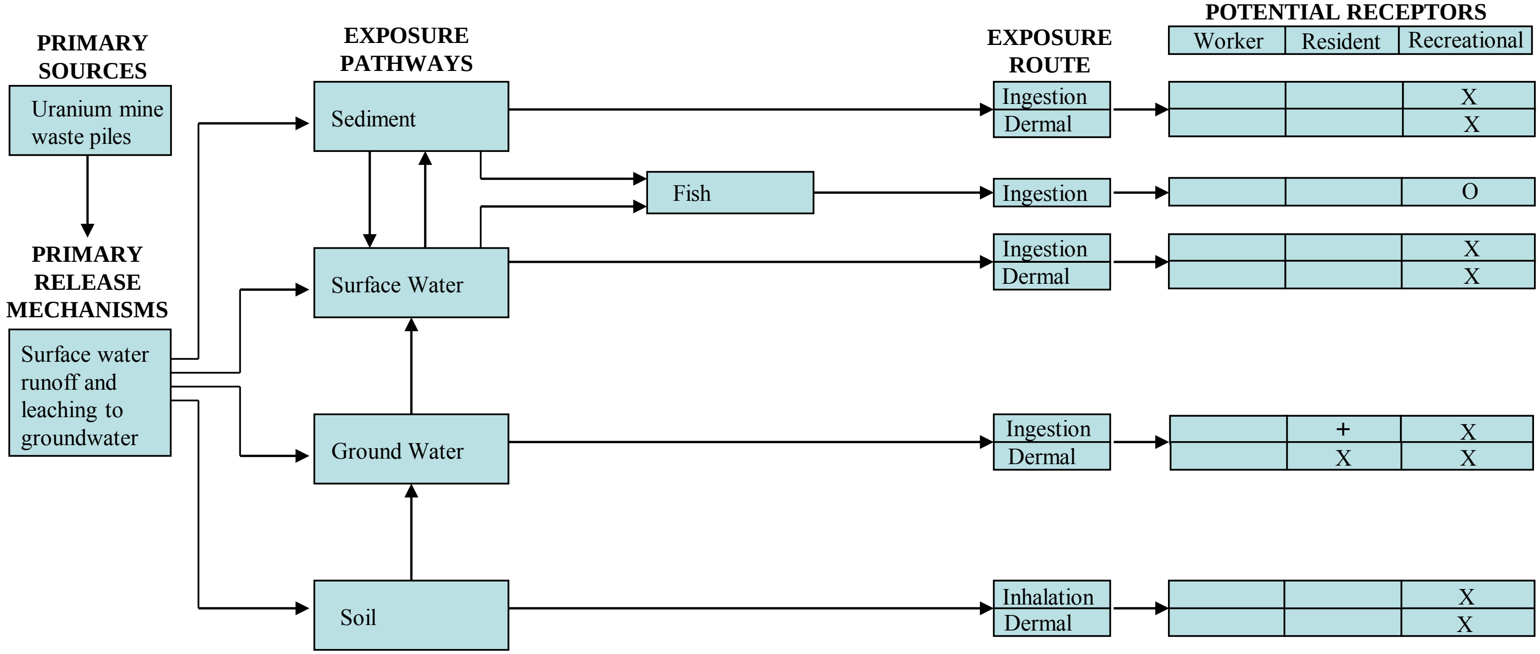
Distance	Sensitive Environment Type/Wetlands Area (acres)
On Site	
0 – 1/4 Mile	
> 1/4 - 1/2 Mile	

APPENDIX E

CONCEPTUAL SITE MODEL

SITE CONCEPTUAL MODEL
DARROW/FREEZEOUT/TRIANGLE URANIUM MINE SITE
EDGEMONT, SOUTH DAKOTA

OST-26



Exposure Pathway	Exposure Route	Worker	Resident	Recreational
Sediment	Ingestion			X
	Dermal			X
Fish	Ingestion			O
Surface Water	Ingestion			X
	Dermal			X
Ground Water	Ingestion		+	X
	Dermal		X	X
Soil	Inhalation			X
	Dermal			X

Legend

	No evaluation required.
O	Pathway is not complete.
X	Pathway is or might be complete but is judged to be minor.
+	Pathway is or might be complete and could be significant.

From:	Jeffery C. Parsons
To:	Shea, Valois
Cc:	"Roger Flynn"
Subject:	RE: Oglala Sioux Tribe Comment Attachments #5.2
Date:	Monday, June 19, 2017 9:48:18 PM
Attachments:	OST-26 Darrow Freezeout Triangle Uranium Mine Site PA Report1.pdf TVA Analysis of Aquifer Tests at the Proposed Burdock Uranium Mine Site Boggs and Jenkins.pdf

Email #5

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:39 PM
To: shea.valois@epa.gov
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

Email #4

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:38 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

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Email #2

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Sent: Monday, June 19, 2017 3:36 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: Oglala Sioux Tribe Comment Attachments

Ms. Shea – in support of the comments submitted this day (June 19, 2017) by the Oglala Sioux Tribe, attached are supplemental documents. As there are several such documents, there are likely to be a series of emails to follow. Thank you.

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Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540

(303) 823-5738
****

From:	Jeffery C. Parsons
To:	Shea, Valois
Cc:	"Roger Flynn"
Subject:	RE: Oglala Sioux Tribe Comment Attachments #6
Date:	Monday, June 19, 2017 6:18:05 PM
Attachments:	So D Horse TVA Draft ES Edgemont U Mine 1979.pdf

Email #6

****
Jeffrey C. Parsons
Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

From: Jeffery C. Parsons [mailto:wmap@igc.org]
Sent: Monday, June 19, 2017 3:43 PM
To: 'shea.valois@epa.gov' <shea.valois@epa.gov>
Cc: 'Roger Flynn' <wmap@igc.org>
Subject: RE: Oglala Sioux Tribe Comment Attachments

Email #5

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Western Mining Action Project
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Email #4

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Jeffrey C. Parsons
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Senior Attorney
Western Mining Action Project
P.O. Box 349
Lyons, CO 80540
(303) 823-5738
****

ENNESSEE VALLEY AUTHORITY

DRAFT ENVIRONMENTAL STATEMENT

Copy

EDGEMONT URANIUM MINE

SUMMARY SHEET
ENVIRONMENTAL STATEMENT
EDGEMONT URANIUM MINING PROJECT

(X) Draft ( ) Final environmental statement prepared by the Tennessee Valley Authority. For additional information, please get in touch with:

Dr. Harry G. Moore, Acting Director
Division of Environmental Planning
268 401 Building
Chattanooga, Tennessee 37401
(615) 755-3161

1. (X) Administrative Action ( ) Legislative Action

2. The proposed action is for TVA to mine, through its operator, the uranium-vanadium deposits located in the Southwestern Black Hills area of Fall River and Custer Counties in South Dakota and in Weston and Niobrara Counties in Wyoming.

3. Construction and operation of the initial underground mines are expected to have the following environmental effects: Dewatering operations will cause a depression of ground water levels in the Lakota Formation which will result in some wells to cease flowing; however, water will still be available by pumping. The impacts on the Fall River Formation because of shaft construction and mining operation will result in a decrease in water levels in wells. Following mining, it is possible that areal potentiometric heads in the Fall River will not recover to pre-mining levels within the affected nearby area because open flow from private wells exceeds recharge under present conditions.

   Some population increase will be caused by the project placing additional pressure on the surrounding communities and counties to provide needed community services. At the same time, state and local revenues will be increased. Specific topographic features near the underground and surface mine sites will be altered. There will be a temporary minor degradation of air quality in the immediate vicinity of the mining operations. There will be a loss of some plant and animal species on the site due to the disruptions of natural habitat. There will be a temporary change in land use from rangeland and forest to mineral extraction during the life of the project.

4. Alternatives of securing uranium ore by other methods were considered, but were found impracticable from standpoints of both scheduling and economics. The alternatives explored showed no ultimate environmental advantage over the proposed project.

5. Alternatives were considered by TVA for the following: siting, mining techniques, and reclamation.

6. Federal Agencies to review are:

   Advisory Council on Historic Preservation
   Council on Environmental Quality
   Department of Agriculture
   Department of Commerce
   Department of Energy
   Department of Health, Education and Welfare
   Department of Housing and Urban Development
   Department of the Interior
   Department of Labor
   Department of Transportation
   Environmental Protection Agency
   Interstate Commerce Commission
   Nuclear Regulatory Commission

   State and local agencies to review are:

   State Planning Coordinator for Wyoming
   State Planning Bureau, South Dakota
   Sixth District Council of Local Governments, South Dakota

7. The draft statement was sent to the Environmental Protection Agency and made available to the public on January 24, 1979.

Table of Contents

a.1

089838

Introduction

The Tennessee Valley Authority (TVA), a corporate agency of the United States,* in order to comply with statutory obligations under the TVA Act to ensure an ample supply of electrical power to the area it serves, has committed to a total installation of approximately 21,500 megawatts of nuclear-fueled generating capacity to be in service by the end of 1986. This capacity will be supplied by 7 plants containing a total of 17 light-water reactors. Browns Ferry, a 3-reactor plant, is now in commercial operation. TVA estimates a requirement of approximately 41.5 million kg (kilograms) (91.5 x 10^6 lb, (pounds)) of uranium oxide (U_3O_8) to meet the nuclear fuel needs for the 17 committed reactors through 1990.

As one of many activities TVA has undertaken to ensure an adequate supply of uranium, TVA purchased, on August 16, 1974, the mineral rights on about 41,000 ha (hectare) (101,000 acre) in Fall River and Custer Counties, South Dakota and Weston and Niobrara Counties, Wyoming (Figure 1.1.1-1). Since that time, minable reserves of uranium have been delineated through the discovery of a major new ore deposit and the extension of existing ore deposits in Fall River and Custer counties. Exploration on the subject properties is continuing and the identified reserves of uranium are expected to increase.

TVA, through its operator, proposes to mine the uranium/vanadium ore deposits in the project area. Mining is scheduled to begin in late 1979.

---

*TVA was created by the Tennessee Valley Authority Act of 1933 (48 Stat., 58 as amended, 16 U.S.C. SS 831-831dd (1970; Supp. VI, 1976))

1. Proposed Action

TVA proposes to mine, through its operator, the uranium/vanadium ore deposits in its mineral properties located in the southwestern Black Hills area of Fall River and Custer Counties, South Dakota and Weston and Niobrara Counties, Wyoming. Both surface and underground mining methods will be used to extract the ore. Plans are to begin construction of underground mine support facilities in mid-1980, followed immediately by shaft sinking. Total employment for the mining operation should reach 140 people including supervisory and technical staffs. Only one deposit recoverable by surface mining has been identified and plans are to hold this lower grade ore for blending with ores from the underground mines.

Current calculations indicate that in excess of a 5-year supply of reserves at a rate of 2.04×10^5 t (tonne) (2.25×10^5 ton) per year, with a minimum of 1.18×10^6 t (1.3×10^6 ton) of ore, containing 1.9×10^6 kg (4.3×10^6 lb) of uranium oxide (U_3O_8) underlies these properties. Exploration and development drilling are continuing and it is anticipated that these reserves may significantly increase through discovery of additional ore bodies and extensions of presently known deposits. In addition, reclassification of sub-ore grade material to ore grade material may result from changes in economics and improved technology. Based on indicated ore reserves and area potential, mining is expected to continue for about 10 years at a rate of approximately 2.04×10^5 t (2.25×10^5 ton) of ore per year. The weighted average geological grade of known uranium ore considered economical for extraction is 0.17 percent U_3O_8. All reserves which can be economically recovered will be mined.

1 kg = 2.2 lb

Typo

?

1.9×10^6 kg

$\neq 4.3 \times 10^6$ lb

089840

1.1 Mining

1.1.1 Mine Site Location - All of the proposed mine site locations delineated are located in western Fall River and southern Custer Counties in South Dakota. These sites are within 24 km (kilometer) (15 mi (miles)) of Edgemont, South Dakota. The Edgemont Uranium Mining Project encompasses approximately 41,000 ha (101,000 acre) of uranium property, consisting of 151 claim groups, 23 state leases, and 65 private leases. (Figure 1.1.1-1.) As planned, the initial shaft for the underground mine, Burdock, will be located on the Francis Peterson Lease in Section 15, T7S, R1E (Township 7 South, Range 1 East); the surface mine, the Spencer-Richardson, is located on the Bud Claims in Section 35, T6S, R1E.

1.1.2 Mining Techniques

1.1.2.1 Underground Mining - Because of the depth and size of the uranium ore bodies, underground mining is considered by TVA as the most feasible method of extracting the ore contained in the Burdock, Darrow, and Runge East deposits. (Figure 1.1.1-1.) The Burdock deposit, which comprises most of the reserves, will be developed and mined from shafts, the first of which is scheduled for construction in late-1980. Minor production is anticipated from the Darrow and Runge East deposits; however, additional drilling is necessary to further delineate these reserves. These deposits will not require extensive development for production because development will be limited to the extension of existing mines. Production from these mines is scheduled for 1981.

Burdock Development and Mining - Two shaft sites have been selected near Burdock. The possibility of a third shaft is being considered, and others may be required as development drilling and mining progress. The shafts will be positioned adjacent to known ore deposits and downdip from them to facilitate water drainage. The rock units that will be penetrated by the shafts will be cored to determine their structural characteristics. Each shaft site will be leveled and prepared for surface facilities. (Figure 1.1.2.1-1.) Roads will be upgraded and all utilities will be made available to service the mine. The initial 4.3 m (Meter) (14 ft (foot)) diameter production shaft at Burdock will extend to a depth of approximately 180 m (600 ft) and the second approximately 130 m (425 ft). One station will be cut about 15 m (50 ft) above the bottom of each shaft to handle men, material, and rock. Figure 1.1.2.1-2 depicts a generalized underground uranium mine and support facilities.

Hydrologic tests have been conducted to determine the water quality and quantity expected in the mines. Plans call for a partial dewatering of the shaft area by two or three wells. (See Section 2.5 for location.) Dewatering may commence up to six months before penetration of the target aquifer by the shaft. These wells are 20 cm (centimeter) (8 in (inch)) or larger in diameter and will each be pumped at an average rate of 14.2 l/sec (liter/second) (225 gal/min (gallon/minute)). Additional water wells may be necessary to ensure greater recovery of ore and for safety of operation personnel.

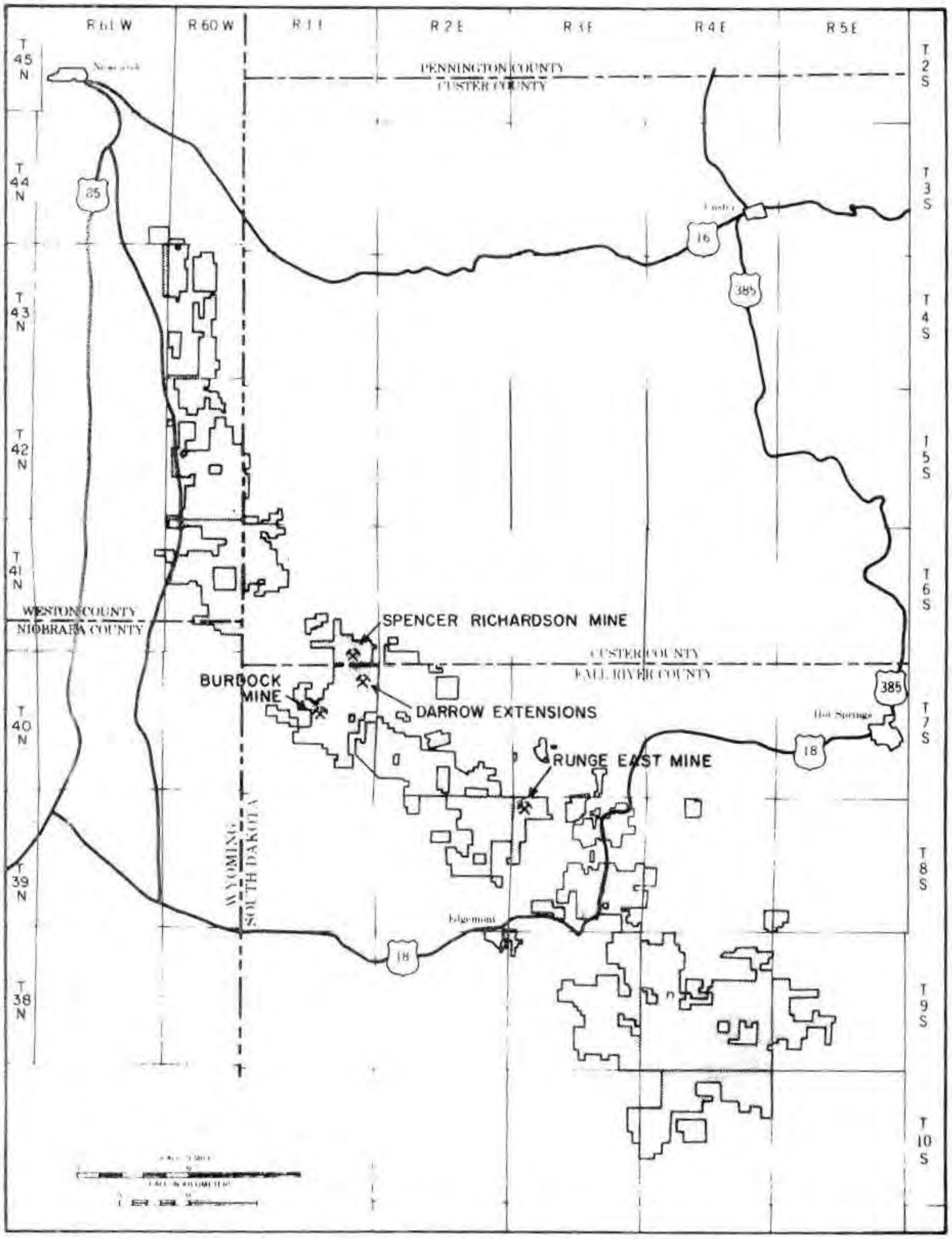

Figure 1.1.1-1 Regional Location of TVA's Edgemont Uranium Mining Project

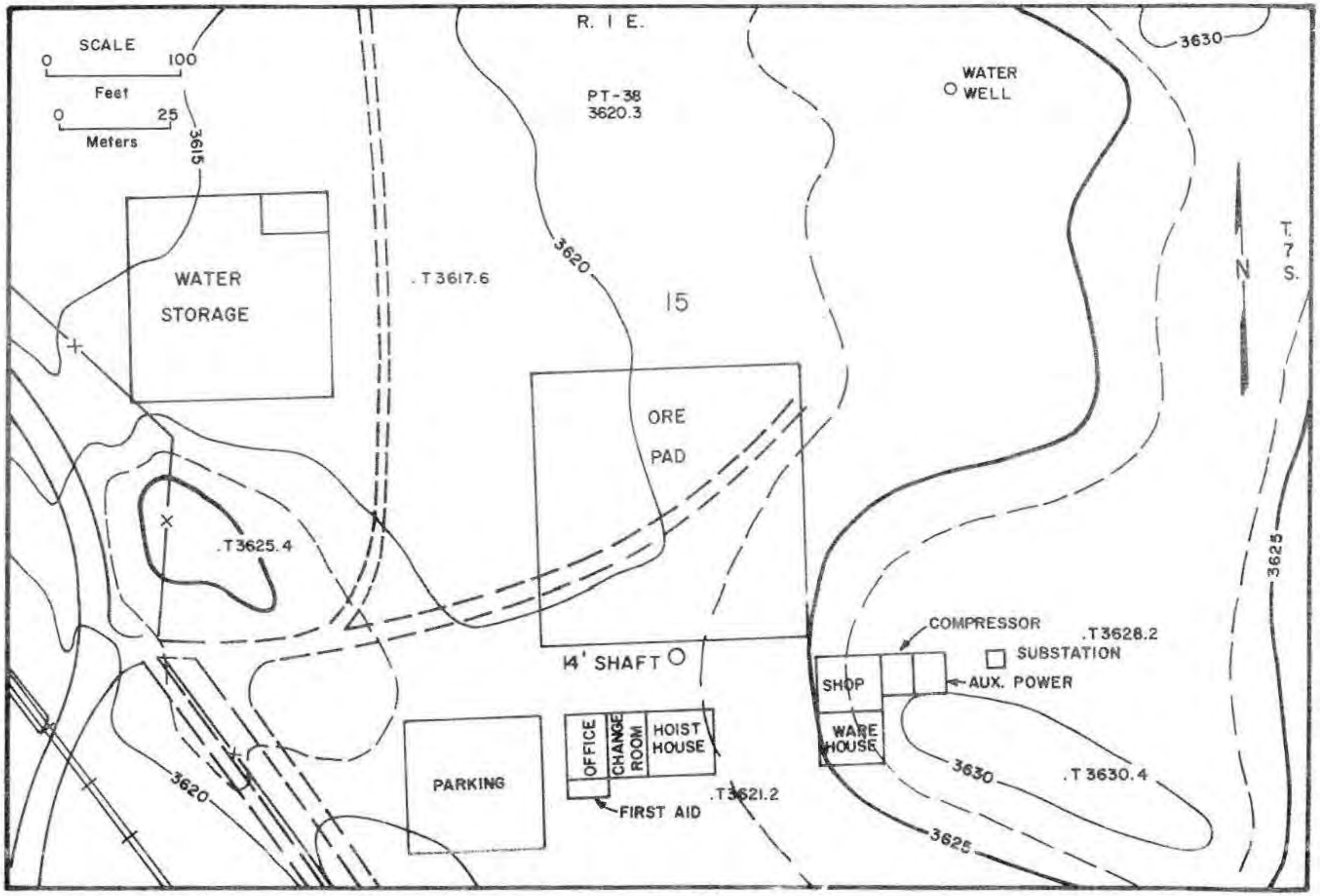

Figure 1.1.2.1-1 Proposed Initial Shaft Site Layout

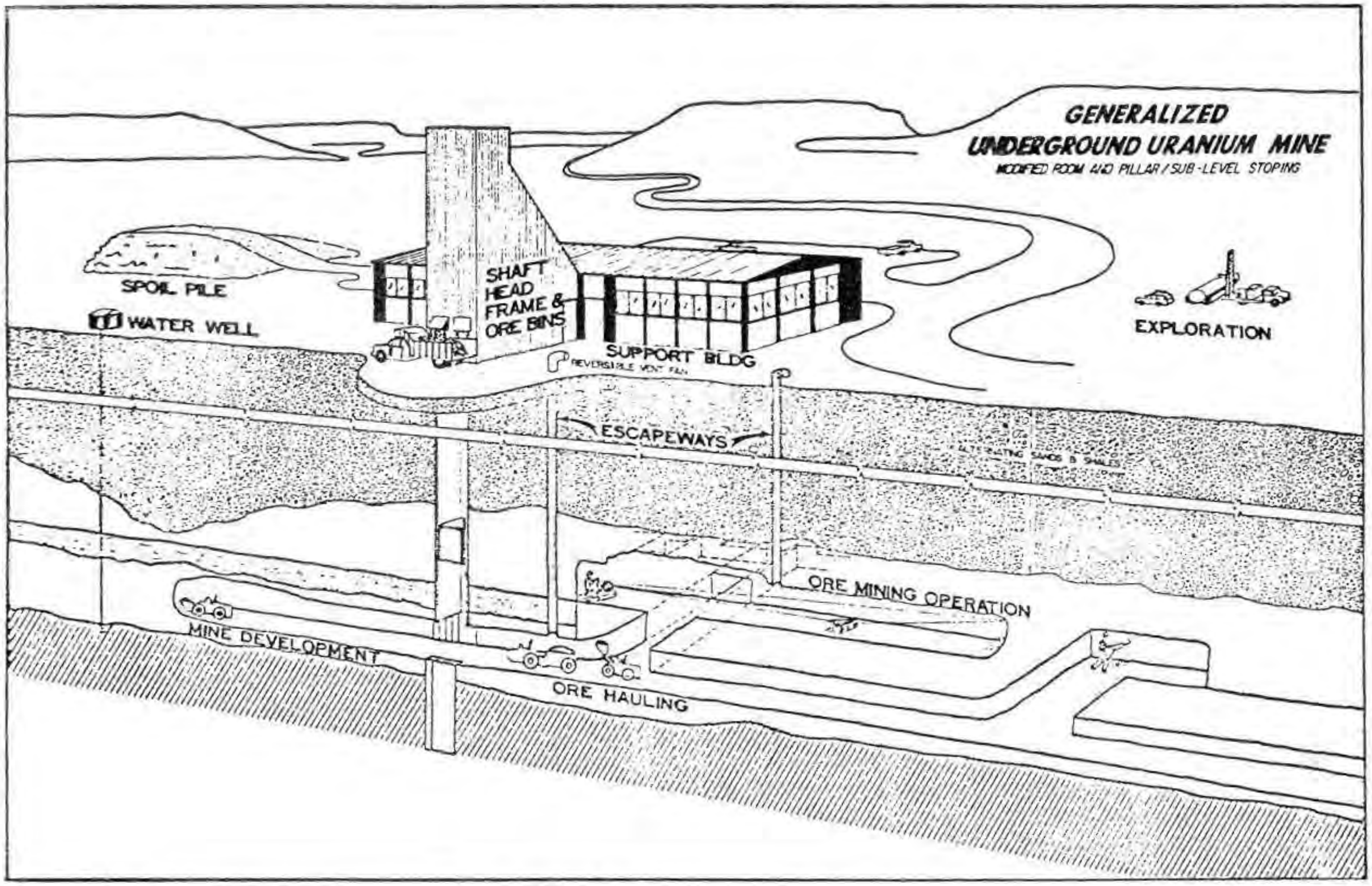

Figure 1.1.2.1-2 Trackless Haulage

At least three 1.2 m (48 in) diameter ventilation shafts are planned with one located within 91 m (300 ft) of the initial production shaft. The ventilation shaft will be equipped with surface hoisting facilities and used for emergency escape. Additional ventilation shafts will be positioned along the axis of the ore deposit in conformance with 30 CFR 57.5 (Air Quality, Ventilation, Radiation and Physical Agents). Refuge chambers and additional escapeways through ventilation shafts will be provided in conformance with 30 CFR 57.11-50.

As necessary, longholes will be drilled to delineate the ore body and to assist in dewatering the ore horizon. Mine water will be drained to a sump in the station where it will be pumped to the surface. Ore production from the stoping operation can begin as soon as sufficient mine development has been completed.

Major equipment to be used underground and in surface support facilities for each shaft is listed in Table 1.1.2.1-1. The ore will be transported to the shaft stations where it will be hoisted to the surface. Waste material will be handled in a similar manner. At the surface, it will be automatically dumped and transported to storage areas.

Permanent roof supports in the mine will consist of timber sets, roof bolts, wire mesh, steel arches, and shotcrete These supports will be used in the main haulage drifts and shaft stations and as required in the mining areas.

Mine ventilation will be provided by axivane-type blowers mounted in the ventilation shafts. Plans are to draw air down the ventilation shafts, through the mine and out the production shafts. The total ventilation rate for each production shaft is estimated to be 3,400 m^3/min (120,000 ft^3/min). Provisions will be made to allow for reversal of the direction of ventilation flow, if required in an emergency.

It is estimated that approximately 100 people (excluding supervisory and technical staff) will be employed in the underground mining operation. A 2-shift, 5-day workweek is planned for ore production. It is expected that shaft sinking and development will be on a 3-shift, 7-day workweek.

Other Underground Mines - Based on present knowledge of ore reserves, less than 5 percent of the total production of the project is expected from the Runge East and Darrow deposits. Detailed mine plans will be prepared after the extent of the deposits is determined by additional drilling. Both mines will be further developed when ore production from them is needed. Mining of the Runge East, an existing mine developed by means of a decline, will involve about 4 ha (10 acre) of surface disturbance for constructing or upgrading support facilities. Mining of the Darrow deposits will be accomplished through a series of adits developed into existing pit walls along ore trends. The five existing pits and associated surface facilities cover approximately 125 ha (310 acre); no significant new surface disturbance should be necessary for mine development.

1.1.2.2 Surface Development and Mining - A schematic open pit mining operation is shown in Figure 1.1.2.2-1. The only proposed surface mining operation is the Spencer-Richardson mine,

Table 1.1.2.1-1

Burdock Mining Equipment
(Partial List Per Mine Shaft)

Underground	No.	Operating Frequency (Hrs/Day)	Specifications	Fuel Requirements
Pumps	4	12	150 HP, 450 gal/min	
Loaders	3	10	2 yd^3, 78 HP Diesel	19 l/hr (5 gal/hr)
	1	6	14 m^3/min (500 ft^3/min) Air	
	3	10	50 HP Electric	
Trucks	4	10	4 yd^3, 76 HP Diesel	19 l/hr (5 gal/hr)
Locomotive	1	6	4.5 tonne (5 ton) Battery	
Drills	20	6	3 m^3/min (100 ft^3/min) Air	
	2	10	8 m^3/min (300 ft^3/min) Air	
Fans	12	24	15 HP, Electric	
	3	24	30 HP, Electric	
Slushers	10	6	25 HP, Electric	
	5	6	10 HP, Air	
	1	10	50 HP, Electric	
Surface				
Hoists	1	10	300 HP, DBL Drum	
	1	10	400 HP, Sal. Drum	
	1	-	Escape Hoist	
Compressors	2	16	350 HP, Electric	
Dewatering Well Pumps	3	24	Electric 50 HP, 225 gal/min	

Table 1.1.2.1-1 (Continued)

Surface	No.	Operating Frequency (Hrs/Day)	Specifications	Fuel Requirements
Ventilation Fans	2	24	150 HP, Electric	
Auxiliary Generators	1	Standby	675 KW, Diesel	
Haul Trucks	1	10	300 HP, Diesel	19 l/hr (5 gal/hr)
Heating Plant	1	0-24	400,000 BTU/Hr	11 l/hr (3 gal/hr)
Utility Truck	1	10	2.7 tonne (3 ton)	11 l/hr (3 gal/hr)
End Loader	1	10	5 yd^3, Diesel	11 l/hr (3 gal/hr)
Road Grader	1	8	225 HP, Diesel	11 l/hr (3 gal/hr)
Forklift	1	8	50 HP, Diesel	8 l/hr (2 gal/hr)

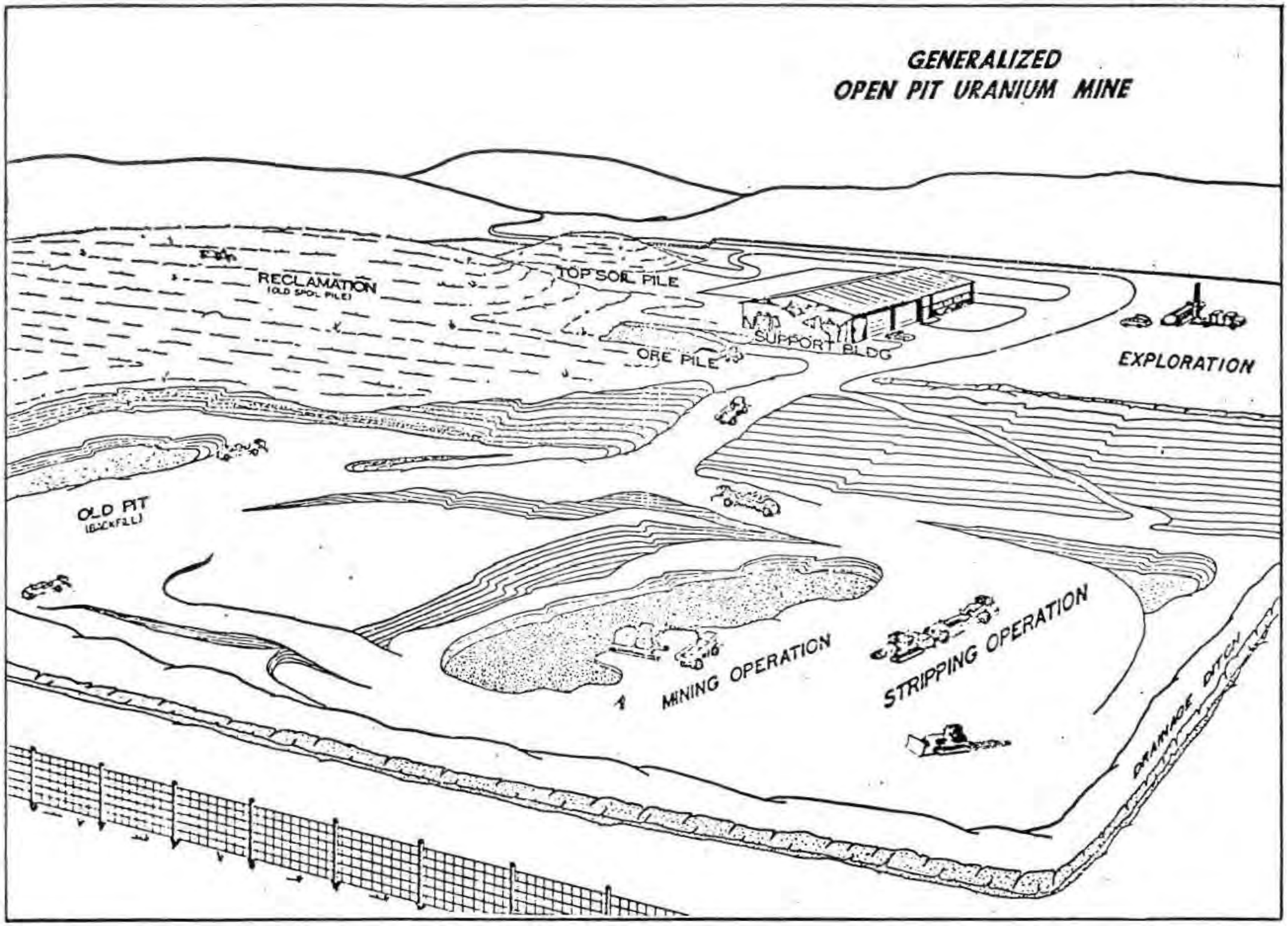

Figure 1.1.2.2-1

an existing open pit where approximately 70 percent of the overburden was removed by the previous owner of the mineral rights. This deposit will be held as a contingency reserve to be mined when necessary to maintain production schedules. Exploration and development drilling is continuing and additional surface mining areas may be delineated.

Where feasible for the existing open pit, topsoil and suitable subsoil will be segregated from the other overburden and stockpiled. Conservation measures will be taken to control erosion. If the stockpiled material is not to be used for an extended period of time, it will be seeded within 5 months to provide temporary cover and stabilization. (See Section 3 for more details.)

In the initial pit, which presently occupies approximately 8.1 ha (20 acre), the remaining overburden will be removed with bulldozers and scrapers; extensive blasting is not anticipated. Removed overburden will be placed on a nearby existing spoil pile. All material moved e.g., waste, ore, topsoil, etc., will be placed in separate piles and conspicuously marked as to content.

Ore production will commence following overburden removal. Proposed surface mining equipment is listed in Table 1.1.2.2-1. Each truck-load of material will be sampled and assayed to determine the ore grade and will then be hauled to the proper stockpile or waste area. Under certain circumstances it may be necessary to drive adits into the wall of the open pit to recover ore from small, narrow trends. The adits will be timbered, with portal sets extending into the open pit to provide adequate protection against pit wall sloughing. Adits are commonly driven by conventional drilling and blasting techniques directly along the ore trends. All material handling is typically accomplished by diesel-powered load-haul-dump vehicles with built-in scrubbers.

A work force of approximately 10 people (excluding supervisory and technical staff) will be employed in the open pit development and ore production operation. This operation is expected to require 6 months.

1.1.3 Surface Facilities

Mine Water Installations - During the development and mining phases of the underground workings, water from underground dewatering will be pumped to the surface and directed to holding ponds to reduce sediments. Based on subsurface hydrologic studies, it is estimated that dewatering will produce 28.4 to 42.6 l/sec (450-675 gal/min). A permit is being applied for under the National Pollutant Discharge Elimination System (NPDES), as implemented by the South Dakota Environmental Protection Agency. If the water meets applicable requirements, as will be delineated in the NPDES permit, it will be discharged into local drainages. Otherwise, it will be treated in conformance with the NPDES permit prior to release.

A drainage system will be built and maintained to minimize the accumulation of surface water and to control runoff at the Spencer-Richardson mine. The system will include:

Table 1.1.2.2-1

Surface Mine Machinery

Equipment	Number	Operating Frequency (hrs/day)	Specifications	Fuel Requirements
Scrapers	2	8	420 HP Diesel	57 l/hr (15 gal/hr) each
Hydraulic Backhoe	1	8	130 HP Diesel	38 l/hr (10 gal/hr)
Tractor	1	8	240 HP Diesel	57 l/hr (15 gal/hr)
Ore Trucks	1	8	300 HP Diesel	57 l/hr (15 gal/hr)
Utility Truck	1	8	175 HP Diesel or Gasoline	11 l/hr (3 gal/hr)

- Dikes and ditches to direct surface runoff away from the open pit area.
- Drainage ditches constructed below the spoil piles to collect runoff.
- Sump pumps and piping systems to remove water from the floors of the open pit mines if required.
- Dikes around impervious ore pads.

Figure 1.1.3-1 shows a typical layout of surface-water control facility in an open pit mine and waste dump area.

Roads - Access to the proposed underground and open pit mine locations will be provided by existing dirt and asphalt roads. However, some will require upgrading and widening. All roads will have culverts where they cross major drainage channels; drainage ditches will be constructed alongside the roads. Unpaved roads will be sprinkled as weather and ground conditions require to control dust.

Utility Services - The utility requirements for the proposed mines and their surface support facilities include electric power, telephone, industrial and potable water, and sanitary sewage disposal.

It is expected that electric power required at the underground sites will be supplied via a 14.4/24.9 kV (kilovolt) primary transmission line. A transformer substation will be installed in the vicinity of the initial underground mine site to supply required voltages for use at the underground mine. The estimated connected electrical load at the underground mine sites is 3,500±500 kVA (kilovoltampere). All underground and surface mining electrical installations will comply with Mine Safety and Health Administration (MSHA) standards.

Natural gas is not available near any of the mine sites and propane will be used where necessary. No. 6 fuel oil is planned for space heating use.

Offices at Edgemont are serviced by the Peoples Telephone and Telegraph System. Current and future field communications will utilize telephone and radio with the base station located at the Edgemont offices. Telephone routing has not yet been established. At the underground mine sites, communications between the shaft stations and surface will be by telephones and a bell system. These communications systems will comply with MSHA safety regulations.

It is anticipated that industrial water required at the underground mine will be provided by dewatering discharge which will be treated as necessary. Industrial water, will be utilized in the mine operations for dust suppression on active haul roads. Maximum use of water for dust suppression may approach 22,800 l/d (6,000 gal/d) during the summer period. Little of this water will run off because of the porous nature of the materials used to upgrade the haul roads. Potable water will be supplied from an approved source.

An approved sanitary sewage system consisting of a combination of septic tanks, sewage lagoons and/or another acceptable system will be constructed at the Burdock underground

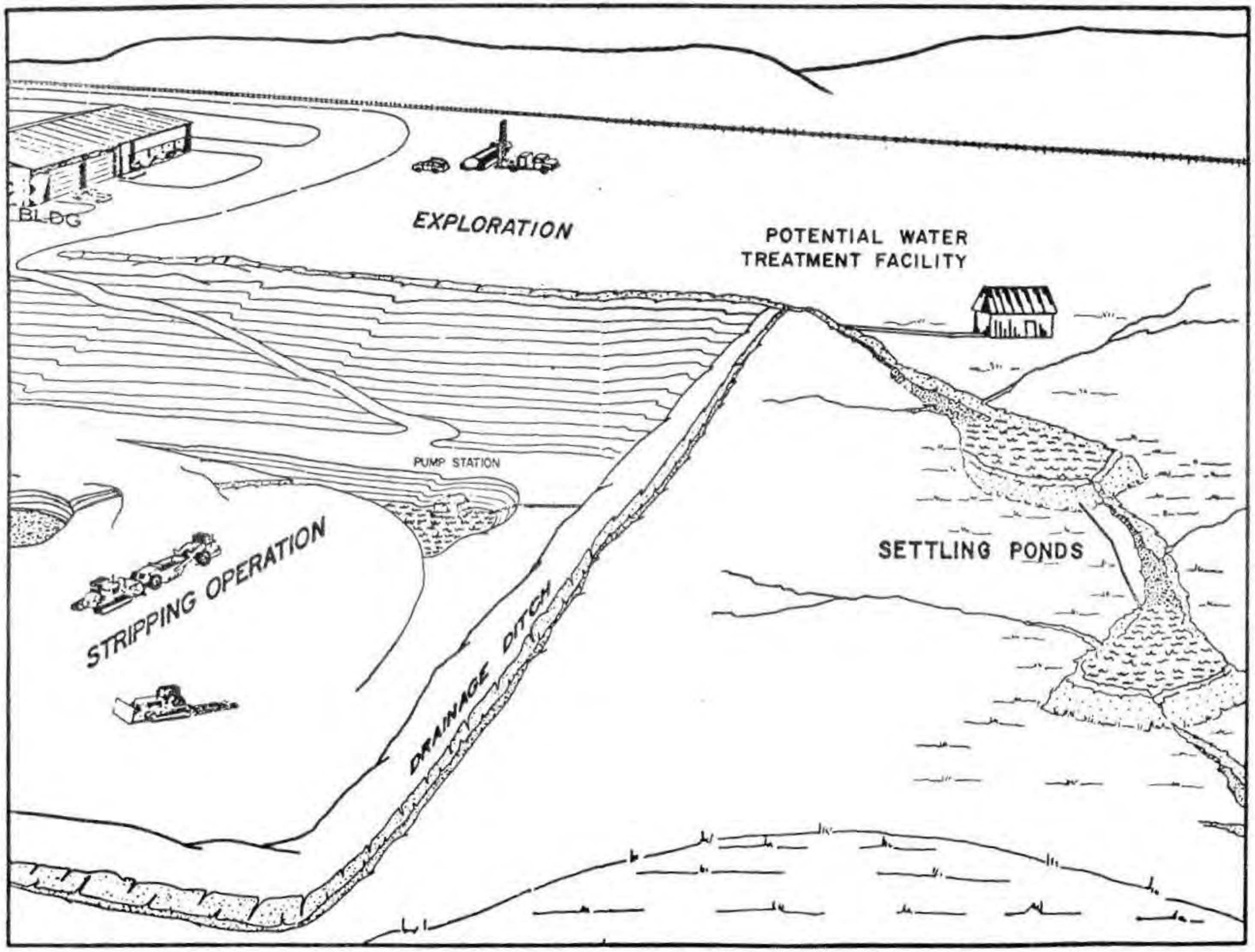

Figure 1.1.3-1 Generalized Water Treatment Facility

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site. This facility will accommodate in excess of 19,000 l (5,000 gal) of sanitary sewage daily. At the other proposed mine sites, portable toilet facilities will be provided.

Office and Shop Buildings - Present plans call for several single story steel paneled buildings to be constructed at each Burdock shaft site. They will be set on concrete slab foundations with approximately 929 m^2 (10,000 ft^2) of floor space. The buildings will contain hoists, mine offices, change rooms, warehouse, shops, mine rescue and first aid station, compressors, and auxiliary power.

A 26 m (85 ft) high head frame will be erected. It will be fabricated steel, and will support three sheave wheels. Skips will dump ore and waste material into a surge bin in front of the head frame to be trucked to separate storage areas. One compartment in the main shaft will be an emergency escapeway equipped with a ladder. Explosives magazines will be located on the surface in compliance with Federal and state requirements. These will provide safe storage for explosives required by the project.

Mine Ore Control Facilities - Adequate facilities equipped with ore sample dryers, pulverizers and beta-gamma or X-ray detection units, used to determine ore grades and to maintain ore stockpile control, will be located adjacent to mines and/or mine haulage roadways.

Fixed Equipment - There is no proposed major fixed, energy-consuming equipment planned for the surface mining operation. Major fixed, energy consuming equipment at the initial underground shaft site is shown in Table 1.1.2.1-1.

On-Highway Support Equipment - About 40 vehicles will be used on the project, consuming approximately 325 l/d (85 gal/d) of gasoline.

1.1.4 Health and Safety - The proposed mine will operate under applicable Federal mine safety regulations. New employees at the mines will be given initial training in safety rules and safe working procedures.

First aid training will be made available to all employees. Fire prevention and fire-fighting instruction will also be given.

All underground employees will be instructed in the use of self-contained respirators and on the location of mine escape routes and procedures applicable in the event of mine fires or other emergencies.

A mine rescue team will be selected, trained, and available for rescue operations at any of the shafts.

On the surface, selected ventilation shafts will be equipped with an emergency hoist and torpedo-shaped man cage. Each shaft site and ventilation shaft will have a 1.83 m (6 ft) chainlink fence on the perimeter to prevent inadvertent access by livestock and humans.

1.1.4.1 Fire Control - All surface structures within 30.5 m (100 ft) of each shaft will be constructed with fireproof materials. The headframes will be structural steel. Any nonfireproof structures will be placed more than 30.5 m (100 ft) from the shaft. The areas surrounding the surface building will be kept clear of combustible materials. Fuel and lubricating oils will be stored at least 30.5 m (100 ft) from any mine opening and will be surrounded by retention dikes capable of retaining 110 percent of the volume of the storage tanks.

Shaft lining will be concrete and supporting frameworks within the shafts will be steel. Where timber is used for sets and lagging at the shaft access station, the timber will be treated with fire-resistant coatings. Where fire doors are used underground, they will be constructed of steel.

Underground storage of lubricating oils and diesel fuel will comply with applicable Federal regulations regarding quantity and location.

Water for firefighting will be available throughout the active areas of the mine. Fire extinguishers will be available at the shaft stations, shops, and storage areas for fuel and lubricating oils. Extinguishers designed for electrical fires will be placed near the electrical substations. Each diesel-powered locomotive will carry a fire extinguisher for use on diesel fuels. Routine inspections will be made of all in-place extinguishers, and used extinguishers will be replaced immediately. All personnel will receive instruction in the use of each type of fire extinguisher.

Emergency exits from each mine will be provided at selected ventilation shafts by means of emergency hoists with man cages. At several locations within the mine, rescue chambers will be constructed. Each chamber will contain food, air, and potable water.

1.1.4.2 Ground Control - Ground control (support) practices at each mine site will be tailored to the particular geological conditions that exist at that site.

During the driving of drifts, temporary supports consisting of jacks with headboards or stulls with headboards will be used until permanent supports can be installed. Permanent support, where required, will be installed within 3 m (10 ft) of the drift face. For roof support in haulage drifts and other permanent mine openings, roof bolts in conjunction with wire mesh will generally be used. Steel sets will be used in large openings near the shaft station. Timber sets will be used for temporary support and, where practical, for permanent support. In mined-out areas of the mine where ground conditions present a hazard, induced caving of the roofs may be employed. Also waste rock from other areas of excavation may be used as backfill material in excavated areas where caving would not be desirable.

Compliance with all applicable Federal Mine Safety regulations will be maintained.

1.1.4.3 Radiation - The Mine Safety and Health Administration (MSHA) requires that when radiation measurements in areas where personnel are working indicate exposure to concentrations of radon daughters in excess of 0.3 working level (WL), complete individual exposure records shall be kept for all employees entering these areas. A working level is defined by 30 CFR 57.2 as follows:

> In those standards which relate to radiation, a working level" (WL) means any combination of the short-lived radon daughters in one liter of air that will result in the ultimate emission of 1.3 x 10^5 MeV (million electron volts) of potential alpha energy, and exposure to these radon daughters over a period of time is expressed in terms of "working level months" (WLM). Inhalation of air containing a radon daughter concentration of 1 WL for 173 hours results in an exposure of 1 WLM.

In order to maintain concentrations less than a 0.3 WL, the ventilation program will be regularly updated; and every area of the mine where men are working will be checked for radon or its short-lived daughters on a scheduled basis and spot checked when necessary. Radon (daughter) checks will be made in compliance with federal regulations at all working areas throughout the underground mine. Individual radon (daughter) exposure records will be kept up-to-date monthly, based on the results of the periodic readings. Records will be made available for inspection at the Safety Director's office at any time.

2. Environmental Description, Impacts, and Interim Mitigation

2.1 Land Use

2.1.1 Description - Land use for Fall River County is shown on Figure 2.1.1-1 and statistics which were derived from the map are contained in Table 2.1.1-1.[1] The predominant land use is rangeland (85 percent) with the remaining consisting mostly of forest (11 percent) and cropland (3 percent). The county is very sparsely settled as indicated by the average population density of 1.9 persons/km^2 (5 persons/mi^2). A combination of the population and land areas of Edgemont and Hot Springs results in a rural population density of 0.4 persons/km^2 (one person/mi^2).

2.1.2 Impacts - Mining activities will disturb and/or restrict the use of 32 ha (80 acre) of shrubland, woodland, and grassland. Rangeland and forest total over 404,700 ha (1 x 10^6 acre) so the small amount temporarily impacted will have no significant effect on land use in Fall River County. Further, because of the sparse settlement pattern, the operation should have no significant effect on inhabitants (see Section 2.10). After production, the reclamation procedures should result in land uses which would be essentially the same as present uses; thus no permanent impacts are expected.

The only planned mining activity outside Fall River County will be the surface mining operation at the existing Spencer-Richardson open pit mine which occupies 8.1 ha (20 acre) in Custer County, less than 1 km (.6 mile) north of the Fall River County line (refer to Figure 1.1.1-1). No additional land disturbance is expected from this mining operation and therefore, no land use changes will occur.

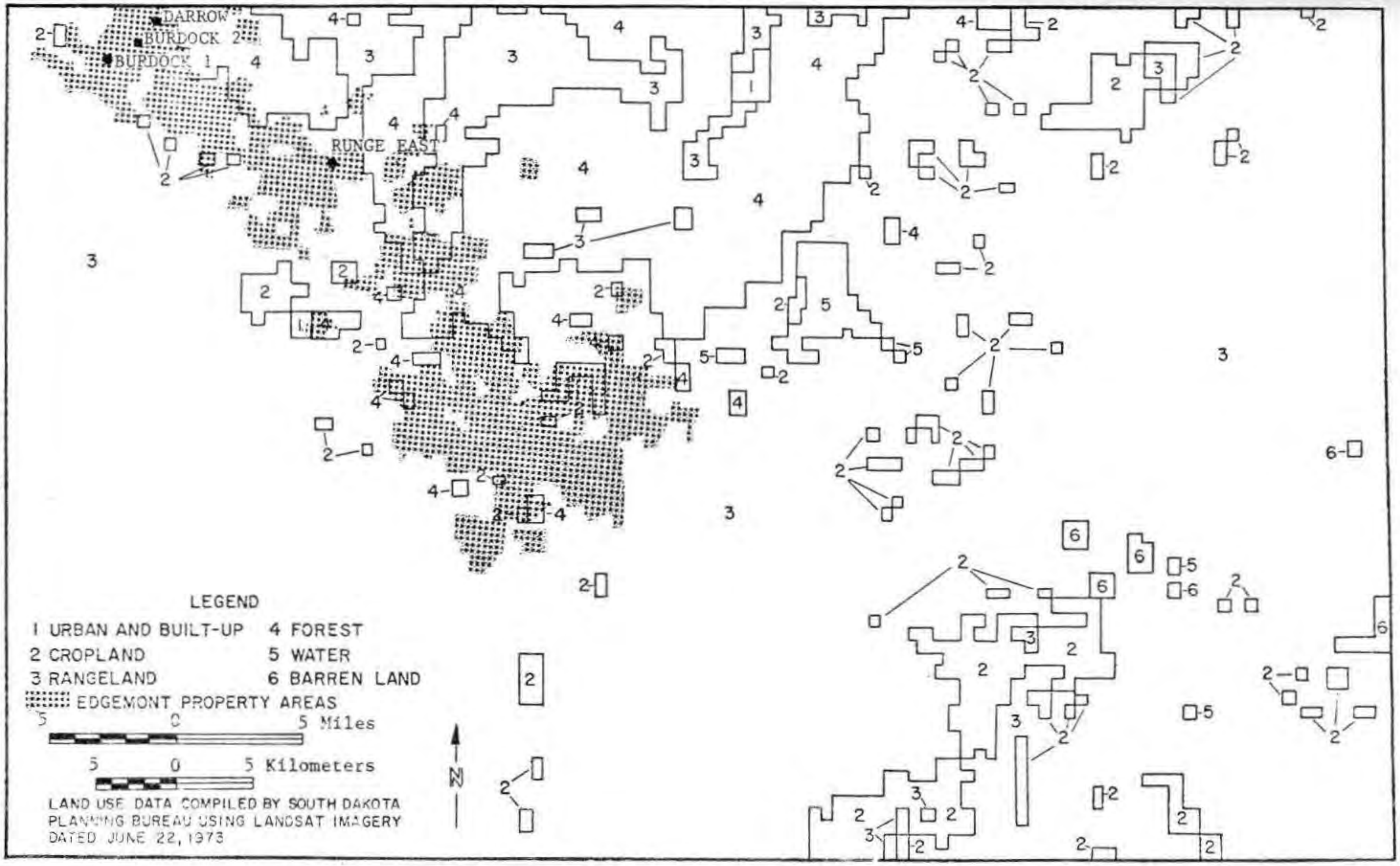

Figure 2.1.1-1 Existing Land Use Fall River County

Table 2.1.1-1

Fall River County Land Use

1973*

	Acres	Percent
Urban and Built-Up	1,920	0.2
Cropland	33,600	3.0
Rangeland	947,520	84.9
Forest	122,880	11.0
Water	6,240	0.6
Barren Land	3,520	0.3
Total	1,115,680	100.0

*Land use data is based on interpretation of LANDSAT scene 1334-17130 taken June 22, 1973. The interpretation and estimations were prepared by the South Dakota State Planning Bureau.

2.1 References

1. Loveland, Thomas A. Land Use Data Analyst. South Dakota State Planning Bureau, letter and enclosure to George DeVenny, TVA. November 8, 1977.

C.1.

2.2 Geology

2.2.1 Geomorphology - The Edgemont project is located on the southwest flank of the Black Hills Uplift in the southwest corner of the State of South Dakota. Flat to rolling topography, deep intersecting canyons, numerous small mesas, cuestas, and hogbacks characterizes the area which is drained by the Cheyenne River and its tributaries. Elevations in the project area range from 1,006 m (3,300 ft) in the low areas of the Cheyenne River Drainage to 1,417 m (4,675 ft) at the crests of the surrounding ridges. In the project area, the local relief is about 75 m (250 ft).

2.2.2 Stratigraphy - The stratigraphy of the southwestern flank of the Black Hills Uplift is composed of a sequence of rocks which range in age from Precambrian to Recent (Table 2.2.2-1). Precambrian rocks outcrop near the center of the Black Hills Uplift and progressively younger rocks outcrop southwesterly to the Powder River Basin. Within the project area, the outcropping rocks range in age from Jurassic to Recent (Table 2.2.2-2).

To date, all of the economically significant uranium occurrences are contained within the Fall River and Lakota Formations of the Inyan Kara Group of Lower Cretaceous age (Figure 2.2.2-1). The Lakota and Fall River Formations were deposited in continental and marginal marine environments, respectively. The Inyan Kara Group is composed of subequal amounts of complexly interbedded and intertonguing sandstones and claystones.[1] The Inyan Kara Group is underlain by continental sedimentary rocks of the Morrison Formation of Jurassic age and is overlain by the marine Skull Creek Shale of Lower Cretaceous age. Resistant Inyan Kara sediments form the outermost hogback ridges circumscribing the Black Hills.[2]

2.2.3 Geologic Structures - The project area is on the southwest flank of the Black Hills Uplift, an elongate north-west trending dome of Laramide age about 200 km (125 mi) long and 97 km (60 mi) wide.[3] To the west and southwest of the project area is the Powder River Basin.[4] Superimposed on the Black Hills Uplift are numerous folds plunging radially outward. Within the project area, local structures of this type are the Chilson Anticline and Sheep Canyon Monocline east of the community of Edgemont, and the Cottonwood Creek Anticline trending southwest from the community of Edgemont (Figure 2.2.2-1). The regional dip of the sedimentary rocks in the project area is 2 to 4 degrees southwesterly.

Two major structural zones, Dewey and Long Mountain, are conspicuous within the project area (Figure 2.2.2-1). These structural zones consist principally of a number of *en echelon* faults. Two subordinate fracture systems are prevalent within the project area. One set of fractures strikes about N 30-60 degrees W and the second set strikes about N 30-60 degrees E. Movement along the fractures appears to have been less than 2 m

Table 2.2.2-1

Generalized Stratigraphic Section of the Black Hills

(Modified from the Geologic Map of South Dakota by N. H. Darton 1951)[2]

Age	Formation	Description
Upper Cretaceous	Pierre shale	Dark shale
Upper Cretaceous	Niobrara	Impure chalk and limy shale
Upper Cretaceous	Carlile shale	Dark shale
Upper Cretaceous	Greenhorn limestone	Limestone
Upper Cretaecous	Belle Fourche and Mowry Shales	Dark shales
Lower Cretaceous	Skull Creek Shale, Inyan Kara Group Fall River, Lakota	(See Table 2.2.2-2)
Jurassic	Morrison	Shale, mostly gray; sandstone and limestone
Unconformity		
Jurassic	Sundance	Greenish shale, buff, and red sandstone
Triassic (?)	Spearfish	Red sandy shale and sandstone; gypsum members
Permian	Goose Egg Formation Minnekahta Member Opeche Member	Limestone Red sandy shale
Pennsylvanian	Minnelusa	Gray, red, and buff, sandstone, mostly limy; red shale at base
Mississippian	Pahasapa & Englewood	Limestone Limestone
Unconformity		
Ordovician	Whitewood	Limestone
Unconformity		
Upper Cambrian	Deadwood	Sandstone, shale, congomerates
Unconformity		
Precambrian		Igneous and Metamorphic Rocks

Table 2.2.2-2

Generalized Stratigraphic Section
for the Project Area

Age	Formation	Member	Thickness meters (feet)	
Quaternary	Alluvium & Terrace Deposits		0-2 (0-5)	Alluvial sand, gravel, and clay.
Cretaceous	Mowry Shale		0-30 (0-100)	Gray, siliceous shale and many thin bentonite beds.
Cretaceous	Newcastle Sandstone		0-12 (0-40)	Sandstone, gray and brown shale, and some bentonite and shaly coal.
Cretaceous	Skull Creek Shale		0-60 (0-200)	Grayish-black shale and a few thin beds of sandstone.
Cretaceous	Fall River Formation	Upper	12-36 (40-120)	Variegated mudstone at the base overlain by fluvial sandstone and its fine-grained equivalents. Highly argillaceous and is characteristically mottled red and gray.
		Middle	10-34 (30-110)	Typically fine-grained fluvial sandstone and the associated marginal fine-grained deposits cemented with calcite and silica. Forms prominent vertical cliffs in canyons.
		Lower	0-16 (0-50)	Principally laminated micaceous carbonaceous siltstone interlayered with thin fine-grained slightly micaceous sandstone. Commonly stained brown or yellowish brown on outcrop.
Cretaceous	Lakota Formation	Fuson	12-18 (40-60)	Typically gray to black to maroon non-calcerous bentonitic shales. Internal sand lenses are common.
		Minnewaste Limestone	0-4 (0-10)	White to gray massive limestone commonly highly brecciated and recemented with calcite. Generally considered to be lacustrine in origin.
		Chilson	30-46(100-150)	Complex intertonguing of sandstones, siltstones and mudstones typical of a fluctuating alluvial depositional environment. Generally contains two well-developed sandstone units and has a dark organic fissile shale near the base.
Jurassic	Morrison Formation		24-36 (80-120)	Red and green claystone interbedded near the base with light gray sandstone and limestone.

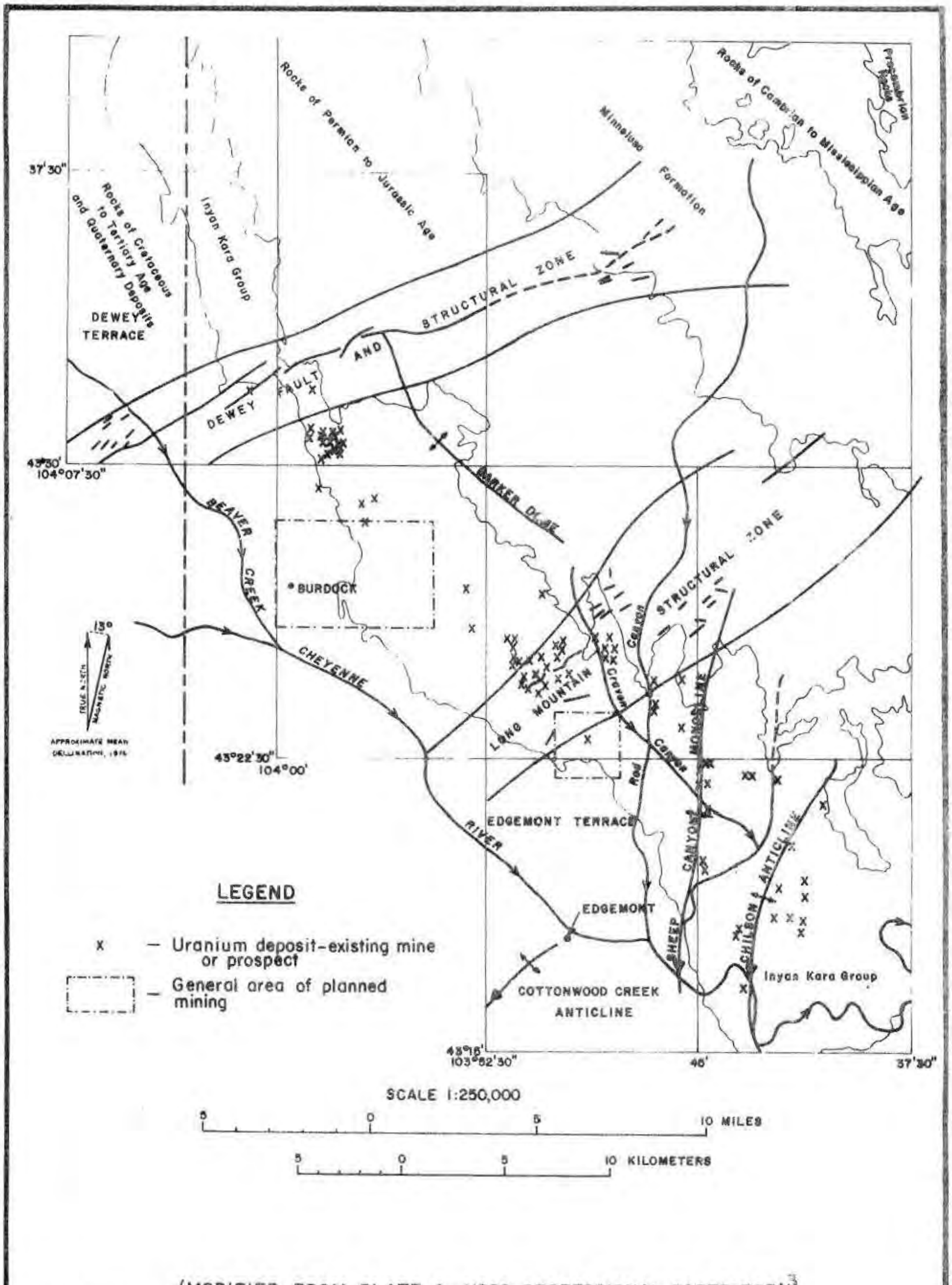

Figure 2.2.2-1 Map Showing Major Structures and Uranium Deposits Edgemont, South Dakota Project

(6 ft) based on observations in existing pits and on information based on electric logs derived from drill holes.

Many small subsidence structures exist in and around the project area.[2] Most of these collapse structures are associated with breccia pipes or with dissolution of beds of anhydrite, gypsum, limestone, dolomite, and possibly salt.

2.2.4 Uranium Deposits - The project area is located within an identified uranium mining district established in 1951.[1] Past production records of this district indicate that production was in excess of 680,400 kg (1.5 x 10^6 lb) of U_3O_8 between 1951 and 1964.

According to O. M. Hart:

> Primary minerals in the deposits are coffinite and uraninite with minor amounts of paramontroseite and haggite. The ore minerals coat sand grains and fill interstices of complexly cross-stratified sandstone along solution fronts similar to "roll" type deposits of the other districts. Minerals of oxidized deposits are typically carnotite and tyuyamunite with different proportions of secondary vanadium accessory minerals. Ground water was the transportation medium and deposition of primary uranium and vanadium minerals occurred in reducing environments produced and controlled by physiochemical characteristics of the sedimentary rocks.[5]

The geochemical cells containing the uranium minerals are typically narrow, 5 to 30 m (15-100 ft), highly sinuous, often kilometers in length and the known deposits occur 1 to 8 km (0.6-5 mi) downdip from the outcrop of the respective sandstone unit.[1] Economic uranium deposits occur intermittently along the trend of the geochemical cells at depths from up to 220 m (720 ft).

2.2.5 Other Mineral Resources - Vanadium generally occurs in association with the uranium in a ratio of approximately 1.5:1 and has been economically recovered during uranium milling operations. No other minerals of economic value have been identified in the project area.

2.2.6 Geologic Impacts - Potential geologic impacts in the project area may be caused by slope instability and subsidence.

Slope Instability - Only minor slope stability problems are anticipated. Some caving and sloughing may occur in open pit mining in areas where pit walls encounter faults or major fracture systems. If these conditions are encountered, action will be taken to avoid unnecessary slumping and to assure safe working conditions for employees. Existing pits within the project area, mined in the 1960's to depths of up to 48 m (150 ft), have had no significant caving or slumping except along fault zones. The existing pit walls are stable with an overall slope ratio of approximately 0.5:1. Existing road cuts in the project area are stable with a slope ratio of 1:1.

Subsidence - Subsidence of less than 1 percent is estimated for uncompacted material from surface mining. In underground mining, no significant surface ground subsidence is anticipated for the following reasons: (a) Existing shallow mines, (15-45m, 50-150 ft, below surface) in and around the project area which were mined in the 1950's and 1960's, show no surface subsidence over the mine workings except for the Gould Mine at which about 6 m (20 ft) of unconsolidated siltstone overlying the adit portal has collapsed. (b) Ground support techniques such as roofbolting, lagging, and timbering will be used when support is necessary, e.g., when faults are encountered which produce unstable ground. The Hauber Mine, located in the northwestern Black Hills, mined in the 1950's and 1960's, has shown no surface subsidence to date. This uranium mine was developed within the Lakota Formation. Ground conditions at the proposed Burdock shaft sites are expected to be similar to those at the Hauber mine.

2.2 References

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2.3 Seismicity

Seismic events in the Black Hills area have been few in number and of low to moderate magnitude. The National Geophysical and Solar-Terrestrial Data Center files show that only 7 earthquakes of any significance have occurred within a 200 km (124 mi) radius of the planned mines during the period from the first documented earthquake in 1895 through 1976[1] (Figure 2.3-1).

The strongest observed earthquake, which had an intensity of VII based on the Modified Mercalli intensity scale,[2] occurred in 1964 and was centered approximately 178 km (110 mi) east-southeast of the mining sites. Some damage was reported in Alliance and Rushville, Nebraska (Figure 2.3-1). Using attenuation curves for maximum accelerations,[3] the maximum estimated acceleration that could be expected at the mining sites from such an earthquake would be less than 0.04g (gravity). The nearest tremor to the sites occurred in 1895. The epicenter was located approximately 80 km (50 mi) northeast of the sites and the tremor was reported to have had an intensity of V. There was no reported damage associated with that tremor. The maximum acceleration at the sites for a seismic event of this intensity is so small that it cannot be estimated from an attenuation curve.

According to the recent probabilistic acceleration map of the U.S.[4], the proposed project site lies within an area of low seismic risk. The probability that accelerations larger than 0.04g would be experienced at the proposed project sites is 10 percent in 50 years.

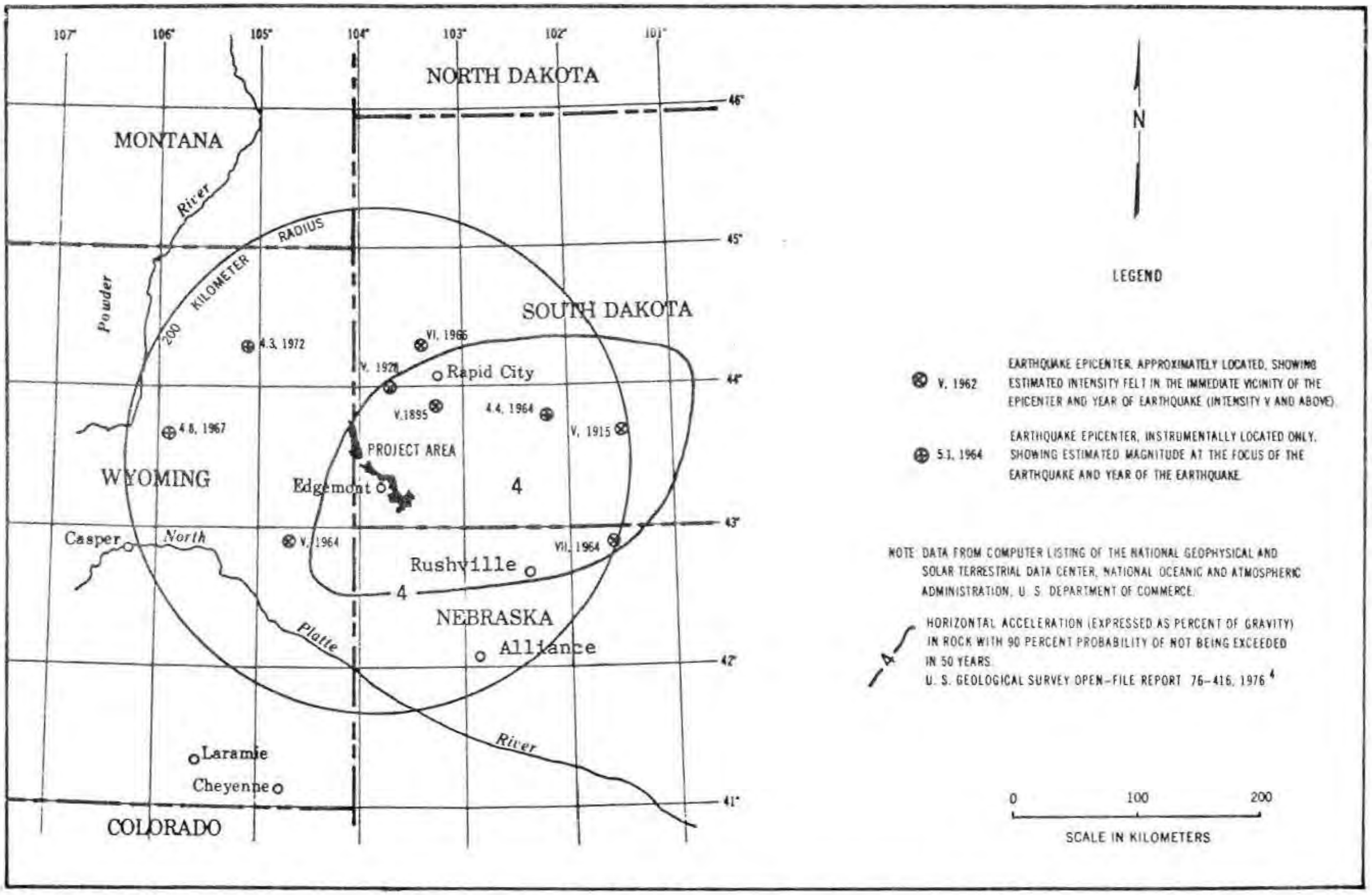

Figure 2.3-1 Regional Seismicity and Seismic Risk

2.3 References

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2. Wood, H. O., and F. Neumann. Modified Mercalli intensity scale of 1931. Bull. Seis. Soc. Am. 21:278-283. 1931.

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2.4 Soils

2.4.1 Description - The generalized soils of the Edgemont property are shown in Figure 2.4.1-1 and may be divided into eight broad groups that differ in major characteristics.[1,2] A brief description of each of the broad groups follows.

MANUEL-SHINGLE-GRUMMIT ASSOCIATION - All of the surface disturbance from the proposed mining activity will fall within this soil association. The soil series which compose this association range from light brownish gray clays to light brown silty clay loams and are found on nearly level to very steep uplands. Many of the soils within this association provide only fair to poor source material for topsoil due to excessive lime and high clay content. Figure 2.4.1-2 displays, in map form, the soil series that will be potentially disturbed from the proposed mining activity. Detailed information displaying the associated soil interpretations and estimated engineering properties of these series are presented in Appendix A. Interpretations in relation to engineering use can be made from the estimated engineering properties of each soil series listed in Appendix A. These interpretations indicate that the soils of the Manuel-Shingle-Grummit Association have limitations as a source of road fill material because of their low strength and high shrink-swell potential. These soil series also have limitations as septic tank absorption fields because of their high clay content and shallow depth to bedrock. They also generally exhibit a moderate to high corrosivity in relation to untreated steel pipe. Because soil associations include a number of soil series with varying characteristics, a detailed soils engineering study will be performed as part of project engineering. This soils engineering study will be used to determine the site specific soil suitability for the various mining activities anticipated. Other soil associations that surround the proposed mining disturbance on the Edgemont property are briefly described below.

BUTCHE ASSOCIATION - This association is found mainly on broad uplift ridges that have gentle or very steep slopes. Drainageways are deeply entrenched. These soils are shallow with interbedded sandstone and siltstone found below a depth of 23 cm (9 in). Butche soils are poor source material for topsoil because of large stones, thin layers, and because they generally occur on slope positions where they cannot be easily obtained for stockpiling.

TILFORD ASSOCIATION - This soil association is nearly level to gently sloping and is found on stream terraces. Tilford soils are deep and well-developed and provide fair material for topsoil.

NORKA ASSOCIATION - This soil association is found on gently to moderately sloping uplands and valley sideslopes. Norka soils are deep and provide good material for topsoil.

TUTHILL-DAILEY ASSOCIATION - Both of the soils in this association are found on very gently sloping to moderately sloping upland deposits of tablelands and terraces. Tuthill soils are good source material for topsoil while the abundance of sand in the Dailey soils contributes to drought conditions due to its poor water retention characteristics.

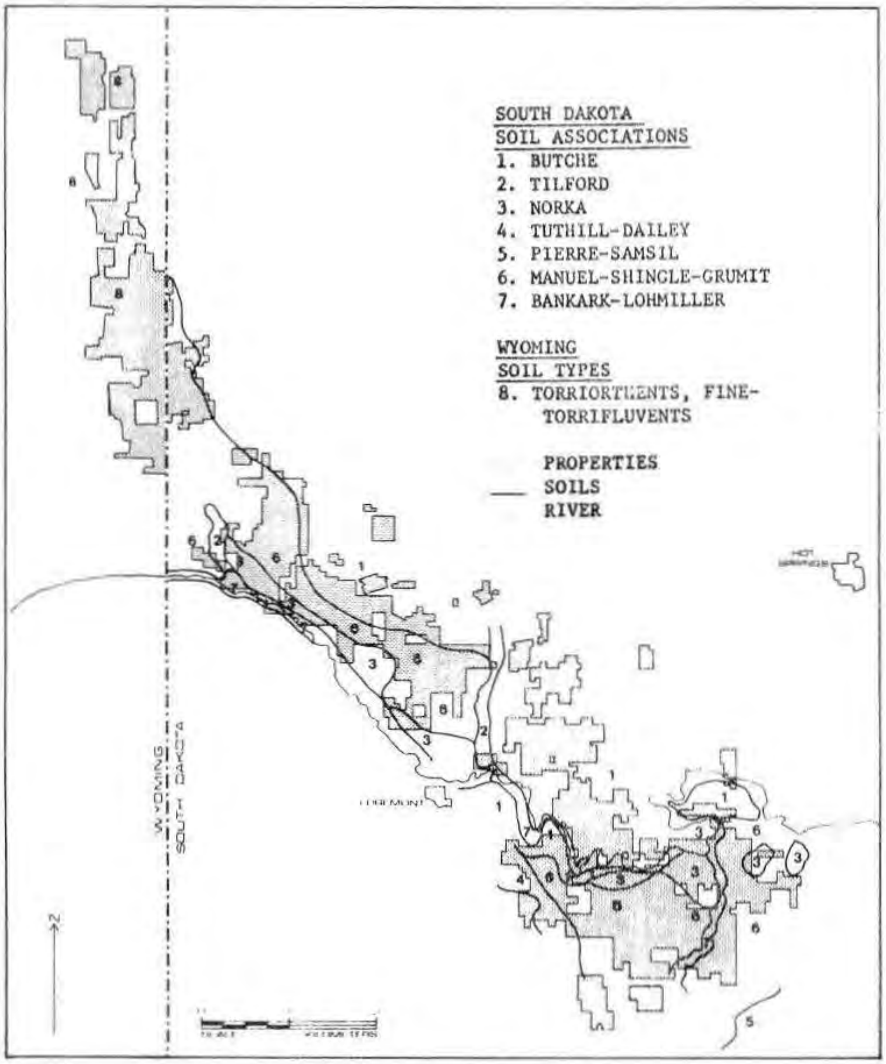

Figure 2.4.1-1

General Soils Map of the Edgemont Project Area

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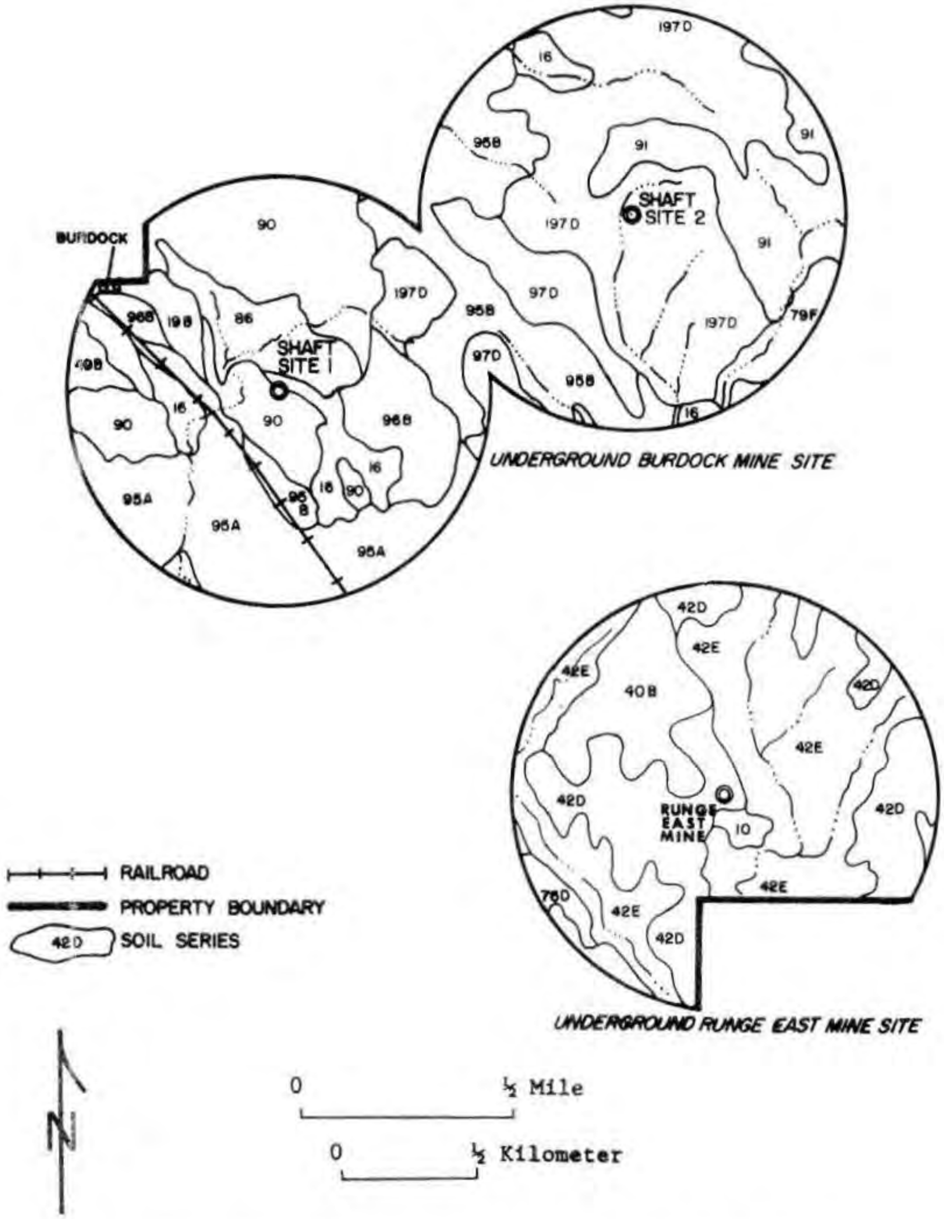


Figure 2.4.1-2 Soils Series of the Immediate Area Surrounding the Burdock and Runge East Mine Sites (Interpretations are Presented in Appendix A)

Shaft site locations are shown in Figure 1.1.1-1.

2.5 Hydrology

2.5.1 Surface Water

Description - The Edgemont project area is drained by the Cheyenne River and tributary streams in an area which lies in Weston and Niobrara Counties along the eastern edge of Wyoming and in Fall River and Custer Counties in southwestern South Dakota. The principal tributaries in this area which enter the Cheyenne River from the north are: Pass Creek; Bennett, Driftwood, Red, and Sheep Canyons; and Beaver Creek and its tributaries (Stockade Beaver, Lime and Hat Creeks). Cottonwood and Hat Creeks are the principal tributaries which enter the Cheyenne River from the south. With the possible exception of Stockade Beaver Creek, all of these streams including the Cheyenne River experience extended periods of no flow.

The Cheyenne River begins on Pine Ridge about 185 km (115 mi) west of Edgemont. The course of the river approximates the boundary between the Black Hills Section and Missouri Plateau Section of the Great Plains Physiographic Province and has a drainage area of 18,500 km² (7,143 mi²) at Edgemont. The river channel is braided, reflecting the low gradient of about 0.0014 in the vicinity of Edgemont. The Cheyenne River is impounded for irrigation, flood control, and power generation purposes by Angostura Reservoir about 54 km (34 mi) downstream from Edgemont. Angostura Dam is about 10.4 km (6.5 mi) southeast of Hot Springs. Contents of the reservoir since initial filling in October, 1949 have ranged from a minimum of 55.96 hm³ (cubic hectometers) (45,350 acre-ft) in September 1960 to a maximum of 179 hm³ (145,200 acre-ft) in June 1962.[1] The Cheyenne River flows northeasterly from Angostura Dam for another 80 km (50 mi) and empties into Oahe Reservoir which is impounded by Oahe Dam on the Missouri River near Pierre, South Dakota. Figure 2.5.1-1 shows the regional drainage surrounding the Edgemont property area.

The U.S. Geological Survey operates or has operated several stream gages in the vicinity of the Edgemont properties. Basic information on the streamflow characteristics of these gaged streams is shown in Table 2.5.1-1.[1,2] Annual runoff at these gaging stations varies widely as indicated[1] by values in the table. The same is true for the ungaged tributary streams draining the Edgemont properties.

The runoff distribution during the year based on the average of the monthly percentages for the Cheyenne River and Hat Creek gages and for the monthly percentages for the Beaver Creek near New Castle gage is shown in Table 2.5.1-2.[2] As indicated in this table, May, June, and July are the months of highest runoff, generally as the result of snowmelt and higher precipitation amounts experienced during these months. Runoff is generally lowest during the fall and winter months when precipitation is low and occurs mostly as snow.

Surface water drainage in the vicinity of the proposed mine locations as shown on Figures 2.5.1-2, and 3, is described in the following paragraphs.

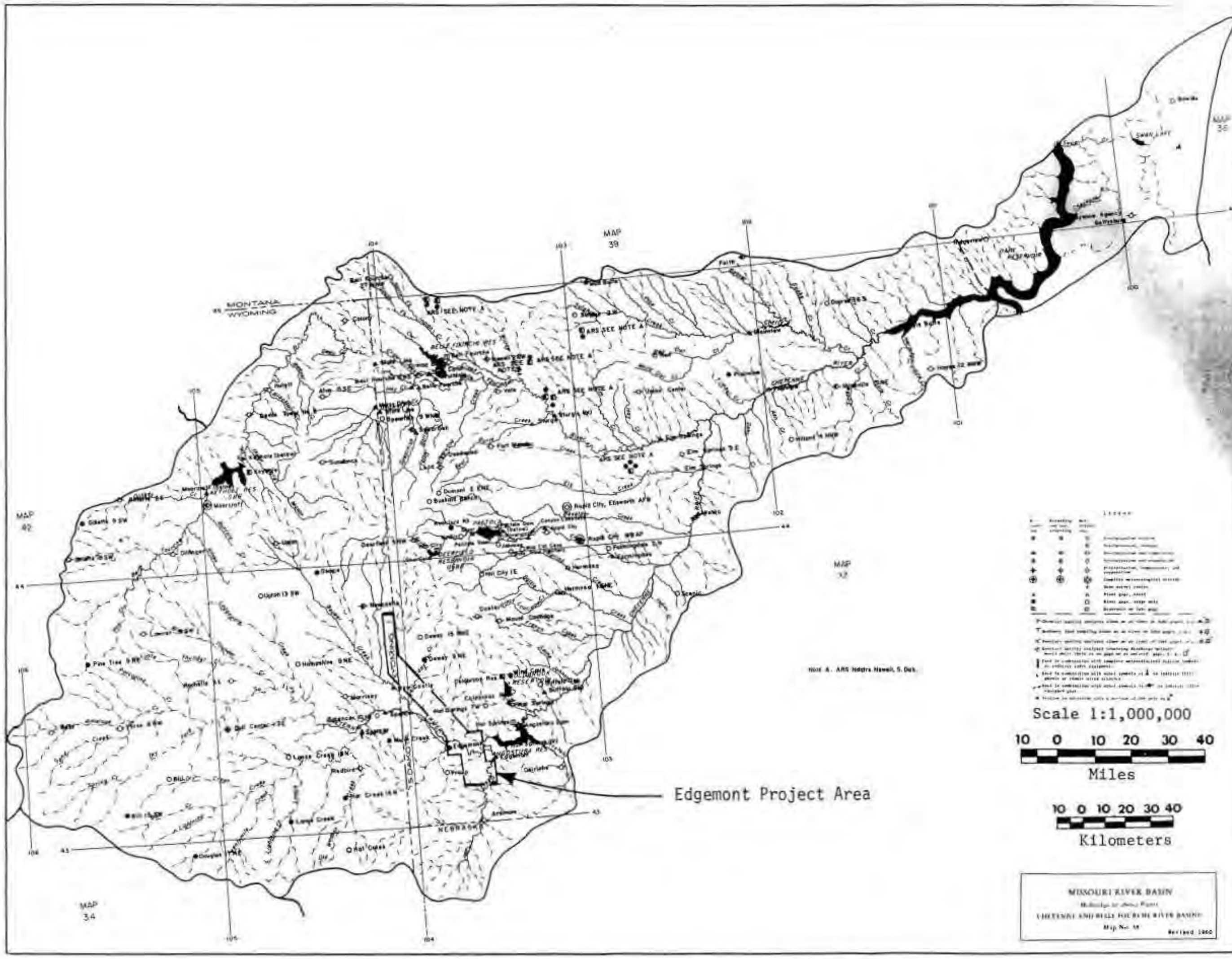


Figure 2.5.1.1 Regional Drainage Edgemont Project Area

Table 2.5.1-1

Streamflow Characteristics at Stream Gages in the Vicinity of Edgemont Uranium Mining Project[1,2]

	Period of Record	Drainage Area mi^2 (km^2)	Streamflow Characteristics for Period of Record: Average Discharge cfs (m^3/sec)	Range of Average Annual Discharge cfs (m^3/sec): Min.	Range of Average Annual Discharge cfs (m^3/sec): Max.	Maximum Discharge cfs (m^3/sec)	Minimum Discharge cfs (m^3/sec)	Remarks
Cheyenne River near Edgemont, SD	1903-1906 1928-1933 1946-1976	7,143 (18,500)	99.5 (2.82)	12.9 (0.37)	434 (12.3)	13,800 (391)	0	Small reservoirs for stock irrigation water upstream. No flow for extended periods most years.
Cheyenne River near Hot Springs, SD	1914-1920 1943-1972	8,710 (22,559)	233 (6.60)	30.9 (0.88)	453 (12.8)	114,000 (3,228)	0.5 (0.014)	Small reservoirs for stock and irrigation water upstream.
Beaver Creek near Newcastle, WY	1944-1976	1,320 (3,419)	32.8 (0.93)	5.1 (0.14)	130 (3.68)	11,900 (337)	0	Diversions for irrigation and small stock reservoirs upstream.
Stockade Beaver Creek near Newcastle, WY	1974-1976	107 (277)	12.8 (0.36)	12.7 (0.36)	12.8 (0.36)	39 (1.10)	8.9 (0.25)	A few small diversions for irrigation upstream.
Hat Creek near Edgemont, SD	1905-1906 1950-1976	1,044 (2,704)	21.3 (0.60)	1.27 (0.036)	112 (3.17)	13,300 (377)	0	No flow many days each year. Flow diversions for irrigation upstream.

Table 2.5.1-2

Average Annual Runoff Distribution for Beaver Creek and the Cheyenne River and Hat Creek

	Percent of Annual Runoff	
	Beaver Creek	Cheyenne River and Hat Creek
January	2.3	0.7
February	8.2	2.5
March	21.3	8.7
April	9.2	7.4
May	12.0	19.1
June	22.9	31.5
July	10.5	15.2
August	4.6	7.8
September	2.1	3.7
October	2.4	1.4
November	2.4	1.1
December	2.1	0.9

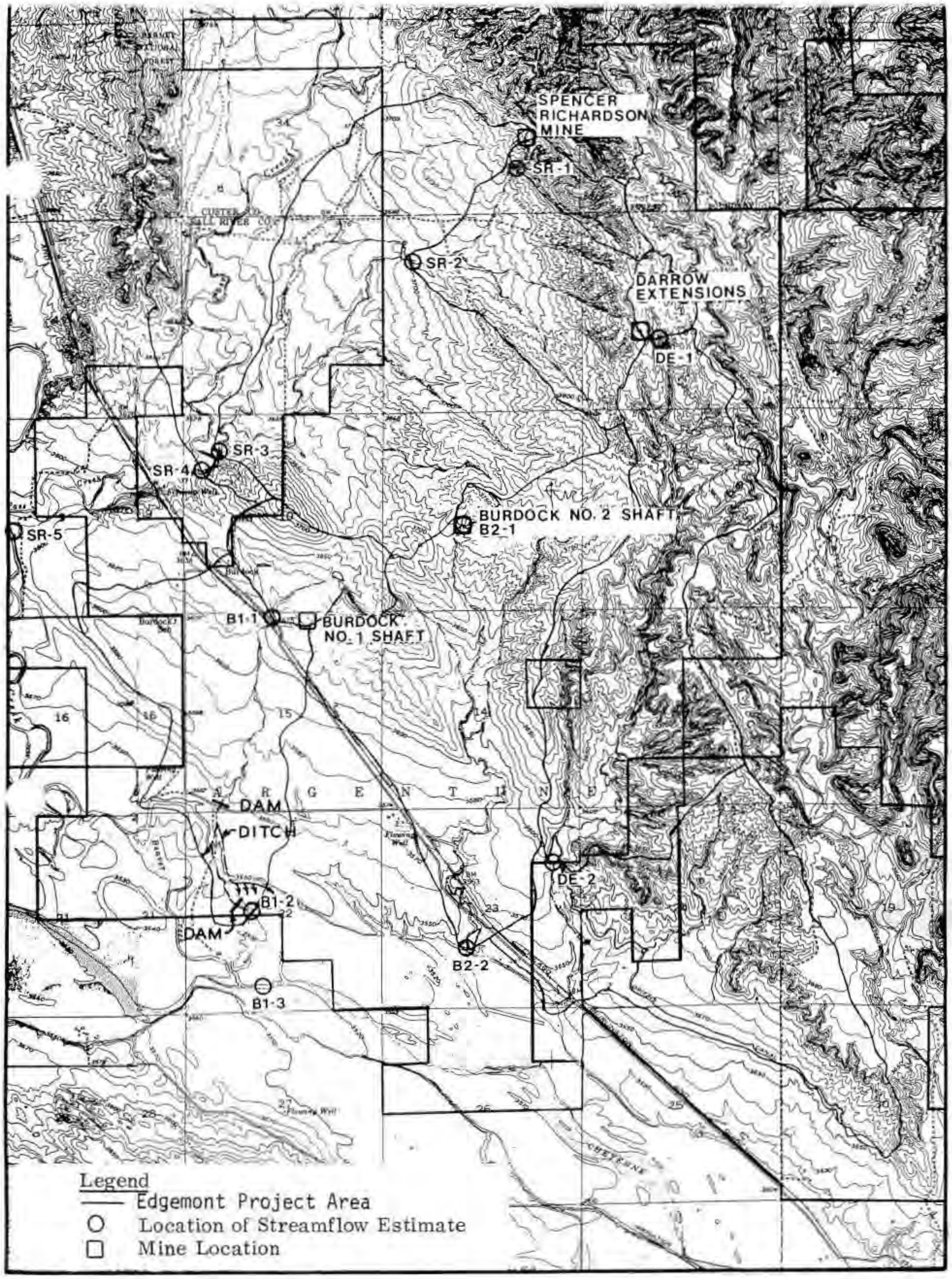


Figure 2.5.1-2 Streams and Subwatersheds - Edgemont Project Area

Figure 2.5.1-3 Streams and Subwatersheds - Edgemont Project Area

Burdock No. 1 Shaft - The location of the proposed shaft is shown on Figure 2.5.1-2. This site is drained by an intermittent, unnamed tributary of Beaver Creek. Elevations in the watershed of this tributary range up to 1,137 m (3,730 ft) on a hill north of the mine site and drop to about elevation 1,103 m (3,620 ft) near the shaft site.

A diversion system of two small dams and ditches has been constructed in the lower 1 km (0.6 mile) of the drainage course as shown on Figure 2.5.1-2. Flow in the drainage course will be dispersed in the flood plain along Beaver Creek and the Cheyenne River. Elevations in this area are in the range of 1,076 to 1,079 m (3,530-3,540 ft). Runoff characteristics at selected sites on this tributary as well as other streams draining mine locations are presented in Tables 2.5.1-3 and 4. These include estimates of average annual runoff and peak discharges of floods with 2, 10, and 50-year recurrence intervals and of the maximum probable flood. These estimates, at selected locations near the mine sites and at downstream locations, are based on techniques developed by the Water Resources Division of the U.S. Geological Survey.[3,4] As indicated in Table 2.5.1-3 average annual runoff is only 1.80 cm (0.71 in) from an area of 0.88 km^2 (0.34 mi^2) in the vicinity of Burdock No. 1 shaft (B1-1). More than half the runoff can be expected to occur during the months of May, June and July as the result of snowmelt and local, heavy rainfall. Average annual runoff from the larger watersheds above downstream locations (B1-2 and B1-3) is even less, in the order of 0.5 to 1.3 cm (0.2-0.5 in). Annual runoff may vary widely depending upon the occurrence of storm rainfall. Flood peak discharges are generally the result of heavy local thunderstorms. The estimates shown include the magnitude of these discharges which can be expected at or near the mine site. Flooding could occur along the drainage course in the vicinity of Burdock No. 1 shaft, but the shaft site would be located above or protected from anticipated flood levels.

Burdock No. 2 Shaft - This shaft site is drained by an unnamed intermittent tributary of the Cheyenne River. (See Figure 2.5.1-2.) The drainage area above the mine site is only 0.08 km^2 (0.03 mi^2). Elevations in this area, as indicated on the topographic map of the area,[5] range from about 1,130 m (3,710 ft) at the mine site to about 1,146 m (3,760 ft) at the watershed divide. Downstream from the shaft site, the drainage course drops quite rapidly to an elevation of about 1,080 m (3,540 ft) where it flows into a small reservoir near the edge of the Cheyenne River flood plain. Overflow from the reservoir during periods of heavy runoff would either infiltrate into the flood plain along the Cheyenne River or eventually flow into the river. Average annual runoff on the unnamed tributary near the mine site (B2-1) and near its mouth (B2-2) is estimated to be 0.53 cm (0.21 in) as indicated in Table 2.5.1-3. Burdock No. 2 shaft site near the head of the unnamed tributary could be affected by heavy surface runoff depending upon the exact location of the site with respect to the drainage course. Some diversion of the surface runoff may be necessary.

Spencer-Richardson Mine - This existing open pit mine site is located near the top of a ridge; there is practically no drainage area above the mine site so flooding by surface runoff is not a consideration. (See Figure 2.5.1-2.) Drainage from the site is

Table 2.5.1-3

Estimates of Mean Annual Runoff - Drainage Basin Parameters[1] for Watersheds Above Selected Location in Vicinity of Proposed Mine Operations Edgemont Uranium Mining Project Wyoming and South Dakota

Mine and Selected Locations	Drainage Area(A) $mi^2(km^2)$	Forest Cover Percent(F) % ±0.1	Maximum 24-Hour-2 Yr. Rainfall (I_{2-24}) in(cm)	Water Content of Snow Mar. 1-16, 25 Yr. Recurrence Interval-Sn_{25} in(cm)	Mean Annual Discharge QA cfs	m^3/sec	acre-ft	in
Burdock No. 1 Shaft								
B1-1	0.34(0.88)	24.1	1.9(4.8)	1.4(3.6)	0.018	0.0005	13	0.71
B1-2	1.48(3.83)	5.5	1.9(4.8)	1.4(3.6)	0.056	0.0016	40	0.51
B1-3	7,083(18,345)	Based on stream gage records at Edgemont (D.A. 7,143 mi^2 (18,500 km^2))			99	2.80	72,500	0.19
Burdock No. 2 Shaft								
B2-1	0.03(0.08)	0.1	1.9(4.8)	1.4(3.6)	0.0005	0.000013	0.3	0.21
B2-2	2.01(5.21)	0.1	1.9(4.8)	1.4(3.6)	0.031	0.0009	22	0.21
Spencer Richardson								
SR-1	0.18(0.47)	11.1	1.9(4.8)	1.4(3.6)	0.008	0.0002	6	0.60
SR-2	0.99(2.56)	12.1	1.9(4.8)	1.4(3.6)	0.045	0.0013	32	0.61
SR-3	3.25(8.42)	6.9	1.9(4.8)	1.4(3.6)	0.13	0.037	94	0.54
SR-4	8.93(23.13)	37.1	1.9(4.8)	1.4(3.6)	0.52	0.147	380	0.79
SR-5 [2]	1,402(3,631)				36	1.02	26,500	0.35
Darrow Extensions								
DE-1	0.11(0.28)	27.1	1.9(4.8)	1.4(3.6)	0.006	0.00017	4.3	0.73
DE-2	1.87(4.84)	21.0	1.9(4.8)	1.4(3.6)	0.095	0.0027	69	0.69

Table 2.5.1-3 (Continued)

Mine and Selected Locations	Drainage Area(A) mi^2(km^2)	Forest Cover Percent(F) % +0.1	Maximum 24-Hour-2 Yr. Rainfall (I_{2-24}) in(cm)	Water Content of Snow Mar. 1-16, 25 Yr. Recurrence Interval-Sn_{25} in(cm)	Mean Annual Discharge QA cfs	m^3/sec	acre-ft	in
Runge East								
RE-1	0.56(1.45)	18.1	1.9(4.8)	1.4(3.6)	0.028	0.0008	20	0.67
RE-2	2.29(5.93)	6.0	1.9(4.8)	1.4(3.6)	0.088	0.0025	64	0.52
RE-3	187(484)	64.1	1.9(4.8)	1.4(3.6)	12.4	0.35	8,960	0.90
RE-4	208(539)	58.1	1.9(4.8)	1.4(3.6)	13.5	0.38	9,750	0.88
RE-5[3]	7,502(19,430)				114	3.23	82,500	0.21

1. Significant parameters based on regression analysis as defined by Larimer[1/]
   Equation used for mean annual discharge:

$$QA = 6.11\times10^{-3}\ A^{1.002}\ F^{0.224}\ I_{2,24}{}^{1.916}\ Sn_{25}{}^{0.624}$$

A = drainage area in square miles
F = Percent forest cover + 0.1
I_{2-24} = Maximum 24-hour rainfall with 2-year recurrence interval as determined from U.S. Weather Bureau Technical Paper No. 40(1961)
Sn_{25} = Water content of snow for the period March 1-16, having a recurrence interval of 25 years from U.S. Weather Bureau Technical Paper No. 50(1964)

2. Based on stream gage records at Beaver Creek at Newcastle.
3. RE-5 - Cheyenne River below Red Canyon Creek. Based on stream gage records at Edgemont plus local inflow estimates.

Table 2.5.1-4

Flood Peak Discharge Estimates at Selected Locations in Vicinity of Edgemont Uranium Mine Sites

Selected Locations*	Drainage Area	Discharge							
		2-Year		10-Year		50-Year		Max. Probable**	
	$mi^2(km^2)$	cfs	m^3/sec	cfs	m^3/sec	cfs	m^3/sec	cfs	m^3/sec
Burdock No. 1 Shaft									
B1-1	0.34(0.88)	15	0.42	110	3.1	340	9.6	4,600	130
B1-2	1.48(3.83)	30	0.85	230	6.5	670	19	9,000	255
Burdock No. 2 Shaft									
B2-1	0.03(0.08)	5	0.14	35	0.99	110	3.1	1,500	42
B2-2	2.01(5.21)	35	0.99	260	7.4	760	22	10,000	283
Spencer Richardson Mine									
SR-1	0.18(0.47)	10	0.28	80	2.3	240	6.8	3,500	99
SR-2	0.99(2.56)	25	0.71	180	5.1	540	15	7,500	212
SR-3	3.25(8.42)	45	1.3	330	9.4	940	27	13,000	368
SR-4	8.93(23.13)	80	2.3	530	15	1,480	42	20,000	566
Darrow Extension Mine									
DE-1	0.11(0.28)	5	0.14	60	1.7	190	5.4	2,700	76
DE-1	1.87(4.84)	35	0.99	250	7.1	720	20	10,000	283
Runge East Mine									
RE-1	0.56(1.45)	15	0.42	140	4.0	400	11	5,800	164
RE-2	2.29(5.93)	35	0.99	280	7.9	790	22	11,000	311
RE-3	187(484)	400	11.3	2,270	64	5,930	168	80,000	2,270
RE-4	208(539)	410	11.6	2,340	66	6,090	172	90,000	2,550

*Refer to location maps
**Reconnaissance-level estimates only

to the south and west into intermittent flowing, unnamed tributaries of Pass Creek, also an intermittent stream, which empties into Beaver Creek, a major tributary of the Cheyenne River. A small reservoir is located on one of the tributaries about a mile downstream from the mine site. The tributaries head on the ridge on which the mine site is located. Elevations along the ridge range up to 1,195 m (3,920 ft). The gradient of the tributary to the south of the mine is quite steep, dropping from about elevation 1,173 to about 1,125 m (3,850-3,690 ft) near the reservoir location.

Estimates of average annual runoff and flood peak discharges at selected sites near the mine and at downstream locations (SR-1 - SR-5) are shown in Table 2.5.1-3 and 4. Estimates of average annual runoff on the tributaries and Pass Creek range from 1.37 to 2.00 cm (0.54-0.79 in). Beaver Creek which drains an area of 3,631 km^2 (1,402 mi^2) at site SR-5 below the mouth of Pass Creek has an average annual runoff of 0.89 cm (0.35 in). All of the streams experience extended periods of no flow. Annual runoff varies widely. At the stream gage site on Beaver Creek near New Castle upstream from SR-5, average annual discharge varied from 3.68 m^3/s (130 ft^3/s) in 1962 (water year) to 0.14 m^3/s (5.1 ft^3/s) in 1961 (water year).

Darrow Extensions - The existing pits from which the underground extensions will be mined are located on a ridge which forms the divide between the unnamed tributaries which flow to the west and southwest into Pass Creek described in the preceding paragraphs, and another unnamed tributary which flows southward to the Cheyenne River. The latter tributary, another intermittent stream, drains an area of 0.28 km^2 (0.11 mi^2) at location DE-1 near the mine site. (See Figure 2.5.1-2.) Elevations on the watershed divide range up to about 1,195 m (3,920 ft). The tributary gradient is quite steep, dropping from an elevation of about 1,170 m (3,840 ft) at location DE-1 to 1,091 m (3,580 ft) at a small reservoir at location DE-2, 5.5 km (3.4 mi) downstream. At the reservoir, the topographic map[5] indicates that part of the runoff may be diverted into Griffis Canal for irrigation purposes. The remainder flows out of the reservoir toward the Cheyenne River. The drainage course as defined on the topographic map[5] ends on the flat flood plain along the river. Estimates of average annual runoff and flood peak discharges at location DE-1 and DE-2 are shown in Tables 2.5.1-3 and 4. Average annual runoff is about 1.8 cm (0.7 in) at both locations. Since the mine site is on a ridge, flooding of the site is not a consideration.

Runge East Mine - The existing underground mine site is located in the drainage of an unnamed tributary of Red Canyon Creek. (See Figure 2.5.1-3.) The tributary, an intermittent stream, begins on the southern slopes of a steep ridge where elevations range up to 1,240 m (4,070 ft). The gradient of the tributary in the area above the mine location is very steep, dropping from an elevation of about 1,200 to 1,134 m (3,940-3,720 ft) in about 1.61 km (1 mi). The tributary drains an area of 1.45 km^2 (0.56 mi^2) at location RE-1 near the mine site. It empties into Red Canyon Creek at location RE-2 about 3.1 km (2 mi) to the south. Red Canyon Creek is a fairly large tributary of the Cheyenne River, draining an area of 539 km^2 (208 mi^2) most of which lies in the Black Hills National Forest. It empties into the Cheyenne River about 3.1 km (2 mi) downstream from Edgemont.

Estimates of average annual discharge and flood peak discharges at selected locations on these streams are shown in Tables 2.5.1-3 and 4. Estimates of average annual runoff at the locations on the unnamed tributary (RE-1 and RE-2) are 1.70 and 1.34 cm (0.67 and 0.52 in) respectively. Red Canyon Creek also has extended periods of no flow. The higher annual runoff estimate, about 2.28 cm (0.90 in) is the result of its more forested drainage area and the slightly higher precipitation in the higher elevations of the Black Hills. The flood peak estimates indicate the magnitude of flood discharges which can be expected at the selected sites. Since the mine location is on a slope well above any drainage course, flooding is not a consideration. Minor diversion of local surface runoff may be necessary at the site.

Impacts - Mining plans[6] indicate that dikes and ditches will be used to divert local surface runoff away from mining operations and into existing drainage channels. Improvement of existing access roads may also include some ditching and culvert installations. On-site drainage will include ditches to collect runoff from ore and spoil piles and direct it to holding ponds. Such construction activities would alter local surface drainage patterns to some extent. Since reclamation plans will essentially restore or improve existing landforms and cover, both short-term and long-term effects of constructing mine facilities upon annual runoff volumes or flood peak discharges are considered to be insignificant. At the proposed Spencer-Richardson open pit operation, an area of about 8.1 ha (20 acre) will be mined initially. Because of the small areas involved, the effect of these mining operations upon annual runoff and flood peak discharges is considered to be insignificant.

Mine dewatering will be required at Burdock No. 1 shaft and possibly at Burdock No. 2 shaft. Very little or no dewatering is expected to be required at the Runge East or Darrow Extension underground mines and the Spencer-Richardson open pit mine is expected to be free of ground water. Any water from mine dewatering operations will be directed to retention ponds and treated as required, before release. A maximum rate of pumping of 42.6 l/s (675 gal/min) is anticipated at the Burdock No. 1 shaft. At present, it is anticipated that dewatering at Burdock No. 2 shaft may not be necessary since dewatering at Burdock No. 1 shaft will probably dewater the shaft site at Burdock No. 2 shaft also.

The water from the mining operations will be discharged into local drainages. This water discharge will comply with the effluent requirements of the permit obtained under the National Pollutant Discharge Elimination System as implemented by the South Dakota Environmental Protection Agency. The magnitude of such releases at the Burdock No. 1 shaft could be in the order of 42.6 l/s (675 gal/min). This discharge would be into the unnamed tributary west of the shaft site. Flow in this drainage course will be dispersed in the flood plain along Beaver Creek and the Cheyenne River. Releases at other underground mine sites are unknown but expected to be very small. Released water would in part evaporate or in part infiltrate into the ground and the dry stream beds. These releases could stimulate the growth of natural vegetation along the drainage courses. Prolonged releases may cause some "soft" areas to develop in the drainage courses. Because of the small volumes of water to be released, no significant erosion of drainage courses is anticipated. Releases of treated water at Burdock No. 1 shaft will be dispersed over the flood plain of Beaver Creek and the Cheyenne River near the mouth of Beaver Creek by the existing small diversion system. Releases could eventually reach those streams. Since such releases would be treated as required to meet regulations governing such discharges, no harmful effects are anticipated. Since the quantity of such releases is small, they would have no significant effect upon flood peak discharges.

2.5.2 Ground Water

Regional - Western Fall River County is underlain by five principal aquifers: Quaternary alluvium; the Fall River Formation, 21 to 85 m (70-280 ft) thick, and the Lakota Formation, 43 to 67 m (140-220 ft) thick, both of Cretaceous age; the Sundance Formation, 21 to 137 m (70-450 ft) thick, of Jurassic age; and the Pahasapa Formation, 91 to 192 m (300-630 ft), of Mississippian age.[7] These formations crop out peripherally to the Black Hills, where they receive recharge from precipitation. Ground-water movement is in the direction of dip, radially from the central Black Hills. In most cases, the water is under artesian conditions away from the outcrop areas, and many wells in the region flow at the surface. The common practice for many years has been to allow wells to flow, which undoubtedly has resulted in declining regional potentiometric head.

Alluvium is used locally as a water source for domestic and stock water supplies.

The Fall River and Lakota Formations are the principal sources of water in the area. The Sundance Formation in Fall River County is used as an aquifer near its outcrop area in the central and northwestern parts of the county. The Pahasapa Formation, accessible in Fall River County only by very deep wells, is a source of water for Edgemont.[7]

The Fall River and Lakota Formations together form the Inyan Kara Group.[8] Water in the Fall River is separated from that in overlying formations by the Skull Creek Shale, which consists of 45 to 61 m (150-200 ft) of dark gray shale, and the Mowry Shale, which is up to 30 m (100 ft) of gray shale. Mudstone beds in the Fuson Member of the Lakota, 12 to 18 m (40-60 ft) thick,[8] generally separate water in the Fall River from that in the 30 to 45 m (100-150 ft) thick Chilson Member of the Lakota, which is the principal water-bearing unit of this formation. The Minnewaste Member of the Lakota, consisting of up to 8 m (25 ft) of limestone, lies below the Fuson Member and does not appear to be water bearing. The Lakota Formation is underlain by the Jurassic Morrison Formation, which consists mostly of shale and clay and is not considered to be an aquifer.[7]

Faults and fractures associated with the Dewey and Long Mountain structural zones, which trend southwesterly through northwestern Fall River County, are believed to affect ground-water movement and may be of considerable influence in future areal effects of drawdown caused by mining, but data are not yet available to quantify this.

According to Bowles[9,10], and Gott, Wolcott, and Bowles[11], large volumes of water may migrate upward from the Minnelusa Formation, along solution collapses and breccia pipes associated with fractures, to recharge the Inyan Kara Group near the margin of the Black Hills. This theory, which is supported by water quality data, is used to account for the source and deposition of uranium in the Inyan Kara Group.

In the Burdock project site area, it appears that little recharge to the Fall River Formation may come from the outcrop area, where open-pit mines are dry except for precipitation and inflow from surface water, with the exception of the existing Triangle mine, the mine farthest down-gradient. Also, the scarcity of water wells in the Fall River in this area suggests that the formation may not be saturated here. However, there is insufficient data to identify the source of recharge to the Inyan Kara Group at the project site.

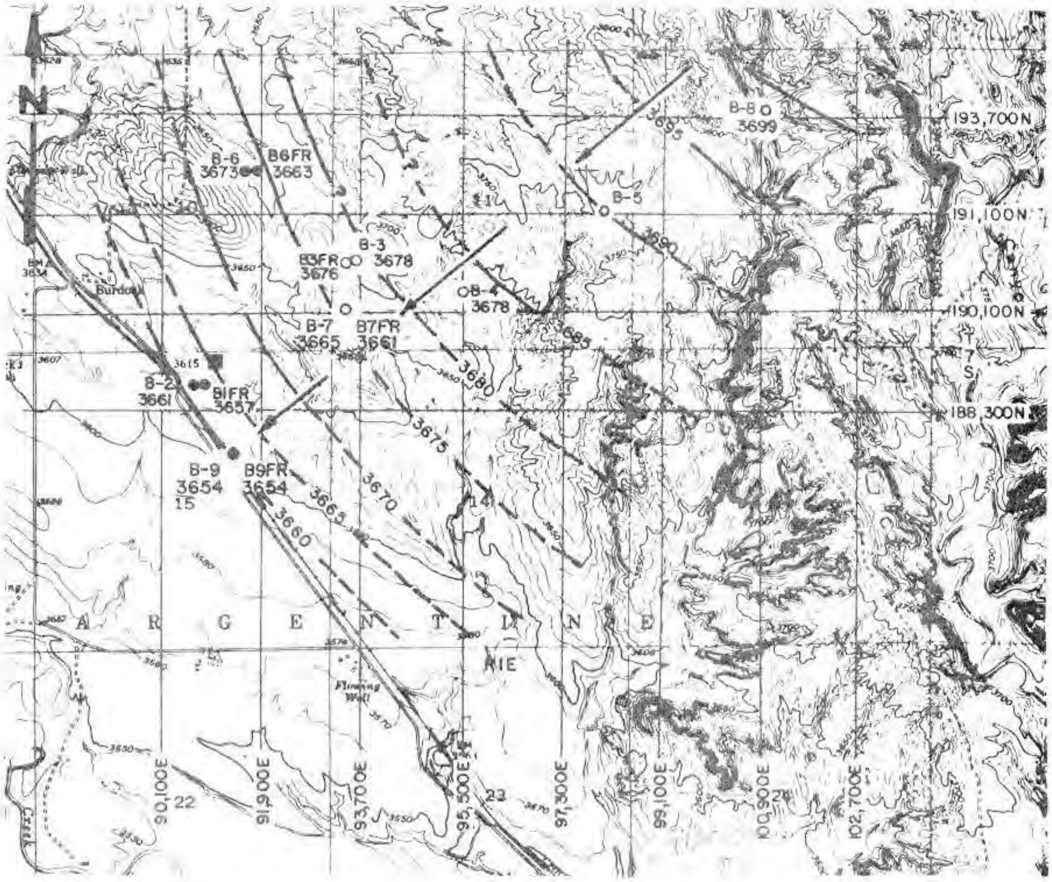
Local - The Fall River and Lakota Formations are the two aquifers of concern to the proposed mining operation at Burdock. The Fall River is the principal aquifer of western Fall River County, followed by the Lakota.[7] These aquifers are of similar thickness and hydrologic characteristics in the vicinity of the project site. At the proposed mine site, the Fall River, which is overlain by up to 61 m (200 ft) of Skull Creek Shale, consists of 23 to 38 m (75-125 ft) of fine-grained sandstone and interbedded carbonaceous shale. The top of the formation is at a depth of about 76 m (250 ft) at the shaft site. Within a 6.4 km (4 mi) radius of the shaft site, 26 wells are known to obtain water from this aquifer; many of these are flowing wells.

The Fuson Member of the Lakota, underlying the Fall River, varies in thickness, but generally is less than 15 m (50 ft) thick. It is expected to be an effective barrier to interaquifer water movement in most of the area. However, results of aquifer tests at the project site suggest that the Fuson Shale is not an effective barrier near and northeast of the shaft site. Interaquifer connection here could result from as-yet-unidentified structural features or old open exploration holes.

The Chilson Member of the Lakota is the ore-bearing and water-bearing unit. It consists of about 40 m (130 ft) of consolidated to semi-consolidated, fine-grained sandstone, the top of which is at a depth of about 134 m (440 ft) at the shaft site. The underlying Morrison Formation, at a depth of 174 m (570 ft), is shale and interbedded sandstone and probably is not water bearing. Within a 6.4 km (4 mi) radius, 23 wells are open to the Lakota, one of which flows an estimated 1.6 l/s (25 gal/min).

Figure 2.5.2-1 is a map showing the approximate potentiometric surface in the Lakota Formation in the vicinity of the project site, and showing the southwesterly gradient of about 9.8 m/km (20 ft/mi). A few water levels in the Fall River are shown, but there are insufficient data to allow contouring. Keene indicates a Fall River aquifer gradient of 9.8 m/km (20 ft/mi) near the project site.[7] Water levels were measured in January 1977, in observation wells installed for an on-site aquifer test. According to Keene[7], potentiometric levels in the Lakota in this area should be somewhat higher than those of the Fall River. This is consistent with data obtained at the project site, where the head in the Lakota is a few feet greater than in the Fall River.

Aquifer Test - A 169 m (555 ft) deep, rotary-drilled 25 cm diameter (10 in) steel cased test well near the proposed shaft site was completed in February 1977. The well is equipped with 17 m (55 ft) of 25 cm (10 in) diameter .030 slot size (0.76 mm)



SCALE: 0 ½ 1 mile

0 ½ 1 kilometer

EXPLANATION

3680 —?— Generalized water-level contour, Lakota Formation, in feet above sea level. Contour interval 5 feet. Dashed and queried where doubtful.

B-6 3673 — Flowing well—number and head in feet above sea level.

B-3 3678 — Non-flowing well number and head in feet above sea level.

Proposed shaft site

Generalized direction of ground-water movement

B6FR — Water level in Fall River Formation (not contoured)

NOTE:

Topography taken from USGS 7.5' quadrangles. Contour interval 10 feet.

Figure 2.5.2-1 Water-Level Contour Map in the Area of the Proposed Burdock Mine stainless steel wire-wound screen, gravel-packed, opposite the Fall River aquifer, [85-102 m (280-335 ft)] and 23 m (75 ft) of 20 cm (8 in) diameter screen, gravel packed, opposite the Lakota aquifer [146-169 m (480-555 ft)]. Upon completion, the well flowed about 3.2 l/s (50 gal/min).

A constant-discharge aquifer test began on February 11 and continued until February 25, 1977, at an average discharge of 16.5 l/s (261 gal/min). Discharge water was piped to a holding pond specially enlarged for the purpose. Water quality samples were obtained during the test.

Water-level responses were observed in nine piezometers, six of which were open to the Lakota and three to the Fall River. Locations of wells are shown on Figure 2.5.2-1.

A second aquifer test was run in November 1977, in which an inflatable packer was used to isolate the two aquifers, and the Lakota was pumped at an average rate of 12.2 l/s (194 gal/min) for 3.25 days. Analysis of results of this test indicates that the transmissivity of the Lakota is about 17.36 m^2 (1400 gal/day/ft) and the storativity is $2x10^{-4}$. Significant drawdown was measured in the Fall River Formation in the vicinity of the pumped well and to the northeast of the site. The estimated hydraulic conductivity of the aquitard is about .13 m/day (3.4 gal/day/ft^2). The estimated transmissivity of the Fall River is about 9.9 m^2 (800 gal/day/ft). These values were used in calculations of projected drawdowns resulting from mine development and operation. Projections of impacts on potentiometric head are based on these aquifer properties.

Water Use - An inventory of water-supply wells within a 6.4 km (4 mi) radius of the proposed shaft site was made in August 1976, during which 61 wells were located, as shown on Figure 2.5.2-2 and summarized in Table 2.5.2-1. Of these, 57 furnish domestic or stock water and 4 are not used. Thirty-five wells were flowing at rates from less than 4 to an estimated 76 l/min (1-20 gal/min). Estimated total flow, almost entirely from the Inyan Kara Group, was about 655 m^3/d (173,000 gal/d), or 23.4 ha-m/yr (190 acre ft/yr). Figure 2.5.2-3 is a generalized water-level contour map showing the area of flowing wells within a 6.4 km (4 mi) radius of the mine site.

A 40 km (25 mi) radius well inventory was completed in 1978. This inventory included all known wells in the Inyan Kara Group. Within the area in South Dakota, 140 wells were visited, 55 of which are in the Lakota, 54 in the Fall River, and 31 for which the aquifer is not identified. Thirty-seven wells are reported to flow from the Lakota, 34 from the Fall River, and 16 from wells in unidentified aquifers.[12]

Impact Assessment - The potentiometric head in the Fall River Formation is expected to be affected by shaft construction, and during mine development and operation, by vertical leakage from the Fall River to the Lakota in those areas where such leakage occurs. Direct impacts on the Fall River Formation from shaft construction will be short-term. Shaft construction through the formation will require about 30 days. Cement or chemical grouting may be required to control water inflows to the shaft sinking operations during construction. An average inflow to the

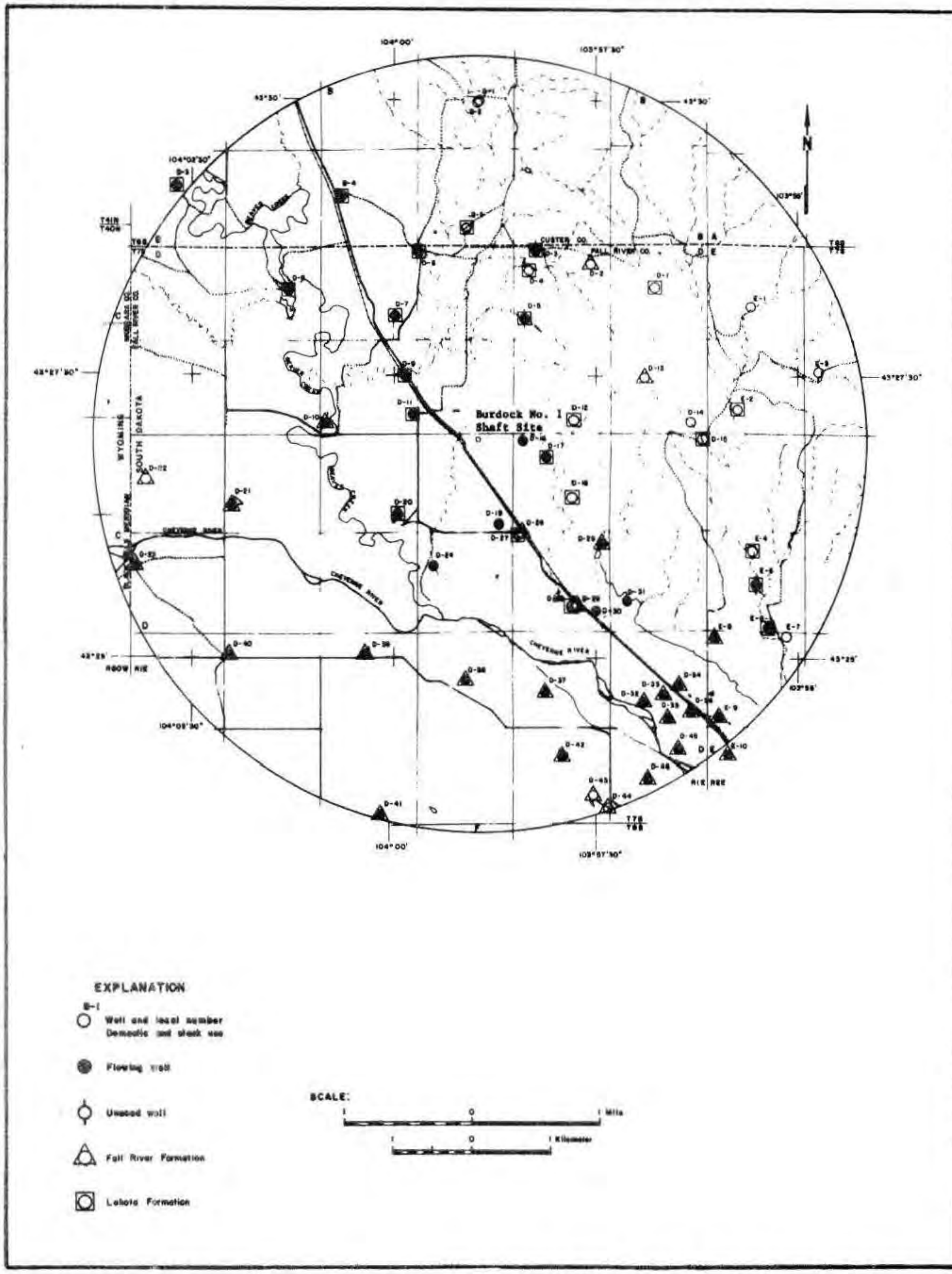


Figure 2.5.2-2 Location of Wells Within a 4-Mile (6.4 km.) Radius of the Proposed No. 1 Shaft Site

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Table 2.5.2-1

Summary of Wells Within a Four-Mile (6.5 km.) Radius of the TVA Burdock, No. 1 Shaft Site

Well No.: Based on the Federal system of township and range. Each township within the project area is assigned a letter in consecutive order beginning with "A" in the northeast corner and ending with "F" in the southern part. Similarly, wells are numbered in consecutive order within a township--for example: B-1, B-2, etc. Location: Number based on township, range, section, 1/4 section, and 1/4 section. Aquifer: Qa, Quaternary alluvial deposits; Kf, Cretaceous, Fall River Formation; Kl, Cretaceous, Lakota Formation; Jm, Jurassic, Morrison Formation; Js, Jurassic, Sundance Formation; Trs, Triassic, Spearfish Formation; PmK, Permian, Minnekahta Limestone. Depth: Given in feet (ft.) and meters (m.) below land surface. Use Rate and Flow Rate: In gallons per minute (gpm) and liters per second (l/s). Elevation of Land Surface and Elevation of Water Surface: In feet (ft.) and meters (m.) above sea level. Superscript a indicates flow rate less than 1 gpm. Superscript b indicates estimated water surface elevations.

Well No.	Latitude	Longitude	Location	Aquifer	Depth (ft)	Depth (m)	Use Rate (gal/min)	Use Rate (l/s)	Flow Rate (gal/min)	Flow Rate (l/s)	Elevation Land Surf. (ft)	Elevation Land Surf. (m)	Elevation Water Surf. (ft)	Elevation Water Surf. (m)	Remarks
B-1	43°30'00"	103°58'57"	6-1-27Db	Qa	50	15	30	1.9	-	-	3715	1132	3700	1128	
B-2	43°29'59"	103°58'57"	6-1-27Db	Qa	46	14	30	1.9	-	-	3715	1132	3700	1128	
B-3	43°29'10"	104°02'43"	6-1-31Bd	-	-	-	-	-	12	.8	3605	1099	3610[b]	1100	
B-4	43°29'09"	104°00'40"	6-1-33Bc	Kl	550	168	-	-	2	.1	3630	1106	3630[b]	1106	
B-5	43°28'51"	103°59'06"	6-1-34Dc	Kl	350	107	-	-	-	-	3653	1116	-	-	Flowed until Triangle mine de-watered. 1/3 h.p. pump.
D-1	43°28'20"	103°56'47"	7-1-1Bd	Kl	330	101	-	-	-	-	3905	1190	3747	1146	
D-2	43°28'32"	103°57'34"	7-1-2Aa	Kf	180	55	10	.6	-	-	3749	1143	-	-	Water contains iron.
D-3	43°28'39"	103°58'15"	7-1-2Bb	Kl	495	151	-	-	a	-	3705	1129	3705[b]	1129	Unused.
D-4	43°28'28"	103°58'20"	7-1-2Bc	Kl	280	85	5	.3	-	-	3698	1127	3674[b]	1120	Water contains iron.
D-5	43°28'01"	103°58'22"	7-1-2Cc	Kl	470	143	-	-	a	-	3679	1121	3680[b]	1122	Unused.
D-6	43°28'38"	103°59'42"	7-1-3Bb	Kl	500	152	-	-	2	.1	3660	1116	3661[b]	1116	A.E.C. water analysis.
D-7	43°28'02"	104°00'00"	7-1-4Dd	Kl	805	245	-	-	1	.06	3645	1111	3646[b]	1111	
D-8	43°28'17"	104°01'19"	7-1-5Ac	Kl	600	183	-	-	25	1.6	3600	1097	3610[b]	1100	Flow rate in 1969, 30 gpm (1.9 l/s).
D-9	43°27'30"	103°59'52"	7-1-9Ad	Kl	550	168	-	-	16	1.0	3615	1102	3620[b]	1103	Water contains iron & sulphur.
D-10	43°27'03"	104°00'54"	7-1-9Cc	Kf	527	161	-	-	8	.5	3700	1128	3701[b]	1128	

TABLE 2.5.2-1 (continued)

Well No.	Latitude	Longitude	Location	Aquifer	Depth (ft.)	Depth (m)	Use Rate (gal/min)	Use Rate (l/s)	Flow Rate (gal/min)	Flow Rate (l/s)	Elevation Land Surf. (ft)	Elevation Land Surf. (m)	Elevation Water Surf. (ft)	Elevation Water Surf. (m)	Remarks
D-11	43°27'C3"	103°59'46"	7-1-9Dd	Kl	600	183	-	-	1	.06	3624	1105	3631	1107	Water contains iron.
D-12	43°27'05"	103°57'47"	7-1-11Dc	Kl	525	160	-	-	-	-	3700	1128	-	-	A.E.C. water analysis.
D-13	43°28'29"	103°56'53"	7-1-12Bd	Kf	156	48	-	-	-	-	3750	1143	-	-	
D-14	43°27'04"	103°56'21"	7-1-12Dd	-	-	-	-	-	-	-	3930	1167	-	-	
D-15	43°26'55"	103°56'12"	7-1-13Aa	Kl	200	61	-	-	-	-	3740	1140	3662	1116	
D-16	43°26'54"	103°58'24"	7-1-14Bb	-	-	-	-	-	a	-	3675	1120	3675[b]	1120	
D-17	43°44'45"	103°58'25"	7-1-14Ba	Kl	850	259	-	-	7	.4	3630	1105	3634[b]	1108	Water contains iron.
D-18	43°25'23"	103°57'48"	7-1-14Db	Kl	280	85	1	.06	-	-	3610	1100	3598	1097	
D-19	43°26'09"	103°58'43"	7-1-15Dd	-	2264	690	-	-	-	-	3576	1090	3580[b]	1091	
D-20	43°25'15"	103°59'58"	7-1-16Dd	Kl	640	195	-	-	15	.9	3555	1084	3560[b]	1085	A.E.C. water analysis.
D-21	43°25'18"	104°02'01"	7-1-17Cb	Kf	530	162	-	-	4	.3	3555	1084	3558[b]	1084	A.E.C. water analysis.
D-22	43°26'33"	104°03'06"	7-1-18Bc	Kf	740	226	-	-	-	-	3700	1128	-	-	
D-23	43°25'48"	104°03'12"	7-1-19Bc	Kf	910	277	-	-	15	.9	3580	1091	3585[b]	1093	
D-24	43°25'48"	103°59'31"	7-1-22Bc	-	2400	732	-	-	3	.2	3548	1081	3550[b]	1082	
D-25	43°25'59"	103°57'24"	7-1-23Aa	Kf	90	27	-	-	3	.2	3625	1105	3625[b]	1105	Flow rate 1969, 10 gpm (.6 1/s).
D-26	43°25'02"	103°58'26"	7-1-23Bb	Kl	500	152	-	-	5	.3	3574	1089	3574[b]	1089	
D-27	43°26'03"	103°58'28"	7-1-23Bb	Kf	200	61	3	.2	-	-	3574	1089	3561	1085	
D-28	43°25'26"	103°57'48"	7-1-23Dc	Kl	500	152	-	-	5	.3	3542	1080	3542[b]	1080	Casing perforated in 10 ft (3 m.) intervals below elevations 3222 (982 m.) and 3384 (1031 m.).
D-29	43°25'27"	103°57'44"	7-1-23Dc	Kf	240	73	-	-	1	.06	3542	1080	3542[b]	1080	
D-30	42°25'24"	103°57'30"	7-1-23Dd	Js-PmK	1470	448	-	-	5	.3	3550	1082	3550[b]	1082	
D-31	43°25'30"	103°57'07"	7-1-24Cb	Js-PmK	2480	756	-	-	6	.4	3577	1090	3578[b]	1091	
D-32	43°24'38"	103°55'58"	7-1-25Ca	Kl	375	114	-	-	2	.1	3508	1069	3508[b]	1069	
D-33	43°24'40"	103°56'37"	7-1-25Db	Kf	96	29	-	-	1	.06	3510	1070	3510[b]	1070	
D-34	43°24'45"	103°56'29"	7-1-25Db	Kf	90	28	-	-	1	.06	3528	1075	3528[b]	1075	

TABLE 2.5.2-1 (continued)

Well No.	Latitude	Longitude	Location	Aquifer	Depth (ft)	Depth (m)	Use Rate (gal/min)	Use Rate (l/s)	Flow Rate (gal/min)	Flow Rate (l/s)	Elevation Land Surf. (ft)	Elevation Land Surf. (m)	Elevation Water Surf. (ft)	Elevation Water Surf. (m)	Remarks
D-35	43°24'28"	103°56'36"	7-1-25Dc	Kf	130	40	-	-	1	.06	3510	1070	3510[b]	1070	
D-36	43°24'30"	103°56'2[illegible]"	7-1-25Dd	Kf	450	137	-	-	3	.2	3508	1069	3508[b]	1069	
D-37	43°24'42"	103°57'59"	7-1-26Ca	Kl	260	79	-	-	2	.1	3530	1076	3530[b]	1076	
D-38	43°24'47"	103°59'07"	7-1-27Ac	Kf	350	107	-	-	-	-	3560	1085	3560[b]	1085	
D-39	43°25'01"	104°00'[illegible]"	7-1-28Ba	Kf	600	183	-	-	-	-	3576	1090	3553[b]	1083	
D-40	43°25'01"	104°02'[illegible]"	7-1-29Bb	Kf	600	183	-	-	1	.06	3590	1094	3590[b]	1094	
D-41	43°23'30"	104°00'[illegible]"	7-1-33Dc	Kl	600	183	-	-	-	-	3670	1119	-	-	
D-42	43°24'05"	103°57'55"	7-1-35Ac	Kf	350	107	-	-	1	.06	3545	1081	3545[b]	1081	
D-43	43°23'44"	103°57'32"	7-1-35Da	Kf	320	98	-	-	-	-	3555	1084	3545	1031	Slight flow in 1969; no flow in 1976.
D-44	43°23'37"	103°57'22"	7-1-35Dd	Kf	320	98	-	-	-	-	3555	1084	-	-	1969 Flow, 15 gpm (.9 l/s); no flow in 1976.
D-45	43°23'10"	103°56'25	7-1-36Aa	Kf	92	28	-	-	9	.6	3500	1067	3504[b]	1068	
D-46	43°23'55"	103°55'57"	7-1-36Ca	Kf	100	30	-	-	1.5	.2	3535	1077	3536[b]	1078	
E-1	43°28'08"	103°55'35"	7-2-5Ca	-	40	12	-	-	-	-	3860	1177	-	-	
E-2	43°27'11"	103°55'45"	7-2-7Cd	-	365	111	-	-	-	-	3755	1145	3475	1059	
E-3	43°27'32"	103°54'45"	7-2-8Bc	Js	470	143	-	-	-	-	3970	1210	-	-	Unused.
E-4	43°25'57"	103°55'33"	7-2-19Ba	Kl	145	44	-	-	-	-	3640	1109	-	-	
E-5	43°25'38"	103°55'3[illegible]"	7-2-19Ca	Kl	148	45	-	-	-	-	3620	1103	-	-	Flow rate in 1969, 2 gpm (.1 l/s); no flow in 1976; unused.
E-6	43°25'15"	103°55'22"	7-2-19Dc	Kl	255	78	-	-	10	.6	3600	1097	3605[b]	1099	
E-7	43°25'11"	103°55'0[illegible]"	7-2-30Aa	-	-	-	-	-	-	-	3600	1097	-	-	
E-8	43°25'13"	103°56'0[illegible]"	7-2-30Bb	Kl	330	101	-	-	2	.1	3530	1076	3530[b]	1076	
E-9	43°24'27"	103°55'56"	7-2-30Cc	Kf	90	27	-	-	a	-	3522	1074	3522[b]	1074	
E-10	43°24'07"	103°55'52"	7-2-31Bc	Kf	104	32	-	-	1.3	.08	3495	1065	3500[b]	1067	

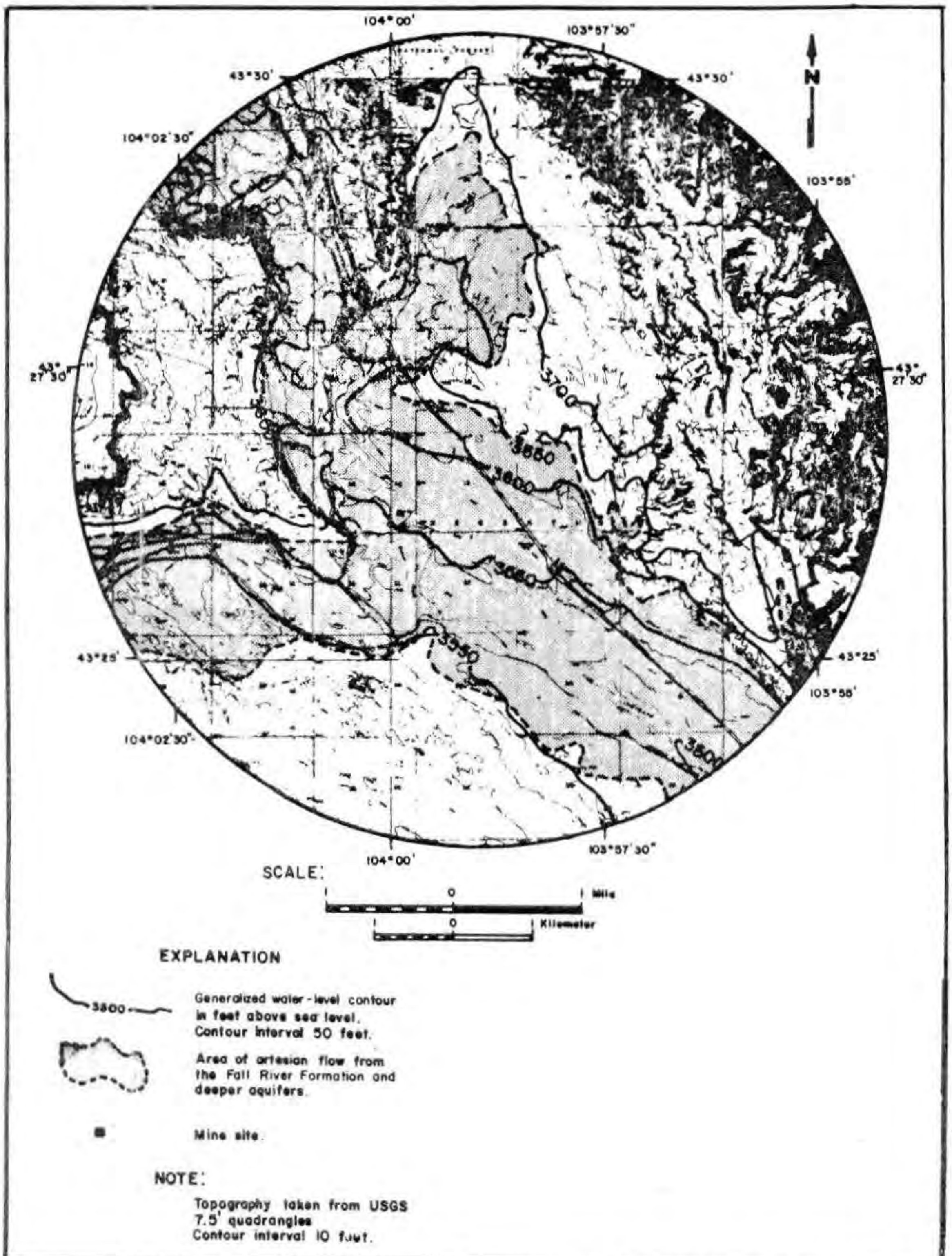

Figure 2.5.2-3 Generalized Water-Level Contour Map Within a 4-Mile Radius of the Proposed Mine Shaft Site

shaft of 12.6 l/s (200 gal/min) is expected during this time. The effects on the Fall River Formation resulting from leakage during mine development and operation will continue as long as water is removed from the lower aquifer. The rate of leakage will decrease with time and the magnitude of leakage will decrease with distance from the area in which leakage occurs. Water levels in wells in the Fall River Formation near the mine workings will be affected, but it is not anticipated that the aquifer will be dewatered.

It is possible that after mining, areal potentiometric heads will not recover to pre-mining levels within the affected area because of open flow from private wells. Discharge from flowing wells outside the radius of influence will continue, and may be sufficient to prevent complete recovery within the affected area.

The Lakota Formation will require depressurizing before it is entered by the shaft, since it is under at least 146 m (480 ft) of head, or more than 14.0 kg_f/cm^2 (200 lb_f/in^2). Two or more wells will be required, pumped at an estimated average total rate of 42.6 l/s (675 gal/min) for 180 days prior to entry into the aquifer by the shaft.

Inflow will increase as station and haulageway construction begin, then decrease gradually as the mine is developed and operated. If inflow averages 25.2 l/s (400 gal/min) over the 10-year expected life of the mine, the theoretical radius at which the potentiometric head will be reduced by 30 cm (1 ft) is about 105 km (65 mi), under the assumptions listed above. However, from experience in other mining areas, in rocks having similar hydrologic properties, lateral geologic changes should limit the growth of the cone of depression. The induced leakage from the Fall River may also limit the growth of the cone in the Lakota. The actual radius of effect is expected to be substantially less than the theoretical radius. The presence of the Long Mountain and Dewey structural zones is expected to constrain growth of the cone, but the extent of effect can not be quantified based on presently available information. Many wells that now flow within the area affected by decreased potentiometric head will cease to do so at some time after mining operations begin. The aquifers will remain saturated, however, and water will still be available by pumping except possibly in the immediate vicinity of the mine.

The planned expansion and deepening of the existing open-pit mine in the area should have little impact on the aquifer systems. The pit will be wholly within the unsaturated portion of the Fall River Formation. If the outcrop area is only a minor source of recharge, little effect on ground water flow should result. Any ground water entering the pits would come from the underlying Lakota Formation via structural features, which would result in local drawdown in the Lakota created by pit dewatering. Only one existing pit (the Triangle) contains ground water; some of the pits bottom near the Fuson Shale. Underground mining in the vicinity of an open pit will lower the potentiometric surface in the Lakota, reducing inflow, if any, to the pit.

Mitigation - Adverse effects on ground-water supplies attributable to the mining operation will be corrected in a manner acceptable to the owner of the supply. It is planned that such problems will be handled on a case-by-case basis. Possible alternatives include installation of electric pumps where power is available; distribution of water by pipeline; construction of new wells into deeper aquifers; renovation of wells if cessation of flow causes well collapse; or reimbursing the landowner for the cost of repairing or replacing a water supply. Whatever action is taken, one main objective, in all cases, will be water conservation.

A comprehensive observation program in which pressure heads, flows, and water levels are measured periodically in selected wells has begun. This program will document premining conditions and changes in potentiometric head before and during mining, in both aquifers, and also will allow assessment of any post-mining impacts.

2.5 References

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2.6 Nonradiological Water Quality

2.6.1 Description of Existing Water Quality Environment - This section describes the non-radiological water quality characteristics in the region of the Edgemont Uranium mining project. (See Section 2.8, for a description of the radiological characteristics.)

2.6.1.1 Surface Water Quality - The Edgemont Uranium Mining Project area is drained by the Cheyenne River and several tributary streams. These streams including the Cheyenne River experience extended periods of no flow. The State of South Dakota[1] has classified the Cheyenne River in the project vicinity as being suitable for the following uses: (1) warm water semi-permanent fish life propagation, (2) limited contact recreation, (3) wildlife propagation and stock watering, and (4) irrigation. Beaver Creek (South Dakota) has been classified as being suitable for the same uses as the Cheyenne River except that this stream has been classified as being suitable for cold water marginal fish life propagation rather than warm water semi-permanent fish life propagation. The State of Wyoming[2] has classified Beaver Creek and Stockade Beaver Creek in the project vicinity as presently supporting game fish or having the hydrologic and natural water quality potential to support game fish. Beaver Creek has also been classified by Wyoming as a warm water fishery.

Surface water quality investigations were performed at the project during the period of December 1974 through September 1977. Additional water quality data from the USGS and the State of South Dakota were utilized in this assessment. A summary of results of water quality analyses of surface water samples obtained on and near the project site are listed in Tables 2.6.1.1-1 and 2. Their locations are shown in Figure 2.6.1.1-1. Table 2.6.1.1-3 provides various water quality standards and criteria for a comparison with the previously reported ranges of water quality parameters. Specific aspects of these data are discussed below.

The warmest water temperature [36.0°C (96.8°F)] within the Cheyenne River was observed at station S-5 in June 1974, which is upstream of Red Canyon Creek. The warmest temperature [31.0°C (87.8°F)] within Beaver Creek was observed at Station S-3, which is near the mouth of the creek. The South Dakota temperature standard for the Cheyenne River [32.2°C (90°F)] was exceeded in August 1973 and June 1974 at Station S-5, and the South Dakota temperature standard for Beaver Creek 23.9°C (75°F) was exceeded in July 1976 at Station S-3.

In the Cheyenne River and Beaver Creek, observed dissolved oxygen concentrations were normally well above State standards. The pH values were observed to be in the normal range of 6.5 to 9.0 Standard Units. Total alkalinity and hardness of the Cheyenne River averaged 156 mg/l (miligram/liter) and 1,390 mg/l, respectively, and Beaver Creek averaged 148 mg/l and 1,425 mg/l, respectively. Both waters are considered to be very hard. Dissolved solid concentrations for the Cheyenne River and Beaver Creek averaged 3,513 mg/l and 2,960 mg/l, respectively. The mean dissolved solids concentrations of the Cheyenne River exceed established criteria for livestock watering, and mean dissolved

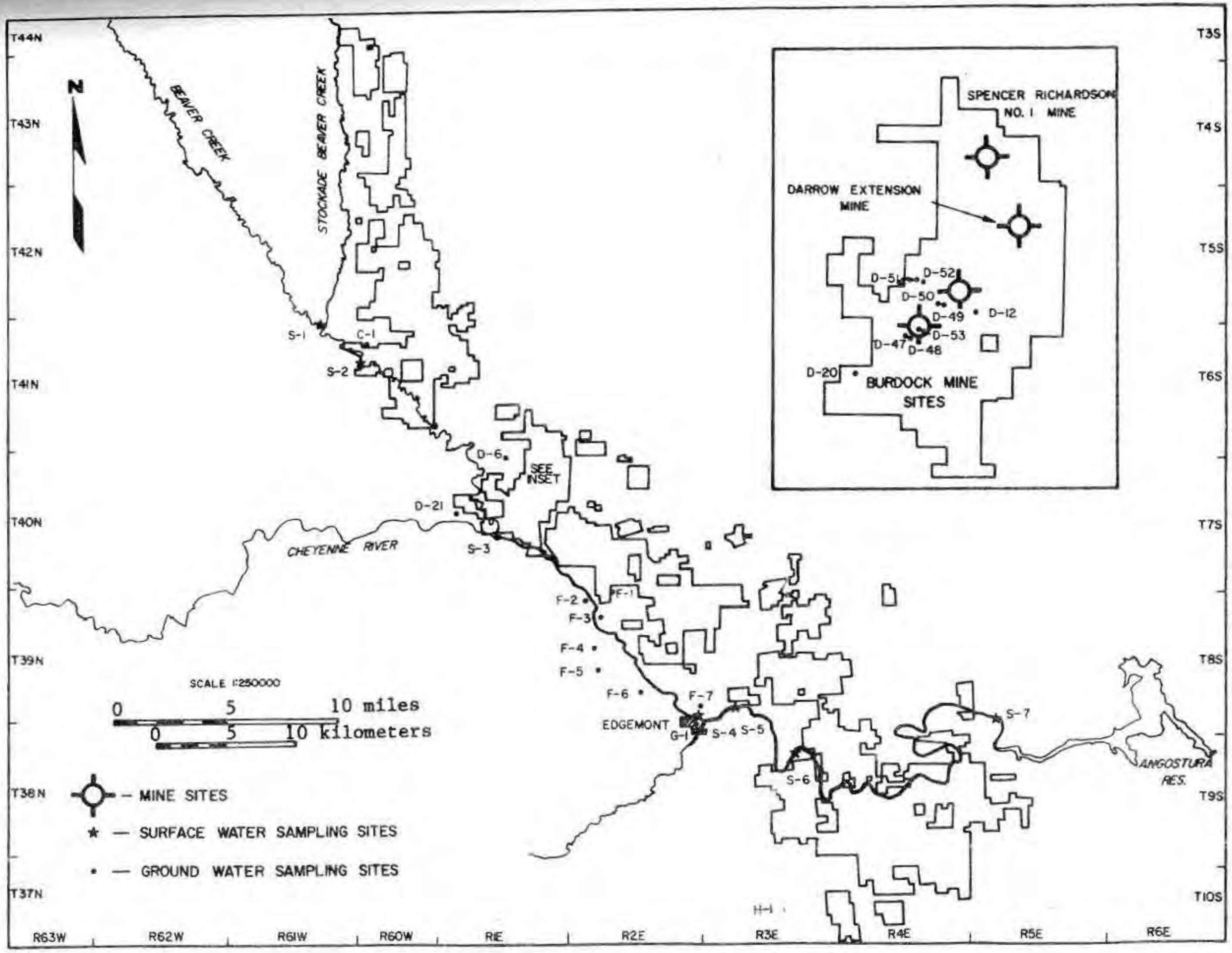

Figure 2.6.1.1-1 Water Quality Sampling Sites

Table 2.6.1.1-1

Summary of Physical and Bacteriological Surface Water Quality Data for the Cheyenne River and Beaver Creek in the Vicinity of the Edgemont Uranium Mining Project

Stream and Mileage		Parameter												
		Water Temp. °C	Dissolved Oxygen mg/l	pH S.U.	Total Alkalinity as $CaCO_3$ mg/l	Hardness as $CaCO_3$ mg/l	True Color PCU	Apparent Color PCU	Turbidity JTU	Solids: Dissolved mg/l	Solids: Suspended mg/l	Coliform (No./100 ml.): Fecal	Coliform (No./100 ml.): Fecal Streptococci	Coliform (No./100 ml.): Total
Beaver Creek[1] (S-1)	Maximum	24.0		8.0	289	1933	95	2400	1100	5700	1300			
	Minimum	14.5		7.4	78	340	12	21	11	750	14			
	Mean	18.1		7.6	151	1343	36	620	300	4060	350			
	No. of Samples	4		4	3	4	4	4	4	4	4			
Beaver Creek[2] (S-2)	Maximum	25.5	10.8	8.2	273	3100	80	29000	11000	5300	19000			
	Minimum	0.0	-	6.5	56	300	6	18	64	630	22			
	Mean	9.8	-	7.7	150	1400	30	7280	2800	2980	4790			
	No. of Samples	68	1	50	68	69	4	4	4	27	6			
Beaver Creek[3] (S-3)	Maximum	31.0	9.7	7.9	130	1825	60	7400	3200	3200	4800			
	Minimum	13.3	-	7.6	96	390	7	70	22	600	70			
	Mean	19.4	-	7.7	100	1221	30	2040	860	1700	1310			
	No. of Samples	4	1	4	3	4	4	4	4	4	4			
Cheyenne River[4] (S-4)	Maximum	29.0	13.1	8.9	433	2770	100	6000	2700	7571	8593	4800	7500	5000
	Minimum	0.0	0.7	7.0	70	260	5	7	8.4	695	0	0	<4	0
	Mean	11.5	9.6	8.6	189	1390	30	1200	700	3526	692	480	620	1300
	No. of Samples	100	74	94	63	65	5	5	4	67	41	52	27	19
Cheyenne River[5] (S-5)	Maximum	36.0	13.7	8.4						4200	17			
	Minimum	0.0	8.3	6.9						3800	17			
	Mean	10.7	10.9	7.9						4000	17			
	No. of Samples	23	21	22						2	2			
Cheyenne River[6] (S-6)	Maximum	26.0	12.4	8.2	180	1900	90	6200	3200	6300	5500			
	Minimum	18.0	-	6.7	84	880	7	14	11	990	9			
	Mean	22.8	-	7.6	130	1400	30	1400	840	3560	960			
	No. of Samples	4	1	5	4	5	5	5	4	6	6			
Cheyenne River[7] (S-7)	Maximum	20	8.4	8.2	163	1692	10	210	68	2700	120			
	Minimum	-	-	8.1	160	1600	5	8	4.4	2500	21			
	Mean	-	-	8.2	162	1646	8	110	36	2600	70			
	No. of Samples	1	1	2	2	2	2	2	2	2	2			
South Dakota Water Quality Standards[8]		32.2 (23.9)	5	6.3-9.0 (6.5-8.8)	750				50	1500	90	1000		5000
Wyoming Water Quality Standards[9]		32.2	6	6.5-8.5					10 (Maximum increase)				1000	
EPA Drinking Water Standards[10]				6.5-8.5			15		5*	500		4*		
NAS-NAE Irrigation Water Criteria[11]				4.5-9.0										
NAS-NAE Livestock Watering Criteria[11]										3300				

1. Beaver Creek (S-1); 43°31'44", 104°09'16"; Upstream of mouth of Stockade Beaver Creek, Wyo; Data Source, TVA (9/75 through 9/77).
2. Beaver Creek (S-2); 43°32'07", 104°07'02"; Upstream of Old US 85 bridge, Wyo; Data Sources, TVA (9/75 through 9/77) and USGS (1/72 through 5/77).
3. Beaver Creek (S-3); 43°25'28", 103°59'30"; ~275 m. upstream of confluence with Cheyenne River, S.D.; Data Source, TVA (9/75 through 9/77).
4. Cheyenne River (S-4); 43°18'20", 103°49'17"; Upstream of US Hwy. 18 bridge at Edgemont, S.D.; Data Sources, TVA (12/74 through 9/77), USGS (1/72 through 9/76), and the State of South Dakota (11/72 through 5/77).
5. Cheyenne River (S-5); 43°18'49", 103°47'16"; ~2.5 km downstream of Edgemont, SD, above Red Canyon Creek; Data Sources, TVA (12/74 through 6/75) and USGS (7/73 through 6/74).
6. Cheyenne River (S-6); 43°17'07", 103°44'21"; ~10 km downstream of Edgemont, SD; Data Source, TVA (12/74 through 9/77).
7. Cheyenne River (S-7); 43°18'23", 103°33'43", Upstream of SR 71 bridge at Angostura Reservoir, SD; Data Source, TVA (6/77 through 9/77).
8. Standards for Beaver Creek are the same as the Cheyenne River with the exception of those more stringent standards in parenthesis which are for Beaver Creek. Reference number 1.
9. Reference number 2.
10. Standards marked with (*) are primary drinking water standards and unmarked standards are the proposed secondary drinking water standards. References numbers 3 and 4.
11. Reference number 5.

Table 2.6.1.1-2

Summary of Chemical Surface Water Quality for the Cheyenne River and Beaver Creek in the Vicinity of the Edgemont Uranium Mining Project*

	Stream and Mileage							
	Beaver Creek[1] (S-1)				Beaver Creek[2] (S-2)			
	Observed Concentrations			Number of	Observed Concentrations			Number of
Parameter	Maximum	Minimum	Mean	Samples	Maximum	Minimum	Mean	Samples
Aluminum, µg/l	13000	<200	3500	4	8600	300	2400	4
Ammonia nitrogen, mg/l	0.02	0.01	0.02	2	0.19	<0.01	<0.10	2
Arsenic, µg/l	19	<2	9	4	85	<2	<25	4
Barium, µg/l	17000	<100	4400	4	16000	<100	4100	4
Beryllium, µg/l	<10	<10	<10	2	<10	<10	<10	2
Boron, µg/l	710	270	440	3	730	100	240	26
Cadmium, µg/l	3	<1	<2	4	180	<1	50	4
Calcium, mg/l	490	97	340	4	815	79	384	69
Chemical oxygen demand	61	38	50	2	140	11	75	2
Chloride, mg/l	1300	40	750	4	1400	32	504	69
Chromium (total), µg/l	13	<5	<7	4	10	<5	<6	4
Cobalt, µg/l	<5	<5	<5	2	18	<5	12	2
Conductivity, µmhos	7000	1380	5070	4	7910	1060	3800	50
Copper, µg/l	40	10	30	4	50	<10	40	4
Fluoride, mg/l	0.60	0.34	0.50	4	1.6	0.35	0.95	69
Iron (total), mg/l	2.60	0.20	1.00	4	4.6	0.0	0.38	27
Lead, µg/l	18	<10	<12	4	20	<10	12	4
Lithium, µg/l	160	80	120	2	160	70	120	2
Magnesium, mg/l	170	24	120	4	320	17	120	69
Manganese (total), µg/l	440	50	270	4	2800	30	770	4
Mercury, µg/l	0.6	<0.2	<0.3	4	0.7	<0.2	<0.4	4
Molybdenum, µg/l	<100	<100	<100	4	<100	<100	<100	4
Nickel, µg/l	<50	<50	<50	3	<50	<50	<50	3
Nitrate nitrogen, mg/l					5.6	0.0	0.3	55
Nitrate plus nitrite nitrogen, mg/l	0.28	<0.01	0.15	2	0.30	<0.01	0.17	3
Organic nitrogen, mg/l	0.92	0.37	0.65	2	1.6	0.28	0.90	2
Phosphorus (total), mg/l	0.97	0.02	0.50	2	1.6	0.0	0.1	44
Potassium, mg/l	7.9	6.8	7.4	2	10	2.3	6.2	67
SAR	-	-	9.1	4	-	-	5.2	69
Selenium, µg/l	3	<1	2	4	4	<1	2	4
Silica (total), mg/l	4.8	0.8	2.5	3	15	0.0	7	68
Silver, µg/l	<10	<10	<10	3	<10	<10	<10	3
Sodium, mg/l	1300	110	770	4	1300	96	460	69
Strontium, µg/l	3500	830	2160	2	4900	1100	3000	2
Sulfate, mg/l	2700	210	1280	4	3600	230	1510	69
Titanium, µg/l	<1000	<1000	<1000	2	<1000	<1000	<1000	2
Vanadium, µg/l	<100	<100	<100	4	<500	<100	<200	4
Zinc, µg/l	60	10	30	4	30	10	40	4

Table 2.6.1.1-2 (continued)

Parameter	Beaver Creek[3] (S-3) Observed Concentrations Maximum	Minimum	Mean	Number of Samples	Cheyenne River[4] (S-4) Observed Concentrations Maximum	Minimum	Mean	Number of Samples
Aluminum, μg/l	7200	700	3200	4	400	<200	<300	3
Ammonia nitrogen, mg/l	0.03	0.01	0.02	2	0.35	<0.01	0.11	19
Arsenic, μg/l	15	<2	9	4	53	<2	<13	6
Barium, μg/l	19000	<100	4900	4	14000	<100	<2900	5
Beryllium, μg/l	<10	<10	<10	2	<10	<10	<10	2
Biochemical oxygen demand (5-day), mg/l					3.0	0.5	1.4	37
Boron, μg/l	560	140	360	3	1300	240	500	7
Cadmium, μg/l	5	<1	<3	4	8	0	2	7
Calcium, mg/l	530	110	340	4	650	67	370	61
Chemical oxygen demand, mg/l	170	18	94	2	150	16	83	2
Chloride, mg/l	940	55	410	4	1190	30	410	66
Chromium (total), μg/l	11	<5	<7	4	42	0	<9	10
Cobalt, μg/l	43	<5	<24	2	11	<5	<8	2
Conductivity, μmhos	5800	1200	3600	4	7690	590	3980	93
Copper, μg/l	50	<10	40	4	50	3	20	9
Fluoride, mg/l	0.66	0.41	0.51	4	0.8	0.2	0.6	31
Iron (total), mg/l	4.1	1.2	2.6	4	80	0.02	5.8	38
Lead, μg/l	23	<10	<13	4	27	0	11	9
Lithium, μg/l	120	110	120	2	280	120	210	3
Magnesium, mg/l	150	27	92	4	301	22	126	61
Manganese (total), μg/l	2000	130	620	4	4150	70	490	37
Mercury, μg/l	0.8	<0.2	<0.4	4	0.9	0.1	<0.3	7
Molybdenum, μg/l	<100	<100	<100	4	<100	2	<80	9
Nickel, μg/l	<50	<50	<50	3	80	5	<40	7
Nitrate plus nitrite nitrogen, mg/l	0.28	<0.01	0.15	2	0.64	<0.01	0.18	18
Organic nitrogen, mg/l	1.6	0.25	0.90	2	4.1	0.08	1.0	23
Phosphorus (total), mg/l	2.2	0.05	1.1	2	1.9	0.0	0.2	59
Potassium, mg/l	10	9.4	9.7	2	25	1.2	10	56
SAR	-	-	5.3	4	-	-	6.0	61
Selenium, μg/l	2	1	2	4	3	<1	<2	7
Silica (total), mg/l	5.1	1.8	3.6	3	12	3.9	8.4	25
Silver, μg/l	<10	<10	<10	3	10	0	6	5
Sodium, mg/l	850	100	430	4	1310	110	530	58
Strontium, μg/l	4900	1000	3000	2	4700	1600	3150	2
Sulfate, mg/l	1700	260	940	4	3720	350	1730	63
Tin, μg/l					<100	-	-	1
Titanium, μg/l	<1000	<1000	<1000	2	<1000	<1000	<1000	2
Vanadium, μg/l	<500	<100	<200	4	<500	3.3	<200	9
Zinc, μg/l	90	10	40	4	420	<10	80	9

Table 2.6.1.1-2 (continued)

Parameter	Stream and Mileage: Cheyenne River[5] (S-5) Observed Concentrations Maximum	Minimum	Mean	Number of Samples	Cheyenne River[6] (S-6) Observed Concentrations Maximum	Minimum	Mean	Number of Samples
Aluminum, μg/l					1100	200	700	3
Ammonia nitrogen, mg/l					0.05	0.01	0.03	2
Arsenic, μg/l	<5	-	-	1	90	<2	<20	5
Barium, μg/l					15000	<100	3100	5
Beryllium, μg/l					<10	<10	<10	2
Boron, μg/l					820	260	520	4
Cadmium, μg/l					4	<1	<2	5
Calcium, mg/l					490	220	340	5
Chemical oxygen demand					240	19	130	2
Chloride, mg/l					890	75	420	5
Chromium (total), μg/l	<5	<5	<5	2	18	<5	<7	6
Cobalt, μg/l					27	<5	<16	2
Conductivity, μmhos	5500	545	3925	22	6100	1490	3790	4
Copper, μg/l	70	<10	<40	2	50	<10	30	6
Fluoride, mg/l					0.61	0.43	0.52	5
Iron (total), mg/l	0.40	0.14	0.27	2	5.00	0.11	1.36	6
Lead, μg/l	13	<10	<12	2	21	<10	14	6
Lithium, μg/l					180	150	170	3
Magnesium, mg/l					190	69	130	5
Manganese (total), μg/l					3900	50	1100	5
Mercury, μg/l					<0.2	<0.2	<0.2	4
Molybdenum, μg/l	<100	<100	<100	2	<100	<100	<100	6
Nickel, μg/l	<50	<50	<50	2	100	<50	<60	4
Nitrate plus nitrite nitrogen, mg/l					0.56	0.10	0.33	2
Organic nitrogen, mg/l					3.60	0.31	2.00	2
Phosphorus (total), mg/l					2.80	0.07	1.40	2
Potassium, mg/l					25	9.6	18	3
SAR					-	-	6.6	6
Selenium, μg/l					4	<1	<2	5
Silica (total), mg/l					8.8	2.1	6.1	3
Silver, μg/l					10	<10	<10	3
Sodium, mg/l					910	170	560	5
Strontium, μg/l					4600	2000	3300	2
Sulfate, mg/l					2700	640	1590	5
Tin, μg/l	<100	-	-	1				
Titanium, μg/l					<1000	<1000	<1000	2
Vanadium, μg/l	<500	<500	<500	2	<500	<100	<200	6
Zinc, μg/l	60	10	40	2	100	<10	50	6

Table 2.6.1.1-2 (continued)

Stream and Mileage

Cheyenne River[7]
(S-7)

Parameter	Observed Concentrations Maximum	Minimum	Mean	Number of Samples
Aluminum, μg/l	1700	<200	1000	2
Ammonia nitrogen, mg/l	0.01	0.01	0.01	2
Arsenic, μg/l	4	<2	<3	2
Barium, μg/l	230	<100	<160	2
Boron, μg/l	140	-	-	1
Cadmium, μg/l	8	<1	<4	2
Calcium, mg/l	510	470	490	2
Chemical oxygen demand	19	5	12	2
Chloride, mg/l	160	150	160	2
Chromium (total), μg/l	<5	<5	<5	2
Cobalt, μg/l	<5	<5	<5	2
Conductivity, μmhos	3000	2770	2880	2
Copper, μg/l	40	20	30	2
Fluoride, mg/l	0.82	0.66	0.74	2
Iron (total), mg/l	0.65	0.14	0.40	2
Lead, μg/l	<10	<10	<10	2
Magnesium, mg/l	100	100	100	2
Manganese (total), μg/l	100	20	60	2
Mercury, μg/l	0.6	<0.2	<0.4	2
Molybdenum, μg/l	100	100	100	2
Nickel, μg/l	<50	-	-	1
Nitrate plus nitrite nitrogen, mg/l	1.60	0.17	0.89	2
Organic nitrogen, mg/l	0.55	0.03	0.29	2
Phosphorus (total), mg/l	0.29	0.01	0.15	2
SAR	-	-	2	2
Selenium, μg/l	2	2	2	2
Silica (total), mg/l	13	-	-	1
Silver, μg/l	<10	-	-	1
Sodium, mg/l	230	140	180	2
Strontium, μg/l	4900	4600	4750	2
Sulfate, mg/l	2200	1600	1900	2
Vanadium, μg/l	<100	<100	<100	2
Zinc, μg/l	30	10	20	2

Table 2.6.1.1-3

Water Quality Standards and

Criteria for Comparison Purposes

Parameter	South Dakota Water Quality Standards[8]	EPA Drinking Water Standards[10]	NAS - NAE[11] Irrigation Water Criteria	NAS - NAE[11] Livestock Watering Criteria
Aluminum, μg/l			5000	5000
Ammonia nitrogen, mg/l	1.0			
Arsenic, μg/l		50*	100	200
Barium, μg/l		1000*		
Beryllium, μg/l			100	
Boron, μg/l			750	
Cadmium, μg/l		10*	10	50
Calcium, mg/l				
Chemical oxygen demand				
Chloride, mg/l		250		
Chromium (total), μg/l		50*	100	1000
Cobalt, μg/l			50	1000
Conductivity, μmhos	2500			
Copper, μg/l		1000	200	500
Fluoride, mg/l		1.4→2.4*	1.0	2.0
Iron (total), mg/l	0.2	0.3	5	
Lead, μg/l		50*	5000	100
Lithium, μg/l			2500	
Magnesium, mg/l				
Manganese (total), μg/l		50	200	
Mercury, μg/l		2*		10
Molybdenum, μg/l			10	
Nickel, μg/l			200	
Nitrate nitrogen, mg/l	50(as NO_3)	45(as NO_3)*		
Nitrate plus nitrite nitrogen, mg/l				100
Organic nitrogen, mg/l				
Phosphorus (total), mg/l				
Potassium, mg/l				
SAR	10			
Selenium, μg/l		10*	20	50
Silica (total), mg/l				
Silver, μg/l		50*		
Sodium, mg/l				
Strontium, μg/l				
Sulfate, mg/l		250		
Titanium, μg/l				
Vanadium, μg/l			100	100
Zinc, μg/l		5000	2000	25000

*Refer to Table 2.6.1.1-1 for footnotes.

solids concentrations for both streams exceed the State of South Dakota water quality standard.

Coliform bacteria data at Edgemont (S-4) showed that high concentrations of fecal, fecal streptococci, and total coliforms were present during various times of the year. The fecal to fecal streptococci ratios indicate the source of pollution to be animal feces.

The chemical water quality of the Cheyenne River and Beaver Creek was poor. Mean concentrations of barium and some arsenic measurements were above those concentrations identified by the EPA "National Interim Primary Drinking Water Standards"[3] for finished drinking water. Mean concentrations of cadmium above these standards were observed in Beaver Creek. Mean concentrations of chlorides, iron, manganese, and sulfates in both the Cheyenne River and Beaver Creek were above those concentrations identified by the EPA "Proposed Secondary Drinking Water Standards."[4] This data supports the fact that those streams are not classified for domestic water supply use. Concentrations of iron and conductivity levels in the Cheyenne River and Beaver Creek exceeded the State of South Dakota water quality standards. Based upon the "1972, NAS - NAE Water Quality Criteria,"[5] water from both the Cheyenne River and Beaver Creek is unsuitable for irrigation use (continuously on all soils). High concentrations of chemical oxygen demand were observed in both the Cheyenne River and Beaver Creek in the project vicinity.

Water quality data resulting from the surveys performed during the late summer and early fall months correlate closely with regional historical ground water quality data[6] from the upper Quaternary and Pierre Formations. This indicates that during this time of the year flow in Beaver Creek and the Cheyenne River are predominately composed of ground water base flows which enter the stream beds through seeps, springs, and flowing wells. Conversely, water quality data resulting from the surveys performed during the spring and early summer months show concentrations of those constituents characteristic of stormwater runoff and snow melt (increased concentrations of suspended solids, color, nutrients, iron, manganese, etc.).

2.6.1.2 Ground Water Quality - In the Edgemont project area the Fall River and Lakota Formations, which together form the Inyan Kara Group, are the principal sources of water for domestic water supplies, irrigation, and stock watering. Water in these formations is under artesian conditions. The Chilson Member of the Lakota Formation is the ore-bearing unit and is the main aquifer to be impacted by underground mining activities. Mining of ore at outcrop regions of the Fall River Formation will occur at surface mining sites.

Ground water quality investigations were conducted at the project during the period of November 1976 through November 1977. A summary of results of water quality analysis of ground water samples obtained on and near the project site are listed in Table 2.6.1.2-1. Their locations are shown on Figure 2.6.1.1-1. This table provides a comparison of reported ranges of water quality parameters with various water quality standards and criteria.

Table 7.6.1.2-1

Summary of Groundwater Quality Data in the Vicinity of the

Edgemont Project Area

Parameter	Burdock Mines Composite Groundwater Pump Test Results[1]				Burdock Mines Piezometers Lakota Formation[2]				Burdock Mines Piezometers Composite Groundwater[3]				Regional Data from the Lakota Formation[3]				Regional Data from the Fall River Formation[4]				EPA Drinking Water Standards[5]	NAS-NAE[6]	
	Max	Min	Mean	Number of Observations	Max	Min	Mean	Number of Observations	Max	Min	Mean	Number of Observations	Max	Min	Mean	Number of Observations	Max	Min	Mean	Number of Observations		Irrigation Water Criteria	Livestock Watering Criteria
Temperature, °C	14	13	13	3	14	6	11	7	13	5	10	7	14	-	-	1							
pH, S.U.	7.9	7.3	7.6	3	7.8	6.8	7.2	4	7.7	6.7	7.2	3	7.9	7.0	7.6	6	8.9	7.7	8.3	7	6.5-8.5	4.5-9.0	
Specific Conductance, µmhos	1675	1410	1580	3	1490	1050	1270	7	1850	1030	1320	7	2600	1094	1800	4	5100	1410	2850	4			
Alkalinity (as $CaCO_3$), mg/l	209	202	206	2	210	22	140	6	210	24	90	6	400	207	272	6	952	238	596	7			
Calcium, mg/l	170	150	160	3	150	7.3	80	7	92	8.1	47	7	260	62	109	6	104	2.8	26	8			
Chloride, mg/l	10	9	9	3	130	9	50	6	130	10	50	6	135	0.15	30	6	286	0.17	84	8	250		
CO_3, mg/l	10	6	8	3	-	-	-	-	140	56	96	2											
Fluoride, mg/l	0.26	0.24	0.25	3	0.64	0.37	0.40	5	0.80	0.32	0.56	6	0.95	0.10	0.50	6	2.4	0.6	1.5	7	1.4-2.4*	1.0	2.0
Hardness (as $CaCO_3$), mg/l	670	610	636	3	579	130	360	7	360	54	190	7	382	50	216	2	412	10	136	6			
Iron, mg/l	0.38	0.16	0.24	3	48	0.64	15	7	22	0.28	7.0	7	1.60	0.02	0.80	5	2.9	0.08	0.6	7	0.3	5	
Magnesium, mg/l	59	53 -	57	3	49	3.8	32	7	34	8.2	18	7	125	3.1	46	6	37	0.7	10	8			
Nitrogens																							
Ammonia, mg/l	0.11	0.10	0.10	3	0.37	0.03	0.18	3	0.37	0.08	0.18	3											
Organic, mg/l	0.02	<0.01	0.01	3	1.20	0.12	0.55	3	0.63	0.29	0.38	3											
Nitrite plus Nitrate, mg/l	<0.01	<0.01	<0.01	3	0.26	0.08	0.14	3	0.17	0.07	0.10	3	0.1(NO_3)	-	-	1						45(NO_3)*	100
Phosphorus, mg/l	0.02	0.01	0.01	3	0.33	0.01	0.12	3	0.10	0.03	0.06	3											
Potassium, mg/l	7.5	7.3	7.4	3	210	14	90	6	160	9	50	6	23	-	-	1							
Silica, mg/l					8.1	0.09	3.9	3	1.4	0.02	0.50	3	10	8.4	9.7	5	17	5.4	12	7			
Sodium, mg/l	120	120	120	3	250	110	150	7	270	110	200	7	390	107	236	6	1064	167	470	8			
Solids (dissolved), mg/l	1000	1000	1000	3	1200	680	940	6	1300	480	870	5	2091	829	1358	6	3189	1010	1689	8	500		
Sulfate, mg/l	580	540	560	3	690	230	510	6	900	180	520	6	1102	246	679	6	1790	8	533	8	250		3300
Aluminum, µg/l	<200	<200	<200	3	520	<200	300	7	500	<200	<270	7										5000	5000
Arsenic, µg/l	2.8	1.6	2.4	3	6	<2	2	7	<2	<2	<2	7									50*		
Barium, µg/l	<100	<100	<100	3	200	<100	<110	7	<100	<100	<100	7									1000*		
Beryllium, µg/l					<10	<10	<10	3	<10	<10	<10	3										100	
Boron, µg/l	120	50	80	3	440	140	240	6	580	160	270	6	70	-	-	1						750	
Cadmium, µg/l	<1	<1	<1	3	2	<1	<1	7	2	<1	<1	7									10*	10	50
Chromium, µg/l	<5	<5	<5	3	<5	<5	<5	7	<5	<5	<5	7									50*	100	1000
Cobalt, µg/l	<5	<5	<5	3	<5	3	<5	7	8	<5	7	7										50	1000
Copper, µg/l	20	10	20	3	140	<10	50	7	160	<10	<30	7									1000	200	500
Lead, µg/l	20	<10	<10	3	1600	<10	360	7	380	<10	80	7									50*	5000	100
Lithium, µg/l					110	40	80	4	90	50	70	4										2500	
Manganese, µg/l	240	230	240	3	530	140	270	7	390	30	180	7									50	200	
Mercury, µg/l					0.5	<0.2	<0.3	5	0.4	<0.2	<0.3	5									2*		10
Molybdenum, µg/l	<100	<100	<100	3	<100	<100	<100	6	<100	<100	<100	6										10	
Nickel, µg/l	<50	<50	<50	3	<50	<50	<50	6	<50	<50	<50	6										200	
Selenium, µg/l	<1	<1	<1	3	2	<1	<1	6	1	<1	<1	6									10*	20	50
Silver, µg/l	<10	<10	<10	3	<10	<10	<10	6	<10	<10	<10	6									50*		
Strontium, µg/l	3700	3400	3600	3	2100	1300	1670	6	2200	370	1130	6											
Vanadium, µg/l	<100	<100	<100	3	<100	<100	<100	7	<100	<100	<100	6										100	100
Zinc, µg/l	290	100	180	3	7700	<10	2250	6	210	40	140	7									5000	2000	25,000
Hydrogen Sulfide, mg/l													2	0.1	1	3	5+	5	5+	3			
SAR	-	-	2.1	3	-	-	3.6	7	-	-	6.2	7	-	-	4.9	4	-	-	20	8			

1. Groundwater samples were obtained during a pump test of well D-53, and represents a composite of water from the Lakota and Fall River Formations (see section 2.5.2). Data Source: TVA, 11/14-17/77.
2. Groundwater samples were from flowing (F) and nonflowing (NF) piezometers D-47 (F), D-49 (NF), and D-51 (F). Data Source: TVA, 1976-1977.
3. Groundwater samples were from flowing (F) and nonflowing (NF) piezometers D-48 (F), D-50 (NF), and D-52 (F). Samples represent a composite of water from the Lakota and Fall River Formations (see section 2.5.2). Data Source: TVA, 1976-1977.
4. Samples were obtained from wells D-6, D-12, D-20, F-1, and G-1 (Data Source: Reference No. 6) and Well G-1 (Data Source: USGS, 1972).
5. Samples were obtained from wells D-21, F-2, F-3, F-4, F-5, F-6, F-7, and B-1 (Data Source: Reference No. 6).
6. Standards marked with (*) are primary drinking water standards and unmarked are the proposed secondary drinking water standards. Reference numbers 3 and 4.
7. Reference number 5.

Hydrologic studies at the Burdock mine sites were conducted utilizing well D-53 and site piezometers during the period of November 14-17, 1977. The results of this study revealed that in the vicinity of the Burdock mines, waters from the Lakota and Fall River Formations intermix and water samples from this well represent a composite of water from these two aquifers (section 2.5.2).

Well D-53 may be utilized as a depressuring well for the Burdock underground mine. Evaluation of water quality data from this pumped well show its physical-chemical quality to be fair. Concentrations of dissolved solids averaged 1,000 mg/l and the ground water is considered to be very hard. The principal cations were calcium and sodium, and the principal anions were sulfate and bicarbonate. Concentrations of analyzed primary (health) trace metals were less than those specified by the EPA for finished drinking water.[4] Mean concentrations of dissolved solids, sulfates, and manganese were greater than those concentrations specified by the proposed EPA secondary (aesthetically undesirable) standards for finished drinking water.[4] Using the USDA[7] diagram for evaluating ground water for irrigation purposes, the ground water is unsuitable for irrigation purposes because of its high salinity hazard.

When depressuring of the Lakota Formation is not in progress, water from the Lakota Formation enters the Fall River Formation because of its greater piezometric head. Piezometers D-47, D-49, and D-51 are screened in the Lakota Formation only thus permitting evaluation of the quality of water in the aquifier. Evaluation of the water quality data from the Lakota Formation, in advance of any hydrologic studies, shows its physical-chemical quality to be poorer than the intermixed ground water obtained during the hydrologic studies. Concentrations of nutrients and most metals were greater than those concentrations observed at well D-53. Nevertheless, except for lead, concentrations of analyzed primary trace metals were less than those specified by the EPA primary standards. An excessively high concentration of lead (1,600 g/l) was observed in a grab sample from piezometer D-49, which is non-flowing. Lower concentrations were observed in D-51 and on a different occasion in D-49, but the observed concentrations still exceeded the EPA standard of 50 g/l for finished drinking water. Mean concentrations of iron, dissolved solids, sulfates, and manganese exceeded those concentrations specified by the proposed EPA secondary standards. The water is considered to be very hard, the principal cations were sodium and calcium, and the principal anions were sulfate and bicarbonate. Based upon the 1972 NAS - NAE criteria[5] the ground water is unsuitable for irrigation and livestock watering purposes and based upon USDA criteria, the salinity hazard for irrigation is high.

Water quality samples were also obtained prior to the hydrologic studies at piezometers (D-48, D-50, and D-52) screened in the Fall River Formation. Based upon hydrologic studies, this ground water also represents a composite of the Lakota and Fall River Formations. An evaluation of the water quality data from samples obtained from these piezometers showed its physical-chemical quality to be better than that of the Lakota Formation. Concentrations of dissolved solids averaged 870 mg/l. The water is considered to be moderately hard, the principal cations were

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sodium and calcium and the principal anions were sulfate and bicarbonate. Although lower concentrations were observed at these piezometers, the mean concentration of lead, iron, dissolved solids, and manganese exceeded the EPA standards. The highest concentrations of Chemical Oxygen Demand and sulfates were reported in samples from these piezometers. A higher mean Sodium Adsorption Ratio was calculated and based upon USDA criteria the salinity hazards for irrigation is high.

A comparison of the water quality of composite ground water obtained at the piezometers screened in the Fall River Formation and the pumped depressuring well reveals that the pumped depressuring well provides water of better quality containing smaller concentrations of most metals and nutrients. Conversely concentrations of minerals, especially hardness causing minerals, and dissolved solids measured in the piezometer samples were less than the concentrations observed in samples from the pumped well.

Based upon this evaluation, it can be concluded that (1) the water quality of the Fall River Formation is better than the water quality of the Lakota Formation, (2) the pumped depressuring well provides the best source of raw water for various uses, and (3) during depressuring the inflow of water from the Fall River Formation to the Lakota Formation will not degrade water quality, but instead enhance water quality in local private wells which tap the Lakota Formation.

Summaries of historical water quality data from the USGS, the Atomic Energy Commission (replaced by NRC), and the South Dakota School of Mines are also listed in Table 2.6.1.2-1. Evaluation of this data would lead to the conclusion that the water quality of the Fall River Formation is poorer than that of the Lakota Formation. The discrepancy between the historical data and the data obtained on the project site may be explained by several reasons: (1) changes in aquifer water quality with time, (2) well locations in the ground water basin, (3) well design, (4) sampling techniques, and (5) laboratory accuracies.

2.6.2 Water Quality Impact Assessment - Impacts to surface and/or ground water quality potentially can be caused by several activities connected with uranium mining. These activities and proposed mitigative measures will be discussed individually for underground and surface mining. A discussion of liquid wastes, their treatment, discharge, and the impact of this discharge is presented under Section 2.12.1.

2.6.2.1 Underground Mining

2.6.2.1.1 Ground Water Depressuring and Quality Protection Measures - Depressuring of the Lakota Formation at the Burdock Mine will be accomplished by pumped wells and subsurface drainage systems. Depressuring will contribute to the drawdown of the piezometric surface of the Lakota Formation, thus permitting waters from the overlying Fall River Formation to enter the Lakota Formation and form a composite of water from the two aquifers. No significant adverse impact to the water quality of the Fall River and Lakota Formations during mining is anticipated since the depressuring operation will always cause the mine to act as a sink for any potentially contaminated water rather than a source. Some local change in the water quality of the Lakota Formation will occur but this should represent an improvement over existing conditions (see Section 2.6.1.2). Depressuring will not be conducted at the Darrow Extensions and Runge East Mines since mining will be within unsaturated portions of the Fall River Formation.

Protection of ground water quality in the vicinity of underground mines will be accomplished by (1) the sealing of all ponds which will receive contaminated mine water, (2) the sealing of ore storage pads and the dikes providing containment of runoff in the ore storage area, and (3) the immediate cleanup following accidental spills of fuel and oils.

2.6.2.1.2 Nonpoint Source Runoff - No significant degradation of the area's water resources is expected from nonpoint source discharges at the underground mines since (1) runoff will be limited due to the semiarid climate, (2) existing drainage patterns will be designed to allow runoff outside the boundary of the mining operations to be diverted around the areas disturbed by mining, (3) runoff from overburden storage, topsoil storage, revegetated areas, and other disturbed areas will be controlled as necessary by a system of dikes, trenches, ponds, or other appropriate measures including routing to the lagoon-treatment system, (4) runoff from ore storage areas will be controlled by diking around the impervious ore pad, (5) erosion of haul roads will be minimal because all roads currently exist, drainage ditches will be constructed alongside the roads, and the roads will be well maintained.

2.6.2.1.3 Spill Control - Areas will be designated for the storage of fuel and oil. These materials will be stored within diked areas of sufficient capacity to retain 110 percent of the total volume contained. In the event of an accidental spill within a diked area, the spilled material will be contained and disposed of in an environmentally acceptable manner. Substantial quantitites of other potentially hazardous or toxic materials are not anticipated to be stored at the underground mining sites.

2.6.2.1.4 Post Mining - After operations cease, waste piles, mine water holding ponds, ore storage areas, disturbed areas, and other surface facilities will be stabilized and/or reclaimed to minimize adverse impacts to ground or surface water quality that might result from rainfall or snowmelt runoff, or ground water contacting these areas. Along with this site stabilization, each shaft will be covered with a concrete slab. Requirements applicable at the time of stabilization of these areas, in addition to those described in the reclamation program, will be met. Upon abandonment of a mine shaft, depressuring operations will cease and natural hydraulic gradients in the Lakota and Fall River Formations will likely recover to approach pre-mining conditions. Some deterioration of ground water quality in the Lakota Formation could occur in the immediate vicinity of the mine. This would be a result of oxidation and other chemical reactions within the abandoned mine. At this time, the potential impact on these aquifers is judged to be insignificant because during aquifer gradient restoration the flow will be towards the mine site, thus confining any potentially contaminated ground water to the immediate area. A return to the chemically reduced state will eventually occur due to the natural geochemical reactions in the formations and the reducing characteristics of the natural ground water. Thus, metals associated with the ore body should be converted from a soluble to an insoluble phase; and precipitate in the mine site area. After the restoration period, any dispersion of the soluble form of these metals should be minimal.

2.6.2.2 Surface Mining

2.6.2.2.1 Ground Water Inflows, Overburden Leachates, and Ground Water Quality Protection Measures - Only one surface mine has been planned to date, the Spencer Richardson Mine. Significant volumes of ground water are not expected to be encountered in surface mines because all surface mining should be in unsaturated portions of the Fall River Formation. Runoff from the overburden spoil piles, ground water seepage, rainfall, and/or snowmelt that does enter the mining pit will be handled as specified in Section 2.12.1.

A portion of the rainfall, snowmelt, and ground water inflows, if any, to the open pit will infiltrate the bottom of the pit. When the surface mine is reclaimed, rainwater and snowmelt will infiltrate the implaced overburden. Rainwater has a pH of less than neutral and therefore is capable of leaching minerals and metals from the overburden matrix. The impact of this leaching on the water quality of the Fall River Formation is judged to be insignificant because all surface mining is proposed in aquifer outcrop areas which normally permit the infiltration of rainwater.

If, in the future, mining is proposed for non-outcrop sections of the Fall River Formation, the impact of leaching on groundwater quality should also be insignificant because of several factors: (1) leaching should be short-termed because a hardpan condition is likely to occur on newly disturbed overburden piles after the first few rainfalls, thus reducing the infiltration rates, (2) the low average rainfall quantities expected at the site, 30 to 40 cm/yr, (13 to 16 in/yr) should reduce the time the rainwater is in contact with the overburden, (3) most of the rain expected at the site is of short duration and high intensity thus resulting in greater volumes of runoff and lesser volumes of water infiltrating the overburden surface, (4) the volume of the portion of the aquifer to be mined is insignificant when compared to its total volume, and (5) the attenuation capabilities of the aquifer should decrease leached metal concentrations within a short distance of the mining zone. Only minor post-mining overburden leaching is expected since the same overburden will have been used in the reclamation program.

Protection of ground water quality in the vicinity of the surface mine sites shall be accomplished as discussed in underground mining (Section 2.6.2.1.1, second paragraph).

2.6.2.2.2 Nonpoint Source Impacts - No significant degradation of the area's water resources is expected from nonpoint source discharges at surface mining areas. Drainage and control systems will be built and maintained to control runoff as discussed in underground mining (Section 2.6.2.1.2).

2.6.2.2.3 Spill Control - Fuels and oils will be handled as discussed in underground mining (Section 2.6.2.1.3). Substantial quantities of other potentially hazardous or toxic materials are not anticipated to be stored at the surface mining sites.

2.6.3 Water Quality Monitoring

2.6.3.1 Surface Water Quality Monitoring - Mining wastewaters will be fed to mine water holding ponds where they will be treated and discharged in compliance with applicable requirements which will be identified in the NPDES permit. Site runoff will be controlled as necessary by a system of dikes, trenches, ponds, or other appropriate measures. Monitoring will be carried out in accordance with the discharge permit requirements.

2.6.3.2 Ground Water Quality Monitoring - At the Burdock underground mining area, the Lakota Formation will be depressurized by a series of wells located around the periphery of each mine shaft. This ground water, which represents a composite of the Lakota and Fall River Formations, will be monitored for various parameters at least once annually to detect changes, if any, as a result of the continued leakage of the Fall River Formation into the Lakota Formation. In addition, selected private water wells will be monitored once annually for a limited period to verify the analysis contained in Section 2.6.1.2.

At the Burdock area, mine water holding ponds will be located on top of the Skull Creek Shale Formation, and the pond bottom and dike walls will be sealed to prevent any seepage. If any seepage were to occur, it would be through a dike and appear on the land surface. Therefore, shallow ground water monitoring will not be conducted at the Burdock mining area.

At the Spencer Richardson mine, Darrow Extensions, and Runge East Mines, mining will occur in unsaturated outcrop regions of the Fall River Formation. Significant volumes of ground water are not expected to be encountered at these sites, but water removed from the mine shafts, open pits, and runoff will be routed to sealed mine water holding ponds. To adequately monitor the integrity of the sealed ponds and ensure that they are efficiently retaining waste waters, shallow ground water quality monitoring will be conducted. Wells will be provided in the saturated portion of the Fall River Formation both upgradient and downgradient to the ponds. Sampling will begin prior to mining activities on a quarterly frequency. Samples will be analyzed for various physical and chemical water quality constituents.

Results of the ground water quality monitoring program will be evaluated on a routine frequency to ensure that water quality conditions are not significantly impacted by the mining activity. At the end of one full year of ore production, the program will be reevaluated to ensure that the objectives of the program are being satisfied and appropriate changes will be made as necessary, consistent with these objectives. Additional program evaluations will be conducted as necessary.

2.6 References

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2. State of Wyoming Department of Environmental Quality. Water Quality Standards for Wyoming. Dated August 8, 1974, and Stream Classifications in Wyoming Oct. 1, 1977; 1973 CS, 35-502.19 and 1973 SL, 35-487-19.

3. U.S. Environmental Protection Agency. National Interim Primary Drinking Water Regulations. CFR. Title 40. Part 141. V. 40, No. 248. December 1975.

4. U.S. Environmental Protection Agency. Proposed National Secondary Drinking Water Regulations CFR. Title 40. Part 143 V. 42, No. 62. March 1977.

5. National Academy of Sciences and National Academy of Engineering. Water Quality Criteria 1972. USEPA R3 73 033. March 1973.

6. Keene, Jack R. Ground-Water Resources of the Western Half of Fall River County, S.D.; South Dakota Geological Survey Rept. of Inv. No. 109. 1973.

7. United States Department of Agriculture. Diagnosis and Improvement of Saline and Alkali Soils. Agriculture Handbook No. 60. 1954.

2.7 Climatology and Air Quality

2.7.1 Physical Environment

2.7.1.1 General Climate - The project area is located in extreme southwestern South Dakota and extreme east-central Wyoming, adjacent to the southwestern extension of the Black Hills. The project area is characterized by low precipitation, high evaporation rates, abundant sunshine, low relative humidities, and moderate temperatures with large diurnal and annual variations.[1,2] The general climate of the project area may be considered as semi-arid continental or steppe with a dry winter season.[3,4]

Migratory storm systems originating in the Pacific Ocean generally release most of their moisture over the Coastal and Cascade Range and Rocky Mountains, thus arriving in the Black Hills area relatively dry, and generally producing only light precipitation. Heavier precipitation normally occurs when these systems reintensify east of the Rocky Mountains and interact with moist air that is either already present or advected into the area from the southeast. Isolated summertime convective storms may also produce heavy localized precipitation, primarily over and adjacent to the Black Hills.

Topography on the lease properties does not vary substantially and therefore should not influence synoptic-scale air flow to any great extent. The adjacent Black Hills, however, are a major barrier to air flow and may cause some variation in the airflow in the general region.

2.7.1.2 Temperature - Temperatures in the project vicinity are reasonably represented by data from nearby Ardmore, South Dakota located approximately 35 km (22 mi) south-southeast of the Edgemont properties . Table 2.7.1.2-1 presents mean monthly and annual mean daily maximum and minimum temperatures for the Ardmore station for 42 years of record.

Temperatures greater than or equal to 32° C (90° F) are estimated to occur on an average of 60 days per year in the project area.[2] The extreme maximum temperature reported for Ardmore is 46° C (114° F).[2] Migrating high pressure systems moving southward out of Canada frequently influence the site area. This fact, combined with elevations of about 3,500 to 3,800 feet MSL (Mean Sea Level), a northern continental location, and infrequent cloud cover, contributes to an average of 198 days per year in the project area recording temperatures less than or equal to 0° C (32° F). The lowest temperature on record for Ardmore is -38° C (-37° F).[2]

Freezing temperatures generally do not occur in the project area after mid-May or before the last of September.[1] However, there are large variations in freeze dates from year to year.

2.7.1.3 Precipitation and Relative Humidity - Maximum precipitation amounts in the project area occur during late spring and early summer, primarily as a result of moist air from the Gulf of Mexico interacting with frontal systems moving across

Table 2.7.1.2-1

Monthly and Annual Mean and Mean Daily Maximum and Minimum

Temperatures in Degrees Centigrade (Fahrenheit)

For Ardmore, South Dakota (1919-1960)[2]

Month	Mean	Mean Daily Maximum	Mean Daily Minimum
January	-6.8 (20)	0.9 (34)	-14.4 (6)
February	-4.1 (25)	3.8 (39)	-11.6 (11)
March	0.8 (33)	8.3 (47)	-7.1 (19)
April	7.0 (45)	14.9 (59)	-0.8 (30)
May	12.9 (55)	20.7 (69)	5.2 (41)
June	18.6 (65)	26.6 (80)	10.4 (5[illegible])
July	23.3 (74)	32.4 (90)	14.3 (58)
August	22.1 (72)	31.3 (88)	12.7 (55)
September	15.9 (61)	25.6 (78)	6.6 (44)
October	8.8 (48)	18.0 (64)	-0.1 (32)
November	1.1 (34)	9.1 (48)	-6.8 (20)
December	-4.8 (23)	2.8 (37)	-12.2 (10)
Annual	7.9 (46)	16.2 (61)	-0.3 (31)

the region. Summertime convective thunderstorm activity also contributes substantially to the precipitation totals during the summer months. Monthly and annual precipitation data from Edgemont, South Dakota (Table 2.7.1.3-1), indicate that approximately one-half of the annual precipitation falls during the months of May, June, and July. Most of the winter precipitation can be expected as snow. Based on snowfall records for Ardmore over a 9 year period of record, the annual average snowfall for the project area is estimated to be approximately 94 cm (37 in).[2]

Based on records from the NWS (National Weather Service) station at Rapid City, South Dakota, located about 105 km (65 mi) northeast of the site, it is estimated that precipitation of 0.25 mm (0.01 in) or more occurs on an average of 90 days per year in the project area.[5,6,7]

The mean annual relative humidity for the project area is estimated to be about 52 percent.[5,7] However, afternoon humidities in the warmer months are often lower than 30 percent.

<u>2.7.1.4 Wind Speed and Direction</u> - Long-term wind information is not available for the immediate project area. The nearest NWS stations with such data are at Rapid City, South Dakota, and Scottsbluff, Nebraska, which are more than 105 km (65 mi) northeast and 160 km (100 mi) south of the site, respectively. Table 2.7.1.4-1 presents monthly and annual mean wind speeds and directions for these two stations. Limited site-specific information for the period March 24, 1977, through March 23, 1978, is presented in Table 2.7.1.4-2.

The NWS data indicate that the general air flow in the region is most frequently from a northwesterly direction with a secondary maximum from a southeasterly direction. Wind speeds are relatively high, generally averaging over 4.5 m/s (10 mi/h). The site specific wind data is reasonably consistent with the NWS information. However, in the site specific data, the wind direction distribution is shifted slightly to a more west-northwest and east-southeast orientation, and the average wind speed during the one year measurement period is lower than that observed over the longer-term NWS period.

<u>2.7.1.5 Severe Weather</u> - Tornadoes are infrequent in western South Dakota and eastern Wyoming. Of those reported, most occurred in the afternoon and early evening hours during the summertime thunderstorm season. Only nine tornadoes were reported within the one-degree (of latitude and longitude) square that includes the project area during the period from 1955 through 1967.[10] Thus, the estimated probability of a tornado striking a point within the project area in any given year is 0.0006.[10,11] In other words, the estimated mean recurrence interval for a tornado occurrence at any point within the project area is about 1,650 years.

Thunderstorms are relatively frequent in southwestern South Dakota and east-central Wyoming during the summer months, occurring on the average of 40 to 45 days per year.[7,12] Hail in

Table 2.7.1.3-1

Mean Monthly and Annual

Precipitation for Edgemont, South Dakota (1949-1957)[2]

Month	Amount (Millimeters)	Amount (Inches)	Years of Record
January	9	.3	9
February	11	.5	9
March	23	.9	9
April	30	1.2	9
May	73	2.9	9
June	67	2.6	9
July	48	1.9	8
August	29	1.1	8
September	28	1.1	8
October	19	.7	8
November	10	.4	9
December	9	.3	9
Annual	356	14.0	

Table 2.7.1.4-1

Monthly and Annual Mean Wind Speeds and Predominant Wind Directions

At Scottsbluff, Nebraska, and Rapid City, South Dakota[7,8,9]

	Scottsbluff, Nebraska		Rapid City, South Dakota	
Month	Mean Speed, m/s (mi/h)[a]	Direction[a]	Mean Speed, m/s (mi/h)[a]	Direction[b]
January	4.7 (10.6)	WNW	4.7 (10.5)	NNW
February	5.1 (11.5)	WNW	4.8 (10.8)	NNW
March	5.5 (12.3)	WNW	5.6 (12.5)	NNW
April	5.8 (12.9)	NW	5.9 (13.2)	NNW
May	5.4 (12.1)	ESE	5.5 (12.4)	NNW
June	4.7 (10.6)	ESE	4.8 (10.7)	NNW
July	4.2 (9.4)	ESE	4.4 (9.9)	NNW
August	4.1 (9.2)	ESE	4.6 (10.2)	NNW
September	4.2 (9.5)	ESE	4.9 (11.0)	NNW
October	4.4 (9.8)	NW	5.0 (11.1)	NNW
November	4.6 (10.4)	NW	4.9 (10.9)	NNW
December	4.8 (10.7)	WNW	4.6 (10.4)	NNW
Annual	4.8 (10.7)	ESE	5.0 (11.1)	NNW

a. Based on 24 years of record.

b. Based on 13 years of record.

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED BY DIRECTION

DISREGARDING STABILITY CLASS

EDGEMONT MILL METEOROLOGICAL FACILITY

MAR 24, 77 - MAR 23, 78

WIND DIRECTION	WIND SPEED (Mi/h) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.12	0.65	0.50	0.38	0.35	0.16	0.0	0.0	2.16
NNE	0.07	0.69	0.41	0.12	0.10	0.0	0.0	0.0	1.39
NE	0.16	0.87	0.44	0.15	0.20	0.06	0.0	0.01	1.89
ENE	0.09	0.96	0.62	0.40	0.66	0.44	0.07	0.0	3.24
E	0.13	1.30	1.50	1.43	4.13	2.52	0.13	0.0	11.14
ESE	0.09	0.54	1.01	1.32	5.10	2.97	0.20	0.0	11.23
SE	0.06	0.56	0.66	0.87	2.63	0.85	0.15	0.02	5.80
SSE	0.17	1.04	1.04	1.22	1.17	0.50	0.10	0.01	5.25
S	0.32	3.89	1.80	0.78	0.55	0.12	0.0	0.01	7.47
SSW	0.26	1.63	0.99	0.41	0.37	0.07	0.01	0.0	3.74
SW	0.09	0.83	0.33	0.30	0.33	0.02	0.01	0.0	1.91
WSW	0.09	1.27	0.45	0.24	0.29	0.09	0.0	0.0	2.43
W	0.38	4.72	3.32	1.41	1.57	0.66	0.24	0.0	12.30
WNW	0.10	2.44	2.90	1.85	3.08	2.29	1.02	0.21	13.89
NW	0.15	1.57	1.83	1.43	2.36	1.82	0.77	0.39	10.32
NNW	0.07	1.26	1.24	0.66	1.49	0.59	0.11	0.16	5.58
SUBTOTAL	2.35	24.22	19.04	12.97	24.38	13.16	2.81	0.81	99.74

Total hours of valid wind observations	8204
Total hours of observations	8747
Recoveability percentage	93.8
Total hours calm	2[illegible]

All columns and calm total 100 percent of joint valid observations

Meteorological Facility: Wind speed and direction measured at the 33.00 foot level

Mean wind speed = 7.2 Mi/h

association with these thunderstorms is generally reported on an average of 4 to 6 days per year.[12]

Extreme winds of short duration in this area are generally associated with thunderstorms. Table 2.7.1.5-1 presents estimated maximum (fastest mile) wind speeds at 9.1 m (30 ft) above the ground for various recurrence intervals.

Maximum short-duration rainfalls are generally associated with intense thunderstorms. Table 2.7.1.5-2 presents estimated maximum precipitation at any point in the project area for various durations and recurrence intervals.

2.7.1.6 Atmospheric Stability - Based on the input parameters of solar altitude, cloud cover, ceiling height and wind speed, atmospheric stability can be classified into several categories. The closest NWS stations with available long-term atmospheric records from which stability conditions can be estimated are Scottsbluff and Chadron, [located about 85 km (53 mi) southeast of the site], Nebraska, and Rapid City, South Dakota. The percent frequencies of the various stability conditions for these three locations are presented in Table 2.7.1.6-1. The data indicate that stability conditions contributing to good dispersion conditions (generally Pasquill classes A through D) occur more than 65 percent of the time at all three stations.

2.7.2 Existing Air Quality

2.7.2.1 Air Quality Standards - The project area is located in the Black Hills-Rapid City and the Wyoming Intrastate AQCR's (Air Quality Control Regions). Both of these AQCR's are classified as Priority III for sulfur dioxide, nitrogen dioxide, carbon monoxide, photochemical oxidants, hydrocarbons, and particulate matter.[17] This means that existing pollutant levels within these AQCR's are currently below Federal secondary standards for these six criteria pollutants. Federal ambient air quality standards are presented in Table 2.7.2.1-1, South Dakota and Wyoming ambient standards in Tables 2.7.2.1-2 and 2.7.2.1-3, respectively.

In addition to ambient standards, Federal laws on the PSD (Prevention of Significant Deterioration) establish ambient increments (Table 2.7.2.1-4) to protect areas with air quality cleaner than minimum national standards.[18] The project area is presently designated as Class II with respect to significant deterioration. These laws specify both conditions under which major new sources or major source modifications must undergo a PSD preconstruction review and those pollutants for which the source is subject to meeting best available control technology. Because of the uncertainties presently associated with the Environmental Protection Agency's implementation of these laws, it has not been determined whether the Edgemont project will be required to undergo a PSD preconstruction review.

Table 2.7.1.5-1

Annual Extreme - Estimated Fastest Mile Wind Speeds

9.1 Meters (30 Feet) Above Ground Level

For the Edgemont Area[13]

Recurrence Interval (Years)	Wind Speed (m/s)	Wind Speed (mi/h)
2	26.8	60
10	32.6	73
25	35.8	80
50	38.4	86
100	41.1	92

Table 2.7.1.5-2

Estimated Maximum Point Precipitation in Millimeters (Inches)

For Selected Durations and Recurrence Intervals

For the Edgemont Area[14,15]

Duration	2 Years	10 Years	25 Years	50 Years	100 Years
1 hour	25 (1.0)	43 (1.7)	50 (2.0)	58 (2.3)	66 (2.6)
12 hours	40 (1.6)	68 (2.7)	78 (3.1)	88 (3.5)	101 (4.0)
24 hours	48 (1.9)	76 (3.0)	88 (3.5)	101 (4.0)	114 (4.5)
2 days	53 (2.1)	83 (3.3)	99 (3.9)	114 (4.5)	124 (4.9)
7 days	71 (2.8)	109 (4.3)	127 (5.0)	149 (5.9)	162 (6.4)
10 days	81 (3.2)	119 (4.7)	142 (5.6)	152 (6.0)	177 (7.0)

Table 2.7.1.6-1

Percent Frequency Distributions of Pasquill Stability Classes

For Rapid City, South Dakota, and Scottsbluff and Chadron, Nebraska[8,9,16]

Stability Class	Percent Rapid City (1959-1968)	Scottsbluff (1948-1975)	Chadron (1948-1954)
A (extremely unstable)	0.3	0.9	0.5
B (unstable)	4.1	5.4	5.1
C (slightly unstable)	9.7	9.9	9.7
D (neutral)	54.8	52.9	55.1
E (slightly stable)	14.7	15.4	11.6
F (stable)	11.7	11.1	10.1
G (extremely stable)	4.6	4.4	7.1

Table 2.7.2.1-1

Federal Ambient Air Quality Standards[19]

Standard	Carbon Monoxide ($\mu g/m^3$)	Oxidants ($\mu g/m^3$)	Nitrogen Dioxide ($\mu g/m^3$)	Suspended Particulates ($\mu g/m^3$)	Sulfur Dioxide ($\mu g/m^3$)
Primary					
1-hour	40,000	160			
8-hour	10,000				
24-hour				260	365
Annual			100	75[a]	80
Secondary					
1-hour	40,000	160			
3-hour					1,300
8-hour	10,000				
24-hour				150	
Annual			100	60[a]	

a. Annual geometric mean.

Table 2.7.2.1-2

South Dakota Ambient Air Quality Standards[20]

Duration	Carbon Monoxide (ppm)	Photochemical Oxidants (ppm)	Nitrogen Dioxide (ppm)	Soiling Index (COHs/1000 ft)	Suspended Particulates ($\mu g/m^3$)
1-hour	35	0.08	-	-	-
3-hour	-	-	-	-	-
8-hour	9	-	-	-	-
24-hour	-	-	0.10	-	150
7-day	-	-	-	-	-
30-day	-	-	-	-	-
Annual	-	-	0.05	0.2	60[a]

Duration	Hydrocarbons (ppm)	Sulfur Dioxide (ppm)
1-hour	-	-
3-hour	0.24[b]	0.50
8-hour	-	-
24-hour	-	0.14
7-day	-	-
30-day	-	-
Annual	-	0.03

a. Annual geometric mean.

b. Maximum 3-hour concentration.

Table 2.7.2.1-3

Wyoming Ambient Air Quality Standards[21]

Duration	Carbon Monoxide (ppm)	Photochemical Oxidants (ppm)	Nitrogen Dioxide (ppm)	Soiling Index (COHs/1000 ft)	Suspended Particulates ($\mu g/m^3$)	Total Settleable Particulates (g/m^2-month)
1-hour	35	0.08	-	-	-	-
3-hour	-	-	-	-	-	-
8-hour	9	-	-	-	-	-
24-hour	-	-	0.10	-	150	-
7-day	-	-	-	-	-	-
30-day	-	-	-	-	-	5-10[a]
Annual	-	-	0.05	0.4	60[b]	-

Duration	Hydrocarbons (ppm)	Fluorides (ppb)	Sulfur Dioxide (ppm)	Hydrogen Sulfide (ppm)	Total Suspended Sulfate (mg/100 cm^2-day)
1/2-hour	-	-	-	0.05[d]	-
3-hour	0.24[c]	-	0.50	-	-
8-hour	-	1.0	-	-	-
24-hour	-	-	0.10	-	0.5[e]
7-day	-	-	-	-	-
30-day	-	-	-	-	-
Annual	-	-	0.02	-	0.25[e]

a. Includes 1.7 g/m^2 background concentration. The 5 g/m^2-month standard applies to a residential area, the 10 g/m^2-month standard to an industrial area.
b. Annual geometric mean.
c. Maximum 3-hour concentration, 6-9 a.m.
d. To be exceeded only twice per year. A standard of 0.03 ppm is not to be exceeded more than twice within 5 consecutive days.
e. Measured as the sulfation rate by the lead peroxide method.

Table 2.7.2.1-4

Federal Prevention of Significant Deterioration (PSD) Increments[18]

Pollutant	Allowable Increases in Pollutant Concentrations ($\mu g/m^3$) Over Baseline					
	Class I PSD Increment	Class I PSD Increment Subparagraph C[a] Variance[b]	Class I PSD Increment Subparagraph D[a] Variance[c] Terrain Areas[d]		Class II PSD Increment	Class III PSD Increment
			Low	High		
Particulates						
Annual geometric mean	5	19	e	e	19	37
24-hour maximum	10	37	e	e	37	75
Sulfur Dioxide						
Annual arithmetic mean	2	20	2	2	20	40
24-hour maximum	5	91	36	62	91	182
3-hour maximum	25	325	130	221	512	700

a. Conditions for receiving variance specified under Clean Air Act Amendments, 1977.

b. Variance must be approved by Federal land manager.

c. Concentrations up to limits of variance permitted only on 18 days/year. Variance must be approved by governor and Federal land manager or President.

d. The division between high and low terrain is 900 feet above the stack.

e. Not applicable for particulates.

2.7.2.2 Existing Air Quality - There are no existing air quality data available for the immediate project area. However, official monitoring station data on total suspended particulates are available for communities in the general region (Table 2.7.2.2-1). The data show a wide range of concentrations for the different locations and, in some cases, for different years at each location, e.g., a high annual geometric mean of 88 $\mu g/m^3$ at Gillette during 1972, a low annual geometric mean of 31 $\mu g/m^3$ at Gillette during 1974. Background particulate levels in the region are highly variable and depend on a large number of factors, such as wind speed, amount of vegetation, soil type, topsoil moisture, and the number and type of anthropogenic sources. The higher concentrations reported at stations like Gillette, Douglas, and Hot Springs may be due to some extent to differences in anthropogenic source activities, such as transportation, construction, and energy production. Background concentrations of other criteria pollutants (sulfur dioxide, hydrocarbons, hydrogen sulfide, total reduced sulfur, photochemical oxidants, nitrogen dioxide, and carbon monoxide) are all expected to be very low in the project area because of the low population density and lack of industrial development.

2.7.3 Air Quality Impacts

2.7.3.1 Sources of Air Pollution - Nonradiological gaseous emissions will result from the combustion of fossil fuels by mining equipment and support vehicles used in the surface and underground mining operations. Lists of the number, type, and probable operation schedules of major fossil-fueled equipment that could be used for this project are presented in Tables 1.1.2.1-1 and 1.1.2.2-1. The estimated total fuel consumption by these vehicles is approximately 7,840 l (2,070 gal) of No. 2 diesel fuel per day. Of this total, 2,540 l (670 gal) per day will be used by the underground equipment and 3,090 l (815 gal) per day will be used by the surface support equipment associated with the initial shaft at the Burdock underground mine: The remaining 2,220 l (585 gal) per day will be used in the various surface mining operations. On-highway support equipment (approximately 40 vehicles) are expected to consume approximately 325 l/day (85 gal/day) of gasoline. Additional fuels will be consumed for building, office, and shaft heating. These heaters will only be operated in the colder months, as weather conditions require.

Because of the limited operation of shop and office heaters, their dispersed locations, and their small fuel consumption rates, the nonradiological air quality impact from their operation obviously will be small. Operation of shaft heaters will result in the emission of nonradiological pollutants into the mine ventilation air. These emissions, when added to other underground nonradiological pollutant emissions, must comply with Federal Mine Safety and Health Administration (MSHA) regulations. Maximum MSHA Air Contaminant Standards are presented in Table 2.7.3.1-1.

Emission rates for nonradiological pollutants resulting from the underground and surface mining operations were

Table 2.7.2.2-1

Measured Particulate Concentrations

(Annual Geometric Mean-$\mu g/m^3$)[22,23]

Station Name	1972	1973	1974	1975	1976
South Dakota					
Hot Springs	-	-	-	-	54
Spearfish	-	-	-	23	32
Wyoming					
Douglas	-	59	55	33	-
Gillette	88[a]	36	31	56[b]	-
Irene Ranch	-	-	-	23[c]	-
Moorcroft	-	-	-	51	-
Stoddard Ranch	-	-	-	16[d]	-
Torrington	-	20[e]	27	24	-

a. Only data from the last 6 months of 1972 are included.
b. Only data from the first 9 months of 1975 are included.
c. Only data from the first 8 months of 1975 are included.
d. Only 6 months of data are included.
e. Only data from the last 4 months of 1973 are included.

Table 2.7.3.1-1

MSHA Air Contaminant Standards[25]

Pollutant	8-Hour Time-Weighted Averages[a]
Nuisance Particulates	10 mg/m^3
Sulfur Oxides	13 mg/m^3
Carbon Monoxide	55 mg/m^3
Nitrogen Oxides	9 mg/m^3

a. These concentrations represent the maximum allowable 8-hour time-weighted average airborne concentrations to which workers can be exposed. These standards consist of the threshold limit values (TLV's) established for chemical substances in workroom air, adopted by the American Conference of Governmental Industrial Hygienists in 1973.

calculated for the equipment listed in Tables 1.1.2.1-1 and 1.1.2.2-1. These emission rates were calculated using emission factors developed by the EPA (Environmental Protection Agency)[24] and by considering the anticipated schedules of operation. The estimated emissions are presented in Table 2.7.3.1-2.

The material mined and the interior surfaces of the Burdock underground mine are expected to be wet. Therefore, particulates emitted from this mine are likely to consist primarily of particulates produced from operation of the underground equipment and intermittent operation of the shaft heater(s). The interior surfaces of the Runge East underground mine, however, will be drier and will be watered to reduce particulate releases to the atmosphere.

Fugitive dust will result from surface activities (construction and ore and waste handling and storage) in support of the underground mining operations. Fugitive dust will also be released from travel on roads, development and production of the Spencer-Richardson mine and to a limited extent from the mining of adits in the Darrow pits.

2.7.3.2 Nonradiological Air Quality Impacts

Underground Mining Operations - Information concerning the actual concentrations of nonradiological pollutants in air vented from the mine is limited at this time. Emission estimates have therefore been made based on MSHA air contaminant standards.[25] Table 2.7.3.1-1 presents the maximum allowable 8-hour-time-weighted averages of pertinent nonradiological contaminant concentrations in underground mine air. It can be reasonably assumed that these will be the upper limits of average concentrations in the mine ventilation air at the surface.

Mine ventilation air is expected to be exhausted through the production shafts. Estimated maximum average emission rates for Burdock from each shaft were calculated (for those pollutants listed in Table 2.7.3.1-1) by multiplying the indicated concentrations by the maximum expected flow rate per shaft of 56.6 m^3/s (120,000 ft^3/min). For hydrocarbons, the emission estimate shown in Table 2.7.3.2-1 was used to estimate ambient hydrocarbon concentrations. This is the maximum flow rate anticipated for each shaft at the Burdock underground mine. The Runge East underground mine will be much smaller in size and will have lower release rates. Nonradiological emission rates from the Runge East mine vents, and resulting ambient pollution contributions, should therefore be much smaller than those from the Burdock operation. The underground mining in the existing Darrow Pits will be limited to adits along ore trends at the bottom of the pits. Nonradiological emission rates from this mining, and resulting ambient pollution contributions, should also be much smaller than those from the Burdock operations. Therefore, only impacts from the Burdock operation are assessed in any further detail. Estimated maximum emission rates of nonradiological pollutants from the Burdock underground mine are presented in Table 2.7.3.2-1.

Table 2.7.3.1-2

Estimated Vehicular Emissions[24] From Mining Equipment[a]

Pollutant	Emissions: Burdock Underground Mine (Initial Shaft) — Underground Equipment[b]		Surface Support Equipment[b]		Spencer-Richardson Surface Mine[b]	
Particulates	.12 g/s	2.0 tons/yr	.15 g/s	1.2 tons/yr	.27 g/s	2.1 tons/yr
Sulfur Oxides	.17 g/s	2.8 tons/yr	.21 g/s	1.7 tons/yr	.29 g/s	2.2 tons/yr
Carbon Monoxide	.49 g/s	8.1 tons/yr	.63 g/s	10.4 tons/yr	1.0 g/s	7.7 tons/yr
Nitrogen Oxides	2.55 g/s	42.1 tons/yr	3.23 g/s	53.3 tons/yr	4.0 g/s	31.3 tons/yr
Hydrocarbons	.17 g/s	2.8 tons/yr	.20 g/s	1.6 tons/yr	.37 g/s	2.9 tons/yr

a. Emissions due to diesel fuel consumption.

b. Emissions given in grams per second are for those periods when vehicles are operating. The tons-per-year figures reflect the schedule of operations for the year.

Table 2.7.3.2-1

Estimated Maximum Average Nonradioactive Burdock Production Shaft Emission Rates[a]

Pollutant	Emission Rate Each Vent
Particulates	.56 g/s
Sulfur Oxides	.72 g/s
Carbon Monoxide	3.10 g/s
Nitrogen Oxides	.51 g/s
Hydrocarbons	.17 g/s

a. During operation of fossil-fueled equipment.

Estimates of maximum short-term nonradiological ambient contributions at selected distances from each underground mine shaft release were determined by assuming various combinations of conservative meteorological circumstances. Consideration was given to equipment operating schedules (16 hours per day, 5 days per week) in selecting appropriate atmospheric stabilities for the 8-hour and 24-hour averaging periods.

The estimated maximum shaft emission rates (Table 2.7.3.2-1) were used as input to a standard short-term diffusion equation.* Calculations were made for selected distances from each shaft and for conservative meteorological conditions in accordance with the preceding paragraph. Resultant concentrations (above background levels) were compared with the most stringent Federal and state short-term ambient standards (Table 2.7.3.2-2). These comparisons show that the maximum short-term concentrations at each selected distance should be much less than short term standards.

At project boundaries and beyond, ambient nonradiological contributions due to shaft emissions are expected to be less than allowable Class II significant deterioration increments.

Annual average ambient concentrations were estimated for nonradiological shaft emissions (Table 2.7.3.2-1) using a sector average straight-line model.[26] The onsite meteorological information shown in Table 2.7.1.4-2 combined with D stability, was used to estimate annual average nonradiological ambient pollutant concentrations. The ambient annual average concentration estimates shown in Table 2.7.3.2-2 represent, for selected distances, the maximum concentration values expected to result from production shaft releases. These results indicate that annual average concentrations can be expected to stay well below Federal and state annual ambient standards (see Table 2.7.3.2-3).

Ambient concentrations resulting from the combustion of fuel from the underground mine surface support equipment were not estimated because of the limited number of vehicles operating above ground, their dispersed locations while in operation, and their less frequent operation. Because of these factors, the degradation of the ambient air quality resulting from the combustion of fossil fuel by the surface equipment will be so small that further discussion of their impact is not considered warranted.

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*Turner's equation 3.1[26] is used for short-term estimations of ambient concentrations (1-, 3-, 8-, and 24-hour averaging periods). A sector averaging diffusion equation was used to estimate 24 hour ambient concentrations.[26]

Table 2.7.3.2-2

Calculated Maximum Short-Term Ambient Contributions of Nonradiological Pollutants At Select Distances Downwind From Each Production Shaft[a]

Pollutant	Maximum Contribution ($\mu g/m^3$) at Select Downwind Distances From Shaft Release: 1000 m	2000 m	3000 m	5000 m	Most Stringent Short-Term Ambient Standards: Federal $\mu g/m^3$	State[c] $\mu g/m^3$	Short-Term Significant Deterioration Increment[b] $\mu g/m^3$
Particulates							
(24-hour average)	29	9.3	4.8	2.2	150	150	37
Sulfur Dioxide							
(3-hour average)	251	85	48	23	1,300	1,300	512
(24-hour average)	27	12	6.2	2.8	365	365	91
Carbon Monoxide							
(1-hour average)	1,278	443	243	117	40,000	40,000	None
(8-hour average)	985	342	187	91	10,000	10,000	None
Nitrogen Dioxide							
(24-hour average)	26	8.3	4.3	2.0		250	None
Hydrocarbons							
(3-hour average)	59	20	12	5.4		160	

a. For 1-, 3-, and 8-hour concentration calculations, emissions from the mine shafts were assumed to diffuse according to Turner's equation 3.1.[26] Estimates of 24-hour average ambient pollutant concentrations are based on application of a standard sector-averaged diffusion equation.[26] Emissions were assumed to occur at ground level.

b. Allowable increase over baseline for Class II areas.

c. South Dakota standards (table 2.7.2-2).

Table 2.7.3.2-3

Calculated Maximum Annual Average Ambient Contributions of Nonradiological Pollutants At Select Distances Downwind From Each Underground Mine Production Shaft[a]

Pollutant	Maximum Contribution ($\mu g/m^3$) at Select Downwind Distances From Shaft Release[c]				Standards		Significant Deterioration Increments[b]
	1000 m	2000 m	3000 m	5000 m	Federal $\mu g/m^3$	State $\mu g/m^3$	$\mu g/m^3$
SO_2	5.9	4.5	2.1	1.1	80	80	20
NO_2	4.3	3.2	1.6	0.8	100	100	None
Particulates[a]	4.5	3.5	1.6	0.8	60[a]	60[a]	19[a]
CO					No annual standards		
Hydrocarbons					No annual standards		

a. Particulate concentrations were calculated as annual arithmetic means. Federal and state ambient particulate standards are listed as annual geometric means. The annual arithmetic mean will always be larger than or equal to the annual geometric mean.

b. Allowable increase over baseline for Class II areas.

c. The indicated pollutant concentrations represent the average concentration values expected to result from production shaft releases. These concentration estimates are based on 1 year of onsite meteorological measurement, and an assumed E stability.

Fugitive dust releases from surface activities around the underground mines are discussed later in this subsection.

Surface Mining Operations - The largest nonradiological air quality impacts expected from surface operations will be at the Spencer-Richardson mine, the only proposed surface mine. However, these impacts will be limited to only about a 6-month period of mining activity. Consequently, air quality impacts from this operation will be of short duration. Estimations of maximum nonradiological air quality impacts at select distances for surface mining are conservatively based on emissions from the limited Spencer-Richardson operation.

In determining emission rates from the Spencer-Richardson mining operation, consideration was given to emissions from the fossil-fueled surface mining equipment (Table 2.7.3.1-2). For calculational purposes, it was assumed that all of the equipment anticipated for all of the surface mining operations will be used in the Spencer-Richardson operation. Fugitive dust was not considered in the source term for particulates in the impact calculation because of the difficulty in obtaining a quantitative release rate with the presently limited preoperational information. However, potential fugitive dust sources will be monitored and controlled as necessary to minimize any impact. A discussion of potential fugitive dust sources is presented in the latter part of this subsection.

The estimated maximum emission rates for this surface mining operation (Table 2.7.3.1-2) were used as input to a standard short-term area source dispersion equation.[26] From preoperational information, it was estimated that most of the emissions would emanate from an area about 300 m (984 ft) on a side. Calculations were made for the meteorological conditions specified in the succeeding paragraph, and resulting concentrations compared with Federal and state air quality standards and PSD standards (Tables 2.7.3.2-4 and 2.7.3.2-5).

It is anticipated that surface mining activities at the Spencer-Richardson mine will be conducted 8 hours per day, 5 days per week over a 6-month period. This operating schedule was assumed in determining the conservative meteorological conditions to use in the nonradiological ambient impact calculations. Since all of the surface mining is during daylight hours, a D-stability was chosen for short-term and annual average ambient impact calculations. For comparison with 1-, 3-, 8-, and 24-hour standards, D-stability was combined with a wind speed of 1 m/s (2.2 mi/h), and a persistent wind direction for ambient contribution estimates at selected distances from the area source. For comparison with annual standards, D-stability and the onsite wind information shown in Table 2.7.1.4-2 was used to estimate annual ambient concentrations for selected downwind distances. All nonradiological releases from surface mining operations were assumed to be ground-level.

The estimated short-term and annual-average ambient contributions presented in Table 2.7.3.2-4 and Table 2.7.3.2-5, respectively, indicate that ambient pollutant concentrations can

Table 2.7.3.2-4

Calculated Maximum Short-Term Contributions of Air Pollutants At Select Distances Downwind From the Spencer-Richardson Surface Mining Operation[a]

Pollutant	Maximum Contribution ($\mu g/m^3$) at Select Downwind Distances From Surface Mine				Most Stringent Short-Term Ambient Standards		Short-Term Significant Deterioration Increment[b]
	1000 m	2000 m	3000 m	5000 m	Federal $\mu g/m^3$	State[c] $\mu g/m^3$	$\mu g/m^3$
Particulates (24-hour average)	1.5	.8	.5	.3	150	150	37
Sulfur Dioxide							
(3-hour average)	7.4	4.0	2.7	1.4	1,300	1,300	512
(24-hour average)	1.8	1.0	.6	.3	365	365	91
Carbon Monoxide							
(1-hour average)	30.7	15.9	10.8	5.8	40,000	40,000	None
(8-hour average)	21.2	11.7	7.5	4.0	10,000	10,000	None
Nitrogen Dioxide (24-hour average)	24.9	13.5	8.7	4.8		250	None
Hydrocarbons	8.9	4.8	3.2	1.7		160	None

a. Emissions from the surface mine were treated as an area source. The dimensions of this area source were defined and a virtual point source determined using methods recommended by Turner.[26] Emissions were assumed to occur at ground level.

b. Allowable increase over baseline for Class II areas.

c. South Dakota standards (table 2.7.2-2).

Table 2.7.3.2-5

Calculated Maximum Annual Average Contributions of Air Pollutants
At Select Distances Downwind From the Spencer-Richardson Surface Mining Operation

Pollutant	Maximum Contribution ($\mu g/m^3$) at Select Downwind Distances From Surface Release[c] 1000 m	2000 m	3000 m	5000 m	Standards Federal $\mu g/m^3$	State $\mu g/m^3$	Significant Deterioration Increments[b] $\mu g/m^3$
SO_2	0.4	0.2	0.1	.07	80	80	20
NO_2	6.0	3.1	1.9	1.0	100	100	None
Particulates[a]	0.4	0.2	0.1	.07	60[a]	60[a]	19[a]
CO					No annual standard		None
Hydrocarbons					No annual standard		None

a. Particulate concentrations were calculated as annual arithmetic means. Federal and state ambient particulate standards are listed as annual geometric means. The annual arithmetic mean is normally larger than the annual geometric mean.

b. Allowable increase over baseline for Class II areas.

c. The indicated pollutant concentrations represent average concentration values expected to result from production shaft releases. These concentration estimates are based on 1 year of onsite meteorological measurement, and an assumed D stability.

be expected to stay far below Federal and state ambient standards. The data presented in these tables also indicate that ambient contributions from the surface mining activities can be expected to be much less than the allowable Class II significant deterioration increments.

Annual-average meteorological conditions were also used in estimating radiological impacts from surface mining operations (Section 2.8.2). Annual-average meteorological assumptions used in radiological impact assessment of underground mine shaft releases are identified in the subsection on underground mining. The meteorology used in the radiological impact estimation consisted of an assumed E stability and the onsite wind information presented in Table 2.7.1.4-2.

Fugitive Dust - Preoperational information on fugitive dust from the planned mining operation is limited. Fugitive dust is expected from four major sources: (1) construction, (2) ore and waste rock storage, (3) vehicular travel on roads, and (4) surface mining.

Construction - Fugitive dust during the project construction phase will be associated with land clearing, ground excavation, cut and fill operations, and equipment traffic over access roads. The EPA has presented an emission factor of 2.7 t/ha/month (1.2 ton/acre/month) for fugitive dust during moderate construction activity.[24] This emission factor was developed from data collected around construction sites in Las Vegas, Nevada, and Maricopa County, Arizona, and is applied to particles less than about 30 µm in diameter.[24] Particles of this size have the potential for remaining airborne beyond project boundaries.

Surface construction activities for this project are expected to be less extensive than those for which this emission factor was developed and to be of short duration (about 6-9 months). In addition, overburden removal activities which have a potential to release substantial amounts of fugitive dust are already 70 percent complete at the Spencer-Richardson mine. The total anticipated surface disturbance for all new mine sites over the life of the mining operation will be about 35 ha (90 acre). An effective mitigation program is estimated to reduce construction-related fugitive dust by up to 50 percent.

Unpaved Roads - On the average, fugitive dust from unpaved roads with no mitigation applied have the following particulate size characteristics:

Particle Size Diameter	Weight Percent
<30 µm	60
≥ 30 µm but <100 µm	40

Particles larger than 100 µm are not considered in fugitive dust estimations from unpaved roads. Studies indicate that with mean wind speeds of 4.4 m/s (10 mi/h) or less, [24] these particles are likely to settle out within 6 to 9 m (20-30 ft) from the edge of the road. Particles with diameters in the 30 to 100 µm range are likely to settle out within a few hundred feet of the road depending on atmospheric turbulence. Thus, only about 60 percent of the fugitive dust from uncontrolled roads has a potential of remaining suspended. The fugitive dust will be carried away and dispersed by turbulent mixing. Resultant impacts are expected to be relatively minor and localized.

Based on EPA-recommended procedures for estimating fugitive dust from unpaved roads, [24] the estimated emission factor for vehicle travel on unpaved roads in the project area is about 3.30 kg/vehicle-km (11.72 lb/vehicle-mi). Approximately 1.98 kg/vehicle-km (7.03 lb/vehicle-mi) is expected to remain suspended.

It is estimated that chemical treatment or frequent watering of unpaved roadways can reduce fugitive dust by up to 50 percent.[24] Continuous watering of frequently traveled roads will be performed as ground and weather conditions require. Thus, the expected fugitive dust emission rates presented in the preceding paragraph will be substantially reduced, and resultant impacts should not be significant.

Ore and Waste Rock Storage - Fugitive dust associated with ore and waste rock storage piles can be divided into the contributions of several distinct source activities: (1) loading onto storage piles, (2) equipment traffic in storage areas, (3) wind erosion, and (4) loadout of ore and waste rock for processing or transportation. Approximate percentages of the total ore and waste rock storage dust emissions for each of these four activities are 12, 40, 33, and 15 percent, respectively.[24] Using EPA recommended procedures, an emission factor for fugitive dust of 0.66 kg/t (1.63 lb/ton) of ore and waste rock placed in storage was estimated for the project area.

Topsoil storage piles associated with the project will be seeded to prevent wind erosion (see Section 3.5). Initially, mined ore for the most part will be moist, so dust control during loading operations should not be necessary. However, sprinkling will be provided to prevent dust releases from ore and waste rock storage piles, if conditions warrant such action. The potential for dust in the storage areas from equipment traffic will be controlled by watering as ground and weather conditions require.

2.7.3.3 Air Pollution Control - Control methods for nonradiological air pollutants applicable to this project will depend primarily on the types or combinations of mining methods chosen. The primary pollutant caused by surface activity is likely to be fugitive dust. This problem will be mitigated to a large extent by revegetation of waste dumps, stockpiles and other disturbed areas and by watering of haulage roads as weather and ground conditions require. Combustion emissions from above-ground vehicles are regulated by EPA. Applicable emission standards depend on the year of vehicle manufacture.

Emissions from diesel engines used in underground mining and the operation of shaft heaters will be controlled in order to maintain underground pollutant concentrations below applicable MSHA standards (Table 2.7.3.1-1). The amount of fugitive dust generated by underground operations depends to a large extent on the moisture content of the material to be mined. High moisture contents are expected in the Burdock mine, so fugitive dust amounts released from underground shafts should be small. As previously mentioned, lower moisture contents are expected in the Runge East underground mine, so some fugitive dust may be released through its mine shafts. However, these amounts should also be small because of the limited nature of the Runge East operation.

2.7.3.4 Cumulative Project Air Quality Impacts - Nonradiological air quality impacts from simultaneous operation of the underground and surface projects will primarily result from fugitive dust attributed to surface mining, vehicular travel on largely unpaved roads, and wind erosion of stockpiles, waste piles, and disturbed lands. With the planned mitigation, fugitive dust impacts can be held to a minimum and should only result in a small impact on the project area's air quality. Nonradiological air emissions from fossil-fuel combustion will also result in some degradation of the local air quality. However, cumulative concentrations from all mining operations should stay well within Federal and state ambient air quality standards because the sources are small, will be widely dispersed, and will have different release characteristics. Increased turbulence associated with the intervening topography is also expected to reduce additive concentrations.

2.7.4 - Nonradiological Air Quality Monitoring - An air quality monitoring program will be performed at the mining site to conform with the requirements of the appropriate regulatory agencies. What is considered to be an adequate monitoring program is described below. However, the actual program would differ somewhat based upon the requirements of the regulatory agencies. Additional monitoring will be carried out as necessary.

At least one year prior to ore production, air quality monitoring will commence to establish background concentrations for particulates. The monitoring station will be maintained by the mine operator and will consist of a high-volume sampler collecting 24-hour samples once every 6 days. A site-specific meteorological facility, located at the old mill site in Edgemont, is presently collecting wind speed, wind direction, temperature, relative humidity, and precipitation information. The air quality monitoring station will be located in such a manner as to preclude significant interference from mine development activities.

Operational air quality monitoring will be conducted at locations where the maximum particulate impact from the mining project is expected. The preproduction information will be analyzed to determine the number of monitoring stations required for the operational program.

Samples from the high-volume monitors will be analyzed for particulate mass. Analysis for radionuclide concentrations are discussed in Section 2.8.3.

Results of the operational monitoring program will be evaluated periodically to determine if changes in the program are appropriate.

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2.8 Radiological

2.8.1 Description of the Existing Environment - Sampling of environmental media for background radioactivity levels was begun in July 1975. Samples of surface and ground waters, sediment, soil, and vegetation have been taken in various seasons of the year and returned to TVA's Radioanalytical Laboratory for analysis. These data establish a baseline on the distribution of background radioactivity in the environment within the project area and may be used in determining the impact of mining operations on the environment. The results from samples collected to date are listed in Tables 2.8.1-1 through 2.8.1-5.

Uranium concentrations were determined by fluorimetry and thorium concentrations (reported as thorium-230) were determined by chemical separation of thorium followed by alpha counting. Beginning in May 1976, radium-226 concentrations were determined by the radon emanation technique.

The available results for bismuth-214 and those results for radium-226 obtained through the use of gamma spectroscopy must be viewed and used with caution. These results were determined by use of gamma scans using lithium-drifted germanium detector systems. The interpretation of a gamma spectrum from such a gamma scan, to identify and quantify some of the uranium isotopes and their progeny, is extremely difficult because of the presence of overlapping peaks. To obtain the reported values, radium-226 was considered to be in equilibrium with bismuth-214 when each of the spectra was interpreted. Consideration also must be given to potential contributions by background and other radionuclides to the reported radium and bismuth concentrations.

2.8.2 Radiological Impacts - Atmosphere - Small amounts of radioactive materials will be released to the atmosphere as a result of mining operations. These releases will result in small exposures to man and other biota from both external and internal sources. Doses from external sources include doses from submersion in gaseous effluent and doses from exposure to soil on which very small amounts of radioactive material have been deposited. Doses to area organisms from radionuclides deposited internally are believed to be larger than the doses from external sources of radiation. These internal exposures result primarily from radionuclides ingested with food and from the inhalation of airborne radioactivity. Taking into consideration the land use characteristics in the project area and the belief that radionuclides such as radium and lead do not concentrate in plants, doses from the inhalation of airborne radioactivity are likely to be the highest doses which organisms in the area will receive.

Underground mining in the saturation zone will be performed at the Burdock mine; therefore, a high water content in the mined material may be expected. This high moisture content is likely to result in minimal particulate generation. Consequently, effluent releases of radioactive materials associated with particulates from the mining operation may be expected to be very small. However, even if appreciable quantities of particulates were generated, dilution of the original concentrations by the large volume of ventilating air and by natural dispersion in the atmosphere would be expected to result in concentrations at the

Table 2.8.1-1

Radioactivity Levels - Edgemont Project Area
Ground Water (Dissolved Activity)

Sampling Location	Date Collected	Gross α pCi/ℓ	Gross β pCi/ℓ	Natural U μg/ℓ	^{230}Th pCi/ℓ	^{226}Ra Dissolved pCi/ℓ	^{226}Ra Suspended pCi/ℓ	^{210}Pb pCi/ℓ	^{210}Po pCi/ℓ
Francis Peterson Ranch Well	8/16/76	-	-	2.29	0.02 ± 0.07[a]	2.55 ± 0.03			
Burdock Site (Lakota)	8/16/76	-	-	1.12	0.84 ± 0.16	1.55 ± 0.02			
Burdock Well B-1 (Fall River)	11/12/76	-	-	0.87	1.1 ± 0.2	0.55 ± 0.03			
	4/27/77	-	-	0.25	0.04 ± 0.07	0.43 ± 0.03			
	7/21/77	-	-	0.25	0.3 ± 0.2	0.91 ± 0.04		b	b
	11/15/77	-	-	0.41	0.4 ± 0.1	0.35 ± 0.03			
Burdock Well B-2 (Lakota)	11/12/76	-	-	9.49	0.5 ± 0.1	133.2 ± 0.4			
	4/27/77	-	-	0.32	0.06 ± 0.07	80.6 ± 0.3			
	7/21/77	-	-	0.19	0.05 ± 0.10	33.2 ± 0.2		c	33.2 ± 0.2
Burdock Well # 1	2/08/77 (Start of Pump Test)	89.9 ± 8.7	75.7 ± 4.7	6.39	0.2 ± 0.08	111.4 ± 0.4			
	2/21/77 (During Pump Test)	169.9 ± 14.9	94.0 ± 9.6	8.20	0.2 ± 0.09	222.4 ± 0.5			
	2/25/77 (end)	113.8 ± 8.9	84.5 ± 4.9	7.29	0.2 ± 0.09	226.6 ± 0.6			
	4/27/77	76.7 ± 5.9	54.9 ± 2.8	0.51	-0.04 ± 0.04[d]	159.3 ± 0.4			
	7/21/77	-	-	0.10	0.1 ± 0.1	230.1 ± 0.6		b	b
	11/14/77 (Start of Pump Test)	178.9 ± 9.7	133.6 ± 4.1	7.49	0.2 ± 0.1	189.8 ± 0.5	0.64 ± 0.004		
	11/14/77 (3 Hours After Start)	204.0 ± 10.3	154.8 ± 4.5	9.50	0.02 ± 0.06	204.6 ± 0.5	0.70 ± 0.004		
	11/17/77 (End of Pump Test)	377.2 ± 14.8	56.7 ± 3.6	5.85	0.9 ± 0.2	183.0 ± 0.5	0.56 ± 0.004		
Holding Pond for Burdock Well # 1	4/27/77	10.6 ± 2.5	26.2 ± 1.8	5.46	0.4 ± 0.1	29.95 ± 0.20			
	7/21/77	-	-	5.00	0.04 ± 0.06	4.31 ± 0.08		b	b
	11/17/77 (After Pump Test)	141.8 ± 9.0	49.0 ± 3.0	4.66	1.15 ± 0.17	83.7 ± 0.3	30.0 ± 0.2		
Miles Spencer Ranch Well	4/27/77	-	-	0.08	0.04 ± 0.07	1.87 ± 0.05			
Preston Richardson Ranch Well	4/27/77	-	-	0.16	0.01 ± 0.07	4.42 ± 0.08			
Wayne Peterson Ranch Well	4/27/77	-	-	1.00	-0.01 ± 0.06[d]	2.97 ± 0.06			
Glen Peterson Ranch, Well D-27 (Lakota)	4/27/77	-	-	0.48	0.13 ± 0.08	10.36 ± 0.12			
	11/15/77	-	-	0.43	0.10 ± 0.08	9.61 ± 0.11			
Glen Peterson Ranch, Well D-26 (Fall River)	4/27/77	-	-	0.06	0.11 ± 0.08	1.08 ± 0.04			
	11/15/77	-	-	0.11	0.70 ± 0.14	2.95 ± 0.07			
Well D-11	11/15/77	-	-	0.32	0.23 ± 0.09	1.37 ± 0.04			
Well D-17	11/15/77	-	-	1.83	0.28 ± 0.10	2.08 ± 0.05			
Well D-19	11/15/77	-	-	4.00	0.22 ± 0.09	1.73 ± 0.05			
Darrow Well	11/15/77	-	-	5.68	0.28 ± 0.10	97.25 ± 0.35			

a - The error reported is the 1-sigma counting error.
b - Insufficient sample.
c - Sample lost during analysis.
d - Negative value is an artifact of counting statistics and does not infer a negative activity.

Table 2.8.1-2

Radioactivity Levels - Edgemont Project Area - Soil[a]

Sampling Location	Date Collected	Gross α pCi/g	Gross β pCi/g	Natural U μg/g	^{230}Th pCi/g	^{226}Ra pCi/g	^{214}Bi[c] pCi/g	^{137}Cs[c] pCi/g	^{210}Pb pCi/g	^{210}Po pCi/g
Burdock, Southeast; East Central Section 11	7/31/75	0.6 ± 0.1[b]	5.2 ± 0.2	-	-	1.11 ± 0.04[c]	1.0 ± 0.04	0.1 ± 0.01	-	-
	5/5/76	6.9 ± 0.8	-	2.98	3.6 ± 0.4	0.74 ± 0.02	1.3 ± 0.07	0.9 ± 0.03	-	-
	8/25/76	-	-	1.73	2.3 ± 0.2	0.91 ± 0.03	-	-	-	-
	11/12/76	-	-	2.07	2.9 ± 0.3	1.11 ± 0.03	-	-	-	-
	4/27/77	14.6 ± 1.7	-	2.26	1.8 ± 0.2	1.10 ± 0.03	-	-	-	-
	7/21/77	-	-	6.33	1.1 ± 0.2	1.30 ± 0.03	-	-	5.2 ± 0.4	2.9 ± 0.3
	11/15/77	-	-	4.08	0.08 ± 0.08	1.35 ± 0.03	-	-	10.8 ± 0.6	5.2 ± 0.4
Burdock, West; North Central Section 15	5/5/76	7.3 ± 0.8	-	2.67	0.6 ± 0.2	0.85 ± 0.03	0.9 ± 0.03	0.3 ± 0.01	-	-
	8/25/76	-	-	4.42	3.8 ± 0.3	1.36 ± 0.03	-	-	-	-
	11/12/76	-	-	1.82	2.0 ± 0.2	1.09 ± 0.03	-	-	-	-
	4/27/77	10.9 ± 1.5	-	2.07	0.8 ± 0.2	1.03 ± 0.03	-	-	-	-
	7/21/77	-	-	2.34	0.0 ± 0.06	1.35 ± 0.03	-	-	6.7 ± 0.4	4.0 ± 0.3
	11/15/77	-	-	2.40	0.2 ± 0.1	0.71 ± 0.02	-	-	5.6 ± 0.5	5.6 ± 0.3
Pit # 6 Area; Northeast Section 2	5/5/76	8.1 ± 0.9	-	4.78	2.3 ± 0.3	2.15 ± 0.04	1.8 ± 0.07	0.9 ± 0.03	-	-
	8/25/76	-	-	0.64	2.3 ± 0.2	1.08 ± 0.03	-	-	-	-
	11/12/76	-	-	1.50	1.9 ± 0.2	1.07 ± 0.03	-	-	-	-
	4/27/77	24.6 ± 2.1	-	2.35	3.0 ± 0.3	3.20 ± 0.05	-	-	-	-
	7/21/77	-	-	5.36	2.3 ± 0.3	2.07 ± 0.04	-	-	56.7 ± 2.9	14.9 ± 2.7
	11/15/77	-	-	4.37	0.2 ± 0.1	1.81 ± 0.04	-	-	8.9 ± 0.6	10.5 ± 0.4
Runge, East; Central Section 31	5/5/76	4.9 ± 0.7	-	2.94	0.1 ± 0.1	0.97 ± 0.03	1.4 ± 0.05	1.2 ± 0.03	-	-
	8/25/76	-	-	2.70	0.4 ± 0.1	1.55 ± 0.03	-	-	-	-
	11/12/76	-	-	1.86	1.6 ± 0.2	1.38 ± 0.03	-	-	-	-
	4/27/77	9.5 ± 1.4	-	2.28	2.1 ± 0.2	1.97 ± 0.04	-	-	-	-
	7/21/77	-	-	3.11	1.4 ± 0.2	1.37 ± 0.03	-	-	14.1 ± 0.7	11.3 ± 1.2
	11/15/77	-	-	2.46	0.05 ± 0.08	1.30 ± 0.03	-	-	4.7 ± 0.5	3.5 ± 0.2
Burdock Mill # 1 (West)	11/15/77	-	-	2.41	0.08 ± 0.08	0.74 ± 0.02	-	-	4.7 ± 0.5	4.8 ± 0.2
Burdock Mill # 2 (North)	11/15/77	-	-	1.13	-0.02 ± 0.06[d]	1.00 ± 0.03	-	-	7.4 ± 0.6	6.3 ± 0.3
Burdock Mill # 3 (East)	11/15/77	-	-	3.76	0.11 ± 0.09	1.32 ± 0.03	-	-	4.8 ± 0.5	5.0 ± 0.3
Burdock Mill # 4 (South)	11/15/77	-	-	1.32	0.08 ± 0.08	0.82 ± 0.03	-	-	4.6 ± 0.4	4.9 ± 0.3

a - All results reported on a dry weight basis.
b - The error reported is the 1-sigma counting error.
c - Results obtained by gamma spectroscopy using a Ge(Li) detection system. Analysis for Ra-226 and Bi-214 using this method may produce results which are of questionable reliability.
d - Negative value is an artifact of counting statistics and does not infer a negative activity

Table 2.8.1-3

Radioactivity Levels - Edgemont Project Area
Vegetation[a]

Sampling Location	Date Collected	Gross α pCi/g	Gross β pCi/g	Natural U μg/g	^{230}Th pCi/g	^{226}Ra pCi/g	^{214}Bi[c] pCi/g	^{137}Cs[c] pCi/g
Burdock, Southeast; East Central Section 11	7/31/75	0.01 ± 0.01[b]	10.1 ± 0.1	-	-	0.30 ± 0.05[c]	0.30 ± 0.05	d
	5/5/76	0.5 ± 0.2	-	0.14	0.17 ± 0.02	0.11 ± 0.01	d	0.2 ± 0.03
	8/25/76	-	-	0.22	0.19 ± 0.03	0.28 ± 0.01	-	-
	11/12/76	-	-	e	e	0.08 ± 0.004	-	-
	4/27/77	-	-	0.14	0.19 ± 0.03	0.12 ± 0.01	-	-
	7/21/77	-	-	0.12	0.00 ± 0.01	0.17 ± 0.02	-	-
	11/15/77	-	-	0.15	-0.002 ± 0.004[f]	0.10 ± 0.001	-	-
Burdock, West; North Central Section 15	5/5/76	0.3 ± 0.2	-	0.07	0.13 ± 0.02	0.19 ± 0.01	d	0.2 ± 0.02
	8/25/76	-	-	0.21	0.19 ± 0.03	0.46 ± 0.02	-	-
	11/12/76	-	-	0.05	0.03 ± 0.01	0.15 ± 0.006	-	-
	4/27/77	-	-	0.17	0.01 ± 0.02	0.11 ± 0.01	-	-
	7/21/77	-	-	0.13	0.01 ± 0.01	1.01 ± 0.04	-	-
	11/15/77	-	-	0.13	0.03 ± 0.02	0.05 ± 0.001	-	-
Pit #6 Area; Northeast Section 2	5/5/76	0.9 ± 0.2	-	0.04	0.03 ± 0.01	0.15 ± 0.01	0.6 ± 0.07	0.2 ± 0.02
	8/25/76	-	-	0.03	0.10 ± 0.01	0.65 ± 0.01	-	-
	11/12/76	-	-	e	e	0.14 ± 0.007	-	-
	4/27/77	-	-	0.24	0.05 ± 0.14	0.17 ± 0.01	-	-
	7/21/77	-	-	0.21	0.01 ± 0.01	0.16 ± 0.02	-	-
	11/15/77	-	-	0.17	0.01 ± 0.02	0.22 ± 0.001	-	-

a - All results reported on a dry weight basis.
b - The error reported is the 1-sigma counting error.
c - Results obtained by gamma spectroscopy using a Ge(Li) detection system. Analysis for Ra-226 and Bi-214 using this method may produce results which are of questionable reliability.
d - None detected.
e - Insufficient sample.
f - Negative value is an artifact of counting statistics and does not infer a negative activity.

Table 2.8.1-3 (Continued)

Radioactivity Levels - Edgemont Project Area

Vegetation[a]

Sampling Location	Date Collected	Gross α pCi/g	Gross β pCi/g	Natural U µg/g	^{230}Th pCi/g	^{226}Ra pCi/g	^{214}Bi [c] pCi/g	^{137}Cs [c] pCi/g
Runge, East; Central Section 31	5/5/76	1.0 ± 0.2	-	0.22	0.14 ± 0.02	0.26 ± 0.01	0.8 ± 0.1	0.4 ± 0.04
	8/25/76	-	-	0.02	0.01 ± 0.01	0.07 ± 0.004	-	-
	11/12/76	-	-	e	e	0.10 ± 0.007	-	-
	4/27/77	-	-	0.90	0.15 ± 0.03	0.34 ± 0.01	-	-
	7/21/77	-	-	0.42	0.01 ± 0.01	0.31 ± 0.02	-	-
	11/15/77	-	-	0.54	0.03 ± 0.01	0.24 ± 0.001	-	-
Burdock Mill #1, West	11/15/77	-	-	0.45	0.01 ± 0.01	0.25 ± 0.001	-	g
Burdock Mill #2, North	11/15/77	-	-	0.13	0.03 ± 0.01	0.08 ± 0.001	-	g
Burdock Mill #3, East	11/15/77	-	-	0.31	0.03 ± 0.01	0.10 ± 0.001	-	g
Burdock Mill #4, South	11/15/77	-	-	0.26	0.03 ± 0.01	0.11 ± 0.001	-	g

a - All results reported on a dry weight basis.
c - Results obtained by gamma spectroscopy using a Ge(Li) detection system. Analysis for Ra-226 and Bi-214 using this method may produce results which are of questionable reliability.
e - Insufficient sample.
g - Analysis not complete.

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Table 2.8.1-4

Radioactivity Levels - Beaver Creek
Surface Water (Dissolved Activity)

Sampling Location	Date Collected	Gross Alpha pCi/ℓ	Gross Beta pCi/ℓ	Natural U μg/ℓ	^{230}Th pCi/ℓ	^{226}Ra pCi/ℓ
Beaver Creek at Hwy. 85 Bridge	7-31-75	1.1 ± 1.1[a]	5.5 ± 2.5	-	-	-
	5-5-76	-	-	9.8	0.09 ± 0.15	1.11
	8-25-76	-	-	4.0	0.27 ± 0.11	0.17 ± 0.02
	11-12-76	-	-	8.6	0.05 ± 0.05	0.15 ± 0.02
	4-27-77	-	-	5.4	0.17 ± 0.09	0.20 ± 0.02
	7-21-77	-	-	9.7	0.14 ± 0.08	1.09 ± 0.04
	11-15-77	-	-	5.4	0.17 ± 0.09	0.38 ± 0.03
Beaver Creek at Mouth	5-5-76	-	-	10.5	0.24 ± 0.20	0.05
	8-25-76[b]	-	-	-	-	-
	11-12-76	-	-	9.6	0.63 ± 0.13	0.08 ± 0.02
	4-27-77	-	-	6.1	0.17 ± 0.09	0.36 ± 0.03
	7-21-77	0.3 ± 2.0	40.4 ± 3.8	16.5	0.17 ± 0.09	0.25 ± 0.02
	11-15-77	-	-	4.6	0.12 ± 0.08	0.20 ± 0.02
Beaver Creek Control (Upstream)	5-5-76	-	-	11.3	0.16 ± 0.16	0.08
	8-25-76	-	-	5.1	0.97 ± 0.30	0.20 ± 0.02
	11-12-76	-	-	9.7	1.08 ± 0.17	0.10 ± 0.02
	4-27-77	-	-	7.4	0.24 ± 0.10	0.22 ± 0.02
	7-21-77	-	-	10.9	0.29 ± 0.10	0.31 ± 0.03

a - The error reported is the 1-sigma counting error.

b - Sample lost in transit.

Table 2.8.1-5

Radioactivity Levels - Beaver Creek Bottom Sediment[a]

Sampling Location	Date Collected	Gross Alpha pCi/g	Gross Beta pCi/g	Natural U µg/g	^{230}Th pCi/g	^{226}Ra pCi/g	^{214}Bi[b] pCi/g	^{137}Cs[b] pCi/g	^{210}Pb pCi/g	^{210}Po pCi/g
Beaver Creek at Old Hwy 85 Bridge	7/31/75	0.7 ± 0.1[c]	5.3 ± 0.2	-	-	1.06 ± 0.04[b]	0.93 ± 0.04	1.7 ± 0.01	-	-
	5/5/76	5.4 ± 0.7	-	2.57	0.3 ± 0.2	1.29 ± 0.03	0.75 ± 0.05	0.1 ± 0.02	-	-
	8/25/76	-	-	1.48	1.5 ± 0.2	1.06 ± 0.03	-	-	-	-
	11/12/76	-	-	1.12	2.1 ± 0.2	0.98 ± 0.03	-	-	-	-
	4/27/77	-	-	1.42	0.3 ± 0.1	1.15 ± 0.03	-	-	-	-
	7/21/77	-	-	3.4	-0.05 ± 0.07[d]	0.91 ± 0.03	-	-	-	-
	11/15/77	-	-	0.02	0.8 ± 0.2	0.44 ± 0.02	-	-	3.3 ± 0.4	1.5 ± 0.2
Beaver Creek at Mouth	5/5/76	8.0 ± 0.9	-	2.65	0.06 ± 0.2	1.25 ± 0.03	1.3 ± 0.7	0.6 ± 0.03	-	-
	8/25/76	-	-	2.23	0.4 ± 0.1	1.71 ± 0.04	-	-	-	-
	11/12/76	-	-	0.86	2.6 ± 0.3	0.84 ± 0.03	-	-	-	-
	4/27/77	-	-	0.87	0.2 ± 0.1	1.31 ± 0.03	-	-	-	-
	7/21/77	-	-	4.1	0.5 ± 0.2	2.45 ± 0.05	-	-	-	-
	11/15/77	-	-	0.72	0.2 ± 0.1	0.83 ± 0.02	-	-	5.5 ± 0.5	4.8 ± 0.4
Beaver Creek, Upstream	5/5/76	5.54	-	4.37	0.4 ± 0.3	1.03 ± 0.03	1.4 ± 0.07	0.2 ± 0.03	-	-
	8/25/76	-	-	3.01	0.9 ± 0.2	1.23 ± 0.03	-	-	-	-
	11/12/76	-	-	1.50	2.9 ± 0.3	1.01 ± 0.03	-	-	-	-
	4/27/77	-	-	0.89	0.02 ± 0.07	1.34 ± 0.03	-	-	-	-
	7/21/77	-	-	3.7	0.02 ± 0.08	1.41 ± 0.04	-	-	-	-

a - All results reported on a dry weight basis.
b - Results obtained by gamma spectrometry using a Ge(Li) detection system. Analysis for Ra-226 and Bi-214 using this method may produce results which are of questionable reliability.
c - The error reported is the 1-sigma counting error.
d - Negative value is an artifact of counting statistics and does not infer a negative activity.

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project boundary which are insignificant. Because sprinkling will be used as necessary to reduce the potential for dust generation along the main ore transport routes, that potential exposure pathway also should lead to insignificant exposure.

The principal gaseous effluent will be radon-222, resulting from the decay of radium-226, which is an established component of uranium ore. For purposes of calculation, radon-222 and its progeny will be assumed to be vented to the atmosphere from the underground mine exhausts such that the short-lived decay products of radon-222 are present in the following concentrations: ^{218}Po(RaA), 2.0 Bq/l (Becquerel/liter) (5.4 x 10^{-8} μCi/cm^3); ^{214}Pb(RaB), 1.1 Bq/l (3.0 x 10^{-8} μ Ci/cm^3); ^{214}Bi(RaC) and ^{214}Po(RaC'), each at 0.78 Bq/l (2.1 x 10^{-8} μ Ci/cm^3). These decay products are assumed to be released at an approximate composite 50 percent of the secular equilibrium level and are present at a concentration of 0.3 working levels (WL). In this regard one working level may be defined as any combination of short-lived decay products of radon-222 in one liter of air, without regard to the degree of equilibrium, that will result in the ultimate emission of 1.3 x 10^{+5} MeV of alpha-particle energy. The radon-222 concentration in the shaft exhaust then is assumed to be approximately 2.2 Bq/l (6.0 x 10^{-8} μCi/cm^3).

Ventilation characteristics have not been finalized. In accordance with preliminary plans, releases are assumed to be exhausted vertically at a ventilation flow rate of 56.6 m^3/s (2,000 ft^3/s) through each of the first two production shafts (see Figure 1.1.2.1-2). The flow is expected to be continuous (24 hours per day 7 days per week). The total estimated radon-222 emission rate is then approximately 2.5 x 10^5 Bq/s (6.8 Ci/s) or 2.2 x 10^{10} Bq/d (0.59 Ci/d).

Two ore stockpiles are expected to be established in the vicinity of each production shaft. Secular equilibrium through radium-226 is assumed for the ore, as is radon-222 flux (Bq/m^2.s) equal to 0.893 times the radium-226 concentration (Bq/g).[4] For purposes of calculation, one ore pile with an average U_3O_8 grade of 0.11 percent and an area of 8640 m^2 is assumed to exist near each production shaft, leading to a conservatively estimated total release from the ore piles of 1.6 x 10^{10} Bq/d (0.42 Ci/d) of radon-222. This release is assumed to be initially free of the short-lived decay products of radon-222.

Concentrations above background of radon-222 and its short-lived decay products are calculated using the emission information listed above and estimated annual average meteorological conditions (see Section 2.7.3) for the project area of interest in conjunction with a point-source, Gaussian plume model[5] for calculating dispersion of effluents.

Buildup of the short-lived decay products of radon-222 in transit is considered; however, processes for removal of the decay products from the atmosphere are not fully considered. Secular equilibirum values would therefore be calculated at large downwind distances. Such values in composite would probably exceed realistic composite values by a factor ranging from 2 to 5.

Concentrations at specified points of interest near the mining operation at the Burdock mine are presented in Table 2.8.2-1. These locations are generally locations where it is believed that the human occupancy factor is greater than zero; for example, residences. For such locations, indoor concentrations (in WL) and doses are calculated from the listed outdoor concentrations by assuming a ventilation rate of one air change per hour for each residence. Removal processes such as plateout of decay products on furniture are not considered. The calculated disequilibrium conditions (approximately 71 to 96 percent of secular equilibrum values) are therefore expected to exceed realistic disequilibrum conditions (believed to be in the 20 to 50 percent range) by factors ranging from approximately 1.5 to 4.5. The production shaft was used as the reference point for determination of distance and compass sector.

The highest annual average above-background concentration calculated at a known residence is approximately 2.7×10^{-4} Bq/l (7.3×10^{-12} μCi/cm^3) of radon-222 or approximately 5.6×10^{-5} WL of the short-lived decay products. This concentration is less than 1 percent of the maximum permissible concentration (MPC) for radon-222 or is less than 1 percent of MPC for the short-lived decay products of radon-222, as these MPC's are listed in the Code of Federal Regulations, Title 10, Part 20 (10CFR20) for release to unrestricted areas. These MPC's are used here as guidelines in the absence of applicable regulatory limits.

At a project boundary location, the maximum radon concentrations is 1.0×10^{-3} Bq/l (2.7×10^{-11} μCi/cm^3) or is 1.1×10^{-4} WL of the short-lived decay products.

These calculated concentrations can be compared roughly to the approximate average 5.5×10^{-3} Bq/l (1.5×10^{-10} μCi/cm^3) background concentration for radon-222 or the approximate average 1.0×10^{-3} WL background concentration for the short-lived decay products of radon-222.[6] In areas where radon exhalation is naturally high, background concentrations of radon-222 and its short-lived decay products may be significantly in excess of the above figures. The Edgemont area is very likely to be an area with high natural exhalation, and therefore high background concentrations.

Limited data collected for TVA to date suggest that background in the Edgemont, South Dakota, area may be in the range of 1.1 to 3.0×10^{-2} Bq/l (3 to 8×10^{-10} μCi/cm^3) for radon-222 and 3 to 6×10^{-3} WL (outdoors) for the short-lived radon progeny.[7] Limited data collected for the Nuclear Regulatory Commission suggest that appropriate background values for radon-222 may be in the range of 3.0 to 4.4×10^{-2} Bq/l (8 to 12×10^{-10} μCi/cm^3).[8]

Annual doses to the lungs (segmental bronchi) of adults residing in the project area from the inhalation of radon-222 and its short-lived decay products may be estimated by multiplying the appropriate decay product concentrations by the following dose conversion factors: ^{218}Po (RaA), 16 rem•l/y•Bq (0.6×10^{9} rem•cm^3/y• μCi); ^{214}Pb(RaB), 27 rem•l/y•Bq (1.0×10^{9} rem•cm^3/y Ci); and ^{214}Bi(RaC), 46 rem•l/y•Bq (1.7×10^{3} rem•cm^3/y μCi). The dose conversion factor for ^{214}Po(RaC') is very small in comparison with the above factors. Use of these dose conversion

TABLE 2.8.2-1

RADIONUCLIDE CONCENTRATIONS AND ANNUAL INHALATION DOSES TO BRONCHIAL EPITHELIUM OF LUNGS OF AREA RESIDENTS

Location No.	Distance(m) and Direction[a]		Outdoor Concentrations Rn-222 Conc. (Bq/l)	Po-218 Conc. (Bq/l)	Pb-214 Conc. (Bq/l)	Bi-214 Conc. (Bq/l)	Rn-222 Decay Product Conc. (WL)[b]	Annual Dose (rem)[c]
1	3,660	N	1.9 (-4)	1.9 (-4)	1.5 (-4)	1.1 (-4)	4.5 (-5)	.015
2[e]	21,300	SE	1.2 (-5)	1.2 (-5)	1.2 (-5)	1.1 (-5)	3.1 (-6)	.001
3	1,770	SSE	2.3 (-4)	2.2 (-4)	1.3 (-4)	8.3 (-5)	4.8 (-5)	.016
4	3,220	SSE	1.1 (-4)	1.0 (-4)	7.3 (-5)	5.2 (-5)	2.4 (-5)	.008
5	1,910	SW	1.3 (-4)	1.3 (-4)	9.3 (-5)	6.6 (-5)	3.0 (-5)	.010
6	3,760	SSW	4.4 (-5)	4.4 (-5)	3.7 (-5)	3.0 (-5)	1.1 (-5)	.004
7	4,180	WSW	5.4 (-5)	5.4 (-5)	4.3 (-5)	3.4 (-5)	1.3 (-5)	.004
8[f]	890	W	1.0 (-3)	9.0 (-4)	4.3 (-4)	2.7 (-4)	1.1 (-4)	.038
9[g]	960	W	8.8 (-4)	7.9 (-4)	3.8 (-4)	2.4 (-4)	1.7 (-4)	.057
10	2,420	W	2.7 (-4)	2.6 (-4)	1.6 (-4)	1.1 (-4)	5.6 (-5)	.019
11	3,960	NW	9.1 (-5)	9.1 (-5)	5.9 (-5)	4.1 (-5)	2.0 (-5)	.007
12	3,360	NNW	1.2 (-4)	1.2 (-4)	7.9 (-5)	5.6 (-5)	2.6 (-5)	.009

Note: (1) Releases from shafts 1 and 2 and the associated ore piles are considered.
(2) 1 Curie (Ci) = 3.7×10^{10} Becquerel (Bq).

a. The reference point used for determining location distances and directions is production shaft number 1.
b. "WL" is working level (see text).
c. Doses to area residents are calculated using radon decay product disequilibrium assumptions which are conservative (see text).
d. 1.9 (-4) = 1.9×10^{-4}
e. City of Edgemont.
f. Lease boundary location; occupancy factor near zero.
g. Burdock School; no longer in use.

factors is believed to result in conservative (e.g., by an order of magnitude) estimates of the inhalation dose rates to the lung. Using these factors, the maximum annual average dose, is approximately 0.019 rem to the lung of an individual continuously occupying the "worst" known residence. The population dose to the lung for the city of Edgemont, with an assumed population of 2000 is estimated to be 2 person-rem. Doses due to natural background concentrations of the radionuclides of interest are likely to be in the range of hundreds of millirem per year and are here assumed to be approximately 0.35 rem/y per individual. The subsequent natural background population dose to the lung for Edgemont is therefore approximately 700 person-rem. The estimated population dose due to mining operations is therefore approximately 0.3 percent of the background lung dose for the nearest population center. If, as previously suggested, the background dose is higher than that estimated, the impact from mining operations would of course be reduced below the 0.3 percent increment.

Note should be made that a significant discrepancy exists between the doses implied by the figures on percentage of maximum permissible concentration and the doses calculated herein. The implied difference is believed to be primarily attributable to the anatomic lung model and the method of lung dosimetry used by the Nuclear Regulatory Commission (NRC) in determining the MPC for radon-222, as compared to the lung model and dosimetry used herein. In general, radon dosimetry is a very complex problem, and presentation of the many factors involved in radon dosimetry is beyond the scope of this statement. However, use of apparent NRC models would reduce the highest calculated doses by approximately a factor of 5.

Calculated concentrations for radon-222 and its short-lived decay products are much less than the maximum permissible concentrations used herein as guidelines. Also, the calculated annual average concentrations are significantly less than the assumed background concentration. The small number of persons continually occupying known residences in the immediate vicinity of the shafts may receive doses which range up to 5 percent of the assumed background dose.

A third production shaft may be sunk at the Burdock mine at some time subsequent to the sinking of the initial production shaft. The postulated location of this third shaft is 760 m (2500 ft) E of the second shaft. Because the location has not been finally determined, an accurate assessment of potential radiological impacts due to mining operations at this shaft site is not possible. However, an assessment was performed, considering releases from the postulated shaft and an adjacent ore pile, with doses determined at the same residence locations previously considered. Source terms for the shaft and ore pile are assumed to be the same as those used for each of the initial production shafts. Results of the calculations are presented in Table 2.8.2-2.

In addition to the Burdock mine, other mining operations are planned for the Edgemont area. Two "underground" mines are the Darrow and Runge East mines, located approximately 4,000 m (13,120 ft) NE and 16.4 km (10.2 mi) ESE of the Burdock No. 1 shaft, respectively. Assuming the same configuration, source

TABLE 2.8.2-2

RADIONUCLIDE CONCENTRATIONS AND ANNUAL INHALATION DOSES TO BRONCHIAL EPITHELIUM OF LUNGS OF AREA RESIDENTS - POSTULATED RELEASES FROM SHAFT NO. 3

Location No.	Distance(m) and Direction[a]		Outdoor Concentrations: Rn-222 Conc. (Bq/l)	Po-218 Conc. (Bq/l)	Pb-214 Conc. (Bq/l)	Bi-214 Conc. (Bq/l)	Rn-222 Decay Product Conc. (WL)[b]	Annual Dose (rem)[c]
1	3,660	N	4.5 (-5)[d]	4.4 (-5)	2.8 (-5)	2.0 (-5)	9.7 (-6)	.003
2	21,300	SE	4.9 (-6)	4.9 (-6)	4.7 (-6)	4.6 (-6)	1.3 (-6)	.0004
3	1,770	SSE	4.0 (-5)	4.0 (-5)	2.9 (-5)	2.0 (-5)	9.1 (-6)	.003
4	3,220	SSE	3.4 (-5)	3.4 (-5)	2.6 (-5)	1.9 (-5)	7.9 (-6)	.003
5	1,910	SW	3.5 (-5)	3.5 (-5)	2.7 (-5)	2.0 (-5)	8.1 (-6)	.003
6	3,760	SSW	1.8 (-5)	1.8 (-5)	1.6 (-5)	1.4 (-5)	4.5 (-6)	.002
7	4,180	WSW	1.8 (-5)	1.8 (-5)	1.5 (-5)	1.3 (-5)	4.3 (-6)	.001
8[f]	890	W	5.1 (-5)	5.1 (-5)	3.6 (-5)	2.6 (-5)	8.9 (-6)	.003
9[g]	960	W	5.0 (-5)	4.9 (-5)	3.5 (-5)	2.5 (-5)	1.1 (-5)	.004
10	2,420	W	6.7 (-5)	6.7 (-5)	4.7 (-5)	3.4 (-5)	1.5 (-5)	.005
11	3,960	NW	4.1 (-5)	4.1 (-5)	2.8 (-5)	1.9 (-5)	9.1 (-6)	.003
12	3,360	NNW	4.2 (-5)	4.1 (-5)	2.7 (-5)	1.9 (-5)	9.1 (-6)	.003

Note: (1) Release of radon-222 from the assumed ore pile adjacent to shaft No. 3 is also considered.
(2) 1 Curie (Ci) = 3.7×10^{10} Becquerel (Bq).

a. The reference point used for determining location distances and directions is production shaft number 1.
b. "WL" is working level (see text).
c. Doses to area residents are calculated using radon decay product disequilibrium assumptions which are conservative (see text).
d. 4.5 (-5) = 4.5×10^{-5}
e. City of Edgemont.
f. Lease boundary location; occupancy factor near zero.
g. Burdock School; no longer in use.

terms (hence, neglecting particulate generation underground), and meteorology as assumed for one shaft at the Burdock No. 1 mine, potential lung doses incurred by residents due to these mining operations are not expected to exceed 0.007 rem annually. A site identified for surface mining is the Spencer-Richardson site located approximately 4,330 m (14,200 ft) NNE of the Burdock No. 1 mine. No occupied residences have been identified within a 2,000 m (6,560 ft) radius of this site. Doses to occupants of the "worst" known residence near this operation are not expected to exceed approximately 0.008 rem to the lungs, based on release and dispersion characteristics the same as for one shaft at the Burdock No. 1 mine. The lung dose to the population of Edgemont due to all of the additional mining operations is conservatively estimated to be 2.8 person-rem per year; that is, the dose from these operations is likely to be approximately 0.4 percent of the assumed background dose. Based on present estimates of ore reserves, the additional operations are likely to be of short duration; therefore, the estimated dose rates will be applicable only for a short period of time (e.g., less than one year).

Concentrations of radon-222 at receptor locations, resulting from such subsequent underground operations as may be scheduled, would not be expected to exceed those concentrations calculated for the first operation, assuming that effluent concentrations do not exceed the concentrations assumed herein and that venting configurations would be similar.

> Note: Preliminary calculations were made to estimate doses from ingestion of beef and vegetables contaminated with the daughter products of radon-222. For the locations previously considered, the highest doses were found at the unoccupied project boundary location. These hypothetical doses were 0.0026 rem/y to bone and 0.0025 rem/y to kidney via the ingestion pathway. Doses to other organs were smaller than the above numbers. Considering the magnitude of these doses in comparison to the doses to the bronchial epithelium, no further discussion of the ingestion pathway was considered warranted.

Water - Small amounts of radioactive materials are contained in water produced during mining operations. Releases of such water could potentially result in small exposures to man and other biota, principally from the ingestion of waters in which there exist small, above-background concentrations of radionuclides.

No water quality changes are expected to be induced below ground during operations at the Burdock mine because net flow will be toward the mine and its depressuring wells. Depressuring operations will result in a quantity of ground water which will be stored in retention lagoons. Any deliberate discharge from the lagoons or any use of the water as drinking water would be permitted only if the proposed effluent or drinking water, respectively, meets applicable standards (see Table 2.6.1.1-3). The water would be treated, as necessary, to assure compliance with those standards. Periodic monitoring of soils and shallow ground water in any effluent discharge area may need to be conducted, depending on conditions of operation.

Proper design and operation of the rentention (of precipitation, drainage, etc.) lagoons, pipelines, and ore and waste storage pads at all of the mining sites will assure that (a) any effluent released in a planned operation would meet applicable standards, (b) any water to be used as drinking water would meet applicable standards, and (c) inadvertent releases of radionuclides will occur at minimal frequency and that any such release will be of minimal quantity. Appropriate radiological monitoring of area surface and ground waters would be conducted following any inadvertent release of sufficient quantities of radioactive materials to affect significantly radionuclide concentrations in those waters.

After cessation of mining operations at the Burdock mine, the reestablished hydraulic gradient will approach premining conditions. There may be some water quality changes down-gradient from the disrupted ore zone. This would be a result of oxidation and other chemical reactions that could change the solubility of salts and chemicals within an abandoned mine. (See Section 2.6.2.1.) Monitoring of the host aquifer could be continued into the post-mining stage to determine whether a study of ground-water quality in and near the abandoned mine area is necessary.

Considering the water use characteristics in the site areas, no significant exposure from ingestion of water containing above-background concentrations of radioactive materials is expected, due to the mining operations. Radiological surveillance programs will be designed to detect significant changes in radionuclide concentrations in the project areas. Mitigating measures would be instituted and implemented if water supplies are found to contain concentrations of radionuclides which are significantly increased due to project operations.

2.8.3 Radiological Monitoring - Waters generated during the mining operations will be treated, monitored, and discharged in compliance with applicable requirements. The actual effluent monitoring program will be designed by the mine operator to conform with the requirements of the appropriate regulatory agencies. It is anticipated that the program will include monthly sampling of the effluent, with analyses being performed to determine uranium and radium-226 contents. The environmental radiological monitoring program is designed to determine the radiological impact of mining operations on the environment. During the life of the facility, increases in radionuclide concentrations in the environment should exist in no more than trace amounts, with very minor or no impact on the environment. Operational monitoring program details (i.e., sampling locations, equipment, frequencies, etc.) will be determined through evaluation of site topography, meteorology, the preoperational monitoring program, and the requirements of appropriate regulatory agencies.

Preoperational sampling is conducted to establish a baseline of data on the distribution of background radioactivity in the environment. Efforts are made to begin this sampling at least one year prior to operation of the facility, with samples being collected in the various seasons of the year. Results available to date are presented in Section 2.8.1.