Northeast Church Rock
30% Design Report

Appendix A:
General Design Information

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LIST OF ACRONYMS / ABBREVIATIONS

AOC	Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery
CSF	construction support facility
CY	cubic yard(s)
GSR	Green and Sustainable Remediation
Mill Site	Church Rock Mill Site
Mine Site	Northeast Church Rock Mine Site
MSOC	Mine Site outlet channel
PTW	principal threat waste
RA	Removal Action
RAL	removal action limit
RAO	Remedial Action Objective
ROD	Record of Decision
TDA	Tailings Disposal Area
USEPA	US Environmental Protection Agency

A.1 INTRODUCTION

This appendix to the Northeast Church Rock 30% Design Report summarizes the general design information and includes:

- A description of the general section (Section 1) of the design drawings
- Reference to how the design addresses the Performance Standards contained in the Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site (2011 Action Memo; USEPA, 2011), the Record of Decision, United Nuclear Corporation Site (ROD; USEPA, 2013), and the Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery (AOC; USEPA, 2015)
- A summary of the Removal Action (RA) elements and construction progression
- Green and Sustainable Remediation (GSR) considerations

A.2 PERFORMANCE STANDARDS

The Performance Standards presented here are defined 2011 Action Memo (USEPA, 2011), the ROD (USEPA, 2013), and the AOC (USEPA, 2015) including the Statement of Work attached as Appendix D to the AOC, and were developed to define attainment of the Removal Action and Remedial Action Objectives (RAOs) for the Selected Remedy. The Performance Standards include both general and specific standards applicable to the Selected Remedy work elements and associated work components. Table A.2-1 presents performance standards related to general design and explains how the design accomplishes these standards. In addition, each subsequent design appendix provides a similar performance standards table based on the table of performance standards included in the main text.

Table A.2-1: Performance Standards Applicable to General Design

Location of Performance Standard Requirement	Performance Standard	Comments
2015 AOC SOW, Paragraph 29 – Green Remediation Best Management Practices	Respondents shall incorporate applicable Best Management Practices for Green Remediation listed in ASTM-E2893-13 consistent with EPA's policy Superfund Green Remediation Strategy (2010), found at http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf.	A general overview of GSR is discussed in A.5. The individual appendices include a description of GSR specific to the design components.
2015 AOC SOW, Paragraph 32 – Data Gaps	If EPA notifies Respondents that there are data gaps that must be addressed by field investigations or by additional analyses not specifically identified in this SOW, or if the Respondents identify such data gaps, then the Respondents shall submit to EPA for review and approval an addendum to the PDSP that will include work plans for additional investigations and/or reports necessary as determined by EPA to support the Design. Respondents shall perform the data gap investigations identified in the addendum to the PDSP once each work plan has been approved by EPA. Respondents shall also submit reports documenting the results of each of the supplemental pre-design investigations within 60 days of completion of the investigation and receipt of any associated laboratory and/or geotechnical data.	No additional data gaps were identified that require supplemental pre-design investigations for the 30% design.
2015 AOC SOW, Paragraph 37 – Preliminary Design	Respondents shall submit to EPA for review and approval a Preliminary Design based on the EPA-approved preferred waste-repository configuration when the design effort is approximately 30% complete but no later than 120 days from EPA's approval of the Design Work Plan. Respondents shall include the following elements in their Preliminary Design: a. Finalized design assumptions and parameters from the Basis of Design/Design Criteria Report; b. Preliminary plans, drawings, and sketches, including design calculations; c. An outline of required specifications; d. A plan for additional field sampling, if needed; e. A traffic safety plan, including upgrades to local roads; f. A storm-water management plan; g. An air monitoring plan; h. A site control and security plan; i. A project delivery strategy;	This document is Appendix A to the 30% Design Report. The items described at left are addressed in the following parts of this report: a. Appendices B through I b. Plans in Volume 2, calculations in Attachments to Appendices B through I c. Appendix J d. Appendix I e. Appendix M f. Appendix P g. Appendix Q h. Appendix M i. Main text

Location of Performance Standard Requirement	Performance Standard	Comments
	j. A preliminary construction schedule, including a schedule for applicable permit requirements; k. A material management plan that shall describe how all NECR Site mine waste, borrow material, backfill material, and cover material will be managed and transported. The material management plan shall include a map and description with coordinates of routes that will be used by heavy equipment and a map and description with coordinates of staging and stockpiling areas. For staging and stockpiling areas, the material management plan shall include a description of activities that will be associated with these areas; l. A description of how the principal threat waste will be segregated and a description of the facility or facilities being considered for disposal of Principal Threat Waste from the NECR Site; m. Detailed plans and specifications for backfilling and re-grading excavated areas of the NECR Site, which address the impacts of re-grading of storm water runoff on and downstream of the NECR Site; n. A permitting requirements and compliance plan that shall ensure all on-site activities meet the substantive (but not the administrative) requirements of environmental permitting regulations; o. A revegetation plan which shall describe the approach that Respondents shall take to revegetate the borrow areas, and other disturbed areas on the UNC Site; p. A water-balance model report that provides the following: A description of how water would behave in the short-term and over an extended period of time within the enhanced design of the tailings impoundment; and, if the water-balance model indicates that, as a result of repository construction, there may be increased water seepage from the impoundment, analysis explaining how increased seepage would not adversely impact the existing groundwater; q. An evapotranspiration analysis which shall describe the complete water-balance model assumptions and calculations for the repository cover system. Respondents' evaluation shall show the percolation response to design parameters such as rooting depth, the type of flora, cover thickness, cover soil properties, initial moisture content of the cover soils, and hydraulic conductivity; r. An outline of the construction quality assurance plan; s. Mitigation measures to minimize traffic, noise, dust and any other impacts to the community and environment t. Biological and cultural resources surveys or reports; u. A description of how the design complies with all Performance Standards, including ARARs; v. A description of procedures for cleanup verification at the NECR Site (including the step out areas), including an updated QAPP for verification sampling; and, w. A description of procedures for revegetation of the NECR Site, including the approach that Respondents shall use to revegetate the NECR Site and to maintain revegetated areas until vegetation is established.	j. Appendix K k. Appendix B, C, D, H l. Appendix B and C m. Appendix C n. Appendix N o. Appendix U p. Appendix G q. Appendix G r. Appendix V s. Appendix M, Q t. Appendix O, P u. Main text and tables throughout v. Appendix T w. Appendix U

A.3 ENGINEERING DESIGN DRAWINGS

The general section, Section 1, of the design drawings contain information related to site location, access, general location of existing and proposed facilities, site boundaries, survey control points, and standard symbols and abbreviations used in subsequent drawings. The general design drawings also depict the principal remedial components as well as the design Site topography and layout upon completion of the RA. The Northeast Church Rock 30% engineering design drawings are contained in Volume II – Design Drawings. Drawings related to the general project info and the site overview are listed in Table A.3-1.

Table A.3-1: Engineering Design Drawings

Drawing No.	Drawing Title
1-01	Cover Sheet
1-02	Sheet Index
1-03	General Notes and Acronyms
1-04	Site Location Map
1-05	Principal Existing Condition, Site Features, and Survey Control
1-06	Existing Condition NECR Mine Site
1-07	Existing Condition UNC Site
1-08	Site Utilities
1-09	Principal Components and Limits of Disturbance
1-10	Final Reclaimed Topography

A.4 REMOVAL ACTION CONSTRUCTION PROGRESSION

The RA will comprise an Early Works element, the RA, a final demobilization and revegetation element, and a schedule-independent Pipeline Arroyo stabilization element, as summarized in the following sections. The preliminary RA schedule is included in Appendix K – Removal Action Schedule.

A.4.1 Early Works

The Early Works element includes preparation of the construction support facilities (CSFs), construction of access and haul roads, preparation of borrow areas, implementation of environmental monitoring, and implementation of stormwater and traffic controls.

A.4.1.1 Construction Support Facilities

The CSFs will be prepared for use during all phases of RA construction, and include security, construction laydown areas, construction water and fuel storage, decontamination zone facilities (including vehicle decontamination pad, drainage controls, and personnel facilities such as showers, lockers and laundry), and facilities required for handling principal threat waste (PTW). The CSFs are shown on the Section 2 Drawings. Additional details regarding the CSFs are included in Appendix B – Construction Support Facilities.

Selected locations for the CSFs include the former mill facilities area of the Church Rock Mill Site (Mill Site), an area at the east end of the Northeast Church Rock Mine Site (Mine Site), and two proposed laydown yards: one west of the Tailings Disposal Area (TDA) and one immediately north of the Mill Site TDA. These areas are identified on the Drawings as:

- Former Mill Site
- Mine Site Yard
- Repository Yard
- Optional Repository Yard

Additionally, support facilities are organized in zones using the following terms and definitions:

- Support Zone: Area(s) free of contamination.
- Exclusion Zone: Area(s) with actual or potential contamination.
- Decontamination Zone: The transition area between the exclusion and support zones. This area is where personnel enter and exit the exclusion zone and where decontamination activities take place.

CSF construction activities will include:

- Site grading
- Infrastructure construction followed by placement of temporary support facilities

A.4.1.2 Access and Haul Roads

Several access and haul roads will be constructed to support the RA. These road details are summarized below and shown on the Section 4 Drawings. Additional details regarding haul and access roads are included in Appendix D – Haul Routes.

Temporary access roads will be constructed to provide access to the CSFs in the Former Mill Site Yard and the Repository Yard(s).

A mine waste haul road will be constructed to haul mine waste excavated at the Mine Site to the repository located at the Mill Site. The haul road will begin at the Mine Site and will be located roughly parallel to NM 566, until it crosses the highway near the north end of the TDA.

Haul roads will be constructed to access each of the four proposed borrow areas. Plans and profiles for the north, east, and west borrow haul roads are shown on the Section 4 Drawings. Haul road construction would be conducted from each borrow area to the edge of the TDA. Once on the TDA, borrow haul trucks would operate directly on the existing cover surface. Upon completion of the RA, areas of the repository cover and the TDA cover subjected to haul traffic would be reconstructed to mitigate over-compaction of cover soils, or other damage that may occur from haul traffic.

The anticipated sequence of road construction will be:

- Access road construction, including stormwater controls
- Mine waste haul road construction, including stormwater controls
- Borrow haul road construction, including stormwater controls

A.4.1.3 Borrow Areas

Approximately 400,000 cubic yards (CY) of soil and rock are required for repository construction, including general fill to meet surface design grades, for the cover system, and long-term stormwater controls. Four proposed on-site borrow areas have been identified to meet volume and material property requirements. These borrow areas are identified as the East, West, North, and South Borrow Areas, and are shown in detail on the Section 8 Drawings. At least one of these borrow area will be developed prior to repository construction. Other borrow areas will be developed as needed during the RA.

Other borrow sources include on-site stockpiles and off-site commercial pits or quarries. Additional details regarding the borrow materials are included in Appendix H – Borrow Areas.

A.4.2 Removal Action

The RA element consists of preparation of the repository to receive mine waste, mine site removals, repository cover construction, and construction of permanent stormwater controls at the Mill and Mine sites.

A.4.2.1 Repository

Mine waste will be placed in a repository constructed on the TDA as shown in the Section 7 Drawings and summarized below. Additional details regarding the repository design are included in Appendix G – Mine Waste Repository Design.

The existing radon barrier above the tailings in the TDA will be modified in-place to serve as the foundation layer for the repository. The sequence for radon barrier improvement is as follows:

- Rock mulch and riprap removal
- Filling swales
- Radon barrier compaction

Following preparation of the radon barrier, the initial lifts of the perimeter stormwater berms will be constructed using clean borrow soils at the edge of waste. These berms will allow for containment of contact water within the repository during waste placement. Waste will be spread in lifts for compaction. The perimeter slopes of the waste surface will be built as the material is placed and the stormwater berms can be raised, as needed, to provide clean cover material over the outer slopes of the waste.

Once the berms are no longer needed for stormwater control, the berms will be graded over the waste surface during placement of the soil cover layer.

Cover placement will be conducted after areas of the repository reach their design capacity. The cover design consists of an erosion protection layer consisting of a rock soil admixture layer overlying a soil layer. The thicknesses of these layers and the sizes of the rock used for erosion protection vary based on locations on the repository, with the overall cover thickness (including erosion protection layers) will be 4 feet.

A.4.2.2 Mine Site

The Mine Site removals are divided into five phases of excavation, with a total estimated volume of about 1,065,000 million CY. Mine site removals will include:

- Excavation of soils within the Mine Site above bedrock and with measured activity concentrations above the 2.24 pCi/g radium-226 removal action limit (RAL)
- Disposal of mine site debris
- Transportation of excavated materials to the Mill Site repository location or off-site as required for PTW.
- Confirmation surveys to demonstrate that remaining materials within Mine Site have measured activity concentrations below USEPA action levels
- Construction and maintenance of temporary stormwater controls during removal activity

Additional details regarding Mine Site removals are included in Appendix C – Mine Site Removals Excavations and Demolition. Additional details regarding verification surveys are included in Appendix T – Cleanup Verification Plan. Additional details regarding temporary stormwater controls are included in Appendix E – Stormwater Management Plan, as well as the other parts of the design.

A.4.2.3 Permanent Stormwater Controls

A.4.2.3.1 Mine Site Stormwater Controls

As part of the RA, the Mine Site outlet channel (MSOC) will be modified to convey stormwater from the Mine Site to minimize scouring of the existing engineered channel and unimproved sections of the downstream Unnamed Arroyo No. 1. These modifications will contain the predicted 100-year flood so that it does not impact the homes located near the MSOC (Unnamed Arroyo No. 1). The proposed channel improvements are shown on the Section 6 Drawings and will be constructed upon completion of the mine site removals. Additional detail is included in Appendix F – Mine Site Stormwater Controls.

A.4.2.3.2 Mill Site Stormwater Controls

Permanent stormwater controls for the Mill Site repository use existing swales and channels constructed for the TDA with improvements and supplemental controls where necessary. These stormwater controls, shown on the Section 9 Drawings, include:

- North Diversion Channel
- East Repository Channel and related sediment controls
- Repository southwest and west side drainage

The East Repository Channel and related sediment controls will be constructed early in the RA to provide upstream stormwater control and to avoid construction constraints due to limited space if they are constructed after waste placement. The remaining

Mill Site stormwater controls will be constructed after waste placement is completed and it is verified that any downstream contamination in these areas has been mitigated. Additional detail is included in Appendix I – Mill Site Stormwater Controls.

A.4.3 Demobilization and Revegetation

Upon completion of the RA, areas subject to mine waste removals will be graded as shown in the Section 3 Drawings, borrow areas will be graded as shown in the Section 8 Drawings, and the repository cover surface will be graded as shown in the Section 7 Drawings.

Haul roads, access roads, and ground areas used for CSFs within the exclusion zone will also be subject to final cleanup and verification in accordance with Appendix T. Trailers and equipment used within the exclusion zone will be scanned and decontaminated (if required). Reclamation would consist of removal of imported gravel surfacing, removal of temporary culverts and stormwater controls, and grading according to the final approved post-reclamation grading plans. Reclamation grading plans for the disturbed areas will be developed during the 95% design phase.

Revegetation will be conducted in accordance with the plans in Appendix U – Revegetation Plans.

A.4.4 Pipeline Arroyo Stabilization

The Pipeline Arroyo is an existing ephemeral arroyo that runs along the northwest side of the TDA. Stability of the Pipeline Arroyo is important for long-term viability of the repository and the TDA, as lateral southeastward migration of the arroyo could create embankment erosion, with significant erosion resulting in release of mine waste or tailings. The Section 9 Drawings show a conceptual design for the reconstructed rock jetty with a riprap weir designed for floods up to the 200-year event. Future studies are needed to characterize the existing bedrock in the proposed location for depths and durability. Additional detail on the design for the reconstructed rock jetty is included in Appendix I – Mill Site Stormwater Controls. Construction sequencing of the Pipeline Arroyo stabilization measures is independent of the other RA elements, and may be conducted at any time during the RA.

A.5 GREEN AND SUSTAINABLE REMEDIATION CONSIDERATIONS

A general GSR overview for the Northeast Church Rock RA is included in Section 4.2.1 of the 30% Design Report. The areas where GSR has been evaluated are related to: 1) construction materials (characteristics and manufacturing considerations), 2) construction methods, and 3) low impact/sustainability measures undertaken during construction. Specific GSR concepts to various parts of the design are included in subsequent design appendices.

A.6 REFERENCES

US Environmental Protection Agency (USEPA), 2011. Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Mine Site, McKinley County, New Mexico, Pinedale Chapter of the Navajo Nation. Prepared for U.S. EPA Regions 6 and 9. September 29.

US Environmental Protection Agency (USEPA), 2013. Record of Decision, United Nuclear Corporation Site, McKinley County, New Mexico, EPA ID: NMD030443303. March 29.

US Environmental Protection Agency (USEPA), 2015. Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery. April 27

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Appendix B:

Construction Support Facilities

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LIST OF ACRONYMS

AOC	Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery
BMP	best management practice
CSF	construction support facility
CY	cubic yard(s)
GSR	Green and Sustainable Remediation
LED	light emitting diode
LEED	Leadership in Energy and Engineering Design
Mill Site	Church Rock Mill Site
Mine Site	Northeast Church Rock Mine Site
NECR	Northeast Church Rock
PTW	principal threat waste
RA	Removal Action
ROD	Record of Decision
SF	square feet
TDA	Tailings Disposal Area
USEPA	US Environmental Protection Agency

B.1 INTRODUCTION

This appendix to the NECR 30% Design Report presents design information for the construction support facilities (CSFs) at the Northeast Church Rock Mine Site (Mine Site) and the Church Rock Mill Site (Mill Site). Specifically, this appendix discusses the layout, configuration, construction and removal (following use) of these facilities.

The CSFs will be located (1) at the east end of the Mine Site, (2) immediately west and/or north of the repository, and (3) within the former mill facilities area of the Mil Site as illustrated on the Drawings. These facilities include Removal Action (RA) security, construction laydown areas, construction water and fuel storage, and Decontamination Zone facilities (including vehicle decontamination pad, drainage controls, and personnel facilities such as showers, lockers and laundry). Facilities required for handling of principal threat waste (PTW) are also discussed herein.

Haul roads for access to support facilities and haul roads constructed to support mine waste excavation and disposal are discussed in Appendix D.

This 30% design presents the physical space required to accommodate the various CSFs and to meet the performance standards specified in the Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery (AOC, USEPA, 2015).

This appendix:

- Demonstrates attainment of applicable standards identified in the Record of Decision (ROD; USEPA 2013)
- Explains the rationale for the proposed location and configuration of the construction support facilities
- Depicts the designed configuration and layout of the construction support facilities
- Discusses the sequence for site preparation and construction of the support facilities and subsequent removal of these facilities
- Presents Green and Sustainable Remediation (GSR) considerations for this design component

B.2 PERFORMANCE STANDARDS

The Performance Standards presented here are defined in the Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site (2011 Action Memo; USEPA, 2011), the Record of Decision, United Nuclear Corporation Site, (USEPA, 2013), and the Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery (USEPA, 2015) including the Statement of Work attached as Appendix D to the AOC, and were developed to define attainment of the Removal Action and Remedial Action Objectives (RAOs) for the Selected Remedy. The Performance Standards include both general and specific standards applicable to the Selected Remedy work elements and associated work components. Table B.2-1 presents performance standards related to the construction support facilities and explains how the design accomplishes these standards.

Table B.2-1: Task Specific Performance Standards

Location of Performance Standard Requirement	Performance Standard	Comments
10 CFR 61.51(a)(2)	10 CFR 61.42 Refer to www.ecfr.gov.	Site access control will prevent inadvertent intrusion from individuals during RA operations (see Section B.4).
2013 ROD, Section 2.9.5 – Site Controls and Security	During response activities access will be restricted by construction of a temporary fence. Domestic livestock or unauthorized persons would not be allowed to enter.	Design provides site access controls. See Section B.4 and Section 2 Drawings
2013 ROD, Section 2.9.5 – Site Preparation Activities	Include an underground utility survey to identify and/or verify the location of subsurface utilities in areas scheduled for consolidation and disposal; identification of heavy equipment routes; and temporary stockpiling activities. These temporary stockpiling activities refer to an area where mine waste will be placed in preparation for placement within the Tailings Disposal Area. A land survey will be completed to delineate the parts of the Tailings Disposal Area that will be used for mine waste disposal. Site construction activities necessary to prepare the site for mine waste placement will be completed. Existing structures such as culverts, catch basins, foundations, and vaults will be decontaminated where practical, disassembled for future use, demolished for removal, or included within the disposal area.	Requirement for utility survey is noted in Section B.4. Other requirements of this performance standard do not apply to Appendix B.
2013 ROD, Table 1	10 CFR §61.41 Protection of the general population from releases of radioactivity. Refer to www.ecfr.gov.	Support facilities are organized into zones for contamination control. See Section B.4.
2015 AOC SOW, Paragraph 19 – Site Controls and Security	In the Design, Respondents shall include plans and specifications for security for the SA Site to prevent access by unauthorized humans and livestock during the construction of the remedy. Respondents shall include plans and specifications for a fence, cattle guards and other security features, as needed.	Design provides site access controls. See Section B.4 and Section 2 Drawings
2015 AOC SOW, Paragraph 20 – Site Preparation Activities	In the Design, Respondents shall include detailed plans and specifications for the following site preparation activities: a. An underground utility survey for the identification and verification of the location of subsurface utilities in SA Site areas that will be used for consolidation or disposal; b. A land survey that will delineate the parts of the Tailings Disposal Area that will be used for NECR Site contaminated soil and mine waste disposal;	a. Requirement for utility survey is noted in Section B.4. b. See Appendix J – Technical Specifications c. See Appendix G – Waste Repository Design

Location of Performance Standard Requirement	Performance Standard	Comments
	c. A description of construction activities to be undertaken on the portion of the SA Site that is at the UNC Site in order to prepare for placement of the NECR Site contaminated soil and mine waste in the Tailings Disposal Area; d. A description of the methods that will be used to decontaminate existing structures such as culverts, catch basins, foundations, and vaults; and, where decontamination is not practicable, a description of methods that shall be used to disassemble these structures, demolish and remove these structures, or include these structures within the Tailings Disposal Area.	d. See Appendix C – Mine Site Removal Excavations and Demolition and Appendix J – Technical Specifications
2015 AOC SOW, Paragraph 22 – Temporary On-Site Facilities	In the Design, Respondents shall include detailed plans and specifications for temporary on-site facilities for project management and project control. Respondents shall include detailed plans and specifications for facilities that enable the decontamination of personnel and equipment, the storage of decontamination equipment (e.g., tools, salvageable equipment, passenger vehicles and heavy equipment), and the staging of contaminated soil and mine waste.	Design of support and decontamination facilities is addressed in Section B.4. PTW handling is addressed in Section B.4.5.
2015 AOC SOW, Paragraph 29 – Green Remediation Best Practices Management	Respondents shall incorporate applicable Best Management Practices for Green Remediation listed in ASTM-E2893-13 consistent with EPA's policy Superfund Green Remediation Strategy (2010), found at http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf.	Addressed in Section B.6

B.3 ENGINEERING DESIGN DRAWINGS

The engineering design drawings are contained in Volume II – Design Drawings (Section 2). Drawings related to construction support facilities are listed in Table B.3-1.

Table B.3-1: Engineering Design Drawings

Drawing No.	Drawing Title
2-01	Early Works and Construction Support Facilities
2-02	Former Mill Site Yard
2-03	Repository Yards
2-04	Mine Site Yard
2-05	Details

B.4 CONSTRUCTION SUPPORT FACILITIES

Support facilities will be constructed during the early stages of the RA. Locations selected for the support facilities are within the Mine Site and Mill Site, but out of the way of the mine waste excavation and disposal activities of the RA. All facilities will be removed at the end of the RA. Support facilities are designed to provide contamination control through segregation of contaminated and non-contaminated materials and activities. A summary table listing the required construction support facilities including functional description, size or required area, and location is included as Table B.4-1.

Selected locations for the CSFs include the former mill facilities area of the Mill Site, an area at the east end of the Mine Site, and previously un-impacted areas immediately north and west of the TDA. These areas are identified on the Drawings as:

- Former Mill Site
- Mine Site Yard
- Repository Yard
- Optional Repository Yard

Additionally, support facilities are organized in zones using the following terms and definitions:

- Support Zone: Area(s) free of contamination.
- Exclusion Zone: Area(s) with actual or potential contamination.
- Decontamination Zone: The transition area between the Exclusion and Support zones. This area is where personnel enter and exit the Exclusion Zone and where decontamination activities take place.

The overall design of these facilities is based on the anticipated space requirements of the Construction Contractor, information from previous investigations and studies, and historical knowledge of the Mine and Mill sites. It will be the selected Construction Contractor's responsibility to meet the requirements identified in the specifications and to facilitate performance of the work. The layout of many, but not all, of the CSFs will be left to the Construction Contractor's discretion; however, specific requirements for each area/facility will be included in a performance specification. Certain facilities, such as those that require collection and containment systems, will be located in designated areas, and constructed as shown on the Drawings. An annotated outline of the support facility performance specification is included as part of Appendix J – Technical Specifications as part of this 30% design.

The primary stormwater control features for the CSFs planned as part of this 30% design are shown on the Section 2 Drawings and discussed in Section B.4.8.

Site preparation activities will include an underground utility survey and overhead utility awareness and mitigation as prudent. Best Management Practice (BMP) installations for sediment and stormwater controls will be installed prior to ground disturbing activities such as stripping and stockpiling of topsoil and organics.

Areas within the Exclusion Zone and Decontamination Zone will be subject to final clean-up and verification upon removal of materials, facilities and equipment accommodated during construction. Cleanup verification is discussed in Appendix T. Upon completion of final clean up and verification, the areas used for construction support facilities will be reclaimed to original condition, or as otherwise indicated by the approved design.

Table B.4-1: Summary of Construction Support Facilities

Area Designation	Function/Use	Location	Approximate Size	Notes/Comments
Security Shack	Access control to Site for all RA related traffic. Scale used for PTW transport and imported materials verification.	Former Mill Site Yard – Support Zone	2,500 SF (x2)	Place scale back in service. Existing paved driveway will be used for daily personnel and visitor entry and exit. Entrance near the truck scale will be used for heavy equipment entry and exit. PTW trucks will enter using the paved driveway and exit via the truck scale.
Parking	Parking for daily personnel and visitors.	Former Mill Site Yard – Support Zone	25,000 SF	Contractor's clean yard is located at the Repository Yard(s).
Construction Offices	Area for construction offices (for contractor foremen, site engineer, etc.) Will be used as the primary sign-in location for all Site visitors (does not include Site worker sign-in/out).	Former Mill Site Yard – Support Zone	20,000 SF	Assumes use of portable trailers (ATCO or similar) of various sizes for office facilities and Conex boxes for storage facilities. Sufficient space for several trailers. Construction Contractor will determine configuration.
Fuel Farm Area	This area will be used for bulk fuel storage. Located within the Support Zone to facilitate deliveries without decontamination of delivery trucks. The area will be adjacent to the Support Zone perimeter fence to facilitate filling of fuel trucks located within the Exclusion Zone. This eliminates the need for the on-Site fuel trucks to enter the Exclusion Zone.	Former Mill Site Yard – Support Zone	5,000 SF	Construction Contractor will be responsible for implementing spill containment measures according to an approved spill containment and cleanup plan (submitted by the Construction Contractor). An additional fuel farm could be placed in the Repository Yard for fueling of repository cover construction equipment. Sufficient space for placement and secondary containment of 5,000 to 10,000 gallons of fuel storage, plus room for fuel transfer.
Water Storage	This area will be used for bulk water storage. Located within the Support Zone to facilitate filling of water trucks operating in the Support Zone and the Exclusion Zone.	Former Mill Site Yard – Support Zone	5,000 SF	Assumes use of portable tanks and temporary pipe connection to the Mill Site well.
Parking and Yard – Exclusion Zone	Area for: (1) Construction crew to be dropped off and picked up by shuttle vehicles, (2) Exclusion Zone vehicle parking, and (3) construction support equipment, maintenance work, storage units, support trailers, etc.	Former Mill Site Yard – Exclusion Zone	50,000 SF	Light vehicles kept within the Exclusion Zone will not require daily decontamination. Layout and utilization to be determined by Construction Contractor.
Decontamination Shack	Decontamination equipment storage and maintenance area.	Former Mill Site Yard – Decontamination Zone	2,500 SF	Assumes use of portable trailer (ATCO or similar) and Conex boxes for equipment storage and maintenance.
Crew Lunch Area	Area for: (1) Contractor trailers for crew lunches, safety meetings, etc., and (2) sanitary facilities.	Former Mill Site Yard – Support Zone	10,000 SF	Assumes use of portable trailers (ATCO or similar). This area will be adjacent to the Personnel Decontamination Area to promote efficient flow of construction crew members through the decontamination facilities and to/from the lunch trailers and pick-up/drop-off area at shift change.
Crew Decontamination Area	Area for decontamination trailers and laundry facilities. Flow of personnel to/from this area will be controlled by fencing and gates. Construction crew will sign in/sign out when moving through decontamination trailer at lunch breaks and shift changes.	Former Mill Site Yard – Decontamination Zone	10,000 SF	Decontamination facilities must include clean side (Support Zone) and dirty side (Exclusion Zone) change rooms for construction workers to change into and out of work coveralls and boots. Lockers must be available in each change room for each Site worker to store of personal items. The facilities also must include scanning equipment, a sign in/sign out area, clearly defined Exclusion Zone (potentially contaminated) and Support Zone (clean) sides, and decontamination showers (to be used as necessary). Laundry facilities will be available in this area for weekly cleaning of worker coveralls. Gray water from the decontamination facilities will drain to decontamination pad sump.
Vehicle Decontamination Area (Primary)	Area for scanning and decontamination of vehicles and equipment leaving the Exclusion Zone. This area will include: (1) a geomembrane-lined, gravel pad and sump, or (2) a paved pad and sump, for collecting impacted water and separating sediment.	Former Mill Site Yard – Decontamination Zone	20,000 SF	Should a driver or other personnel in this area require additional decontamination, they will report to the Personnel Decontamination Area. Decontamination drainage will be collected in the pad sump and transported to evaporation ponds for disposal. An asphalt pad option is shown on the drawings as an option to limit sump excavation in the former mill site area.
Vehicle and Equipment Decontamination Area (Optional Secondary)	Area for scanning and decontamination of heavy equipment leaving the Mine Site. The existing geomembrane-lined, gravel pad and sump will need to be restored to useable condition. Small support trailer will include an area where the driver can scan out and sign out.	Mine Site Yard (existing pad)	10,000 SF	Intended for optional limited use of equipment that is difficult to transport to the primary decontamination area (i.e. tracked equipment). A water truck or storage tank will be used for a water source. Power will be needed for the support trailer. Decontamination drainage will be collected and transported to the evaporation ponds for disposal. Should a driver or other personnel in this area require additional decontamination he/she will need to report to the Personnel Decontamination Area.
Contractor Clean Yard	Clean laydown in the Support Zone immediately north or west of the tailings disposal area to be used for construction materials storage, clean borrow or imported material stockpiles, construction support equipment, maintenance, storage units, support trailers, clean vehicle parking, fuel storage, etc.	Repository Yard(s)	270,000 SF	Situated to segregate clean and contaminated support services. Layout and utilization will be left to Construction Contractor's discretion.
PTW Stockpile and Loadout Area	Area for loading PTW material onto haul truck for off-site disposal. Loaded trucks must remain clean or be decontaminated prior to leaving site. All trucks use scale to verify optimal loading. Direct truck haul to off-site facility or local rail facility.	Former Mill Site Yard – Exclusion Zone	150,000 SF	PTW waste is located in several discrete areas within the mine waste, limiting the practicality of direct load into off-site haul vehicles. Sufficient space is available in the Former Mill Site Yard for stockpiling (up to 35,000 CY) and load out. Load out operations could be conducted in multiple operations based on stockpile accumulation.
Mine Site Yard	Area for: (1) construction support equipment, maintenance work, storage units, support trailers, etc., and (2) interim stockpiling of PTW material.	Mine Site Yard – Exclusion Zone	78,500 SF	Sufficient space is available in the Mine Site Yard for stockpiling up to 15,000 CY of PTW if needed. Load out operations in this location will conflict with haul operations.

CY – cubic yards, PTW – principal threat waste, RA – removal action, SF – square feet

B.4.1 Support Zone Facilities

Support zone facilities and locations include the Former Mill Site Yard and the Repository Yard(s) as shown on the Section 2 Drawings. The Former Mill Site Yard will include: access control, parking, construction and personnel management facilities, construction crew lunch, meeting, and transfer facilities, fuel storage, and PTW load out facilities (Section B.4.5). The Repository Yard(s) will include: access controls and the contractor's clean yard.

The Former Mill Site yard was selected for the above uses for its central location and existing infrastructure for access controls and utilities. A paved driveway entrance is currently in use for the Mill Site offices. This driveway will be used for daily construction crew and visitor traffic. A driveway entrance suitable for large vehicles and equipment exists at the north end of the yard. This entrance will be re-established and upgraded as needed to provide safe and secure entrance and egress from the Mill Site. Fencing and gates will be repaired and/or installed as needed to restrict unauthorized access. The scale will also be placed in service to verify imported or exported material quantities. Grading and drainage improvements will be constructed, as required, to suit the facilities. Gravel surfacing will be required for vehicle travel lanes, parking, and office areas.

Existing infrastructure will be used for temporary water and power for offices and crew facilities. It is anticipated that the Construction Contractor will use mobile trailers or other mobile structures for the majority of the CSFs. Securing temporary trailers or structures and connecting utilities will be in accordance with the recommendations of the manufacturer of each type of temporary structure. The technical specifications (Appendix J) will address the standards and requirements for temporary utilities, sanitary facilities, and disposal of sanitary and domestic waste.

The Repository Yard was selected for use as the Construction Contractor's clean yard based on proximity to the repository and borrow areas. Maintaining segregation of borrow material haul trucks and mine waste haul trucks is critical for contamination control. Construction and use of the Repository Yard will require construction of an access road and access controls, drainage controls (including grading), and haul traffic segregation controls. There is also suitable space for a secondary yard immediately north of the Tailings Disposal Area (TDA) as shown on the Section 2 Drawings.

B.4.2 Water Supply

The Mill Site well will be used to supply water for decontamination, sanitary uses, and dust control. As discussed in Appendix Q, hourly water requirements for dust control are likely to exceed the production capacity of the well so temporary on-site storage of water (water tanks) will be required. Portable water tanks will be placed in the Former Mill Site Yard and connected to the well with temporary high-density polyethylene piping. Water use and storage calculations are included in Appendix Q.

B.4.3 Decontamination Zone Facilities

Decontamination zone facilities will be located at the Former Mill Site Yard and will include: access controls, a vehicle decontamination area, and a personnel decontamination area. These decontamination areas will be adjacent to one another, but separate to isolate personnel traffic from vehicular traffic and reduce the potential for accidents. The decontamination areas are designed to promote safe and efficient flow of personnel and vehicles between the Exclusion Zone, in which the RA construction will be occurring, and the Support Zone. The personnel decontamination area is primarily intended for use by RA construction workers whose construction vehicles and equipment will be left within the Exclusion Zone for use during the RA. The vehicle decontamination area is intended for use only by vehicles that must leave the Exclusion Zone (such as demobilized construction equipment).

Access to and from the Exclusion Zone will be controlled through the Decontamination Zone. Construction personnel and visitors will be required to pass through an access control office and gates. It is anticipated that construction personnel working within the Exclusion Zone will park in the Support Zone, enter the Exclusion Zone, and be transferred by van or light truck to their equipment and/or work area. To the extent practical, light vehicles will be kept in the Exclusion Zone for this purpose throughout construction.

The vehicle decontamination area will be: (1) a gravel-surfaced area that contains a geomembrane-lined gravel pad and collection sump, or (2) an asphalt pavement pad with a water tight collection sump. The decontamination area is sized based on the anticipated construction equipment, and design details for the gravel pad are shown on the Section 2 Drawings. The decontamination pad sump will collect and contain water used for decontamination activities for conveyance to the evaporation ponds. The final design configuration of the vehicle decontamination pad and sump will also be sized to store direct precipitation from the 5-year, 24-hour precipitation event with no outflow. Either configuration shown on the Drawings will be effective for contamination control. As the design progresses, unforeseen drainage, traffic, and/or health and safety constraints may become apparent that favor a particular configuration. This 30% design demonstrates the ability to meet performance standards with either configuration and the preferred surface materials and configuration will be determined during the 95% design phase.

Vehicles and equipment that leave the Exclusion Zone will be scanned and if necessary, decontaminated, within the vehicle decontamination area. Portable decontamination equipment (such as pressure washers) is anticipated for this application. Proposed decontamination action levels and procedures for vehicles, equipment, and personnel are discussed in Appendix M. Specific decontamination procedures and equipment selection will be the responsibility of the selected Construction Contractor.

The personnel decontamination area will include equipment and facilities to accommodate scanning of site construction workers, with decontamination facilities available for use if and when they are needed. The facilities in this area will include: scanning equipment, showers, lockers (for changing from civilian clothes into work clothes and vice versa), and laundry facilities. It is anticipated that specialty construction trailers will be used for these facilities. Construction personnel will access “clean” and “dirty” lockers to store personal items and change into their work coveralls.

Personnel leaving the restricted work area will enter the personnel decontamination area to change out of potentially contaminated clothing. Workers then will undergo scanning. Workers who meet the scanning criteria will sign out and proceed to the Support Zone. Workers failing to meet the scanning criteria will attempt to remove contamination from their undergarments. If a situation occurs where the contamination cannot be removed from a worker’s garments (i.e., denim pants, long underwear, etc.), the worker will remove those garments, shower, and pass to the clean side lockers where all workers will be required to store a clean change of clothes.

B.4.4 Exclusion Zone Facilities

Exclusion Zone facilities will be located at the Former Mill Site Yard and the Mine Site. Exclusion Zone facilities at the Former Mill Site will include: access control, Exclusion Zone parking, contractor yard, and the PTW storage and handling facilities (Section B.4.5). Access control for the Exclusion Zone will be provided using fencing and gates as shown on the Section 2 Drawings. As noted above, primary access for personnel and equipment will be controlled through the Decontamination Zone. A combination of permanent and temporary fencing will be utilized for perimeter control. This area is expected to be congested during construction, thus the primary access to the Mine Site will be via the haul road. This configuration also maximizes the segregation of public traffic and construction traffic. Access and haul roads are discussed in Appendix D

As shown on the Section 2 Drawings, a temporary gate will be placed near the end of NM 566, just west of Red Water Pond Road. The short segment of paved road beyond the temporary gate will be used for light vehicle parking and access control. Vehicle access to or from the Mine Site at this location will be restricted to emergency use and the limited mobilization or demobilization of heavy construction equipment that is intended for use within the mine area. Personnel or visitors that may require entrance to the Mine Site on foot (only) will be able to park and sign in at this location. Portable equipment will be used to scan personnel and visitors prior to existing the Mine Site.

Space for a contractor’s yard is provided at the Former Mill Site Yard. It is anticipated that this location will be used for laydown and storage, equipment maintenance, and parking of vehicles and equipment kept within the Exclusion Zone during construction. This location was chosen based on proximity to the Decontamination and Support zones and to avoid congestion at the Mine Site.

The Mine Site Yard shown on the Drawings is available for temporary use as a laydown yard and PTW stockpiling, if necessary (Section B.4.5). Exclusion zone facilities at the Mine Site will include: access control (gated entrance, parking, and security shack), a secondary decontamination pad, contractor yard, and temporary PTW storage (Section B.4.5). An existing geomembrane-lined gravel decontamination pad and sump are located at the east end of the Mine Site. It is anticipated that this decontamination pad may be useful for occasional demobilization of heavy construction equipment such as tracked equipment that are not well-suited for travelling to the Former Mill Site yard for scanning and decontamination. Future use will require reconditioning of the gravel surface and testing the sump for leakage and proper operation. Portable equipment will be used for scanning and decontamination. Water collected in the sump will be conveyed to the evaporation ponds by truck for disposal or pumped to temporary impacted stormwater impoundments on the Mine Site. Power is available at this location.

B.4.5 Principal Threat Waste Handling

PTW material will be verified and excavated concurrently with other mine waste as discussed in Appendix C. Given the distribution of PTW in the mine waste, it is not practical to excavate and export the PTW without stockpiling. PTW material will be hauled to a stockpile area for storage until the material can be transported off-site. There is sufficient space to temporarily stockpile approximately 15,000 CY at the Mine Site Yard and 35,000 CY at the Former Mill Site Yard as shown on the Drawings (2-02 and 2-04). Temporary stormwater run-on/runoff controls and dust control measures will be implemented at each site to mitigate the risk of releasing contaminated material. Management of stormwater during construction is addressed in Appendix E.

It is anticipated that PTW material will be loaded from the Former Mill Site Yard into highway vehicles for transport to an USEPA-approved off-site repository via truck or rail. The Mill yard is located such that off-site transport operations for PTW material will not conflict with mine waste removal operations, enhancing both safety and efficiency. The Mine Site Yard location is planned for interim stockpiling of material subject to laboratory testing to confirm PTW status.

Transport vehicles will enter the Support Zone via the existing paved driveway entrance and proceed to a loading area within the Exclusion Zone, where PTW loading will take place. Upon completion of loading, vehicles will be inspected for external contamination, and then either proceed to the decontamination pad or proceed directly through the Decontamination Zone to the scale to verify that the transport vehicle has been loaded to maximum capacity before leaving the Mill Site. The Construction Contractor will be required to develop loading methods that minimize the need for vehicle decontamination. Traffic control is discussed in Section B.4.6.

USEPA mandated in the Non-time Critical Action Memo (USEPA, 2011) that PTW either be reprocessed to reclaim metals and radionuclides or be transported off-site to a licensed and controlled disposal facility meeting the performance standard, as defined by the USEPA, under the Off-Site Rule 40 CFR § 300.440 (USEPA, 2011). USEPA states in the 2013 ROD Section 1.4 (USEPA, 2013), that PTW from the Mine Site will not be disposed at the Mill Site. The following facilities will be considered for off-site disposal of PTW:

- Waste Control Specialists Facility, Andrews, TX – 483 miles from Northeast Church Rock (NECR)
- Energy Solutions Facility, Clive, UT – 576 miles from NECR
- US Ecology Facility, Richland, WA – 1135 miles from NECR

B.4.6 Dust Control

Dust will be controlled primarily through the use of water, gravel surfacing, covers, and operational controls. The CSFs occupy flat surfaces which can be efficiently treated with water, gravel, and/or chemical agents. Dust control is addressed in more detail in Appendix Q.

PTW stockpiles may require more robust dust control than from using water or chemical agents. Dust control on active stockpile areas (where PTW is being placed or excavated) may be managed using water and small tracked equipment for moderate compaction. This will also include water application for dust control during excavation and loading. Inactive PTW stockpiles (where PTW is stored for a period of time) may require a membrane cover, of which there are many effective alternatives for this application. The Construction Contractor will be required to submit for approval the cover materials and system it will use to manage the PTW stockpiles. The Construction Contractor will be required to demonstrate that its proposed cover system will be stable during reasonably anticipated high-wind events.

B.4.7 Traffic Control

Traffic patterns have been designed to segregate worker traffic and visitor traffic from heavy equipment and construction traffic. The existing paved entrance will be used for workers and visitors. Personnel and visitors will enter and exit the Support Zone via a secure entrance and park in a designated area near the construction offices. When PTW loading operations are in progress, empty highway trucks will enter the site in the same manner and proceed to the loading area. However, these vehicles will exit the site via the truck scale. Traffic control is addressed in more detail in Appendix M.

B.4.8 Construction Support Facilities Temporary Stormwater Controls

The proposed CSFs are shown in the Section 2 Drawings. The CSFs include the Exclusion Zone and Support Zone in the Former Mill Site Yard, the Repository Yard (located between the Former Mill Site Yard and the Pipeline Arroyo), and the optional Repository Yard (north of the repository). MWH designed the temporary stormwater controls for the CSF for the 5-year, 24-hour storm event, based on the relatively short operational period of the CSFs.

The design concept for the CSF stormwater controls is to separate non-contact and contact stormwater through use of diversion ditches and retention ponds. Non-contact stormwater from catchments upgradient of the CSFs will be diverted around the CSFs in diversion ditches. The diversion ditch around the Former Mill Site Yard will be triangular in cross section, with a depth of 2 feet, which is designed to provide capacity to contain the peak 5-year storm discharge (see calculations in Attached D.1 of Appendix D). Catchment areas for the Repository Yard and Optional Repository Yard are small relative to the catchment above the Former Mill Yard Site, and diversion ditches for these facilities, if necessary, will be designed and constructed by the Construction Contractor as part of the Construction Stormwater Pollution Prevention Plan (see Appendix E).

The stormwater runoff within the proposed Exclusion Zone at the Former Mill Site will be potentially impacted. The Exclusion Zone will be graded to shed stormwater runoff to one of two retention ponds that will be located within the Exclusion Zone. MWH designed these retention ponds to have capacity to retain all rainfall falling within the Exclusion Zone during the 5-year, 24-hour storm (see calculations in Attachment D.1 of Appendix D). The Construction Contractor will need to provide means to remove the stormwater from the retention ponds and dispose of it in the temporary stormwater basin (at the Mine Site), or at the evaporation ponds on the TDA, within 48 hours following the storm event.

B.4.9 Verification and Reclamation

Upon completion of the RA, trailers and equipment used within the Exclusion Zone will be scanned and decontaminated (if required). All ground areas used for CSFs within the Exclusion Zone will also be subject to final cleanup and verification in accordance with Appendix T, prior to reclamation. Reclamation of the Former Mill Site Yard and the Repository Yard will include grading according to the final approved post-reclamation grading plans. Reclamation grading plans will be developed during the next design phase. Revegetation will be conducted in accordance with Appendix U.

B.5 CONSTRUCTION SEQUENCING

The anticipated sequence for preparation, mobilization, and construction of the construction support facilities will be as follows:

1. Underground utility survey to identify and/or verify the location of subsurface utilities within the CSF areas
2. Overhead utility survey and safety mitigation as needed
3. Construction of water supply connections and storage
4. BMP installations for sediment and stormwater controls
5. Site preparation including stripping and stockpiling of topsoil and organics
6. Grading and drainage improvements
7. Construction of the access roads
8. Construction and mobilization of the access control trailer(s), fencing, and gates
9. Initial Decontamination Zone construction (decontamination office, drainage controls, and vehicle decontamination pad)
10. Mobilization of crew meeting/lunch trailers, restroom trailers, construction office trailers, an administration/storage trailer, and construction fuel and water storage and delivery systems
11. Construction of zone controls such as fencing, berms, or other controls to maintain separation between support, decontamination, and exclusion zones

B.6 GREEN AND SUSTAINABLE REMEDIATION CONSIDERATIONS

B.6.1 Construction Material Considerations

Site grading for the CSFs and associated roads will be minimized to the extent possible to reduce the required construction equipment operating time, greenhouse gas emissions, and fill material.

The use of LEED®-certified portable structures will be investigated and utilized if available and cost effective. The benefits of LEED®-certified portable structure use include the conservation of energy and water, reduction in greenhouse gas emissions and operating costs, improved health and safety of occupants, and reduction of waste sent to landfills.

If LEED®-certified portable structures cannot be found or are cost prohibitive, LEED® principles will be applied where feasible including utilization of Energy Star compliant equipment. This can include low energy light bulbs (e.g. LEDs), passive cooling and lighting when possible, trailers constructed using re-used and recycled materials wherever possible (i.e. insulation, metal and wood framing from retired trailers, recycled high-density polyethylene walls), and procedural/engineering controls for indoor air quality. Such controls for indoor air quality include but are not limited to ventilation (passive and/or active) and use of adhesives and paints with low percentage of volatile organic compounds.

Temporary facilities requiring power will be located near existing infrastructure to reduce the use of diesel generators. If connection to existing infrastructure is not possible, use of photovoltaic cells or small wind power will be investigated and utilized if practicable.

B.6.2 Construction Methods

The construction equipment used for the construction support facilities will be appropriately sized to reduce fuel consumption and greenhouse gas emissions. Dust suppression will be utilized throughout the area and on the access roads to decrease visible dust related emissions. Section B.4.8 discussed temporary stormwater controls and Appendix E identifies BMPs and specific sediment control measures that will be employed during construction for both sediment and stormwater control.

B.6.3 Low Impact Development/Sustainability

Consolidation of CSFs at the Former Mill Site Yard focuses construction and longer-term support activities in one previously impacted area. The route of the access and haul roads was optimized to minimize site disruption and vehicle mileage and to protect public health and safety on the existing highway. The routes chosen utilize existing or historical roads to the extent practical to limit additional habitat degradation.

Access roads and haul roads will be reclaimed upon completion of construction. Additionally, a primary point of entry/exit to the Exclusion Zone will be maintained to help prevent re-contamination of areas already remediated or contamination of areas that were previously uncontaminated. This primary point of entry/exit also minimizes the required support facilities and associated infrastructure required for construction.

B.7 REFERENCES

US Environmental Protection Agency (USEPA), 2011. Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Mine Site, McKinley County, New Mexico, Pinedale Chapter of the Navajo Nation. Prepared for U.S. EPA Regions 6 and 9. September 29.

US Environmental Protection Agency (USEPA), 2013. Record of Decision, United Nuclear Corporation Site, McKinley County, New Mexico, EPA ID: NMD030443303. March 29.

US Environmental Protection Agency (USEPA), 2015. Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery. April 27.

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Appendix C:
Mine Site Removal Excavations and Demolition

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LIST OF ACRONYMS / ABBREVIATIONS

AOC	Administrative Settlement Agreement and Order on Consent for Design and Cost Recover
BMP	best management practice
CFR	Code of Federal Regulations
COC	constituent of concern
cpm	counts per minute
CY	cubic yard(s)
DCGLemc	derived concentration guidance level (elevated measurement comparison)
DCGLw	derived concentration guidance level (for wide area average of site)
FSL	field screening level
IRA	Interim Removal Action
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detection concentration
mg/kg	milligrams per kilogram
Mill Site	Church Rock Mill Site
Mine Site	Northeast Church Rock Mine Site
NECR	Northeast Church Rock
pCi/g	picocuries per gram
PDS	Pre-Design Studies
PTW	principal threat waste
RA	Removal Action
RAL	removal action level
RAO	Remedial Action Objective
ROD	Record of Decision
RSE	Removal Site Evaluation
SOW	Statement of Work
TPH	total petroleum hydrocarbons
USEPA	US Environmental Protection Agency

C.1 INTRODUCTION

C.1.1 Project Background

The Northeast Church Rock (NECR) Mine Site (Mine Site) Removal Action (RA) consists of removal of mine spoils and debris (hereafter termed mine waste). Mine waste is defined by the 2011 Action Memo (USEPA, 2011) as soils and debris with Ra-226 concentrations above the field screening level (FSL) of 2.24 pCi/g. These materials will be excavated and disposed. Characterization of the Mine Site is provided in the Northeast Church Rock Mine Site Removal Action Pre-Design Studies (PDS) Reports (MWH, 2014a and 2014b). This appendix provides the following information:

- Demonstration that the excavation plans for the Mine Site meet requirements of the Performance Standards identified in the Action Memo (USEPA, 2011), Record of Decision (ROD; USEPA, 2013), and the Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery Statement of Work (AOC SOW; USEPA 2015)
- Calculations and assumptions for determination of mine waste volume, materials management strategies, estimated limits of excavations, and brief identification of temporary stormwater and erosion controls to be used during removal of impacted materials
- Excavation and grading plans for removal of mine waste within the Mine Site
- Processes for verifying regulatory cleanup levels have been achieved in the excavated areas
- Considerations for Green and Sustainable Remediation

C.2 PERFORMANCE STANDARDS

The Performance Standards presented here are defined in the Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site (2011 Action Memo; USEPA, 2011), the ROD, United Nuclear Corporation Site (USEPA, 2013), and the AOC (USEPA, 2015) including the SOW attached as Appendix D to the AOC, and were developed to define attainment of the Remedial Action Objectives (RAOs) for the Selected Remedy. The Performance Standards include both general and specific standards applicable to the Selected Remedy work elements and associated work components. Table C.2-1 presents Performance Standards related to the Mine Site Removal Action and how the design accomplishes these standards.

Table C.2-1: Task Specific Performance Standards

<table>
<tr><th>Location of Performance Standard Requirement</th><th>Performance Standard</th><th>Comments</th></tr>
<tr><td>2011 Action Memo, Table 4.1 – Field Screening Levels</td><td>Table 4.1 Selected Field Screening Levels
<table>
<tr><td>Contaminant of Potential Concern</td><td>Field Screening Level</td></tr>
<tr><td>Ra-226</td><td>2.24 pCi/g</td></tr>
<tr><td>Arsenic</td><td>3.7 mg/kg</td></tr>
<tr><td>Molybdenum</td><td>390 mg/kg</td></tr>
<tr><td>Selenium</td><td>390 mg/kg</td></tr>
<tr><td>Uranium</td><td>200 mg/kg</td></tr>
<tr><td>Vanadium</td><td>390 mg/kg</td></tr>
</table></td><td>Mine waste identified as material with field screening level (FSL) values for Ra-226 greater than 2.24 pCi/g. See Section C.4.3.</td></tr>
<tr><td>2011 Action Memo, Table 4.2 – Selected Action Levels</td><td>Table 4.2 Selected Action Levels
<table>
<tr><td>Contaminant of Concern</td><td>Action Level</td></tr>
<tr><td>Ra-226</td><td>2.24 pCi/g</td></tr>
<tr><td>Uranium</td><td>230 mg/kg</td></tr>
</table></td><td>Removal Action Level for project is 2.24 pCi/g for Ra-226 and 230 mg/kg for uranium. See Section C.4.3.</td></tr>
<tr><td>2011 Action Memo, V.A.1, Bullet 4 – Excavation</td><td>Excavation. Excavation at the NECR Site and transportation of waste with concentrations of uranium and Ra-226 that exceed Action Levels to a repository at the UNC Mill Site for co-disposal at the existing Tailings Disposal Cells. This action is contingent on the U.S.EPA decision document for the surface contamination at the UNC Mill Site, and the NRC approval of a license amendment for the UNC Mill Site disposal cells. Depth of excavation will not exceed ten feet, except in areas susceptible to erosion or where placing clean backfill to current grade is not planned, or in areas where principal threat waste will be removed. Excavation within these areas will continue until confirmation sample results are below the Action Levels per MARSSIM procedures.</td><td>Mine waste will be removed to depths where Action Levels are below 2.24 pCi/g for Ra-226 and 230 mg/kg for uranium, or to contact with bedrock, but will not exceed 10 feet in depth in areas where clean fill will be placed to final grade. See Section C.4.4 and C.4.5.</td></tr>
<tr><td>2011 Action Memo, V.A.1, Bullet 7 –</td><td>Confirmation Sampling. Conduct confirmation scanning, sampling and analysis to ensure that the action levels have been met in excavated areas.</td><td>Confirmation scanning, sampling and analysis are included in mine waste verification</td></tr>
</table>

Location of Performance Standard Requirement	Performance Standard	Comments
Confirmation Sampling		procedures. See Section C.4.5 and Appendix T.
2011 Action Memo, Section V.A.1, Bullet 8 - Site Restoration	Restoration activities will include the backfilling and regrading of excavation areas for erosion and storm water control. These areas will also be re-vegetated with native species.	Final restoration grading plans are shown in the Section 3 Drawings. The revegetation plan for the Mine Site is in Appendix U, Attachment U.1.
2011 Action Memo, V.A.1	40 CFR §300.440 Procedures for planning and implementing off-site response actions. Refer to www.ecfr.gov.	Off-site response actions for principal threat waste (PTW) include excavation removal of PTW and transport to USEPA approved off-site disposal facility.
2011 Action Memo, V.A.1, Bullet 6 – Principal Threat Waste	**Principal Threat Waste.** Principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. At the NECR Mine Site, all wastes, containing either 200 pCi/g or more of Ra-226 and/or 500 mg/kg or more of total uranium present a significant risk to human health; therefore, this contaminated material is considered principal threat waste. To treat this Principal Threat Waste, this Action Memorandum calls for reprocessing of the Principal Threat Waste to reclaim metals and radionuclides. If reprocessing technologies are not technically feasible, or are not available within a reasonable time frame as determined by the U.S. EPA, then the Principal Threat Waste will be disposed of in a facility that has been determined by U.S.EPA to be acceptable under the Off-site Rule, 40 CFR § 300.440.	PTW will be removed and transported to a USEPA-approved offsite facility. See Section C.5.2.
2011 Action Memo, V.A.2	Contribution to remedial performance This removal action would address the mine waste and soil contamination at the NECR Mine Site, to a depth of at least 10 feet. It is expected that this removal action will remove the threat of direct or indirect contact with or inhalation of hazardous substances from the mine waste and soils at the NECR Mine Site. As noted above, the soils in the area east of Red Water Pond Road will be addressed in a separate removal action. The EE/CA presented alternatives for surface and near-surface mine waste and soil to be addressed in a non-time-critical removal action only. This removal action does not address contamination that may remain at greater depths. U.S. EPA has recently worked to assess groundwater for the NECR Mine Site and surrounding facilities, including historic releases from these facilities; however, the removal action that is the subject of this memorandum does not address groundwater.	Mine waste will be removed to depths where Action Levels are below 2.24 pCi/g for Ra-226 and 230 mg/kg for uranium, or to contact with bedrock, but will not exceed 10 feet in depth in areas where clean fill will be placed to final grade. See Section C.4.4 and C.4.5.
2013 ROD, Section 1.4 - Receiving	**Receiving.** NECR Site waste that is transported to the UNC Site will be disposed in the Tailings Disposal Area if NRC	Mine waste will be removed to depths where Action Levels are below 2.24 pCi/g for Ra-226

Location of Performance Standard Requirement	Performance Standard	Comments
	approves a license amendment. The waste from the NECR Site will contain concentrations of uranium and radium 226 (Ra-226) that exceed Action Levels established in the 2011 NECR Site Non-Time-Critical Action Memorandum (hereinafter the 2011 NECR Site Action Memorandum). The 2011 NECR Site Action Memorandum provides that excavation at the NECR Site will not exceed ten feet, except in areas susceptible to erosion or where placing clean backfill to current grade is not planned, or in areas where principal threat waste will be removed. As stated earlier, principal threat waste is not a part of this Selected Remedy and will not be brought to the UNC Site. Excavation within these areas will continue until confirmation sample results are below the Action Levels established in the 2011 NECR Site Action Memorandum as determined using Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) procedures.	and 230 mg/kg for uranium, to contact with bedrock, but will not exceed 10 feet in depth in areas where clean fill will be placed to final grade See Section C.4.4 and C.4.5.
2013 ROD, Section 2.9.5 – Site Preparation Activities	Include an underground utility survey to identify and/or verify the location of subsurface utilities in areas scheduled for consolidation and disposal; identification of heavy equipment routes; and temporary stockpiling activities. These temporary stockpiling activities refer to an area where mine waste will be placed in preparation for placement within the Tailings Disposal Area. A land survey will be completed to delineate the parts of the Tailings Disposal Area that will be used for mine waste disposal. Site construction activities necessary to prepare the site for mine waste placement will be completed. Existing structures such as culverts, catch basins, foundations, and vaults will be decontaminated where practical, disassembled for future use, demolished for removal, or included within the disposal area.	Site preparation activities include utilities surveys, haul roads and temporary stockpiles early works, installation of erosion controls, and cultural surveys. See Section C.4.1. Repository design is described in Appendix G. All on-site debris will be excavated and disposed, as it is anticipated that this debris has no economic value. See Section C.4.3.2.
2013 ROD, Section 2.9.5 – Waste Volume	Approximately 871,000 cubic yards from the removal action described in the 2011 Non-Time-Critical Removal Action Memorandum for the NECR Site, 109,800 cubic yards from a removal action at the NECR Site that predates the 2011 Non-Time-Critical Removal Action Memorandum for the NECR Site, and an estimated 30,000 cubic yards to be excavated as part of a separate time-critical removal action at the NECR Site will be interred at the Tailings Disposal Area and capped. Although the additional 109,800 and 30,000 cubic yards volume was not included in the EE/CA, the additional volume and associated cost are minimal compared to the overall volume and cost evaluated. In addition the added expense is within the EE/CA's margin of error. Based on this, the additional volume and cost are considered included and addressed under this alternative. The waste acceptance criteria for mine waste that will be disposed at the UNC Site Tailings Disposal Area are 200 pCi/g or less of Ra-226 and/or 500 mg/kg or less of uranium.	Mine waste exceeding the removal action limits (RALs), with the exception of waste meeting the definition of PTW, will be placed in the repository to be located on the existing tailings impoundment. See Section C.4.6.

Location of Performance Standard Requirement	Performance Standard	Comments
2013 ROD, Table 1	10 CFR 40, Appendix A, Criterion 2. Refer to www.ecfr.gov.	Mine waste exceeding the RALs will be excavated and placed in a single repository on the existing tailings impoundment. See Section C.4.5.
2013 ROD, Table 1	10 CFR 61 52(a)(11). Land disposal facility operation and disposal site closure. Refer to www.ecfr.gov	Mine waste containing radioactive materials exceeding the RALs for Ra-226, will be placed in the repository. A limited amount of soil, mine debris, and stripped vegetation that are not contaminated with radioactive materials may also be placed in the repository. See Section C.4.5.
2015 AOC SOW, Paragraph 17 – Soil Transportation and Management	In the Design, Respondents shall provide detailed plans and specifications explaining how mine waste from the NECR Site and other materials (including borrow, backfill, and cover materials) will be managed and transported. Respondents shall include details for ensuring that Principal Threat Waste from the NECR Site, as described in the 2011 Action Memo, is not transported to the UNC Site or disposed at the Tailings Disposal Area.	Mine waste exceeding the RALs will be excavated and transported to the repository. Mine waste characterized as PTW will be stockpiled for removal from the site. See Sections C.4.5 and C.5.2.
2015 AOC SOW, Paragraph 18 – Cleanup Verification	In the Design, Respondents shall include procedures for cleanup verification (including confirmation sampling and scanning for COCs and COPCs) for the NECR Site. Respondents shall include procedures to verify that the NECR Site has achieved performance standards by presenting confirmation sample results that indicate that Action Levels have been met using Multi-Agency Radiation Survey and Site Investigation Manual ("MARSSIM") procedures for radiological COCs (Radium-226) and EPA-approved lab analysis for heavy metal COCs (uranium) confirmation soil samples.	Confirmation scanning, sampling and analysis are included in the cleanup verification procedures. See Section C.4.6.6 and Appendix T.
2015 AOC SOW Paragraph 20 – Site Preparation Activities	In the Design, Respondents shall include detailed plans and specifications for the following site preparation activities: a. An underground utility survey for the identification and verification of the location of subsurface utilities in SA Site areas that will be used for consolidation or disposal; b. A land survey that will delineate the parts of the Tailings Disposal Area that will be used for NECR Site contaminated soil and mine waste disposal; c. A description of construction activities to be undertaken on the portion of the SA Site that is at the UNC Site in order to prepare for placement of the NECR Site contaminated soil and mine waste in the Tailings Disposal Area; d. A description of the methods that will be used to decontaminate existing structures such as culverts, catch basins, foundations, and vaults; and, where decontamination is not practicable, a description of methods that shall be used	a. See Appendix B – Construction Support Facilities b. See Appendix J – Technical Specifications c. See Appendix G – Mine Waste Repository Design d. Existing Mine Site debris will be excavated and demolished into transportable sizes for disposal. Placement of debris within the repository will be conducted in accordance with the Technical Specifications. See Section C.4.3.2 and Appendix J.

Location of Performance Standard Requirement	Performance Standard	Comments
	to disassemble these structures, demolish and remove these structures, or include these structures within the Tailings Disposal Area	
2015 AOC SOW Paragraph 27 – Site Restoration	In the Design, Respondents shall include detailed plans and specifications for restoration of the Tailings Disposal Area and borrow areas on the UNC Site and for restoration of the NECR Site. Respondents shall also include plans and specifications for contouring to promote drainage, and for re-vegetation of the Tailings Disposal Area, borrow pits and NECR Site with native species. Respondents shall include plans and specifications for backfilling and regrading of disturbed (e.g., excavated) areas in the NECR Site and the UNC Site for erosion and storm water control, including re-vegetation of those areas with native species.	Excavated areas will be regraded to promote positive drainage to existing drainages and minimize ponding of water. Disturbed slopes will be graded to provide long-term slope stability. All disturbed areas will be revegetated to mitigate against erosion. See Section C.6 and Appendix U.
2015 AOC SOW, Paragraph 29 – Green Remediation Best Management Practices	Respondents shall incorporate applicable Best Management Practices for Green Remediation listed in ASTM-E2893-13 consistent with EPA's policy Superfund Green Remediation Strategy (2010), found at http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf.	Proposed best management practices for green remediation for the Mine Site Excavation Plan are described at the end of this appendix. See Section C.7.

C.3 ENGINEERING DESIGN DRAWINGS

The engineering design drawings are contained in Volume II – Design Drawings (Section 3). Drawings related to the Mine Site removal excavations are listed in Table C.3-1.

Table C.3-1: Engineering Design Drawings

Drawing No.	Drawing Title
3-01	Existing Condition
3-02	Impacted Material Excavation Depths
3-03	Removal Areas and Debris Map
3-04	Phase 1 Removal Areas
3-05	Phase 2 Removal Areas
3-06	Phase 3 Removal Areas
3-07	Phase 4 Removal Areas
3-08	Phase 5 Removal Areas
3-09	Final Grading
3-10	Temporary Plug Cross Sections and Typical Berm Detail

C.4 MINE SITE REMOVAL EXCAVATION

C.4.1 Pre-Excavation Site Preparation

Pre-excavation site preparation activities include:

- Survey to identify and/or verify the location of subsurface utilities within the removal areas in accordance with the Performance Standards provided in the ROD (USEPA, 2013)
- Confirmation that power lines have been de-energized, and removal of overhead power lines within the work areas
- Identification of Mine Site removal haul routes and temporary stockpile areas in accordance with the Performance Standards provided in the ROD (USEPA, 2013)
- Placement of temporary construction erosion and stormwater controls by the Construction Contractor to conform to the Technical Specifications. Temporary stormwater controls are described in Section C.4.6.7.

C.4.2 Air Quality Monitoring

Air quality monitoring will be completed in accordance with the Technical Specifications and applicable regulatory requirements. Perimeter air quality monitoring equipment will monitor emissions during site preparation, excavation and removal of mine waste, stockpiling and removal of PTW materials, and final grading and restoration activities. Appendix Q describes the air monitoring and dust control plan.

C.4.3 Excavation Volume Determination

Investigations have been completed within the Mine Site area to identify the extent and quantity of mine waste and debris. The performance standard for identification and action levels of mine waste is defined by the 2011 Action Memo (USEPA, 2011) as soils and debris with Ra-226 concentrations above the FSL of 2.24 pCi/g. Static gamma surveys to identify the lateral extent of surface soils containing Ra-226 above the FSL (the FSL boundary) were conducted at the Mine Site in 2007 as part of the initial Removal Site Evaluation (RSE) (MWH, 2007) and in 2008 during the supplemental RSE (MWH, 2008). Removal volumes will be tracked on regular basis during the RA. Processes for material tracking will be developed with a site-wide material balance for the Pre-Final Design.

C.4.3.1 Mine Waste for Removal

As part of the 2014 Mine Site PDS (MWH, 2014b), MWH estimated depths and impacted soil volumes using subsurface soil investigations and screening, gamma and geophysical surveys, institutional knowledge of mining operations, and comparison of pre-mine and post-mine topography. MWH estimated at that time that approximately 783,000 CY of impacted material within the Mine Site will require removal based on the above information and existing ground topography. Given the random nature of the impacted soil depths, a reasonable chance exists that some mine waste was not accounted for in the 2014 estimate.

To refine the estimate for the 30% design, and account for potential additional impacted soil volumes, MWH developed a maximum excavation cut surface, which is MWH's best estimate of the original surface before mining. This surface accounts for the known quantity of soils deposited on the site since commencement of mining operations, including impacted surface soils (with one foot estimated depth). This new maximum cut surface was compared to available borehole information to confirm that the maximum cut surface is located below the identified mine waste. The maximum cut surface was then compared to the existing surface to determine the maximum potential soil volume that may require removal, which was estimated at approximately 1,064,500 CY, of which 32,200 CY is estimated to be principal threat waste (PTW). These surfaces can be used to verify excavation volumes, as well as for management of removal verification surveys during construction. Table C.4-1 summarizes the anticipated soil removal volumes by area.

Table C.4-1: Estimated Mine Waste Removal Volumes

Area ID	Excavation Area Description	Soil Removal Volume (CY)	Principal Threat Waste (PTW), (CY)
1	Vent Holes 3 and 8	14,764	-
2	Boneyard and Non-Economic Material Storage Area	50,535	-
3	Sandfill No. 2, NECR-2, NECR-2 Drainage, and Sandfill No. 3	223,080	-
4	Area North of Sediment Pond and Pond 3	18,148	-
5	TPH Stockpile	30,000	-
6	Sediment Pad	56,646	6,000
7	Sandfill No. 1	35,506	-
8	NECR-1 and Pond 3 Drainage	491,382	3,000
9	Pond 1 Area	44,634	20,500
10	Pond 2 Area	18,948	-
11	TPH Stockpile Area	16,290	-
12	Pond 3 Area and Eastern Portion of Construction Access Track 4	22,375	2,700
13	Drainage East of Sandfill 1	41,937	-
	Subtotals	1,064,245	32,200
	Total (to the Repository)	1,032,045	

This estimated total volume includes total petroleum hydrocarbon (TPH) impacted soil and PTW material, but does not include the Mine Site debris volumes. The volume of PTW is discussed further in Section C.5.1. Mine Site debris volumes are discussed in the following sub-section.

C.4.3.2 Mine Site Debris Volume Determination

The 2014 PDS included a site reconnaissance survey within the Mine Site area to identify and quantify surface mine debris and structures, including concrete, building foundations, pipes, waste piles, and other scrap metal. Mine site debris is scattered throughout the Mine Site and is mostly located on the surface with the exception of the vent hole hoist foundations (Area 1) and the buried debris located within the Boneyard (landfill) Area (Area 2). Details of this site reconnaissance are provided in the 2014 PDS Reports (MWH, 2014a and 2014b). This survey identified approximately 25,600 CY of mine debris. MWH added a conservative estimate of an additional 10,000 CY of mine debris to account for trees and other vegetation that could be removed from the Mine Site during the RA. This estimated vegetation volume will be further refined once a site-wide tree survey has been completed. Mine site debris, including vegetation, may or may not be above the FSL and alternative means of disposal, other than the repository, may be considered for materials that are below the FSL. Table C.4-2 summarizes the anticipated in-place volume of debris, if moved and consolidated within the repository.

Table C.4-2: Estimated Mine Site Debris Volumes

Debris Type	Volume (CY)	Location(s)
Mixed/Buried – Boneyard	12,800	Areas 2 and 9
Concrete	8,200	Various Areas
Wood	2,600	Various Areas
Metal	2,000	All Areas
Rubber	<10	Various Areas
Plastic	<10	Various Areas
Vegetation	10,000	All Areas
Total	**35,600**	

The estimated 35,600 CY of Mine Site debris does not include the TPH stockpiles, which are located northwest of Ponds 1 and 2. It is anticipated that the Construction Contractor will address the mine debris early in the removal activities and will cut the debris into transportable sizes. If disposed of in the repository, the debris will be further size-reduced (crushed) if necessary, spread in thin lifts, and filled over and around with mine waste soils after placement to minimize void spaces and associated settlement. For conservatism in the estimate, the volumes of each type of mine debris have not been reduced to account for compaction of debris during placement.

C.4.4 Design Basis for Removal

The Mine Site investigation data was used to develop a preliminary Mine Site excavation and grading design. The design basis for the Mine Site excavation and final grading plans is provided in Table C.4-3. The individual design basis items comply with regulatory requirements and/or generally accepted engineering practice and meet the overall project design criteria as provided in the Design Work Plan (MWH, 2016).

Table C.4-3: Mine Excavation and Final Grading Design Basis

Design Category	Design Basis	Design Reference
Archeological/Cultural Sites	Archaeological/Cultural survey was completed in 2005 and did not reveal any eligible or significant resources or Traditional Cultural Properties.	New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division – Closeout Plan Guidelines for Existing Mines (NMEMND, 1996)
Mine Waste Removal	Mine waste, including debris, with concentrations exceeding the RAL of Radium-226 (2.24 pCi/g) or Uranium (230 kg/mg), are to be removed	2011 USEPA Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site (USEPA, 2011)
Segregation of PTW	Mine waste materials with radium concentrations exceeding 200 pCi/g or more of Ra-226 and/or 500 mg/kg or more of total uranium are classified as PTW and must be segregated from the general mine site waste and disposed of offsite. The Mine Site excavation design identifies areas where PTW is present and provides areas for stockpiling of PTW material prior to shipment offsite.	2011 USEPA Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site (USEPA, 2011)

Design Category	Design Basis	Design Reference
Temporary Construction Stormwater/Erosion Controls Design Storm	Temporary Construction Stormwater/Erosion Controls for the Mine Site were developed using a 2-year, 24-hour design storm	Engineer's experience and judgment
Final Mine Site Grading	Mine Site excavation and final grading surfaces have been designed to provide stable slopes, with no slopes steeper than 3H:1V, unless founded in rock. Excavated slope lengths have been shortened where possible	New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division – Closeout Plan Guidelines for Existing Mines (NMEMND, 1996)
Long-Term Stormwater/Erosion Control	Excavated Mine Site Removal areas will be final graded to provide for long-term slope stability as well as positive drainage into existing drainages, including the arroyo on the north end of the Mine Site Removal Area.	Consistent with industry standards, including Federal Emergency Management Agency and New Mexico Department of Transportation
Site Reclamation	Disturbed areas in and around the proposed Mine Site Excavation Areas will be reclaimed and revegetated	New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division – Closeout Plan Guidelines for Existing Mines (NMEMND, 1996)

C.4.5 Excavation Control and Methods

The following list provides the anticipated excavation methods for the Mine Site RA. These methods align with generally accepted excavation practices used for mining remediation projects.

- Excavations should be completed from high to low elevations (i.e. downhill), utilizing a horizontal working surface whenever possible.
- To the extent possible, excavated mine waste materials and debris exceeding the removal action limits (RALs) should be loaded directly into haul trucks, transported, and placed within the Church Rock Mill Site (Mill Site) repository. The only exception will be the PTW materials that will be stockpiled and then transported to an approved off-site location.
- Excavations should continue until material radiological levels are shown to be below Action Levels or until bedrock is encountered but will not exceed 10 feet in depth in areas where clean fill will be placed to final grade.
- Temporary stockpiles should be maintained in accordance with generally accepted practices, including practices for stormwater controls, dust suppression, and good housekeeping. The temporary PTW stockpile(s) will require covers to prevent erosion and wind-blown contamination.
- Surface water and stormwater management should be in accordance with the Construction Stormwater Management Plan for the Mine Site as described in Appendix E. The plan identifies best management practices (BMPs) that should be implemented during construction to control, divert, and manage surface water as well as mitigate sediment transport.
- Verification should be performed that demonstrates excavated areas meet cleanup levels and that additional contaminant delineation has been completed during the Mine Site removal, in accordance with the project performance standards. Verification procedures are described in Appendix T.
- Mine waste excavation should be performed using standard excavating equipment and haul trucks.
- Excavations should be sequenced, if possible, during drier periods to minimize the potential for flooding of work areas.
- Final regrading of excavated areas should be performed to provide for positive drainage to existing waterways and minimize ponding of waters within the Mine Site.

An Excavation Control Plan (Attachment T.1) has been developed for the Mine Site Removal Action and is included as part of the Cleanup Verification Plan (Appendix T). The objective of excavation control is to support removal of waste at the Mine Site that exceeds the RALs established in the 2011 Action Memo. The excavation control surveys will be conducted consistent with the MARSSIM, Section 5.4, Remedial Action Support Surveys, to support and monitor effectiveness of remediation to achieve residual soil radioactivity to RALs. The 2011 Action Memo specifies RALs for Ra-226 at 2.24 pCi/g and for total uranium at 230 mg/kg for removal of mine waste at the Mine Site. Since the soils at the Mine Site are impacted by uranium ore, which would be in secular equilibrium with associated decay products, the 230 mg/kg total uranium would be equivalent to about 76 pCi/g of Ra-226. Therefore, removal of mine waste exceeding the 2.24 pCi/g Ra-226 RAL would also assure that uranium ore mine waste above the total uranium RAL of 230 mg/kg are removed.

The Excavation Control Plan guides the cleanup in real-time. In situ direct gamma radiation surveys will provide real-time information and enable excavation control for efficient removal of impacted soil to the RALs, as compared to soil sampling. The excavation control will be performed by conducting direct gamma radiation scan and static surveys. The direct gamma surveys provide the Ra-226 level in soil as counts per minute (cpm) while the RAL for Ra-226 concentration in soil is in pCi/g. The RAL in cpm will be determined for the gamma survey detectors using the site specific correlation for Ra-226 concentration in soil to detector cpm developed for RSEs and updated and used for Interim Removal Actions (IRAs) as discussed in detail in the Cleanup Verification Plan (Appendix T). The direct gamma radiation survey will be conducted using a 2x2 NaI(Tl) scintillation detector interfaced with a Ludlum 2221 Scaler/Rate meter, similar to the instrumentation used for the Site RSEs, IRAs and PDS. This selected instrumentation will meet the static survey minimum detection concentration (MDC) at less than 50 percent of the 1.24 pCi/g Ra-226 derived concentration guidance level (DCGLw), and the scan MDC at less than 50 percent of the 2.0 Ra-226 DCGLemc for the Mine Site. The Cleanup Verification Plan (Appendix T) describes the survey instrument in detail.

Lateral and vertical extent of the mine waste above the RALs has been characterized and established in the 2014 PDS (MWH, 2014a and 2014b), as well as in the following RSE documents:

- Removal Site Evaluation Report (MWH, 2007)
- Supplemental Removal Site Evaluation Report (MWH, 2008)
- Removal Site Evaluation Report, Red Water Pond Road (MWH, 2010)
- Supplemental Removal Site Evaluation Report, East Drainage Area (MWH, 2011)

The removal areas are shown on the Section 3 Drawings. The excavation will consist of initial removal of the mine waste to the estimated depth in each area of mine site as discussed in Section 4.6, and shown in the Section 3 Drawings. Following the initial excavation, a scan gamma radiation survey will be conducted in the excavated area to identify any residual levels of Ra-226 soils above the RALs. If necessary, the residual gamma radiation levels will be verified with static survey based on the levels from the gamma survey. This method will be repeated until the excavated area shows levels below the RALs. In addition to providing the impacted soil excavation support, the excavation control survey will help determine if the area is ready for the final status survey.

C.4.6 Sequencing

MWH developed a preliminary Mine Site excavation sequence. The mine waste excavation was broken down into 13 different removal areas. This proposed sequence is preliminary and will be finalized by the selected earthworks contractor prior to execution of the work. The proposed mine waste excavation and removal sequence is provided in the Section 3 Drawings and is discussed in the following subsections.

Main objectives for the mine excavation activities are:

- Maintain a safe work environment
- Removal of materials within the Mine Site above the 2.24 pCi/g Ra-226 RAL or above bedrock

- Transport excavated mine waste and debris exceeding the RALs to the Mill Site repository location, or off-site as required, meeting Performance Standards included in the ROD (USEPA, 2013)
- Confirmation surveys to demonstrate that remaining materials within Mine Site fall below USEPA Action Levels
- Containment of contact surface water, including run-on and runoff flows within the Mine Site boundaries
- Minimization of construction traffic within previously cleaned areas (maintain a removal haul access track to the cleaned upper portions of the Mine Site valley)
- Diversion of clean runoff water around areas where mine waste is being removed

C.4.6.1 Phase 1 Removal

Phase 1 Removal includes the following areas shown on Drawing 3-04: (1) Vent Holes 3 and 8, (2) Boneyard, (3) Sandfill No, 2 and No. 3, (4) Area North of Sediment Pond, and (5) Sandfill No. 1.

Activities in this phase include removal (and demolition if required) of near-surface mine waste as well as concrete and masonry structures (as shown in Photo C.4-1) in and around Vent Holes 3 and 8 (Area 1) on the northwest side of the mine area as shown on Drawing 3-04. Based on surface radiological survey information, mine waste within this area is located near-surface to an estimated depth of one foot.

Mine waste and debris exceeding the RALs will be transported to the repository along an existing dirt track (Construction Access Track 1 on Drawing 3-04) from the Vent Shaft Area to a track (Construction Access Track 2 on Drawing 3-04) along the Mine Site valley and to the proposed haul road (discussed in Appendix D) as shown in Drawing 3-04. Construction Access Track 1 will need to be widened and graded to allow safer and easier access for haul trucks. An estimated 14,764 CY of mine waste and several thousand CY of debris are anticipated to be removed from the Vent Shaft Area. Temporary stormwater controls are not anticipated for this specific area as there is not a large run-on catchment. It is anticipated, however, that the Construction Contractor will install temporary erosion control features, as discussed in Appendix E and in accordance with the Technical Specifications, as well as work from higher elevation to lower elevation to minimize runoff from impacted areas over completed removal areas.

Phase 1 Removal will also include removal of mine waste from the two “legs” of the Boneyard Area (Area 2) in the far southwest reaches of the Mine Site area, as shown in Drawing 3-04. The debris are primarily buried below grade in this area. The northwestern leg of the Boneyard Area includes areas with surface and buried debris including pipes, scrap metal, concrete, and wood. This debris will be removed and debris exceeding the RALs will be placed within the Mill Site repository along with the mine waste. Photo C.4-2 shows buried debris within the Boneyard Area.

The southeastern leg of the Boneyard Area is not known to contain debris, and only mine waste will be removed. Mine waste removal is estimated to range from surface clean-up within the southeastern leg, to excavation depths of approximately 10 feet in the northwestern leg.

Mine waste and debris exceeding the RALs removed from the Boneyard Area will be transported to the repository via Construction Access Track 2 and the proposed haul road, as described in Appendix D. An estimated total of 50,535 CY of mine waste will be removed from the Boneyard Area. Temporary stormwater controls will not be necessary for the Boneyard Area during construction. It is anticipated that the Construction Contractor will install temporary erosion control measures and complete mine waste removal moving from the upper elevations (south and west), to lower elevations (north and east). Runoff from this area will drain to Pond 3, which serves as the main temporary stormwater collection point, or retention basin, during construction as discussed in Section C.4.6.7.

Mine waste, including concrete and masonry structures within Sandfill No. 2, NECR-2, NECR-2 Drainage Area, and Sandfill No. 3 (shown as Area 3 on Drawing 3-04) will be excavated and removed as part of Phase 1. Based on soil radiological surveys, MWH estimates that mine waste will be removed to varying depths, with a maximum depth of 20 feet in the southeast portion of Area 3. MWH recommends that the Construction Contractor excavate and remove mine waste from upgradient to downgradient (roughly south to north), while maintaining positive drainage back to the south to prevent run-on and runoff from flowing over impacted, then clean areas. Mine waste exceeding the RALs will be transported to the repository via Construction Access Track 3, Construction Access Track 2, and the proposed Haul Road. Approximately 223,080 CY of mine waste will be removed from this area. Temporary stormwater diversion around this area is not anticipated to be required. The Construction Contractor will be responsible for temporary erosion controls as well as ensuring that runoff from impacted areas does not flow over remediated areas. Runoff from this area will flow to the Pond 3 temporary construction stormwater collection basin (see Section C.4.6.7).

Mine waste in the area north and west of the Pond 3 and Sediment Pad Area (shown as Area 4 on Drawing 3-04) will also be removed as part of this phase. Soil surveys in this area indicate that mine waste is mainly surficial; it is anticipated that the upper one foot (an estimated 18,148 CY) of material will be removed within the area. In addition, an existing diversion channel within Area 4 will be modified to allow upstream flows to be diverted around the Sediment Pad and Pond 3 areas during work in those areas. Modification of the drainage channel is discussed in Section C.4.6.7.

Mine waste within the Sandfill No. 1 area (Area 7 on Drawing 3-04) will also be removed during Phase 1. Soil survey results indicate that mine waste is near surface to a depth of approximately 6 feet, with a small area of mine waste reaching to a depth of approximately 20 feet in the northern half of Sandfill No. 1. Mine waste exceeding the RALs will be transported to the repository via Construction Access Track 4 and the proposed Haul Road. This area is located on a hill and the run-on catchment area is small, therefore temporary stormwater controls will not be required. Runoff from this removal area would flow to the temporary diversion channel to be located on the uphill side of the Mine Waste haul road. This diversion would convey water northwest to the first containment pond (S01) to be located along the haul road for collection and removal to the evaporation ponds. The Construction Contractor will be responsible for installation of temporary erosion control measures and ensuring that contact water does not flow over areas where removals have been completed.

C.4.6.2 Phase 2 Removal

Phase 2 activity will include removal in the Sediment Pad area (Area 6) and the NECR-1 stockpile (Area 8). Based on soil surveys, MWH estimates that mine waste within the Sediment Pad Area will be removed to a maximum depth of 22 feet (approximately 56,646 CY of mine waste). Excavated materials will be transported to the haul road via Construction Access Track 2. Approximately 6,000 CY of the total quantity of mine waste removed from the Sediment Pad Area are expected to meet the definition of PTW and will require removal and transport off-site as discussed in Section C.5.2. Upstream stormwater flows will be diverted to the north around the Sediment Pad Area in the diversion channel (Area 4) built during Phase 1.

The second area included in Phase 2 is the NECR-1 stockpile (Area 8 on Drawing 3-05). This area extends to the northern property line and will require temporary construction access (50-foot easement) onto the Navajo Nation property to the north to complete the removal excavation. Construction access to this area will be provided by the existing access track located along the toe of the NECR-1 stockpile or alternatively via Construction Access Track 2. This stockpile was previously consolidated into a smaller footprint during the IRA completed in 2007. Based on subsurface soil investigation results, MWH assumes that the entire stockpile will need to be removed. The NECR stockpile has a maximum removal depth of approximately 50 feet. An estimated 491,382 CY of impacted soil and rock will be removed during this activity. It is estimated that approximately 3,000 CY of PTW material is included in the total quantity of mine waste to be removed from this area. This PTW material will be disposed off-site as discussed in Section C.5.2. The approximate location of the PTW within the NECR-1 area is shown in Drawing 3-05. Final determination of the extents of this PTW material will be required during removal activities, and will be completed in accordance with procedures provided in Section C.5.2.

Since the NECR-1 stockpile serves as a portion of the southeastern abutment for the Pond 3 embankment, a significant portion of the embankment will be removed. The clean embankment materials will be stockpiled for use during final site grading. Hydrologic studies of the Pond 3 basin indicate, once impacted NECR-1 materials have been excavated, the remaining berm height and corresponding Pond 3 capacity will be sufficient to provide storage of impacted upstream flows during construction. Based on site hydrologic studies, the height of the remaining portion of the Pond 3 embankment will be sufficient to provide storage of impacted upstream runoff flows during construction. The use of Pond 3 as a construction stormwater control feature is discussed in Section C.4.6.7.

Mine waste exceeding the RALs removed from the NECR-1 stockpile will be transported to the repository via Construction Access Track 2 and the proposed Haul Road. A temporary stormwater diversion berm or channel will be constructed along the upstream edge of the NECR-1 stockpile as shown in Drawing 3-05. This diversion structure would channel runoff upstream of the NECR-1 stockpile into Pond 3 to prevent contact water from flowing over the remediated NECR-1 area. This diversion structure will remain in place until Pond 3 removals are complete in Phase 4. An existing access road along the current toe of the NECR-1 Stockpile will be converted into a stormwater collection channel capturing flow from NECR-1 footprint and conveying it to a temporary stormwater collection basin upstream of the armored arroyo on the north edge of the Mine Site, as shown in the Section 3 Drawings.

C.4.6.3 Phase 3 Removal

Phase 3 includes the TPH stockpiles (Areas 5 and 11) and Ponds 1 and 2 (Areas 9 and 10, respectively). Removal activities will include the covered TPH materials, concrete, mulched trees and other vegetation, and scrap metal stockpiles to the south of Pond 3 (shown in Drawing 3-06 as Area 5). There is an estimated volume of 30,000 CY of TPH material within the covered stockpiles. Concrete, tree limbs, and scrap metal volumes are included in the debris volumes provided in Section C.4.3.2. Photo C.4-3 shows the TPH, concrete, and tree debris stockpiles. The scrap metal pile (not shown in this photo) is to the left of the tree debris stockpile.

Once the material stockpiles have been removed, mine waste (to an estimated depth of 1 foot) underlying and in the area of the stockpiles will be excavated and removed (Area 11). An estimated 16,290 CY of mine waste will be removed from this area. Runoff from this area drains to Pond 3 and no additional temporary stormwater diversions will be required. Excavated stockpile and mine waste exceeding the RALs will be transported to the repository via Construction Access Track 2 and the proposed Haul Road.

Phase 3 activities will also include excavation and removal of mine waste in existing Ponds 1 and 2 (Areas 9 and 10, respectively). These ponds are south of the TPH stockpiles area with each of the ponds impounded on the northern side by the existing berm road (Construction Access Track 4) as shown on Drawing 3-06. Based on results of subsurface surveys, MWH estimates that mine waste range up to approximately 15 feet in depth within Pond 1 and up to a depth of approximately 10 feet in Pond 2. An estimated 44,634 CY and 18,948 CY will be removed from Ponds 1 and 2, respectively. The Pond 1 work area is expected to contain approximately 20,500 CY of PTW material. Excavation and management of the PTW material is discussed in Section C.5.2.

MWH proposes to begin excavation of the mine waste within Pond 1 because steeper terrain in Pond 2 hinders access into the pond. Excavated mine waste exceeding the RALs from Pond 1 will be removed and transported to the repository via the existing berm road (Construction Access Track 4), as shown on Drawing 3-06. Once mine waste has been removed from Pond 1, MWH proposes to move clean fill from the berm road north of Ponds 1 and 2 and place it within Pond 1 to establish positive drainage from the Pond 1 area. As clean material is moved from the berm road, accessibility to Pond 2 for removal of mine waste will improve. Mine waste exceeding the RALs excavated from Pond 2 will be transported to the repository via Construction Access Track 4 and the proposed Haul Road. Once the mine waste has been removed from Pond 2, additional clean fill from the berm road will be excavated and placed in lifts in Pond 2 to establish positive drainage from the pond.

At present, run-on water reporting to Ponds 1 and 2 is contained within each of the ponds. This will remain the case until excavation of the Construction Access Track 4 road berm and material placement within Ponds 1 and 2 is completed allowing drainage north into the TPH area and eventually into Pond 3.

C.4.6.4 Phase 4 Removal

Phase 4 removal will include excavation of mine waste from within the Pond 3 area as well as the area along the eastern portion of Construction Access Track 2 (Area 12 on Drawing 3-07) to the Mine Site gate. Based on results of the subsurface radiologic survey, MWH estimates that mine waste reaches a maximum depth of approximately 15 feet in this area. Soils surveys indicated the presence of an estimated 2,700 CY of PTW material within the Pond 3 work area. Removal and management of this PTW material is discussed in Section C.5.2.

Pond 3 is proposed to serve as the primary stormwater collection location for the Mine Site catchment during construction. Prior to removal of mine waste within Pond 3 a temporary diversion plug will be constructed within the existing drainage upstream of Pond 3 to divert run-on water into the diversion channel, modified in Phase 1, north around Pond 3. In addition, impounded water, if any, will require removal, likely via pump truck, and will be transported and discharged into the evaporation ponds on the reclaimed tailings impoundment. In addition, eroded sediment that accumulates in the pond during construction will also be removed during this phase. The process of removing mine waste from upgradient to downgradient (generally southwest to northeast) will also minimize the amount of impacted stormwater.

Once mine waste and eroded sediments have been removed from Pond 3, removal will continue to the northeast along Construction Access Track 2 to the existing Mine Site gate. Soil surveys indicate that only surface soils along the construction track are impacted; therefore an excavation depth of one foot is assumed. Up to approximately 22,375 CY of mine waste will be removed from Pond 3 and eastern portion of Construction Access Track 2.

Once mine waste has been removed from the Pond 3 and the eastern portion of Construction Access Track 2, the remaining Pond 3 embankment (clean material) will be removed and used for final grading within the Mine Site. The removal of this embankment will allow drainage reporting to Pond 3 to continue northeast, through the reclaimed NECR-1 area, to discharge into the lined arroyo along the northern border of the property.

C.4.6.5 Phase 5 Removal

The final removal phase involves the removal of impacted surface soils from the drainage east of Sandfill No. 1, as well as removal of mine waste within the removal haul access track running up the Mine Site valley, as shown within Area 13 on Drawing 3-09. This removal area extends north across New Mexico Highway 566 to the northern mine property boundary. MWH estimates 41,937 CY of mine waste will be removed from this area. This mine waste exceeding the RALs will be transported along the proposed Haul Road to the repository. Mine waste removal within the road right-of-way, if required, will be determined based on scanning results in the vicinity, as previously described.

C.4.6.6 Mine Waste Removal Verification

Once mine waste has been removed from a defined area, a verification radiological scanning survey, as well as sample collection and laboratory testing will be completed to confirm that mine waste has been removed. Verification activities will be completed for each remedial area in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) procedures. Details of the mine waste removal verification procedures are provided in the Cleanup Verification Plan in Appendix T.

C.4.6.7 Mine Site Removal Area Temporary Stormwater Controls

The existing Pond 3 at the Mine Site will be used to contain contact water during the removal process. Pond 3 is impounded by an embankment dam constructed of clean soil. The dam will be partially removed during Phase 2 removals but a significant part of the dam can remain in-place to retain contact water until removals are completed. The Section 3 Drawings show other temporary stormwater controls that will be installed during the Mine Site RA. These controls are intended to be installed and removed during specific phases of construction (as shown on the Drawings) once contaminated material is removed from certain excavation areas. Table C.4-4 lists the installation and removal of temporary stormwater controls by construction phase. In addition to these temporary stormwater controls, a permanent grade control structure will be installed during Phase 3 at the inlet of the channel. Details for this structure are shown in Section 6 of the Drawings.

Table C.4-4: List of Mine Site Temporary Stormwater Controls by Phase

Removal Phase	Temporary Control	Objective
1	Install a temporary stormwater collection basin in Area 8 near the start of the Mine Site Outlet Channel.	Contain stormwater from the channel, where the RA is completed, from entering Area 8, which is under active removal.
2	Install a temporary diversion berm or collection channel separating Area 8 (NECR-1 and Pond 3 Drainage) and Area 12 (Pond 3 Area and Mine Site Excavation Haul Route).	Prevent stormwater runoff from Area 12, which is impacted, from entering Area 8, which is under active removal.
3	Install a temporary diversion berm across the eastern edge of Area 6 (Sediment Pad), extending from Area 3 (Sandfill No. 2) to the arroyo.	Divert stormwater from upgradient areas where the RA is complete to the arroyo.
4	Install a temporary earthen "Plug" in the arroyo near the inlet to Area 12 (Pond 3).	Prevent non-contact stormwater in arroyo from entering Pond 3, which is under active removal.
5	Remove all temporary stormwater controls	Allow natural stormwater drainage to occur after removal for all areas is complete.

Temporary stormwater controls for the Mine Site also must include BMPs to prevent erosion from excavated areas and unprotected slopes. These BMPs are to be defined in the Construction Stormwater Management Plan. Appendix E provides general guidelines for the preparation of the Construction Stormwater Management Plan.

C.5 PRINCIPAL THREAT WASTE

Principal threat waste is defined by the USEPA as “source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur” (USEPA, 2011). At the Mine Site, wastes with Ra-226 values greater than 200 pCi/g and/or greater than 500 milligrams per kilogram (mg/kg) of total uranium are considered PTW and were identified in five locations within four of the removal areas. The approximate locations of the PTW are shown on Drawing 3-03.

C.5.1 PTW Volumes by Area

PTW material was identified in four of the 13 impacted soil removal areas. The lateral and vertical extents of the PTW were estimated based on surface and sub-surface radiological survey results. Estimated boundaries of each of the four PTW areas identified are shown in their respective Removal Phase drawings (Drawings 3-04 through 3-07). The PTW material volumes estimates are:

- Sediment Pad Area (Area 6) – 6,000 CY
- NECR-1 Area (Area 8) – 3,000 CY
- Pond 1 (Area 9) – 20,500 CY
- Pond 3 Area (Area 12) – 2,700 CY

Actual PTW volumes will be confirmed during excavation and screening of the mine waste and may vary from the estimates above.

C.5.2 Management of Principal Threat Waste

The excavation and segregation of the PTW will be performed using a combination of in situ and ex-situ gamma radiation level measurements as discussed in Section C.4.5 and further detailed in Appendix T. The 2011 Action Memo specifies PTW RALs as wastes at NECR containing either 200 pCi/g or more of Ra-226 and/or 500 mg/kg or more of total uranium. Since the soils at the Mine Site are impacted by uranium ore, which would be in secular equilibrium with associated decay products, the 500 mg/kg total uranium would be equivalent to about 165 pCi/g of Ra-226. Therefore, excavation and segregation of mine waste exceeding the 165 pCi/g Ra-226 RAL would also assure that uranium ore mine waste above the total uranium RAL of 500 mg/kg are segregated.

PTW will be excavated concurrently with mine waste present within each removal area. MWH anticipates that the estimated extents of the PTW will be delineated with boundary stakes prior to any removal activities from these areas, to assist the Construction Contractor with identification of potential PTW material. Actual lateral and vertical extents will be confirmed through excavation control.

An action level for in situ gamma radiation excavation control survey in cpm for PTW segregation will be determined using the site-specific correlation between direct gamma radiation levels and Ra-226 concentrations in soil as discussed for the excavation control. While excavating in areas that may contain PTW, and the PTW action level in gamma radiation cpm is reached, the soils will initially be segregated and stockpiled near the excavation areas. A grab composite soil sample will be collected for ex-situ soil screening from the stockpiles. If the ex- situ soil screening shows the soil contains more than an estimated level of Ra-226 at 165 pCi/g or more, the segregated soils will be hauled to one of the two PTW staging areas (within the Mine Site at the top of the NECR-1 pile or in the former Mill Site yard). A confirmatory soil sample will then be collected for Ra-226 and total uranium analysis by a laboratory. The proposed PTW staging areas are discussed in Appendix B. If the ex-situ soil screening results show the Ra-226 level in the soils below 165 pCi/g, the removed mine waste will be hauled to the repository.

The Construction Contractor will be responsible to verify removal and stockpiling of PTW material within each remedial area. MWH anticipates that a full-time material radiological scanning technician will be required during excavation to confirm removal of the PTW material. PTW material will be loaded from the temporary stockpiles into highway trucks for transport to a USEPA-approved off-site disposal facility. Loading areas, clean vs. dirty truck access, and on-site haul routes for the PTW are discussed in Appendix B.

Temporary stormwater run-on/runoff controls as well as dust control measures, including temporary cover of the PTW, will be implemented at each temporary stockpile location, when materials are not being placed, to prevent contamination of surrounding areas in accordance with BMPs and Technical Specifications. These measures are discussed in Appendix E.

C.6 MINE SITE RESTORATION

C.6.1 Anticipated Removal Schedule

The estimated duration for removal and disposal of the mine waste at the Mine Site is one to two years. This estimated duration is preliminary and will be further refined in the 90% design and in consultation with the selected Construction Contractor. A proposed project schedule is discussed in Appendix K.

C.6.2 Localized Final Regrading

Once mine waste has been removed from the removal areas, the Construction Contractor may be required to complete localized regrading to establish positive drainage to the lined arroyo on the north edge of the Mine Site. Based on the design bottom of excavation contours, minimal final grading is anticipated. If removal excavations extend deeper than planned, clean fill may be required to establish positive drainage from the site. Clean fill material, if required to provide positive drainage, could be sourced from the Pond 3 embankment or the Construction Access Track 4 embankment located north of Ponds 1 and 2. Final design grading plans for the Mine Site are shown on Drawing 3-09.

C.6.3 Mine Site Area Restoration

As required by the 2015 AOC SOW (USEPA, 2015), the Mine Site mine waste excavation and remediation shall require restoration of remediated Mine Site areas. These restoration activities include revegetation and grading to mitigate against erosion, as well as provide stormwater control. Proposed revegetation activities and details are provided in Appendix U.

C.7 BEST MANAGEMENT PRACTICES FOR GREEN REMEDIATION

C.7.1 Construction Materials

Green and Sustainable Remediation BMPs for construction materials include promoting use of recycled, recyclable and biodegradable products, as well as products with a minimal environmental footprint. Technical specifications will be written to encourage and/or require contractors to use these types of materials (e.g. biodegradable fabric or tarps, biodiesel, recycled construction materials) when possible. Where using biodegradable or recycled/recyclable products is not feasible, contractors will be encouraged to use environmentally friendly products (e.g. phosphate-free detergents for equipment decontamination, ultra-low sulfur diesel) to the extent possible. Technical specifications will also encourage material re-use and salvage, such as re-using covers that secure and cover material in open trucks during off-site transport or using uncontaminated soil as fill or other restoration purposes.

C.7.2 Construction Methods

Construction method BMPs for mine site excavation and demolition include practices that promote efficient equipment use, sequencing activities to avoid recontamination of remediated areas and minimize rework, maintain the integrity of the natural setting and protect the local ecosystem. The technical specifications will include language to reduce idling and encourage the use of machinery with automatic idle-shutdown devices when possible. Designated speed limits will be established to reduce dust production and improve fuel efficiency. Energy efficient engines will be used where possible and contractors will be encouraged to use low-maintenance equipment with multistage filters for cleaner engine exhaust. Equipment will be required to receive regular maintenance to improve efficiency and prevent unnecessary breakdown requiring additional resources and transport for repairs. In addition, throughout the RA continuous adjustment of excavation and placement planning shall occur to maximize use of actual amounts of cut/fill available to avoid excessive use of borrow sources. Excavated areas will be graded to conform to pre-mining topography and will be revegetated in a timely manner to limit erosion and re-work.

C.7.3 Low Impact Development/Sustainability

Low impact/sustainability measures to be implemented during the RA consist of minimizing equipment and vehicles use where possible, planning activities to maximize efficiency, sizing equipment correctly, and potentially using temporary design features for final design elements. The design will minimize haul route lengths to the extent possible to reduce equipment use as well as water use for dust control. Where possible, buses will be used for operator transport and supervisors will be encouraged to plan activities to minimize vehicle use. The selected contractor will be asked to minimize the volume of waste hauled off-site by effectively separating uncontaminated waste, contaminated waste (non-PTW) and PTW to minimize loads taken to the Mill Site and to the off-site disposal facility. If possible, rail shipping may be used in place of truck shipping to transport PTW to an off-site disposal facility. Excavation and placement of mine waste will be planned prior to beginning work to minimize moving stockpiles and work locations in order to reduce fuel consumption and greenhouse/dust emissions. The excavation and placement plan will also be evaluated throughout the project to maximize use of actual cut/fill volumes and avoid excessive use of borrow sources. The selected contractor will be encouraged to size equipment correctly to task needs thereby minimizing use of heavy equipment for small tasks. The design may also evaluate the potential of using excavated areas as retention basins in final stormwater control plans.

C.8 REFERENCES

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PHOTOS

Photo C.4-1: Concrete Structures at Vent Hole Shaft Area

Photo C.4-2: Buried Debris in Boneyard Area

Photo C.4-3: Material Stockpiles South of Pond 3

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Appendix D:
Haul Routes

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ATTACHMENTS

Attachment D.1 Sizing Calculations for Temporary Stormwater Controls for Mine Waste Haul Road and Construction Support Facilities

LIST OF ACRONYMS / ABBREVIATIONS

AOC	Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery
BMP	best management practice
CSF	construction support facility
CY	cubic yard
GSR	Green and Sustainable Remediation
Mill Site	Church Rock Mill Site
Mine Site	Northeast Church Rock Mine Site
MPH	miles per hour
NMDOT	New Mexico Department of Transportation
PTW	principal threat waste
RAO	remedial action objective
ROD	Record of Decision
SOW	Statement of Work
STA	road station
TDA	Tailings Disposal Area
USEPA	US Environmental Protection Agency

D.1 INTRODUCTION

This appendix to the Northeast Church Rock 30% Design Report presents the layout and design of temporary haul and access roads at the Northeast Church Rock Mine Site (Mine Site) and the Church Rock Mill Site (Mill Site). Temporary roads have been designed for three types of use. The first is the haul road to transport mine waste from the Mine Site to the repository at the Mill Site. The second are haul roads to transport borrow material from designated borrow areas to the repository at the Mill Site for use in cover construction. The third are access roads to provide access to construction support facilities (CSFs). Design of CSFs is discussed in Appendix B of the 30% Design Report.

This appendix:

- Provides 30% design plans, profiles, and design details for access and haul roads
- Demonstrates attainment of the applicable standards identified in the Record of Decision (ROD) (USEPA, 2013)
- Explains the rationale for the proposed access and haul road alignments
- Discusses sequencing for site preparation, construction, and reclamation of these roads
- Presents Green and Sustainable Remediation (GSR) considerations

D.2 PERFORMANCE STANDARDS

The Performance Standards presented here are defined in the Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site (2011 Action Memo; USEPA, 2011), the ROD, United Nuclear Corporation Site, (USEPA, 2013), and the Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery (AOC; USEPA, 2015) including the Statement of Work (SOW) attached as Appendix D to the AOC, and were developed to define attainment of the Removal Action and Remedial Action Objectives (RAOs) for the Selected Remedy. The Performance Standards include both general and specific standards applicable to the Selected Remedy work elements and associated work components. Table D.2-1 presents performance standards related to the haul roads and explains how the design accomplishes these standards.

Table D.2-1: Task Specific Performance Standards

Location of Performance Standard Requirement	Performance Standard	Comments
2015 AOC SOW, Paragraph 17 – Soil Transportation and Management	In the Design, Respondents shall provide detailed plans and specifications explaining how mine waste from the NECR Site and other materials (including borrow, backfill, and cover materials) will be managed and transported. Respondents shall include details for ensuring that Principal Threat Waste from the NECR Site, as described in the 2011 Action Memo, is not transported to the UNC Site or disposed at the Tailings Disposal Area.	Mine waste and clean borrow materials will be transported by truck along the haul roads described in this appendix. Mine waste excavation is addressed in Appendix C. Principal threat waste (PTW) will be transported off-site for disposal. Appendix B addresses the design and layout of PTW handling facilities.
2015 AOC SOW, Paragraph 29 – Green Remediation Best Management Practices	Respondents shall incorporate applicable Best Management Practices for Green Remediation listed in ASTM-E2893-13 consistent with EPA's policy Superfund Green Remediation Strategy (2010), found at http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf.	Addressed in Section D.6

D.3 ENGINEERING DESIGN DRAWINGS

The relevant engineering design drawings are contained in Volume II – Design Drawings (Section 4). Drawings related to the haul roads are listed in Table D.3-1.

Table D.3-1: Engineering Design Drawings

Drawing No.	Drawing Title
4-01	Haul Road Overall Plan
4-02	Haul Road Plan Index
4-03	Mine Waste Haul Road Plan and Profile (1 of 4)
4-04	Mine Waste Haul Road Plan and Profile (2 of 4)
4-05	Mine Waste Haul Road Plan and Profile (3 of 4)
4-06	Mine Waste Haul Road Plan and Profile (4 of 4)
4-07	Mine Waste Haul Road Spur Plan and Profile
4-08	Clean Access Road Plan and Profile
4-09	Clean Access Ramp Plan and Profile
4-10	Repository Yard Clean Access Road Plan and Profile
4-11	Mine Waste Haul Road Drainage Control Plan (1 of 2)
4-12	Mine Waste Haul Road Drainage Control Plan (2 of 2)
4-13	Borrow Haul Roads
4-14	West Borrow Haul Road Plan and Profile
4-15	East Borrow Haul Road Plan and Profile
4-16	North Borrow Haul Road Plan and Profile
4-17	Typical Cross Sections and Details

D.4 HAUL ROAD DESIGN

D.4.1 Common Design Elements

For the 30% design, it is assumed that 30-cubic-yard capacity articulated dump trucks will be used to transport both mine waste and borrow material. Example trucks of this type include the Caterpillar 745, Terex TA40, and Volvo A40, which are well-suited for variable terrain and space constrained areas such as the Mine Site and the repository.

A combination of one-lane and two-lane road widths will be used. For this design, the running surface for one-lane haul traffic is sized at twice the haul vehicle width and the running surface for two-lane haul traffic is sized at 3.5 times the haul vehicle width. This is consistent with guidelines for mine haul road design presented by Tannant and Regensburg (2001). Typical haul vehicle width for the example equipment listed above is 11.25 feet, resulting in one-lane and two-lane running surface widths of 22.5 feet and 39.4 feet, respectively. A summary of the haul road design basis is presented in Table D.4-1.

Table D.4-1: Haul and Access Road Design Basis

Road	Design Vehicle	Traveled Way Width	Max. Grade	Prism Detail	Ditch Detail	Speed Limit
Mine Waste Haul Road (1-lane)	30 CY articulated truck (11.25 ft. wide)	22.5 feet	8%	2% cross-slope to ditch, no crown; gravel surfacing on grade > 5%	1ft depth, 1.5H:1V sides	20 MPH
Mine Waste Haul Road (2-lane)	30 CY articulated truck	39.4 feet	8%	2% cross-slope to ditch, no crown	1ft depth, 1.5H:1V sides	20 MPH
Access Road	30 CY articulated truck	22.5 feet	8%	2% cross-slope to ditch, no crown	1ft depth, 1.5H:1V sides	20 MPH
Borrow Haul Road	30 CY articulated truck	39.4 feet	8%	2% cross-slope to ditch, no crown	1ft depth, 1.5H:1V sides	20 MPH

CY – cubic yard, MPH – miles per hour

Site preparation activities will include an underground utility survey and overhead utility awareness and safety mitigation. Best Management Practice (BMP) installations for sediment and stormwater controls will be installed prior to ground disturbing activities such as stripping and stockpiling of topsoil and organics.

Haul and access roads will be constructed from native materials as a cut-to-fill, with excavated material from the uphill side placed as fill on the downhill side. Shallow native soils consist primarily of sandy clays and sandy silts which are suitable for temporary haul road construction, but are likely to require regular maintenance by the Construction Contractor. Material needed to fill gully crossings or other low areas will be generated by road cuts in close proximity to the needed fill. For the 30% design, temporary cut and fill slopes are 1.5V:1H. Additional geotechnical characterization of the native materials for final design is not anticipated, as these are temporary roads that will be maintained regularly during construction operations. During construction, the native materials will be evaluated by the Field Engineer (defined in Appendix V) and slopes may be flattened in areas where highly erodible materials are encountered, or steepened in rock cuts or rocky material.

The technical specifications will require haul road fills to be compacted to 95 percent standard Proctor density. Because these are temporary roads, gravel surfacing will not be utilized except for discrete areas (shown on the Drawings) where needed to mitigate soft or muddy surface conditions, or where additional traction control may be needed. Gravel surfacing for roads grades of 5 percent or greater and performance standards for maintenance of a safe and efficient running surface are included in the technical specifications.

Culverts will be constructed at gully and arroyo crossings to convey flow beneath haul and access roads. Design information specific to temporary construction stormwater controls is presented in Section D.4.6.

Safety berms will be provided and maintained on the banks of haul roads where a drop-off exists of sufficient grade or depth to cause a vehicle to overturn or endanger persons in equipment. Berms will be at least mid-axle height of the largest self-propelled mobile equipment which usually travels the roadway.

D.4.2 Mine Waste Haul Road

The mine waste haul road shown on the Drawings will be used to haul mine waste excavated at the Mine Site to the repository located at the Mill Site. The haul road will begin at the east end of the Mine Site, immediately adjacent to the existing entrance at the terminus of New Mexico State Highway 566 (NM 566). The haul road will be located roughly parallel to NM 566, until it crosses the highway near the north end of the Mill Site Tailings Disposal Area (TDA). This will be the only point where haul trucks contact NM 566. The typical haul road offset from NM 566 is about 300 feet. Upon crossing NM 566, the haul road will be located on the alignment of an existing access road to the north end of the North Cell of the TDA. Haul trucks will access the repository at the northwest corner of the TDA. The mine waste and clean borrow haul roads will not intersect.

The mine waste haul road can be described in three segments. Refer to the Drawings for alignments and road stations (STA). Segment 1 (STA 0+00 to 21+00) is a two-lane rolling segment that begins at the Mine Site and runs parallel to NM 566 to an existing rock cut above the approximately 90 degree curve in NM 566. Segment 2 (STA 21+00 to 36+50) is a one-lane decline in relatively steep terrain from the intersection of the rock cut to the intersection with NM 566. Segment 3 (STA 36+50 to 48+50) is a mixed one-lane and two-lane segment from the intersection with NM 566 to the repository. One-lane segments are used to reduce the construction footprint of the haul road in the steeper terrain and to limit traffic activity at the intersection with NM 566. These segments are considered one-lane only in terms of available width for passing vehicles. Turnouts are included to allow haul trucks to pass each other for efficient haul operation. Gravel surfacing will be used on haul road grades steeper than 5 percent.

Stormwater controls for the mine waste haul road are designed to segregate contact and non-contact runoff. The haul road will be constructed with a ditch and sediment pond system to collect and contain contact runoff from the haul road surface. Containment will be accomplished with unlined sediment ponds at locations shown on the Drawings (refer to Drawings 4-10 and 4-11). Water and sediment from these ponds will be collected within 48-hours of storm events and hauled to the Mine Site for disposal within the temporary stormwater basin (see Appendix C). It is anticipated that a 3,000 to 4,000 gallon capacity vacuum truck or similar equipment will be used for this purpose. The Drawings include 30% design details for haul road stormwater controls.

Within the footprint of the repository, the TDA surface cover layer will be removed to expose the radon barrier for moisture conditioning and compaction prior to placement of mine waste. Mine waste haul trucks will not be allowed to operate directly on the surface of the radon barrier. Haul trucks will only be allowed to operate where the TDA surface cover has not yet been removed, or on mine waste that has been placed over the prepared radon barrier.

D.4.2.1 State Highway Crossing

A traffic control system is necessary for the intersection of the mine waste haul road and NM 566. NM 566 is a relatively low volume highway that ends at the Mine Site and is primarily used by residents beyond the end of NM 566. A temporary traffic light system will be employed during working hours for traffic safety at the crossing. During haul operations, public traffic on NM 566 will be stopped by the temporary traffic light when haul trucks are operating. Once clear of haul trucks, the light will change allowing public traffic to proceed.

During the first week of hauling, periodic (2-3 times during the work day) radiological scanning of the crossing will be conducted to verify that the highway crossing is not being impacted by haul traffic from the Mine Site. Following this initial haul period and confirmation that the road is not being impacted, gamma surveys will continue to be conducted at the end of each haul day on the crossing, prior to fully reopening the highway to the public for the evening. The Construction Contractor will be responsible for preventing the accumulation of mud and dirt on the paved highway. Prior to work beginning, the Construction Contractor will have the ability to submit for approval, alternate methods of traffic control for this location. Temporary gates will be used to restrict haul road access when the mine waste haul road is not in use. Additional traffic control procedures are presented in Appendix M – Traffic Safety and Security.

A baseline (scan) gamma radiation survey at 100 percent coverage will be performed at the highway crossing prior to hauling mine waste across NM 566. The gamma radiation survey will be consistent with procedures outlined in Appendix T. Following completion of the mine waste hauling on Highway 566, a post mine waste hauling activity status survey, similar to the baseline survey will be performed for the entire haul route, including this crossing. The post hauling status survey will be compared to the baseline survey to determine if there has been an impact from mine waste hauling activities.

Coordination with New Mexico Department of Transportation (NMDOT) and other stakeholder agencies for approval and operation of this haul road crossing will be conducted during the 95% design phase. Upon construction completion, impacted areas of NM 566 will be inspected for structural damage. Any damage to the pavement or underlying road prism resulting from haul operations will be corrected to the satisfaction of NMDOT.

D.4.3 Borrow Haul Roads

Haul roads will be constructed to access each of the four proposed borrow areas, utilizing existing access roads as much as possible. Plans and profiles for the north, east, and west borrow haul roads are shown on the Drawings. Borrow haul roads will have two-lane running widths. Haul road construction will be conducted from each borrow area to the edge of the TDA. Once on the TDA, borrow haul trucks will operate directly on the existing cover surface. The current TDA cover surface is a rock mulch suitable for haul traffic. Leaving the existing rock mulch surface in place provides dust control and eliminates the need to use borrow material to construct these road segments.

To maintain the integrity of the existing TDA cover outside the limits of the repository, the technical specifications require the Construction Contractor to establish and delineate designated haul routes on the TDA cover and to restrict construction traffic to within these designated routes. Within the footprint of the repository, traffic patterns will be determined by the Construction Contractor. However, borrow haul trucks will only be allowed to operate where the existing TDA surface cover has not been removed. During cover placement over mine waste, a clean running surface must be maintained at all times to avoid the need to decontaminate borrow haul trucks. As cover construction on the repository progresses, the Construction Contractor will be required to establish and maintain designated haul routes on the newly placed cover, similar to the requirements for the existing TDA cover. Upon construction completion, areas of the repository cover and the TDA cover subjected to haul traffic will be reconstructed to mitigate over-compaction of cover soils, or other damage that may occur from haul traffic.

Temporary haul road crossings will be required where haul trucks must cross existing TDA drainage channels and cover swales. Details for these crossings are shown on the Drawings.

D.4.4 Access Roads

Temporary access roads will be constructed or located to provide access to the CSFs in the Former Mill Site Yard and the Repository Yard(s) (see Appendix B). These roads will have a one-lane running surface width and will be located, to the extent practical, on the alignments of existing or abandoned roads to minimize construction impacts.

The access road to the Former Mill Site Yard connects to the Mine Site, via the mine waste haul road. This road will utilize similar drainage controls as the mine waste haul road for segregation and control of contact runoff.

The access road to the Repository Yard(s) will require construction of a new access point from NM 566, south of the mine waste haul road crossing. A separate access point from NM 566 will be added immediately north of the mine waste haul road crossing for temporary public access to Pipeline Canyon Road.

Coordination with NMDOT and other stakeholder agencies for approval of this temporary access road will be conducted during the next design phase. Additional traffic control discussion is presented in Appendix M.

D.4.5 Dust Control

A Dust Control and Air Monitoring Plan is presented in Appendix Q, which includes the requirements for Construction Contractor dust control during construction.

D.4.6 Temporary Stormwater Controls

The Section 4 Drawings show temporary stormwater controls for the haul road. In addition to these temporary stormwater controls, the Construction Contractor will be responsible for implementing BMPs according to its Construction Stormwater Pollution Prevention Plan, as discussed in Appendix E.

The design concept for the haul roads and CSF stormwater controls is to separate non-contact stormwater from contact stormwater through use of roadside ditches, culverts, and retention ponds. Contact stormwater from the haul roads will drain into the road side ditches and then be conveyed in the ditches to one of several retention ponds (Drawings Section 4). Culverts are designed to convey stormwater from non-contact catchments under the haul roads, road side ditches, and (where necessary) retention ponds. MWH designed stormwater controls for the haul road for the 5-year, 24-hour storm event, based on the relatively short operational period of the haul road. These stormwater controls are further described in the subsections below.

D.4.6.1 Roadside Ditches

The roadside ditches will be constructed along the interior side of the haul road to collect surface runoff and divert water to sediment ponds for controlled collection of contact water during operations. The roadside ditches will be triangular in cross section, with a design depth of 1 foot, which is designed to provide capacity to convey the peak discharge from the 5-year, 24-hour storm event (calculations are included in Attachment D.1). The flow in the ditches is calculated to be supercritical in many locations under the design discharge conditions. Since no erosion protection is planned for these temporary ditches, maintenance of some areas may be required following storm events.

D.4.6.2 Retention Ponds

Eleven retention ponds will serve as collection points for contact water diverted by the roadside ditches. The required volume of the retention ponds varies depending on the drainage area associated with each pond. The required retention pond volumes range from 1,000 to 5,000 cubic feet (see pond sizing calculations in Attachment D.1). The Construction Contractor will need to collect water and sediment from these ponds within 48-hours of storm events for disposal within the temporary stormwater basin at the Mine Site (see Appendix C) or the TDA evaporation ponds. The Construction Contractor also may need to periodically remove accumulated sediment in the retention ponds to maintain the pond capacities.

D.4.6.3 Culverts

Ten culverts will collect stormwater from non-contact catchments that cross the haul road, convey it under the road, and release it downgradient of the road. The culverts will be corrugated metal pipe, or an approved equivalent material. Calculations indicate culvert diameters of 16 inches (C02 to C06) and 24 inches (C01, C07 to C10) to convey the design discharge (see Attachment D.1).

Soil excavation and removal is required at some locations within Drainage Basins 0, 1, and 2. For construction sequencing, the haul road and drainage control plan facilities will be constructed prior to soil removal excavation within these basins. Surface water runoff from this area is currently allowed to pass downstream and will be diverted to a culvert as part of the drainage control plan. However, BMPs will need to be implemented during operations in this area to provide intermittent stormwater containment and prevent the uncontrolled release of contact water. At three locations (C01, C03, and C05), culverts will be combined with retention ponds. At these locations, the culvert inlet will be at the upstream berm of the retention pond, and the culvert will pass through the pond and then under the haul road to maintain separation of non-contact and contact waters. The culvert design does not include erosion protection at the culvert outlet, and some maintenance may be required at the outlets following storm events.

D.4.7 Haul Road Verification and Reclamation

Upon the completion of the Removal Action, roads used for hauling mine waste (including associated ditches, sediment ponds, or other associated features) will be subject to verification and clean up in accordance with Appendix T. Verification will also be conducted on affected portions of NM 566 in accordance with Appendix T.

Upon completion of verification and clean up, the roads will be reclaimed. Reclamation will consist of removal of imported gravel surfacing, removal of culverts, and grading according to the final approved post-reclamation grading plans. Reclamation grading plans will be developed during the 95% design phase. Revegetation will be conducted in accordance with Appendix U.

D.5 CONSTRUCTION SEQUENCING

The anticipated sequence for preparation, mobilization, and construction of the haul roads is as follows:

1. Underground utility survey to identify and/or verify the location of subsurface utilities along the alignments
2. Overhead utility survey and safety mitigation as needed
3. BMP installations for sediment and stormwater controls along haul routes
4. Site surface preparation including stripping and stockpiling of topsoil and organics
5. Construction of roads and associated drainage features
6. Construction of safety berms where required
7. Construction of fencing and gates

D.6 GREEN AND SUSTAINABLE REMEDIATION CONSIDERATIONS

D.6.1 Construction Material Considerations

Road lengths will be minimized to the extent possible to reduce the required construction equipment operating time, greenhouse gas emissions, fill material, and habitat disruption. Roads will be constructed from in-situ native soils to reduce material haul distances and use of imported materials.

Use of water for dust suppression will be minimized by utilizing alternate dust suppressant methods and techniques when possible including gravel surfacing, application of magnesium chloride (or other approved suppressants) on main haul and transport routes and minimization of vehicle speed (20 MPH).

D.6.2 Construction Methods

Construction equipment will be appropriately sized to reduce fuel consumption and greenhouse gas emissions. Dust suppression will be utilized in the area and on the access roads to decrease visible dust related emissions. Appendix E identifies BMPs and specific sediment control measures that will be employed during construction for both sediment and stormwater control.

D.6.3 Low Impact Development/Sustainability

Access and haul routes were optimized to minimize site disruption, vehicle mileage, and to protect public health and safety. Minimizing vehicle mileage and limiting speeds is a high yield action as it limits fuel consumption, minimizes emissions of both greenhouse gasses and dust and increases site safety by reducing likelihood of both minor and serious crashes. Additionally, a primary point of entry/exit to the Exclusion Zone will be maintained to help prevent re-contamination of areas already remediated or contamination of areas that were previously uncontaminated. This primary point of entry/exit also minimizes the required support facilities and associated infrastructure.

Access and haul roads chosen utilize existing or historical roads to the extent practical to limit additional disturbance and reduce amount of cut/fill and grading required. Access and haul roads will be reclaimed and revegetated as quickly as possible upon completion of construction.

D.7 REFERENCES

Tannant, D.D. and B. Regensburg, 2001. Guidelines for Mine Haul Road Design.

US Environmental Protection Agency (USEPA), 2011. Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Mine Site, McKinley County, New Mexico, Pinedale Chapter of the Navajo Nation. Prepared for U.S. EPA Regions 6 and 9. September 29.

US Environmental Protection Agency (USEPA) Region 6, 2013. Record of Decision for Operable Unit OU02, Surface Soil Operable Unit, United Nuclear Corporation Site, McKinley County, New Mexico. March 29.

US Environmental Protection Agency (USEPA), 2015. Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery, United Nuclear Corporation Superfund Site and Northeast Church Rock Mine Removal Site, McKinley County, New Mexico. April 27.

ATTACHMENT D.1

Sizing Calculations for Temporary Stormwater Controls for Mine Waste Haul Road and Construction Support Facilities

MWH now part of Stantec

CALCULATIONS

Client:	*General Electric/United Nuclear Corporation*	**Sheet:**	*1* **of** *17*
Project:	*NECR 30% Design*	**Date:**	*05/13/2016*
Description:	*Design of Haul Road Stormwater Controls*	**Job No:**	*10508639*

ATTACHMENT D.1: TEMPORARY STORMWATER CONTROLS FOR MINE WASTE HAUL ROAD AND CONSTRUCTION SUPPORT FACILITIES

Revisioning

Rev.	Date	Description	By	Checked	Date
0	*5/13/2016*	*Preliminary (30%) Design*	*T. Steen*	*N. Haws*	*6/6/2016*

Revisions

Issue Date	Description
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Location and Format

Electronic copies of these calculations are located on the project team site.

http://projects.mwhglobal.com/sites/genecrpreliminarydesign/Pages/Technical/Design/Stormwater_Hydrology_Hydraulics/

Calculations were generated using the following software:

- HEC-HMS – Hydrologic Modeling System. Version 4.1 July 2015. U.S. Army Corps of Engineers Hydraulic Engineering Center
- Microsoft Excel 2013

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Objective

The objective of these calculations is to evaluate the 30% design for stormwater controls for the mine waste haul road that would be constructed for the Northeast Church Rock (NECR) Removal Action (RA).

Background

The proposed Mine Waste Haul Road for the NECR RA runs from the Mine Site to the proposed repository area at the Mill Site. The design includes temporary roadside ditches, retention ponds, and culverts to prevent co-mingling of contact and non-contact stormwater as described in Appendix E of the NECR Design Report and as shown in the Design Drawings (Section 2 and 4).

Applicable Codes and Standards

MWH used the following design criteria for the design of the temporary haul road stormwater controls.

Design Storm Event

MWH selected the 5-year, 24-hour storm event for the design of the temporary haul road stormwater controls. Potential risks associated with large storm events where the road may be overtopped are considered acceptable as performing repairs is likely more economic than designing large structures. Hauling operations may be temporarily affected in the event of road failure.

Road Side Ditches

- The road side ditches must have capacity to convey the peak design discharge from surface runoff from the haul roads.
- Where practical, the design must prevent co-mingling of stormwater runoff from the haul road and stormwater runoff from upgradient, non-contact catchments through the use of culvert crossings. Where separation of runoff waters would not be practical, the design must include capacity in the haul road ditches to convey runoff from upgradient catchments.
- The side slopes of the channels should be 1.5:1 (Horizontal:Vertical) or flatter.
- The ditches can be sized without freeboard considerations.

Retention Ponds

- Retention ponds should be sized to retain the total volume of runoff delivery by the upstream roadside ditch during the 5-year, 24-hour storm event.
- Retention ponds may require maintenance and pumping after storm events to maintain capacity to retain additional runoff from subsequent storm events.

Culvert Crossings

- Culverts must be sized to convey the stormwater runoff from upgradient catchments.
- The velocity in the culvert must not exceed10.0 feet per second (ft/s) to protect the conduit from erosion.
- The minimum cover for each culvert should be 3 ft (assumed value).

Methods

Stormwater Runoff

MWH estimated peak stormwater flow rates and runoff volumes for the 5-year, 24-storm event using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's – Hydrologic Modeling System (HEC-HMS) version 4.1, build 1542. Catchment delineations for the model are shown in **Figure 1** and catchment areas are listed in **Table 1**. MWH developed the 5-year storm hyetograph using the center-peaking alternative block technique with the depth-duration frequency curve built from the National Oceanic and Atmospheric Association (NOAA) Precipitation Data Frequency Server (PDFS) (Bonnin et al, 2011) using the methods described in Attachment I-1 of Appendix I. The estimated total depth for the 5-year, 24-hour storm is 1.6 inches and the calculated cumulated hyetograph ordinates are listed in **Table 2** and shown in **Figure 2.**

MWH used the Green Ampt method to simulate rainfall losses and the Clark Unit Hydrograph method to simulate hydrograph transforms at the catchment outlets. The Green-Ampt and Clark Unit Hydrograph parameters for each catchment are listed in **Table 1**. Attachment I-1 of Appendix I described the methods for estimating these parameters.

Ditch Sizing

MWH assumed normal flow in the roadside ditches and computed the maximum flow depth (Y_{max}) using Manning's Equation:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

Where:

Q = Peak design discharge (cubic feet per second [cfs])
A = Channel cross-sectional area (square feet [ft^2]
R = Channel hydraulic radius = A/P, where P is the wetted perimeter
n = Manning roughness

MWH then computed the maximum flow depths using the geometric relationships for the area and wetted perimeter of the channel. MWH approximated Manning's roughness for the ditches to be 0.03, which assumes the ditches are relatively straight and are maintained to be clean and free of debris or accumulated sediment.

Stormwater Retention Pond Sizing

MWH sized the retention ponds to contain the estimated runoff from the 5-year, 24-hour storm. This assumes the Construction Contractor will evacuate the ponds within 24 hours after large storm events. The two sediment ponds in the Exclusion Zone were sized for the full storm depth, without accounting for rainfall losses in the catchment.

Culvert Sizing

MWH computed culvert capacities for both inlet and outlet control conditions. For inlet control, MWH used the orifice equation:

$$Q = CA\sqrt{2gH}$$

Where:

C = Contraction coefficient = 0.7 for an abrupt transition to the culvert
A = Culvert inlet area (ft^2)
g = gravitational constant (32.2 ft/s^2)
H = Hydraulic head of water at inlet

For outlet control, MWH calculated the flow for a given headwater condition using entrance, friction, and exit loss relationships:

$$HW = h_o + H - S_o L$$ and $$H = \left[1 + k_e + \left(\frac{29n^2 L}{R^{1.33}}\right)\right]\left[\frac{V^2}{2g}\right]$$

Where:

H = Hydraulic head required at inlet (ft)
k_e = Entrance loss coefficient = 0.9 for corrugated metal pipe projecting out of backfill
n = Manning's roughness coefficient
L = Length of culvert (ft)
R = Hydraulic radius of culvert (ft)
V = velocity in culvert

For the sizing, MWH assumed a Manning's n value of 0.027, a culvert slope of 5 percent, and allowed headwater to pond a maximum of 2 feet above the crown of the culvert inlet for culverts where the inlet was adjacent to the roadway. For culverts where the inlet would be adjacent to the detention pond berms, MWH allowed a ponding depth of 5 feet.

Assumptions

MWH made the following assumptions for these calculations:

- The slope of the road side ditches would coincide with the slope of the haul road.
- Culverts are corrugated metal pipe (CMP) with a Manning's roughness value of 0.027.
- The culverts would be installed with the inlet projecting out of backfill materials.
- The culverts would be straight with no bends and a constant slope of 5 percent.
- Retention ponds would be evacuated within 48 hours following large storm events.

Results

Roadside Ditches

The minimum depth required for road side ditches would be generally less than 1 foot (with 1.5:1 side slopes) to pass, and a MWH selected a standard depth of 1 foot. Drainage Basin 28 is the largest drainage basin in the area analyzed and would require a minimum channel depth of 2.0 feet. The roadside ditch geometric design is shown in **Table 3** and calculation worksheets are provided in Attachment A.

Retention Ponds

The required sediment pond volumes generally range from 1,065 cubic feet (cf) to 4,926 cf along the haul road. The average size is about 2,090 cf. The two sediment ponds in the exclusion zone are 15,876 cf and 20,744 cf. Three sediment ponds that will be combined with culverts range from 1,775 cf to 4,759 cf. Minimum sizing for sediment ponds is shown in **Table 4**.

Culverts

The minimum sizing required and standard sizing selected for each culvert is shown in **Table 5**. The culvert calculation worksheet is provided in Attachment A.

References

Bonnin, G.M., D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley, 2011. Precipitation-Frequency Atlas of the United States. NOAA Atlas 14, Volume 1, Version 5.0: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah). Accessed online February 2016 at: http://www.nws.noaa.gov/oh/hdsc/PF_documents/Atlas14_Volume1.pdf

TABLES

Table 1: Model Input Parameters by Catchment

Catchment	Area (acres)	Initial Loss (inches)	Initial Content	Saturated Content	Suction (inches)	Saturated Hydraulic Conductivity (in/hr)	Percent Impervious	Time of Concentration (hr)	Storage Coefficient (hr)	Time of Concentration (min)	Storage Coefficient (min)
0.00	1.05	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
01a	6.70	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
01b	26.66	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
2	3.31	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
3	1.50	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
4	1.79	0.00	0.25	0.50	4.72	0.24	0.00	0.08	0.08	5.00	5.00
5	2.71	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
6	0.47	0.00	0.25	0.50	5.20	0.20	0.00	0.08	0.08	5.00	5.00
7	1.42	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
8	0.97	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
9	4.19	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
10	1.23	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
11	1.00	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
12	0.30	0.00	0.35	0.50	7.00	0.10	0.00	0.08	0.08	5.00	5.00
13	4.10	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
14	2.26	0.00	0.25	0.50	4.72	0.24	0.00	0.08	0.08	5.00	5.00
15	0.95	0.00	0.25	0.50	5.20	0.20	0.00	0.08	0.08	5.00	5.00
16	3.89	0.00	0.25	0.50	4.72	0.24	0.00	0.08	0.08	5.00	5.00
17	0.82	0.00	0.25	0.50	4.40	0.30	0.00	0.08	0.08	5.00	5.00
18	0.77	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
19	0.49	0.00	0.25	0.50	4.40	0.30	0.00	0.08	0.08	5.00	5.00
20	4.66	0.00	0.25	0.50	4.72	0.24	0.00	0.08	0.08	5.00	5.00
21	3.80	0.00	0.25	0.50	4.72	0.24	0.00	0.08	0.08	5.00	5.00
22	1.08	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
23	1.60	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
24	0.92	0.00	0.25	0.50	4.72	0.24	0.00	0.08	0.08	5.00	5.00
25	0.12	0.00	0.35	0.50	7.00	0.10	0.00	0.08	0.08	5.00	5.00
26	4.48	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
27	3.13	0.00	0.25	0.50	3.60	0.46	0.00	0.08	0.08	5.00	5.00
28	61.87	0.00	0.25	0.50	4.72	0.24	0.00	0.30	0.29	18.29	17.29

Table 2: Cumulative Hyetograph Values for the 5-year, 24-hour Storm Event

Time (minutes)	Cumulative Rainfall (inches)	Time (minutes)	Cumulative Rainfall (inches)	Time (minutes)	Cumulative Rainfall (inches)	Time (minutes)	Cumulative Rainfall (inches)
5	0.00	365	0.07	725	1.01	1085	1.54
10	0.00	370	0.07	730	1.11	1090	1.54
15	0.00	375	0.07	735	1.17	1095	1.55
20	0.00	380	0.08	740	1.22	1100	1.55
25	0.00	385	0.08	745	1.25	1105	1.55
30	0.00	390	0.08	750	1.27	1110	1.55
35	0.01	395	0.08	755	1.29	1115	1.55
40	0.01	400	0.08	760	1.31	1120	1.55
45	0.01	405	0.08	765	1.32	1125	1.55
50	0.01	410	0.08	770	1.33	1130	1.56
55	0.01	415	0.09	775	1.35	1135	1.56
60	0.01	420	0.09	780	1.36	1140	1.56
65	0.01	425	0.09	785	1.36	1145	1.56
70	0.01	430	0.09	790	1.37	1150	1.56
75	0.01	435	0.09	795	1.38	1155	1.56
80	0.01	440	0.09	800	1.39	1160	1.56
85	0.01	445	0.10	805	1.39	1165	1.56
90	0.01	450	0.10	810	1.40	1170	1.56
95	0.01	455	0.10	815	1.41	1175	1.57
100	0.02	460	0.10	820	1.41	1180	1.57
105	0.02	465	0.10	825	1.42	1185	1.57
110	0.02	470	0.11	830	1.42	1190	1.57
115	0.02	475	0.11	835	1.43	1195	1.57
120	0.02	480	0.11	840	1.43	1200	1.57
125	0.02	485	0.11	845	1.44	1205	1.57
130	0.02	490	0.11	850	1.44	1210	1.57
135	0.02	495	0.12	855	1.44	1215	1.57
140	0.02	500	0.12	860	1.45	1220	1.58
145	0.02	505	0.12	865	1.45	1225	1.58
150	0.02	510	0.12	870	1.45	1230	1.58
155	0.02	515	0.13	875	1.46	1235	1.58
160	0.03	520	0.13	880	1.46	1240	1.58
165	0.03	525	0.13	885	1.46	1245	1.58
170	0.03	530	0.13	890	1.47	1250	1.58
175	0.03	535	0.14	895	1.47	1255	1.58
180	0.03	540	0.14	900	1.47	1260	1.58
185	0.03	545	0.14	905	1.48	1265	1.58
190	0.03	550	0.14	910	1.48	1270	1.58

Time (minutes)	Cumulative Rainfall (inches)	Time (minutes)	Cumulative Rainfall (inches)	Time (minutes)	Cumulative Rainfall (inches)	Time (minutes)	Cumulative Rainfall (inches)
195	0.03	555	0.15	915	1.48	1275	1.59
200	0.03	560	0.15	920	1.48	1280	1.59
205	0.03	565	0.15	925	1.49	1285	1.59
210	0.04	570	0.16	930	1.49	1290	1.59
215	0.04	575	0.16	935	1.49	1295	1.59
220	0.04	580	0.16	940	1.49	1300	1.59
225	0.04	585	0.17	945	1.50	1305	1.59
230	0.04	590	0.17	950	1.50	1310	1.59
235	0.04	595	0.18	955	1.50	1315	1.59
240	0.04	600	0.18	960	1.50	1320	1.59
245	0.04	605	0.18	965	1.50	1325	1.59
250	0.04	610	0.19	970	1.51	1330	1.60
255	0.04	615	0.19	975	1.51	1335	1.60
260	0.05	620	0.20	980	1.51	1340	1.60
265	0.05	625	0.20	985	1.51	1345	1.60
270	0.05	630	0.21	990	1.51	1350	1.60
275	0.05	635	0.22	995	1.52	1355	1.60
280	0.05	640	0.22	1000	1.52	1360	1.60
285	0.05	645	0.23	1005	1.52	1365	1.60
290	0.05	650	0.24	1010	1.52	1370	1.60
295	0.05	655	0.24	1015	1.52	1375	1.60
300	0.05	660	0.25	1020	1.52	1380	1.60
305	0.06	665	0.26	1025	1.53	1385	1.60
310	0.06	670	0.27	1030	1.53	1390	1.60
315	0.06	675	0.28	1035	1.53	1395	1.60
320	0.06	680	0.30	1040	1.53	1400	1.60
325	0.06	685	0.31	1045	1.53	1405	1.60
330	0.06	690	0.33	1050	1.53	1410	1.60
335	0.06	695	0.35	1055	1.53	1415	1.60
340	0.06	700	0.38	1060	1.54	1420	1.60
345	0.07	705	0.42	1065	1.54	1425	1.60
350	0.07	710	0.47	1070	1.54	1430	1.60
355	0.07	715	0.54	1075	1.54	1435	1.60
360	0.07	720	0.71	1080	1.54	1440	1.60

Table 3: Roadside Ditch Design Summary

Approximate Station		Drainage Basin(s)	Peak 5-year Flow	Length of Channel	Terminal Retention Pond ID	Minimum Channel Height	Selected Channel Height
From	To		cubic feet per second	feet		feet	feet
0	450	0	1.4	450	S01	0.5	1.0
1040	450	2	4.5	590	S01	0.8	1.0
1040	1410	4	3.1	370	S02	0.8	1.0
1590	1410	6	0.8	180	S02	0.5	1.0
1590	1900	7	1.9	310	S03	0.5	1.0
1900	2320	8	1.3	420	S04	0.4	1.0
2320	2580	10	1.7	260	S05	0.5	1.0
2580	2960	11, 12	2.0	380	S06	0.6	1.0
2980	1000(Spur)	14, 15	5.5	320	S07	1.0	1.0
1000(Spur)	500(Spur)	17, 18	2.4	500	S08	0.7	1.0
500(Spur)	220(Spur)	19	0.8	280	S09	0.4	1.0
0(Spur)	220(Spur)	23	2.9	220	S09	0.9	1.0
3100	3610	24	1.6	510	S10	0.5	1.0
3610	4640	Road Only	1.0	1030	S11	0.5	1.0
		28	49.2		J-Channel	2.0	2.0

Table 4: Retention Pond Design Summary

Sediment Pond ID	Approximate Station	Drainage Basin(s)	Volume (cf)	Notes
S01	450	00,2	4,759	Adjacent to Culvert C01
S02	1410	4, 6	3,447	Adjacent to Culvert C03
S03	1900	7	1,553	Adjacent to road
S04	2300	8	1,065	Adjacent to road
S05	2580	10	1,346	Adjacent to road
S06	2980	11, 12	1,775	Adjacent to Culvert C05
S07	1000 (Spur)	14, 15	4,926	Adjacent to road
S08	500 (Spur)	17, 18	1,934	Adjacent to road
S09	220 (Spur)	19, 23	2,398	Adjacent to road
S10	3600	24	1,390	Adjacent to road
S11	4640	N/A	1,141	Adjacent to road
S12	N/A	West of Decon Zone	20,744	West of Exclusion Zone
S13	N/A	East of Decon Zone	15,876	East of Exclusion Zone

Table 5: Culvert Design Summary

Culvert ID	Drainage Basin(s)	Total Q (5-Year Runoff)	Number of Pipe(s)	Minimum Pipe Diameter I.D.	Selected Pipe Diameter for Construction	Notes
		cfs		in	in	
C01	0, 2	45.2	2	22	24	Adjacent to Retention Pond S01
C02	3	2.0	1	10	16	
C03	5	3.7	1	14	16	Adjacent to Retention Pond S02
C04	4	5.7	1	16	16	Adjacent to road
C05	13	5.6	1	12	16	Adjacent to Retention Pond S06
C06	16	6.6	1	14	16	Adjacent to road
C07	20,21	14.4	1	18	24	Adjacent to road
C08	22	49.4	2	24	24	Adjacent to road
C09	25,16	6.9	1	18	24	Adjacent to road
C10	13,16,25,26	18.5	1	20	24	Adjacent to road

FIGURES

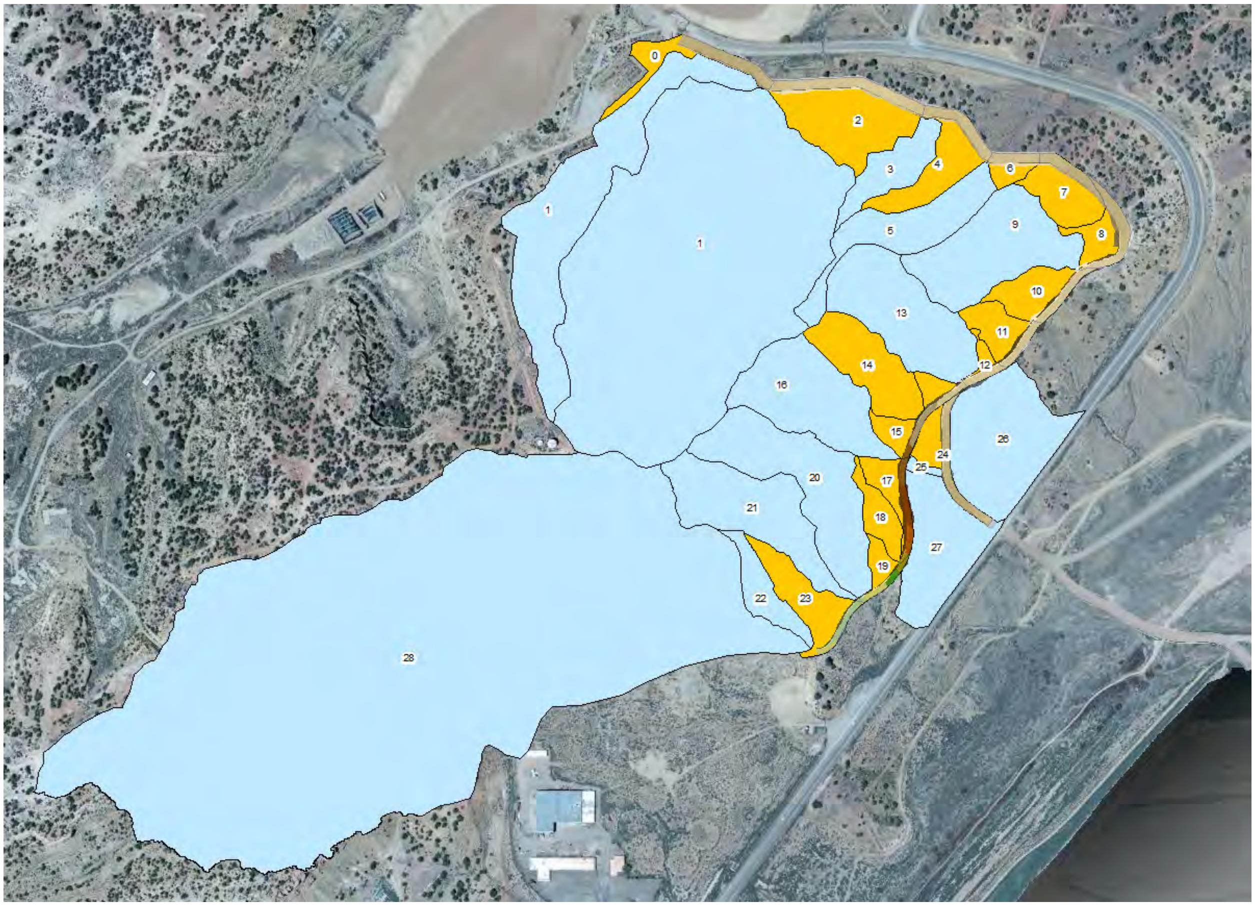

Figure 1: Catchment Delineations

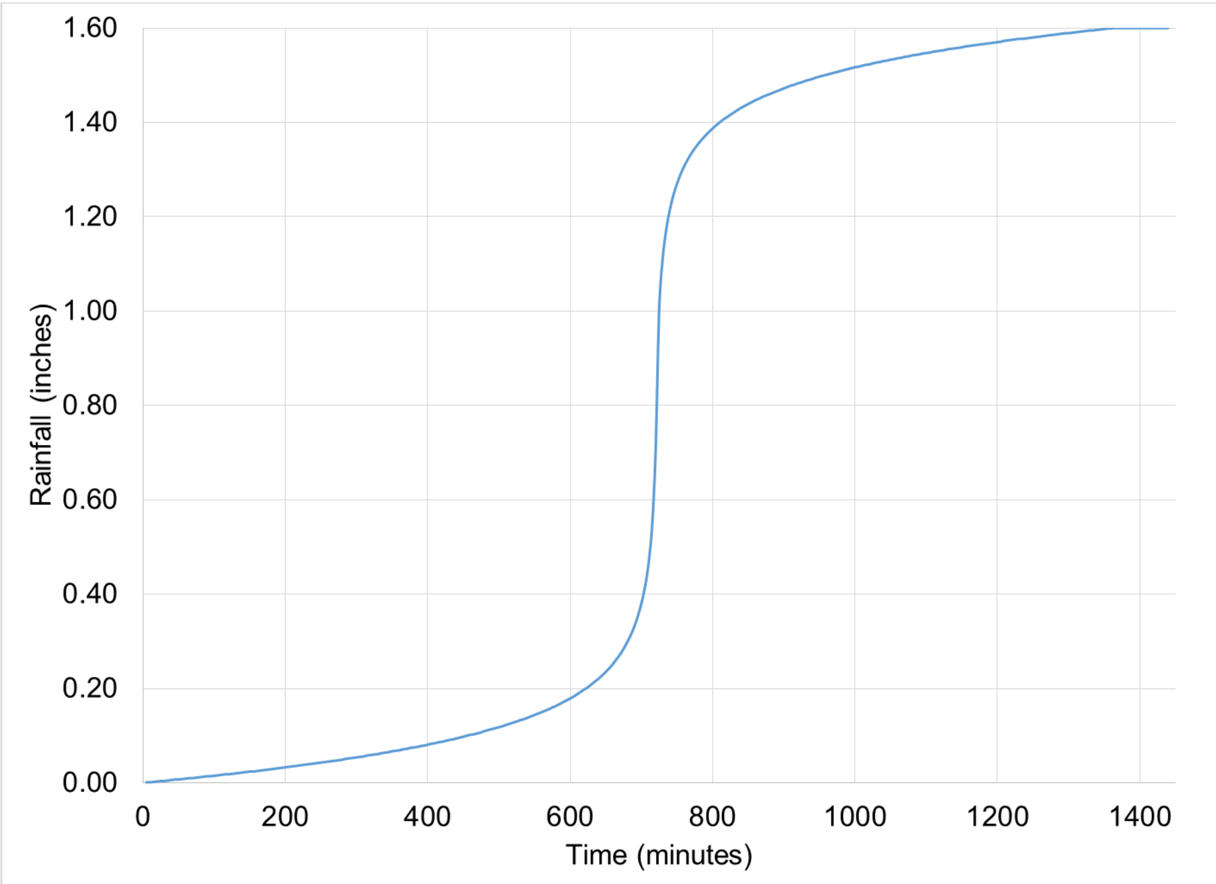

Figure 2: Cumulative Hyetograph for the 5-year, 24-hour Storm

ATTACHMENT A

CALCULATION WORKSHEETS

Calculation Worksheet for Roadside Ditches

Approximate Station		Drainage Basin(s)	Total Q (5-Year Runoff)	Length of Channel	Terminal Sediment Pond ID	Average Slope	Minimum Channel Height	Selected Channel Height	Flow Area	Wetted Perimeter	Hydraulic Radius	Top Width	Velocity	Froude #
From	To		cfs	ft		ft/ft	ft	ft	ft²	ft	ft	ft	ft/s	
0	450	0	1.4	450	S01	0.076	**0.5**	**1.0**	0.3	1.6	0.2	1.4	4.5	1.67
1040	450	2	4.5	590	S01	0.046	**0.8**	**1.0**	0.9	2.8	0.3	2.3	5.0	1.42
1040	1410	4	3.1	370	S02	0.023	**0.8**	**1.0**	0.9	2.7	0.3	2.3	3.5	1.00
1590	1410	6	0.8	180	S02	0.023	**0.5**	**1.0**	0.3	1.7	0.2	1.4	2.5	0.92
1590	1900	7	1.9	310	S03	0.074	**0.5**	**1.0**	0.4	1.9	0.2	1.5	4.8	1.68
1900	2320	8	1.3	420	S04	0.074	**0.4**	**1.0**	0.3	1.6	0.2	1.3	4.4	1.64
2320	2580	10	1.7	260	S05	0.041	**0.5**	**1.0**	0.4	2.0	0.2	1.6	3.7	1.26
2580	2960	11, 12	2.0	380	S06	0.04	**0.6**	**1.0**	0.5	2.1	0.2	1.8	3.9	1.26
2980	1000(Spur)	14, 15	5.5	320	S07	0.017	**1.0**	**1.0**	1.5	3.6	0.4	3.0	3.6	0.90
1000(Spur)	500(Spur)	17, 18	2.4	500	S08	0.025	**0.7**	**1.0**	0.7	2.4	0.3	2.0	3.4	1.02
500(Spur)	220(Spur)	19	0.8	280	S09	0.057	**0.4**	**1.0**	0.2	1.4	0.2	1.2	3.5	1.41
0(Spur)	220(Spur)	23	2.9	220	S09	0.008	**0.9**	**1.0**	1.2	3.3	0.4	2.7	2.3	0.61
3100	3610	24	1.6	510	S10	0.078	**0.5**	**1.0**	0.3	1.7	0.2	1.4	4.7	1.70
3610	4640	Road Only	1.0	1030	S11	0.038	**0.5**	**1.0**	0.3	1.6	0.2	1.4	3.2	1.18
		28	49.2		J-Channel	0.032	**2.0**	**2.0**	6.2	7.3	0.8	6.1	7.9	1.39

Notes

5 Year, 24 Hour peak discharge used to estimate design flow

Minimum channel sizing based on Manning's equation to contain 5 year peak flow (no freeboard)

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

Side slopes are assumed to be 1.5:1 (H:V)

Normal Manning's n = 0.030 for channels that are clean, straight, full stage, no rifts or deep pools (Chow, 1959)

Approximate station and average channel slope based on Northeast Church Rock Project 30% Design Drawings

Chow, V.T., 1959. Open-Channel Hydraulics. McGraw-Hill Civil Engineering Series.

Calculation Worksheet for Culverts

Culvert ID	Approx. Station	Drainage Basin(s)	Total Q (5-Year Runoff)	Approx. Length of Culvert	Inlet Head	Contraction Coefficient (C)	Entrance Loss Coefficient (K_e)	Number of Pipe(s)	Minimum Pipe Diameter I.D.	Selected Pipe Diameter for Construction	Pipe Area	Velocity	Total Q, Discharge Per Pipe	Total Q	Flow Area	Wetted Perimeter	Critical Depth	Head Loss	Hw Outlet Control	Control	Headwater Depth Below Road/ Platform
			cfs	ft	ft				in		ft²	ft/s	ft³/s	ft³/s	ft²	ft		ft	ft		
C01	450	0, 2	45.2	120	3.8	0.7	0.9	**2**	**22**	**24**	2.6	9.2	24.2	48.4	1.36	3.35	0.2	7.0	2.0	Inlet	**4.8**
C02	1040	3	2.0	75	2.8	0.7	0.9	**1**	**10**	**16**	0.5	8.5	4.1	4.1	0.13	0.66	0.1	4.4	1.2	Outlet	**2.7**
C03	1410	5	3.7	105	3.2	0.7	0.9	**1**	**14**	**16**	1.1	8.7	8.7	8.7	0.27	1.01	0.2	4.7	0.1	Outlet	**6.1**
C04	2330	4	5.7	55	3.3	0.7	0.9	**1**	**16**	**16**	1.4	8.8	11.7	11.7	0.31	1.07	0.2	3.3	1.3	Inlet	**3.0**
C05	2980	13	5.6	90	3.0	0.7	0.9	**1**	**12**	**16**	0.8	8.6	6.2	6.2	0.46	1.90	0.1	9.3	5.3	Inlet	**0.7**
C06	910 (Spur)	16	6.6	40	3.2	0.7	0.9	**1**	**14**	**16**	1.1	8.7	8.7	8.7	0.68	2.43	0.2	5.2	3.9	Inlet	**0.3**
C07	280 (Spur)	20,21	14.4	40	3.5	0.7	0.9	**1**	**18**	**24**	1.8	8.9	15.3	15.3	0.95	2.72	0.2	4.2	3.1	Inlet	**1.4**
C08	040 (Spur)	22	49.4	50	4.0	0.7	0.9	**2**	**24**	**24**	3.1	9.2	29.6	59.1	1.74	3.98	0.3	4.4	3.1	Inlet	**1.9**
C09	3350	25,16	6.9	60	3.5	0.7	0.9	**1**	**18**	**24**	1.8	8.9	15.3	15.3	0.40	1.25	0.2	3.3	1.2	Inlet	**3.3**
C10	3630	13,16,25,26	18.5	45	3.7	0.7	0.9	**1**	**20**	**24**	2.2	9.0	19.5	19.5	1.13	2.99	0.2	4.2	2.9	Inlet	**1.7**

Notes

5 Year, 24 Hour peak discharge used to estimate design flow

Culvert C01, C03, and C05 are combined with sediment ponds

The slope of each culvert is assumed to be 0.05 ft/ft

Inlet control is based on the orifice equation:

$$Q = CA\sqrt{2gH} \quad \text{and} \quad H_e = K_e \frac{v^2}{2g}$$

Contraction Coefficient (C) = 0.7 for an abrupt transition to the culvert

Entrance Loss Coefficient (K_e) = 0.9 for corrugated metal pipe projecting out of backfill

Inlet head is assumed to be 2 ft above the crown of the pipe for most culverts and 5 ft above the crown of the pipe for culverts combined with sediment ponds

Outlet control is based on Entrance, Friction and Exit Losses to calculate the headwater for the design flow:

$$HW = h_o + H - S_o L \quad \text{and} \quad H = \left[1 + k_e + \left(\frac{29n^2 L}{R^{1.33}}\right)\right]\left[\frac{V^2}{2g}\right]$$

Manning's n is assumed to be 0.027 for Corrugated Metal Pipe (CMP)

Northeast Church Rock 30% Design Report

Appendix E:

Stormwater Management Plan

MWH® now part of Stantec

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LIST OF ATTACHMENTS

Attachment E.1 Selected BMPs from New Mexico NPDES (NMDOT, 2012)

LIST OF ACRONYMS / ABBREVIATIONS

AOC	Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery
BMP	best management practice
CSWPPP	Construction Stormwater Pollutant Prevention Plan
Mill Site	Church Rock Mill Site
Mine Site	Northeast Church Rock Mine Site
NMDOT	New Mexico Department of Transportation
NPDES	National Pollutant Discharge Elimination System
RA	Removal Action or Remedial Action
RAO	Remedial Action Objective
ROD	Record of Decision
SWMP	Stormwater Management Plan
TDA	Tailings Disposal Area
USC	United States Code
USEPA	US Environmental Protection Agency

E.1 BACKGROUND

This appendix presents the Stormwater Management Plan that will be followed for the Northeast Church Rock Mine Site (Mine Site) and Church Rock Mill Site (Mill Site) Removal Action (RA). The Stormwater Management Plan (SWMP) provides a framework for how stormwater and other surface water will be managed to limit the release of contact stormwater, sediment, pollutants, and deleterious debris to downstream areas during and following the RA at the Mine Site and Mill Site. This SWMP also provides a catalog of best management practices (BMPs) for reducing adverse impacts of stormwater during and following the RA. The Construction Contractor must prepare a Construction Stormwater Pollution Prevention Plan (CSWPPP) that presents stormwater management protocols and procedures specific to the RA. The Construction Contractor's CSWPPP will reference this SWMP for general stormwater management practices and will identify the BMPs applicable to scheduled construction activities.

The RA includes excavating potentially contaminated soils at the Mine Site and constructing a repository at the Mill Site for mine waste along with capping the repository and constructing permanent stormwater controls. Surface water and stormwater with potential to contact mine wastes (contact water) will be captured and isolated from co-mingling with surface water and stormwater that has not contacted mine waste (non-contact water) or other potential contaminated materials. As the RA progresses, surface water and stormwater in the removal areas can be allowed to shed to natural drainages. The Construction Contractor will manage stormwater in active construction areas and the removal areas in accordance with their CSWPPP. The CSWPPP will be updated prior to each construction season, if construction extends over multiple seasons, or more frequently if necessary, to account for changing site conditions during the RA. Section E.4 provides foundation information and requirements to support preparation of the Construction Contractor's CSWPPP. The 30% Design Report main text, design drawings and appendices C, D, F, I and J provide information on the existing conditions at the Mine Site and Mill Site and relevant information on permanent and interim designs for stormwater controls. The Construction Contractor should refer to this information when preparing the CSWPPP.

The Section 5 Drawings depict BMPs to be implemented for construction and construction support zones. In addition, certain temporary stormwater controls are specified and shown on the drawings for the following areas:

- Construction Support Facilities – see Appendix B and Section 2 of the Design Drawings
- Mine Site Removal Areas – see Appendix C and Section 3 of the Design Drawings
- Mine Waste Haul Road – see Appendix D and Section 4 of the Design Drawings
- Mill Site Repository Area – see Appendix G and Section 7 of the Design Drawings

E.2 TASK-SPECIFIC PERFORMANCE STANDARDS

The Performance Standards presented here are defined in the Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site (2011 Action Memo; USEPA, 2011), the Record of Decision, United Nuclear Corporation Site, (ROD; USEPA, 2013), and the Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery (AOC; USEPA, 2015) including the Statement of Work attached as Appendix D to the AOC, and were developed to define attainment of the Removal Action and Remedial Action Objectives (RAOs) for the Selected Remedy. The Performance Standards include both general and specific standards applicable to the Selected Remedy work elements and associated work components. Table E.2-1 presents Performance Standards related to the stormwater management plan and temporary stormwater controls and explains how the design accomplishes these standards.

Table E.2-1: Performance Standards Applicable to Management of Stormwater During Construction

Location of Performance Standard Requirement	Performance Standard	Comments
2013 ROD, Section 2.9.1 Bullet 3	Remediation Action Objectives • Prevent the migration of concentrations of contaminants located in the soil, mine waste, and tailings contained within the Tailings Disposal Area to ground water where the migration of those contaminants would result in ground water concentrations that exceed remediation goals established in EPA's 1988 ROD for the Ground Water Operable Unit (including any amendment), and, through this action, prevent human and ecological receptors from being exposed to ground water with concentrations of contaminants that exceed remediation goals established in the 1988 ROD, including any amendment.	Designs are provided for temporary controls to isolate and contain contact surface stormwater within construction zones and minimize infiltration of contact stormwater within the Tailings Disposal Area (TDA). The repository design and limiting the associated impacts to groundwater are further discussed in Appendix G.
2013 ROD, Section 2.9.2 Bullet 3	2.9.2 Remediation Goals • Migration of contaminants from the Tailings Disposal Area shall not result in ground water concentrations that exceed remediation goals established in EPA's 1988 ROD for the Ground Water Operable Unit, including any amendment.	Designs are provided for temporary controls to isolate and contain contact surface stormwater within construction zones and minimize infiltration of contact stormwater within the TDA. The repository design and limiting the associated impacts to groundwater are further discussed in Appendix G.
2013 ROD, Section 2.9.5 – Storm Water and Erosion Control	Disturbed areas will be graded to reduce scouring and erosion potential using gentle slopes, terraces, earthen ridges and catch drains (swales) as necessary. These controls will also be used to minimize the potential for ponded water, reduce the risk of percolation from ponded water, and divert water away from open disposal locations, construction zones, and exposed mine waste. The drainage patterns in the disturbed areas will be integrated with the existing topography and drainage patterns to the extent possible. During construction activities, stormwater controls may include stormwater control channels (header), weirs, spillways, catch basins, check dams, and sediment basins. These controls will be implemented to maintain a safe working environment, to	This appendix discusses specific temporary construction stormwater controls that will be implemented to prevent co-mingling of contact and non-contact stormwater. These controls include ditches, diversion berms, culverts, retention ponds and other site-specific engineering controls. BMPs for construction stormwater controls are also provided in this appendix.

Location of Performance Standard Requirement	Performance Standard	Comments
	protect human health and the environment, mitigate off-site migration of mine waste, and protect response construction actions.	
2013 ROD, Table 1	10 CFR 61.41 Protection of the general population from releases of radioactivity. Refer to www.ecfr.gov.	This appendix discusses temporary stormwater controls intended to isolate and contain contact stormwater and prevent its release and mixing with non-contact water. This appendix also outlines BMPs that the Construction Contractor is to incorporate into its CSWPP. Also outlined are requirements to provide monitoring and maintenance as required so that controls function as intended.
2013 ROD, Table 1	10 CFR 61.53(c) Environmental Monitoring During the land disposal facility site construction and operation, the licensee shall maintain a monitoring program. Measurements and observations must be made and recorded to provide data to evaluate the potential health and environmental impacts during both the construction and the operation of the facility and to enable the evaluation of long-term effects and the need for mitigative measures. The monitoring system must be capable of providing early warning of releases of radionuclides from the disposal site before they leave the site boundary.	During construction of the repository, the CSWPPP will identify required observations and mitigation measures to address problems related to controlling stormwater and sediment from leaving the project work areas. The CSWPPP will be prepared based on the details and requirements outlined in this appendix.
2015 AOC SOW, Paragraph 25 – Storm Water and Erosion Control	In the Design, Respondents shall include detailed plans and specifications for storm-water and erosion control. Respondents' Design shall include detailed plans and specifications for contouring (e.g., grading) of construction areas to prevent, to the extent practicable, storm-water scouring. Respondents' Design shall also include detailed plans and specifications for the use of landscaping techniques such as gentle slopes, terraces, earthen ridges and catch drains (swales). Respondents shall produce detailed plans and specifications for using such controls to minimize, to the extent practicable, the potential for ponded water, and to divert water away from open disposal locations, construction zones, exposed contaminated soil and mine waste at construction zones and impacted areas disturbed by the work. Respondents' detailed plans and specifications shall call for integrating drainage patterns in the disturbed areas with the existing topography and drainage patterns. Respondents' detailed plans and specifications shall provide that during construction activities storm-water controls shall be used. Such controls may include, among other controls, storm-water control channels (header), weirs, spillways, catch basins, check dams, and sediment basins. Respondents' plans and specifications shall provide that such controls shall be implemented to maintain a safe working environment, to protect human health and the environment, to prevent off-site	The design includes both permanent and temporary stormwater controls. Permanent stormwater controls would be installed to control erosion from stormwater that could negatively impact the Mine Site or repository. These permanent stormwater controls are described in Appendix F and Appendix I. This appendix discusses temporary stormwater controls to be installed during construction to separate non-contact and contact stormwater and to control erosion and sediment loss from areas disturbed during construction. This appendix also provides a Stormwater Management Plan that outlines minimum BMPs that the Construction Contractor must include in its CSWPP and that must be implemented during construction.

Location of Performance Standard Requirement	Performance Standard	Comments
	migration of contaminated soil and mine waste, and to protect response action construction.	
2015 AOC SOW, Paragraph 29 – Green Remediation Best Management Practices	Respondents shall incorporate applicable Best Management Practices for Green Remediation listed in ASTM-E2893-13 consistent with EPA's policy Superfund Green Remediation Strategy (2010), found at http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf.	Section E.6 of this appendix discusses green remediation best management practices.

E.3 ENGINEERING DESIGN DRAWINGS

The engineering design drawings for the temporary stormwater controls and BMPs are contained in Volume II – Design Drawings (Section 5). The complete set of Drawings related to the temporary stormwater controls and BMPs are listed in Table E-3.1.

Table E.3-1: Engineering Design Drawings

Drawing No.	Drawing Title
5-01	Mine Site Temporary Stormwater Controls
5-02	Mill Site and Borrow Areas Temporary Stormwater Controls

E.4 CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

This section provides minimum requirements and framework information to support preparation of the Construction Contractor's CSWPPP. This plan provides requirements to comply with criteria in the *National Pollutant Discharge Elimination System Manual, Storm Water Management Guidelines for Construction and Industrial Activities, Revision 2* (NMDOT, 2012). It provides the BMPs, construction site-specific stormwater management monitoring program, and framework for the development of the CSWPPP as well as CSWPPP updates and addendums. The Design Drawings (Sections 2, 3, 4, 5, and 7) contain designs and descriptions for temporary stormwater controls that must be incorporated into the CSWPPP. Many temporary controls must be installed and/or decommissioned during specific RA phases as described in this appendix and shown in the drawings referenced above. The CSWPPP must also outline BMPs to reduce the potential for commingling contact and non-contact waters to the extent practical. Attachment E.1 contains BMPs that the Construction Contractor may include in the CSWPPP. The Construction Contractor must determine the need to implement these and other BMPs as the RA progresses, as approved by the Supervising Contractor.

The following sub-sections list required CSWPPP elements, and Section E.5 lists appropriate BMPs. The Construction Contractor's CSWPPP will draw from this SWMP to identify stormwater control procedures and BMPs specific to the phased construction activities. MWH may also require other BMPs to address specific concerns observed in the field.

E.4.1 Site Evaluation and Design Development

The CSWPPP must define site characteristics and the type of construction to be performed. Specific characteristics that must be included in the Construction Contractor's CSWPPP include:

- Site information
    - Site map of the construction area. The map should be to scale and show topographic contours. The scale of the map should be fine enough to show features relevant to stormwater management.
    - Soils information for the construction area.
    - Runoff water quality.
    - Name and locations of receiving water.
- Construction phasing plan. General construction phasing for the Mine Site and Mill Site are provided in the Design Drawings. The Construction Contractor should use this general phasing as a basis for a phasing plan that minimizes disturbance to vegetated areas, minimizes the amount of cut and fill, and limits impacts to sensitive areas (e.g. steep slopes, erodible soils, and existing drainages).
- Description of construction activities. The description should include project goals and soil disturbing activities required to achieve these goals.

E.4.2 Impact Assessment

The Construction Contractor's CSWPPP must assess the total area to be impacted by construction activities. It must also evaluate how construction activities would alter stormwater runoff volumes and flows, and identify drainage outlets and accumulation areas for stormwater and sediment. The Construction Contractor must use guidance provided in NMDOT (2012) for this evaluation and must also refer to temporary stormwater controls shown in Sections 2, 3, 4, 5 and 7 of the Design Drawings.

E.4.3 Control Selection and CSWPPP Design

Control selection and CSWPPP design includes (1) selecting control measures, (2) preparing a site map, (3) preparing an inspection and maintenance plan, and (4) preparing a sequence of major activities. These are described below.

E.4.3.1 Control Measures

The CSWPPP should design construction stormwater control based on the impact assessment (described in Section E.4.2). The site map will show the controls. The controls will include measures to (1) reduce erosion and sediment runoff, (2) prevent release of pollutants, and (3) manage stormwater. Attachment E.1 identifies potentially applicable BMPs for controls.

Controls to reduce erosion and sediment runoff include stabilization measures for disturbed areas and structural controls to divert runoff and control sediment. Erosion and sediment controls are implemented during construction to control soil loss from the construction site into the receiving waters. Such controls should remain in place until vegetation has established or other permanent controls are in place. The State of New Mexico requires that the CSWPPP includes a formal Sediment Control Plan.

Controls to prevent the release of pollutants should address: (1) disposal of construction and sanitary waste materials, (2) prevention of offsite tracking of sediments, and (3) dust suppression. In particular, the CSWPPP should define areas and methods for personnel decontamination and equipment transitioning between potentially contaminated and uncontaminated areas.

Controls to manage stormwater should prevent commingling of contaminated and non-contaminated stormwater and release of contaminated stormwater into native drainages. The controls could include measures to retain or attenuate stormwater flow (e.g., retention or detention ponds), measures to promote infiltration (e.g., infiltration trenches or basins), and dissipate stormwater flow velocities (e.g. check dams).

The United States Environmental Protection Agency (USEPA) General Permit requires that sediment basins be sized to provide at least 3,600 cubic feet of storage per acre or the calculated runoff from the 2-year, 24-hour storm. In some instances, this design uses a stricter requirement; for example, the temporary retention basins for the mine waste haul road are sized for the calculated runoff from the 5-year, 24-hour storm.

E.4.3.2 Site Map

The CSWPPP should include a site map with the following:

- Boundaries of the disturbance area and construction activities, including the Mine Site (Appendix C and Section 3 Drawings), vehicle access (Appendix D and Section 4 Drawings), construction support facilities (Appendix B and Section 2 Drawings), borrow areas (Appendix H and Section 8) and locations of structures and impervious surfaces
- Locations of surface waters and wetlands
- Boundary lines of natural buffers
- Area of federally-listed critical habitat
- Topography of the site, existing vegetation cover, and natural and engineered drainages and planned stormwater discharges (authorized and non-authorized)
- Locations of pollutant generating activities
- Locations where polymers, flocculants, or other treatment chemical will be used

E.4.3.3 Inspection and Maintenance Plan

The Construction Contractor's CSWPPP should include a plan for regularly inspecting and maintaining the controls. The Construction Contractor will document inspection and maintenance activities. Template inspection and maintenance forms are available in NMDOT (2012). The Construction Contractor can use these forms, or other forms with equivalent information, to document the inspection.

The inspection and maintenance plan should include visual inspections of disturbed areas and stormwater control features, including inspection of control features in inactive or reclaimed work areas. Temporary and permanent erosion and sediment control BMPs should be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair should be conducted in accordance with each particular BMP's specifications.

The inspection and maintenance plan must require that site inspections be conducted at least once a week and within 24 hours after storms with 0.25 inches or greater of precipitation in 30 minutes, or a 24-hour total greater than 0.5 inches.

The inspection and maintenance plan must also require that temporary erosion and sediment controls be removed within 30 days after final site stabilization, or after the temporary controls are no longer needed. The Construction Contractor should remove trapped sediment and consolidate it with the mine wastes if necessary. The Construction Contractor should permanently stabilize disturbed soil or vegetation resulting from removal of controls.

E.4.3.4 Sequence of Major Activities

The CSWPPP should include a sequence of major activities for installing and implementing stormwater, sediment, and pollution prevention controls. The sequence should show the order in which activities will be performed, and should adhere to the general plans outlined in Section 5 of the Design Drawings. The sequencing plan should also conform to the following principles noted in NMDOT (2012):

- Install downslope and side slope perimeter controls before land-disturbing activity occurs.
- Do not disturb an area until it is necessary for construction to proceed. Cover or stabilize disturbed areas as soon as possible.
- Time activities to limit impact from seasonal climate changes or weather events.
- Delay construction of infiltration measures until the end of the construction project when upstream drainage areas have been stabilized.
- Do not remove temporary perimeter controls until after all upstream areas are finally stabilized.

E.4.3.5 Incorporate Federal, State, and Local Regulations

No federal, state, or local permits are required for the work as allowed under 42 USC 9621e(1); however, the CSWPPP should meet the substantive requirements associated with these permits. Appendix N of the 30% Design Report summarizes applicable federal, state, and local regulations.

E.4.4 Certification and Submittal

The CSWPPP should be signed by the Construction Contractor and subcontractor's representatives responsible for implementing the CSWPPP controls.

E.5 BEST MANAGEMENT PRACTICES GUIDELINES

This section summarizes stormwater erosion and sediment control BMPs along with some common BMPs that are appropriate for this project. The CSWPPP may specify additional or alternative BMPs with MWH's approval. Attachment E.1 includes a catalog of the BMPs outlined below. This BMP catalog is from the New Mexico National Pollutant Discharge Elimination System (NPDES) manual (NMDOT, 2012) and provides information on applications, installation, and limitations.

E.5.1 Erosion Control

BMPs for erosion control include the following:

- Seeding and temporary vegetation. Temporary seeding should be applied to disturbed areas that have not been worked for 21 days or more, unless the Construction Contractor provides alternative effective measures to control erosion. Disturbed areas include denuded areas, soil stockpiles, dikes, berms, temporary embankments, and excavation slopes. The Construction Contractor may need to install erosion control matting, swales, or berms to protect newly seeded areas.
- Mulching. Mulching should be used to prevent slow runoff velocities, trap sediment, and protect surfaces, including newly seeded areas. Mulch should be free from noxious weeds and invasive species.
- Surface Roughening. Surface roughening consists of creating along-contour depressions that slow surface flow and allow sediment deposition on slopes. The Construction Contractor should use surface roughening along with seeding and mulching. Surface roughening should not be used for rocky slopes or slopes with fine sands or silts.
- Erosion Control Mat. An erosion control mat is material placed on disturbed areas or slopes to aid in erosion control and promote the establishment of vegetative cover. The Construction Contractor should use erosion control mats in newly seeded areas where slow vegetation growth is expected.

E.5.2 Runoff Control

BMPs for runoff control include the following:

- Diversion dikes and swales. Diversion dikes and swales are berms and depressions that channelize or divert flow. The Construction Contractor can use diversion dikes and swales to direct contact stormwater runoff into a controlled collection area or to divert non-contact stormwater around disturbed or contaminated areas.
- Slope drain. A slope drain is a temporary pipe that runs downslope. The Construction Contractor can use slope drains to convey water down unstabilized, steep slopes. The pipe must be anchored, and the pipe must be frequently inspected and maintained to confirm that it can function properly. The pipe must be inspected after each significant (greater than 0.5-inch) rainfall to repair joint damage and remove pipe clogs.
- Check dam. A check dam is a small temporary dam constructed across a swale or ditch with the intent of slowing the flow velocity. The Construction Contractor should install rock check dams perpendicular to the flow-line of temporary stormwater diversion channels. Dams in permanent stormwater channels may require inspection prior to installation of channel revetment. The Construction Contractor should install check dams channels where the expected in-channel flow does not exceed 1 cubic foot per second.
- Detention Basin. A detention basin is a depression with an outlet that slowly releases stored water. The Construction Contractor can use detention basins to reduce flow rates and provide sediment removal from stormwater. The Construction Contractor should inspect detention basins at least bi-weekly.
- Toe Rock. Toe rock is riprap or soil/rock matrix placed at the base of steep slopes to stabilize the toe of a slope. The Construction Contractor can use toe rock for outlet protection and grade transitions. Toe rock should be inspected at least monthly during construction and after large storm events.

E.5.3 Sediment Control

BMPs for sediment control include the following:

- **Silt fence.** Silt fences can be used to reduce sediment loss on disturbed slopes. The Construction Contractor should construct silt fences at the toes of slopes and adjacent to channels and streams with the potential to receive sediment from construction activities. The Construction Contractor should inspect silt fences at least weekly and after heavy storm events (0.25 inches in 30 minutes or a 24 hour total greater than 0.5 inches). The Construction Contractor should remove sediment upstream of the silt fence once the depth of sediment reaches approximately half the fence height. Due to windy site conditions, silt fence, if used, should be heavily reinforced, and regular maintenance will be required.
- **Straw Bale.** The Construction Contractor should place straw bales perpendicular to the flow-line at the confluence of both temporary and permanent diversion channels. The Construction Contractor should anchor the straw bales using stakes or posts. Straw bales should be replaced at least every three months. The Construction Contractor should also replace straw bales if straw is distributed downstream of the bale, indicating that the bale ties are no longer capable of maintaining the integrity and shape of the straw bale.
- **Sediment Trap.** A sediment trap is a temporary ponding area that slows runoff and captures sediment. The Construction Contractor can install sediment traps within a drainage way or at a point of discharge. The sediment trap should be inspected frequently to check for reduced efficiency.
- **Straw Wattle.** A straw wattle is a geotextile fabric cylinder filled with straw. The Construction Contractor should install straw wattles along contours on sloping grade to limit migration of fine sediment and inhibit rilling and rutting of the slope surfaces until an appropriate cover has been constructed. Straw wattles should be spaced a maximum of 200 feet apart on slopes less than 10 percent and a maximum of 100 feet apart on slopes exceeding 10 percent. The Construction Contractor should inspect straw wattles with a frequency defined in the CSWPPP and also following storm events. Wattles should be replaced if straw debris is outside of the geotextile encasement downgradient of the wattle.

E.6 BEST MANAGEMENT PRACTICES FOR GREEN REMEDIATION

E.6.1 Construction Materials

Green and Sustainable Remediation considerations involving construction materials include requiring use of green concrete for channels and culverts (via technical specifications) and use of on-site, non-contaminated materials (soil and rock) for riprap and construction of berm sub-grades in order to limit fuel consumption and emissions due to import of off-site materials.

E.6.2 Construction Methods

Green and Sustainable Remediation considerations involving construction methods include requiring construction contractors to use correctly sized construction equipment to avoid higher greenhouse gas and dust emissions resulting from oversized construction equipment.

E.6.3 Low Impact/Sustainability Measures

Low impact/sustainability measures include using temporary stormwater controls (described in this appendix and in the Section 5 Drawings) to segregate contaminated water from non-impacted water. Disturbed slopes in work areas would be protected by implementation of BMPs including temporary seeding, erosion control mats and silt fences.

E.7 REFERENCES

New Mexico Department of Transportation (NMDOT), 2012. National Pollutant Discharge Elimination System Manual – Storm Water Management Guidelines for Construction and Industrial Activities. Revision 2. August.

US Environmental Protection Agency (USEPA), Region 6 and Region 9, 2011. Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site, McKinley County, New Mexico, Pinedale Chapter of the Navajo Nation. September 29.

US Environmental Protection Agency (USEPA) Region 6, 2013. Record of Decision, United Nuclear Corporation Site, McKinley County, New Mexico. Operable Unit OU2: Surface Soil Operable Unit. March 29.

US Environmental Protection Agency (USEPA), Region 6 and Region 9, 2015. Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery, Appendix D: Statement of Work. April 27.

ATTACHMENT E.1

Selected BMPs from New Mexico NPDES Manual (NMDOT, 2012)

Seeding – Temporary/Vegetation

DESCRIPTION

As a BMP, temporary seeding/vegetation is used to establish a temporary vegetative cover on disturbed areas by seeding with appropriate rapidly growing annual vegetation, annual grasses, small grains, or legumes. This short-term vegetative area will reduce erosion and sedimentation on disturbed areas that will not be permanently stabilized within an acceptable period of time. Temporary seeding will also reduce problems associated with mud and dust from construction activities on bare, unprotected soil surfaces.

PRIMARY USE

Temporary seeding should be considered for disturbed areas that will not be permanently stabilized or have work performed thereon for a period of 21 days or more. Such areas include denuded areas, soil stockpiles, dikes, berms, temporary embankments, excavation slopes, etc. As a temporary control, vegetation is used to stabilize stockpiles and barren areas that are inactive for long periods of time. As a permanent control, grasses and other vegetation provide good protection for the soil, along with some filtering for overland runoff. Subjected to acceptable runoff velocities, vegetation can provide a good method of permanent storm water management, as well as a visual amenity to the site.

Other BMPs may be required to assist in the establishment of vegetation. These other techniques include erosion control matting; swales and dikes to direct flow around newly seeded areas; and proper grading to limit runoff velocities during construction.

APPLICATIONS

Planting should take place when conditions are most favorable for growth (as long as the planting does not interfere with the schedule of other activities and/or regulatory requirements). Before seeding, other erosion control practices such as dikes, basins, and surface runoff-control measures (e.g., interceptor dikes and swales, etc.) should be installed. Temporary bale barriers and silt fences may have to be placed/replaced after seeding operations, since they may get in the way of the machinery. However, use common sense to coordinate operations to maximize the effectiveness of the erosion control measures. Temporary seeding may not be an effective practice in arid and semi-arid regions where the climate prevents fast plant establishment. In those areas, or when seasonal planting restrictions prohibit, temporary mulching may be better for the short term.

For further information, refer to Section 632 of *Standard Specifications for Highway and Bridge Construction* (New Mexico State Highway and Transportation Department [NMSHTD] 2000).

Applications

- Perimeter Control
- ✓ Slope Protection
- ✓ Sediment Trapping
- ✓ Channel Protection
- ✓ Temporary Stabilization
- ✓ Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- Floatable Materials
- Construction Wastes

Impact

- ✓ Significant
- Medium
- Low
- Unknown or Questionable

SEED

Seeding – Temporary/Vegetation (continued)

All seeded areas should be covered with mulch to provide protection from the weather. Frequent inspections are necessary to check that conditions for growth are good. If the plants do not grow quickly or thick enough to prevent erosion, the area should be reseeded as soon as possible.

Temporary seed selection should take into account the season and location. Specific seed mixes can usually be found in the construction plans. The plans and specifications should reflect temporary seeding locations, quantities, and pay items. For suggested seed types, see Appendix D, Guidance on Seed Selection and Seeding of Temporary Vegetation on Disturbed Areas.

Native grasses should not be used for temporary seeding. Irrigation or a temporary watering facility should be provided. Seed should be selected in accordance with local Natural Resources Conservation Service (NRCS) rules.

Vegetative techniques can and should apply to every construction project, with few exceptions. Vegetation effectively reduces erosion in swales, stockpiles, berms, mild to medium slopes, and along roadways. Vegetative strips can provide some protection when used as a perimeter control for utility and site development construction.

Surface Preparation

- Interim or final grading must be completed prior to seeding, minimizing all steep slopes.
- Install all necessary erosion structures such as dikes, swales, diversions, etc., prior to seeding.
- Groove or furrow slopes steeper than 3:1 on the contour line before seeding.
- Provide 4-6 inches of topsoil over rock, gravel, or otherwise unsuitable soils.
- Seedbed should be well pulverized, loose, and uniform.

Plant Selection, Fertilization and Seeding

- Use only high quality, U.S. Department of Agriculture (USDA)-certified seed.
- Use an appropriate species or species mixture adapted to local climate, soil conditions, and season. Consult with the local NRCS office or local County Extension Service as necessary for selection of proper species and application techniques in the area. Seeding rate should be in accordance with recommendations by the NRCS or Engineering Extension Service.
- Fertilizer shall be applied according to the manufacturer's recommendation with proper spreader equipment. Typical application rate for 10-10-10 grade fertilizer is 700-1000 lb/acre. DO NOT OVER APPLY FERTILIZER.
- If hydro-seeding is used, do not mix seed and fertilizer more than 30 minutes before application.
- Evenly apply seed using cyclone seeder, seed drill, cultipacker, or hydroseeder.
- Provide adequate water to aid in establishment of vegetation.
- Use appropriate mulching techniques where necessary.

Mulching

DESCRIPTION

Mulching is used to provide a stabilized surface for seeding or to prevent erosion using chemical soil stabilizers and a variety of organic or inorganic materials, netting, or mats.

PRIMARY USE

Mulching is used to prevent erosion by creating a permanent material to slow surface velocity, trap sediment, and protect surface areas around structures.

APPLICATIONS

Mulching is used in areas where permanent velocity control and sediment trapping will be required. Follow Section 632, pp. 684-685 of *Standard Specifications for Highway and Bridge Construction* (NMSHTD 2000).

NOTES

- Hay should consist of native grasses free of noxious weed seeds (certified weed-free hay or straw may be required in designated areas of the state).
- Straw should consist of clean cereal shafts.
- Hay and straw mulch should be spread at a rate of 1.5 to 2 tons per acre.
- At a minimum, 65% of the mulch, by weight, should be 10 inches or more in length.
- Applied mulch depth should not be less than 1 inch and not more than 2 inches. The mulch should be uniformly applied so that no more than 10% of the soil surface is exposed.
- Hay and straw mulch should be anchored to the soil surface using tackifiers, blankets, or nets, or with a mulch-crimping machine. Mechanical anchoring, or crimping, is preferred and recommended for slopes flatter than 2:1. Blankets or nets on slopes steeper than 2:1 should be anchored to the soil.
- Tackifiers (for anchoring) should consist of a free-flowing non-corrosive powder. This material shall not contain any mineral filler, recycled cellulose fiber, clays, or other substances that may inhibit germination or growth of plants.
- Tackifiers (for anchoring) shall be applied in a slurry with water and wood fiber (100 lbs of powder and 150 lbs of fiber per 700 gallons of water). Application rate of powder should be between 80 and 200 lbs per acre.

Applications

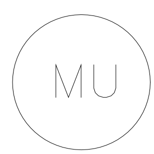
- Perimeter Control
- ✓ Slope Protection
- ✓ Sediment Trapping
- Channel Protection
- ✓ Temporary Stabilization
- Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

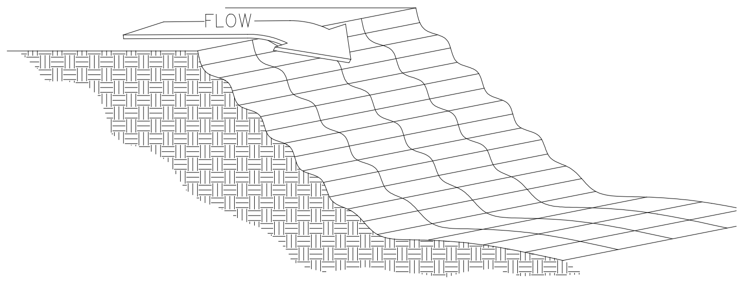
- ✓ Sediment
- ✓ Nutrients
- Toxic Materials
- Oil and Grease
- Floatable Materials
- Construction Wastes

Impact

- ✓ Significant
- ✓ Medium
- Low
- Unknown or Questionable



Surface Roughening



Applications

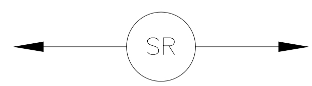
- Perimeter Control
- ✓ Slope Protection
- ✓ Sediment Trapping
- Channel Protection
- ✓ Temporary Stabilization
- Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- Floatable Materials
- Construction Wastes

Impact

- Significant
- ✓ Medium
- Low
- Unknown or Questionable



DESCRIPTION

Surface roughening provides a rough soil surface with horizontal depressions created on the contour, leaving slopes in a roughened condition by not fine grading them.

PRIMARY USE

Surface roughening is used to slow surface flow and to allow material and water deposition in steps, which encourages plant growth.

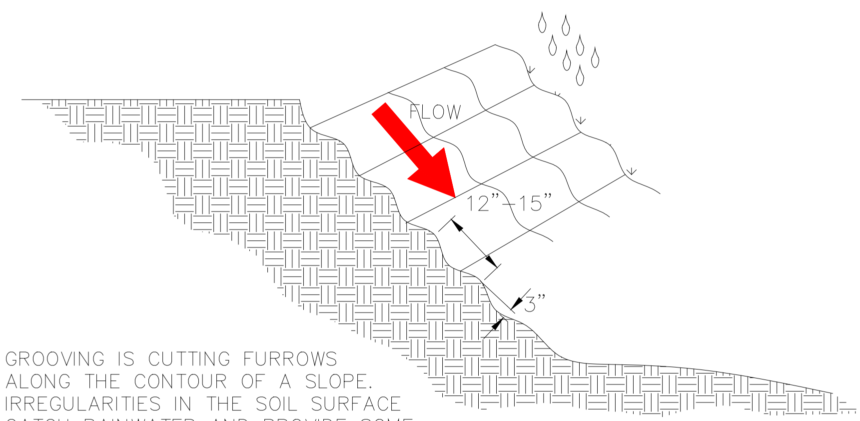
APPLICATIONS

Surface roughening is used on steep slopes prior to or in conjunction with seeding or mulching; on slopes where seeding and mulching cannot be accomplished due to wrong season or lack of water.

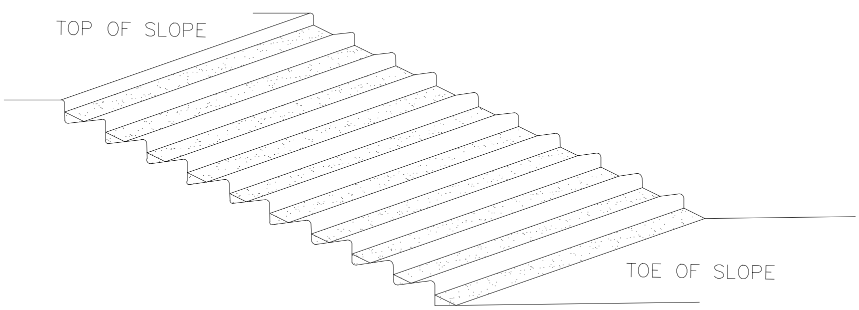
NOTES

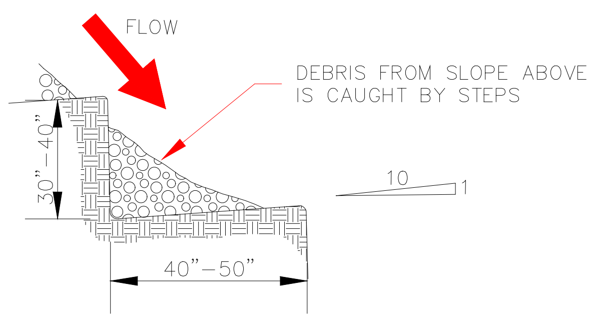
- Horizontal depressions must be created approximately 2-4 inches deep, and spaced 4-6 inches apart.
- Use stair-step grading, grooving, or tracking.
- Roughening of ridges and depressions should follow along the contours of the slope.
- Use machinery to create a series of ridges and depressions that run perpendicular to the slope (on the contour). Operate the machinery up and down the slope to leave horizontal depressions in the soil. Make as few passes as possible to minimize compaction.
- Seed and mulch roughened areas as soon as possible.
- Do not drive vehicles or equipment over areas that have been roughened.

Surface Roughening (continued)



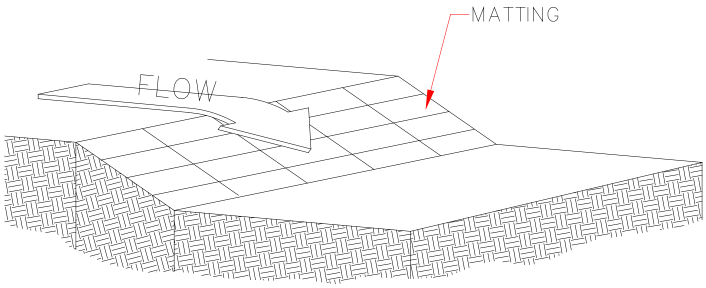
GROOVING SLOPES





STAIR STEPPING CUT SLOPE

Erosion Control Mat



DESCRIPTION

Organic or synthetic erosion control matting is placed on disturbed areas or slopes to aid in erosion control and to promote the establishment of vegetative cover.

PRIMARY USE

Erosion control mats provide either temporary or permanent stabilization for barren or disturbed areas on steep slopes, drainage swales, embankments, or high-traffic areas.

APPLICATIONS

Erosion control mats can be used in any construction-related disturbed area; areas with fine-grained soils; short steep slopes; or where vegetation growth is slow.

See, for instance, Class 'D' seeding and geotextiles, Section 604, p. 618 in *Standard Specifications for Highway and Bridge Construction* (NMSHTD 2000).

Applications

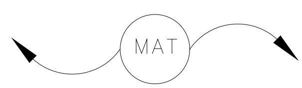
- Perimeter Control
- ✓ Slope Protection
- ✓ Sediment Trapping
- Channel Protection
- ✓ Temporary Stabilization
- ✓ Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

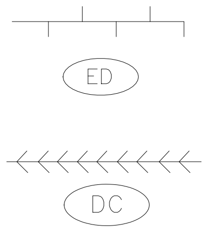
- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- Floatable Materials
- Construction Wastes

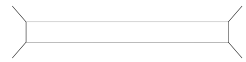
Impact

- ✓ Significant
- Medium
- Low
- Unknown or Questionable

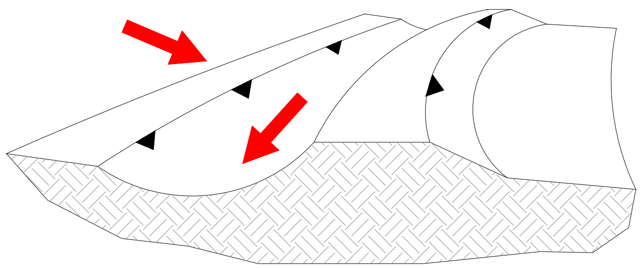


SYMBOLS

Diversion Channel Dike and Swale	 ED / DC
Check Dam	CD
Brush Barrier	BB
Fiberschines/Biologs	FS
Toe Rock	TR
Guardrail Treatment	GET

Slope Drain	
Bioretention	BR
Detention Basin	DB
Wood Chip Berm	WB
Outlet Structure	OS

Diversion Channel Dike and Swale



TYPICAL SWALE CONFIGURATION

Applications

- ✓ Perimeter Control
- ✓ Slope Protection
- Sediment Trapping
- Channel Protection
- Temporary Stabilization
- Permanent Stabilization
- Waste Management
- Housekeeping Practices

DESCRIPTION

Diversion channel dikes and swales are constructed conveyances that concentrate and route flow away from construction areas or toward certain locations, treatments, or BMP locations.

PRIMARY USE

Diversion channels can be used to direct sediment-laden flow into a controlled outlet, or to clean flow around disturbed areas.

APPLICATIONS

Dikes and swales are useful when significant offsite flow could disturb a site; when flow needs to be directed away from staging, storage, or fueling areas; or where routing is required to treatment.

LIMITATIONS

Earth Dike (Berm)

Compacted earth dikes require stabilization immediately upon placement so as not to contribute to the problem they are addressing.

The diversion dikes can be a hindrance to construction equipment moving on the site; therefore, their locations must be carefully planned prior to installation.

Diversion Channel (Swale)

Interceptor swales must be stabilized quickly upon excavation so as not to contribute to the erosion problem they are addressing.

Swales may be unsuitable to the site conditions (too flat or steep).

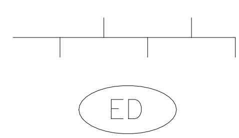
Limited flow capacity for temporary swales. For permanent swales, the 1.5-foot maximum depth can be increased as long as provisions for public safety are implemented.

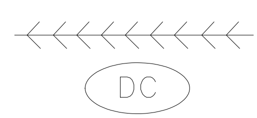
Targeted Constituents

- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- ✓ Floatable Materials
- Construction Wastes

Impact

- ✓ Significant
- ✓ Medium
- Low
- Unknown or Questionable





Diversion Channel Dike and Swale (continued)

MAINTENANCE REQUIREMENTS

Earth Dike (Berm)

Dikes must be inspected on a weekly basis and after each significant (>0.5 inch) rainfall to determine if silt is building up behind the dike, or if erosion is occurring on the face of the dike. Silt shall be removed in a timely manner. If erosion is occurring on the face of the dike, the slopes of the face shall either be stabilized through mulch or seeding, or the slopes of the face shall be reduced.

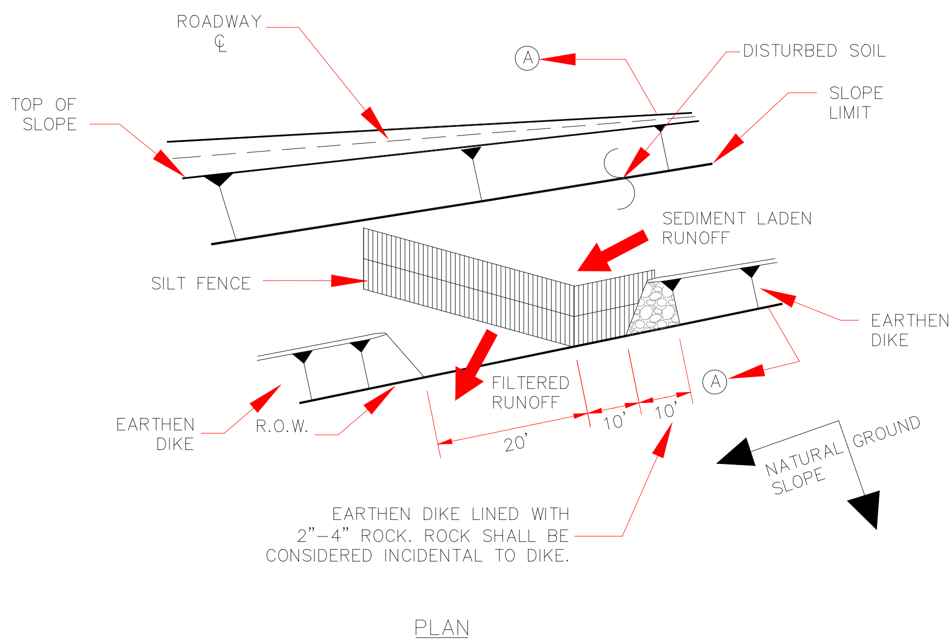
Diversion Channel (Swale)

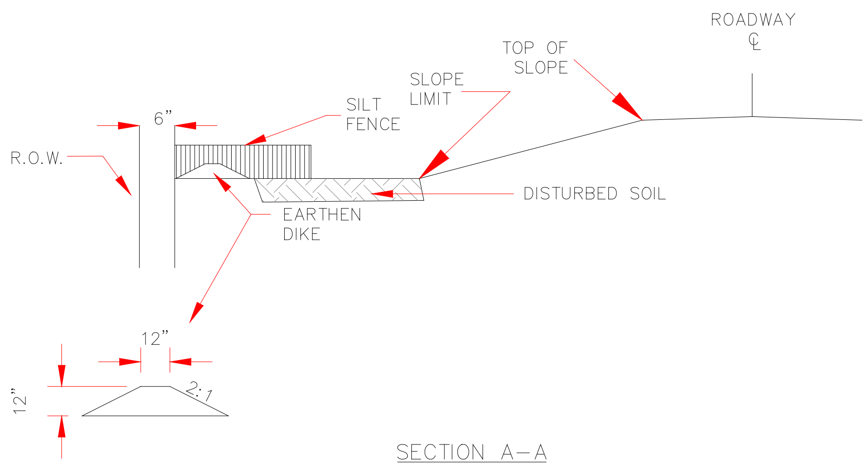
Inspection must be made weekly and after each significant (>0.5 inch) rainfall to locate and repair any damage to the channel or to clear debris or other obstructions so as not to diminish flow capacity. Damage from storms or normal construction activities, such as tire ruts or disturbance of swale stabilization, shall be repaired as soon as practical.

NOTES

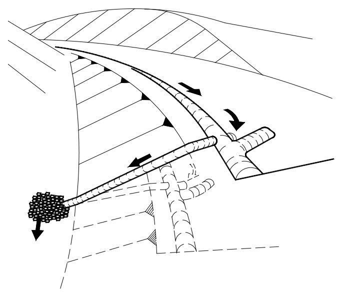
- Berms shall have a minimum height of 18 inches, side slopes of 2:1 or flatter, and a minimum base width of 2 feet.
- The minimum freeboard shall be 6 inches.
- Berms and diversions should be constructed of compacted soil or coarse aggregate.
- All berms shall have an uninterrupted positive grade to a stabilized outlet.
- Diversion channels shall be excavated or shaped to line, grade, and cross section as indicated in the plans and as required to meet the criteria specified.
- Berrns and diversion channels should be stabilized within 14 days of their construction.
- Periodically, and after each rain event, berms and dikes should be inspected, and accumulated sediments against berms should be removed.

Diversion Channel Dike and Swale (continued)





Slope Drain



DESCRIPTION

A slope drain is a temporary pipeline that conveys flow down an unstabilized slope. The drain is anchored on the upstream end with some form of headwall to limit erosion and secure the pipe.

PRIMARY USE

Slope drains are used on long, unstablized, steep slopes subject to erosion from overland flow. Flow from the drain should be routed to a sediment-reduction treatment.

APPLICATIONS

Slope drains are useful on sites with large berms or grade changes. Since flow must be directed into the drain, some upstream grading is usually required, as is some form of velocity reduction treatment at the downstream end to reduce velocity and spread the flow.

The allowable runoff flow rates to a temporary slope drain are as follows:

Runoff Flow Rate (cfs)	Pipe Diameter Required (inches)
0 – 6.0	18
6.0 – 9.0	21
9.0 – 12.0	24
12.0 – 20.0	30

LIMITATIONS

Drains must be located away from construction areas, since the drain can easily be damaged by construction traffic.

Securing the pipe to the slope can be difficult and require significant maintenance during the life of the system.

Applications

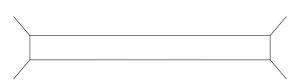
- Perimeter Control
- ✓ Slope Protection
- Sediment Trapping
- Channel Protection
- Temporary Stabilization
- Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- ✓ Floatable Materials
- Construction Wastes

Impact

- ✓ Significant
- ✓ Medium
- Low
- Unknown or Questionable



Slope Drain (continued)

In situations where pipe slope drains convey sediment-laden runoff, pipes can become clogged during large rain events, causing water to overtop the diversion dike and thereby creating a serious erosion condition.

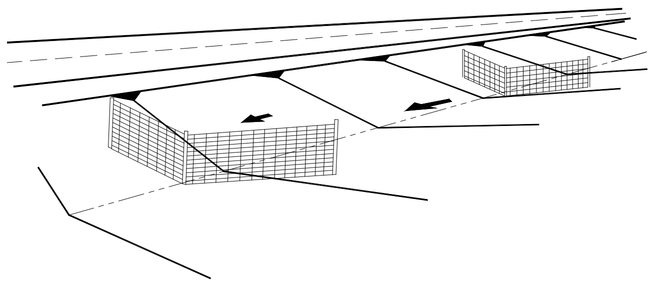
Grading is normally required upstream of the pipe slope drain in order to direct flow into the system. This can cause additional cost and maintenance.

A pipe slope drain reduces erosion but does not prevent it or reduce the amount of sediment in the runoff. Additional measures should be used in conjunction with the pipe slope drain to treat the flow.

MAINTENANCE REQUIREMENTS

Inspection must be made of the pipe after each significant (>0.5 inch) rainfall to locate and repair any damage to joints or clogging of the pipe. In cases where the diversion dike has deteriorated from around the entrance of the pipe, it may be necessary to reinforce the dike with sandbags or to install a concrete collar to prevent failure. Signs of erosion around the pipe drain should be addressed in a timely manner by stabilizing the area with erosion control mats, crushed stone, concrete, or other acceptable method.

Check Dam



DESCRIPTION

Check dams are small temporary dams constructed across a swale or drainage ditch.

PRIMARY USE

Check dams are used to reduce the velocity of concentrated storm water flows, thus reducing erosion in the swale or ditch; to slow the flow velocity to allow sediment capture.

APPLICATIONS

Check dams are used to slow velocity in smaller channels and temporary swales (i.e., open channels that drain ten acres or less).

The maximum allowable runoff flow rate to an individual check dam is as follows:

Longitudinal Slope (%)	Runoff Flow Rate (cfs)
0 – 2	1.0
2.1 - 4	0.5

LIMITATIONS

Minor ponding will occur upstream of the check dams.

For heavy flows or high-velocity flows, extensive maintenance or replacement of the dams will be required.

Check dams are not a total treatment technique.

MAINTENANCE REQUIREMENTS

Maintenance of the dams should adhere to the maintenance requirements of the management practice used for the dam.

Applications

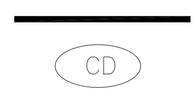
- Perimeter Control
- Slope Protection
- ✓ Sediment Trapping
- ✓ Channel Protection
- Temporary Stabilization
- Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

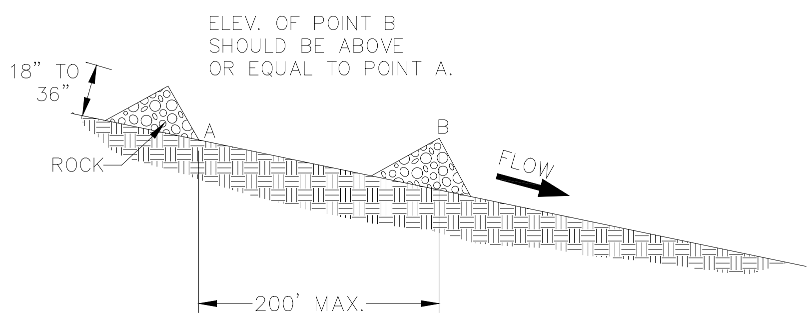
- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- Floatable Materials
- Construction Wastes

Impact

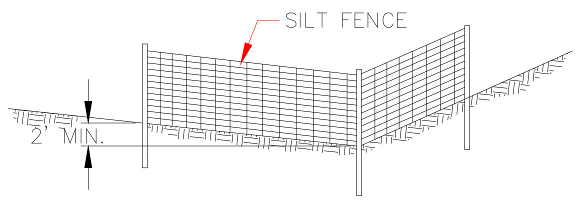
- ✓ Significant
- ✓ Medium
- Low
- Unknown or Questionable



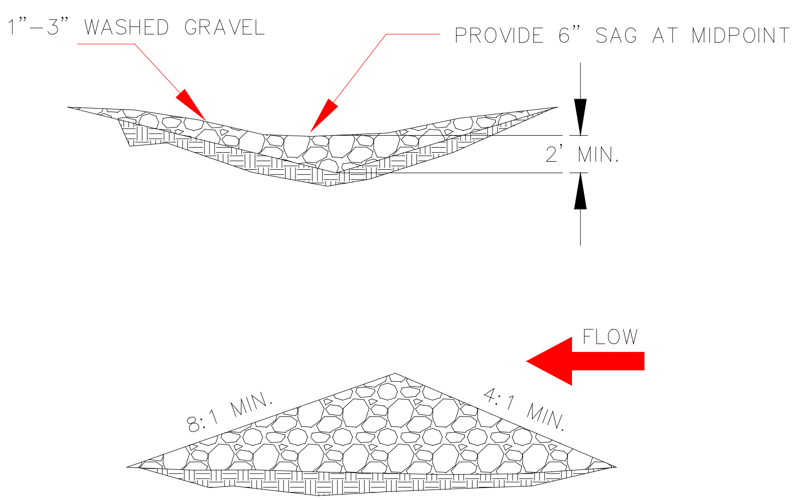
Check Dam (continued)



CHECK DAMS



TYPE I
SILT FENCE



TYPE II
STONE DAM

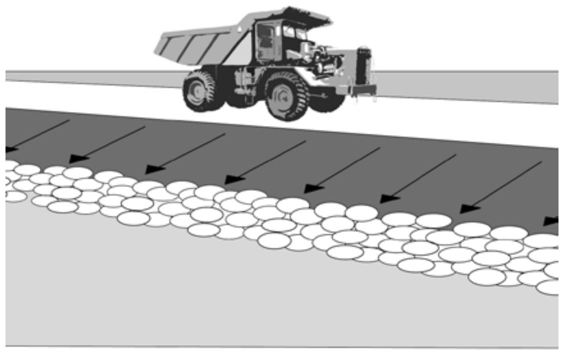
Check Dam (continued)

Check dams at roadside ditch

Check dam at roadside ditch

Check dams at median

Toe Rock



DESCRIPTION

Rock toe of slope protection is a rock or rip rap matrix placed against a failed portion of slope or at toe of slope to provide a buttress against additional failure and to provide a check structure at the toe of steep slopes. The weight and interlocking characteristics of large rip rap provides a stabilizing force.

PRIMARY USE

Steep slope stabilization and screening of flows at the toe of slopes.

APPLICATIONS

Typically utilized at toe of slopes draining to small streams or rovers, may also be utilized for slope and toe of slope protection. May be employed to stabilize small slides, or to protect grade transitions adjacent to small structures against erosion. Can be utilized as temporary BMP during construction phase.

LIMITATIONS

Toe rock protection does not provide protection against erosion due to overland flow

Fairly expensive for a temporary construction phase BMP.

Higher solids loading will cover BMP.

MAINTENANCE REQUIREMENTS

Inspections should be made on a monthly basis, especially after large storm events. If the rock becomes inundated with sediment, screening and reconstruction may be required.

Applications

- ✓ Perimeter Control
- ✓ Slope Protection
- ✓ Sediment Trapping
- Channel Protection
- ✓ Temporary Stabilization
- ✓ Permanent Stabilization
- Waste Management
- Housekeeping Practices

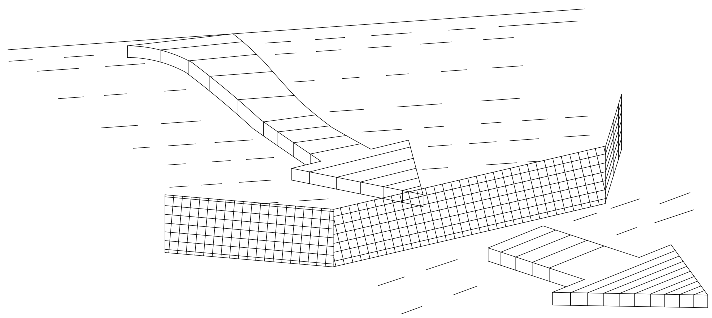
Targeted Constituents

- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- ✓ Floatable Materials
- Construction Wastes

Impact

- Significant
- ✓ Medium
- ✓ Low Unknown or Questionable

Silt Fence



DESCRIPTION

A silt fence consists of geotextile fabric supported by backing stretched between posts, with the lower edge securely embedded in soil downstream of disturbed areas. Intercepts runoff in the form of sheet flow and provides filtration, sedimentation, and velocity reduction.

PRIMARY USE

Silt fences are used as perimeter control downstream of disturbed areas, and for non-concentrated sheet-flow conditions.

APPLICATIONS

Silt fences provide an economical way to mitigate overflow, non-concentrated flows, and as a perimeter control device. Best with coarse to silty soil types and to control wind erosion on sandy soils.

LIMITATIONS

Minor ponding will likely occur at the upstream side of the silt fence, resulting in minor localized flooding.

Fences that are constructed in swales or low areas subject to concentrated flow may be overtopped, resulting in failure of the filter fence. Silt fences subject to areas of concentrated flow (waterways with flows >1 cfs) are not acceptable.

Silt fence can interfere with construction operations; therefore, planning of access routes onto the site is critical.

Silt fence can fail structurally under heavy storm flows, creating maintenance problems and reducing the effectiveness of the system.

MAINTENANCE REQUIREMENTS

Inspections should be made on a weekly basis, especially after large storm events. If the fabric becomes clogged, it should be cleaned or, if necessary, replaced.

Sediment should be removed when it reaches approximately one-half the height of the fence.

Applications

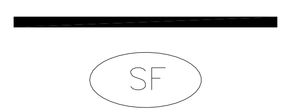
- ✓ Perimeter Control
- ✓ Slope Protection
- ✓ Sediment Trapping
- Channel Protection
- Temporary Stabilization
- Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

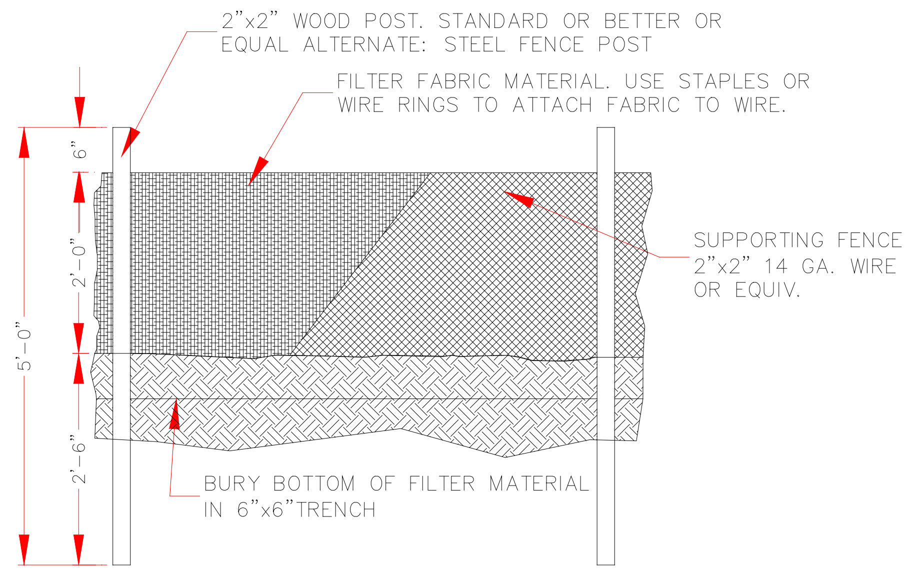
- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- ✓ Floatable Materials
- Construction Wastes

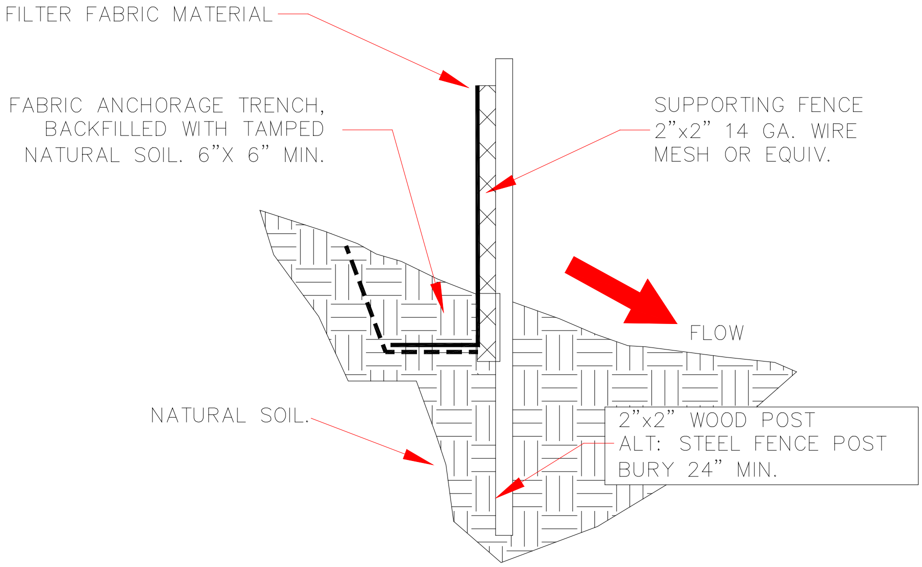
Impact

- ✓ Significant
- ✓ Medium
- Low
- Unknown or Questionable



Silt Fence (continued)





Silt Fence (continued)

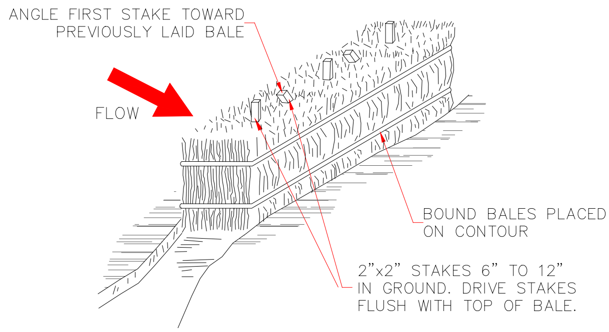
Silt fence in urban area

Silt fence in urban area

Silt fence in rural area

Silt fence at outlet of box

Straw Bale



ANCHORING DETAIL

Applications

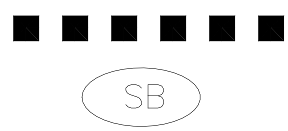
- ✓ Perimeter Control
- Slope Protection
- ✓ Sediment Trapping
- Channel Protection
- Temporary Stabilization
- Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- ✓ Floatable Materials
- Construction Wastes

Impact

- ✓ Significant
- ✓ Medium
- Low
- Unknown or Questionable



DESCRIPTION

A temporary barrier can be constructed of straw bales anchored with posts or stakes, which intercepts sediment-laden runoff from small, disturbed areas. Straw-bales barriers can provide filtration or serve as a dam/device to direct flow.

PRIMARY USE

Straw bales barriers trap sediment-laden runoff from small, relatively level areas; velocity reduction causes sediment to settle out.

APPLICATIONS

Straw bales barriers treat flow from small sites for short-duration projects. Can be used as check dams on small watercourses. Problems with uniformity, degradation and installation; residential applications suggested.

Sheet-Flow Applications

- Place the bales in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting.

LIMITATIONS

Due to a short effective life caused by biological decomposition, straw bales must be replaced after a period of no more than 3 months. During the wet and warm seasons, however, they must be replaced more frequently as is determined by periodic inspections for structural integrity.

Straw bale dikes are not recommended for use with concentrated flows.

The effectiveness of straw bales in reducing sediment is very limited. Improperly maintained, straw bales can have a negative impact on the water quality of the runoff.

Straw Bale (continued)

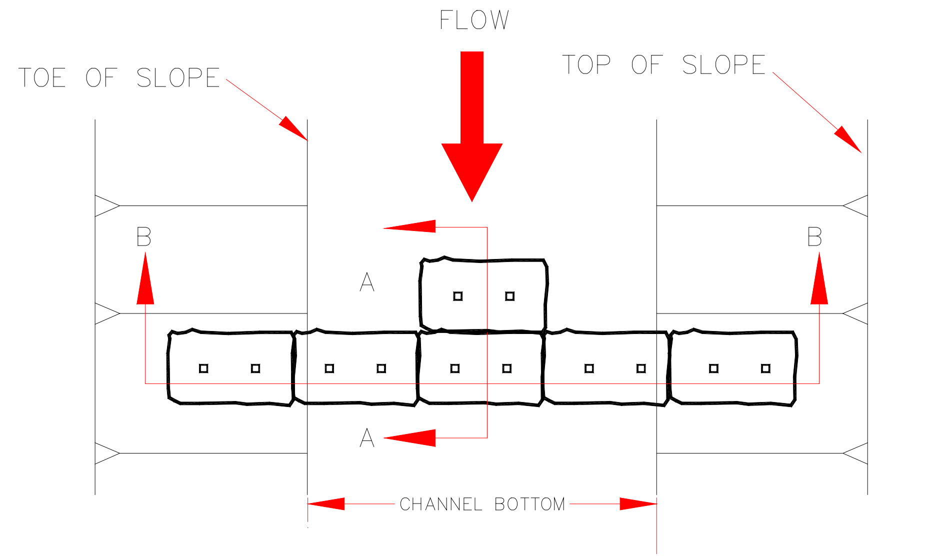
MAINTENANCE REQUIREMENTS

Straw bales shall be replaced if there are signs of degradation such as straw located downstream from the bales, structural deficiencies due to rotting straw in the bale, or other signs of deterioration. Sediment should be removed from behind the bales when it reaches a depth of approximately 6 inches.

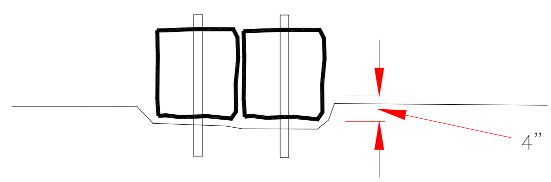
NOTES

- The straw bale barrier must be entrenched, anchored, and backfilled. A trench should be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked, the excavated soil must be backfilled against the barrier. Backfill soil should conform to the ground level on the downhill side and should be built up to 4 inches against the uphill side of the barrier.
- Each bale must be securely anchored by at least two wooden stakes driven toward the previously laid bale to force the bales together. Stakes should be driven 6–12 inches into the ground. Stakes should have a minimum diameter or cross section of 2 inches.
- All bales must be either wire-bound or string-tied.
- Fill gaps between bales by wedging with straw.
- Along toe of fills, install the straw bales along a level contour and leave enough area behind the barrier for runoff to pond and sediment to settle. A minimum of 5 feet away from the fill toe is recommended.
- Inspect frequently during construction. Repair or replacement should be made as promptly as needed.
- Remove sediment accumulated against the straw bale barrier when it reaches half the exposed barrier height.
- Remove bales after they have served their usefulness.
- Trenches where straw bales were located should be graded and stabilized.

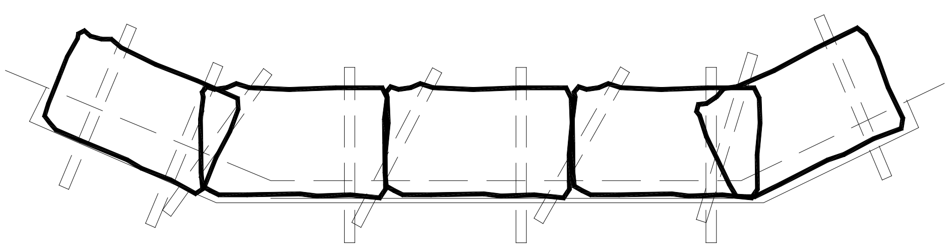
Straw Bale (continued)



STRAW BALE

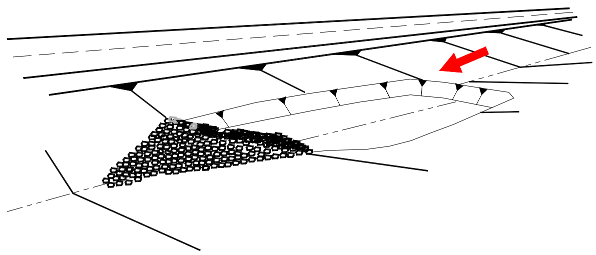


SECTION A-A



SECTION B-B

Sediment Trap – Berm/Excavated



DESCRIPTION

A sediment trap is a small temporary ponding area with a gravel outlet, either excavated or formed by an embankment.

PRIMARY USE

Sediment traps are used to collect and store sediment from small sites cleaned or graded during construction. A temporary measure maintained until permanent measures are installed.

APPLICATIONS

Sediment traps are used where the site area is less than ten acres, usually installed in drainage way or point of discharge from disturbed area.

LIMITATIONS

There are limited applications for sediment traps due to the cost of construction, the availability of materials, and the amount of land required.

Can cause minor flooding upstream of dam, impacting construction operations.

This technique serves as a temporary measure during construction. It should not be used for more than 18 months due to reduced efficiency.

MAINTENANCE REQUIREMENTS

Sediment shall be removed and the area directly behind the berm shall be re-graded to its original dimensions when the capacity of the impoundment has been reduced to one-half of its original storage capacity. The removed sediment shall be stockpiled or redistributed in areas that are protected from erosion.

The stone outlet structure should be inspected frequently and after each major rain event to check for clogging of the void spaces between stones. If the aggregate appears to be silted in such that efficiency is diminished, the stone should be replaced.

Applications

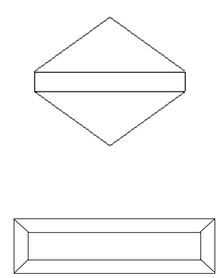
- Perimeter Control
- Slope Protection
- ✓ Sediment Trapping
- Channel Protection
- Temporary Stabilization
- Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

- ✓ Sediment
- Nutrients
- Toxic Materials
- Oil and Grease
- Floatable Materials
- Construction Wastes

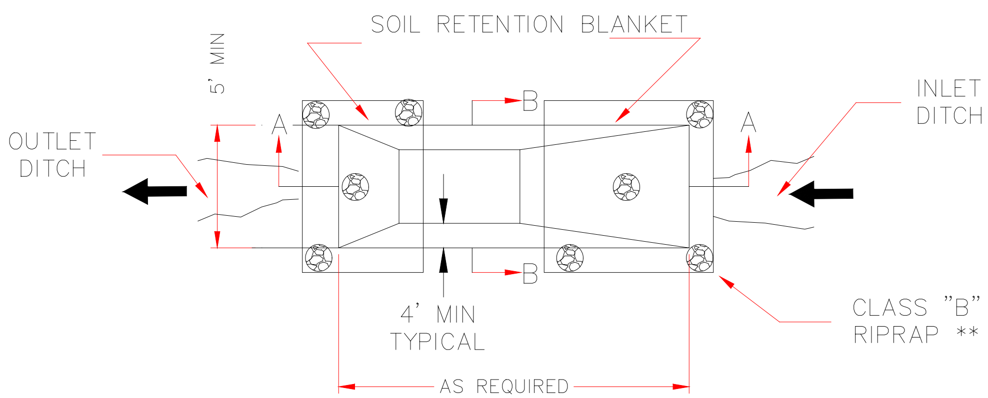
Impact

- Significant
- ✓ Medium
- Low
- Unknown or Questionable



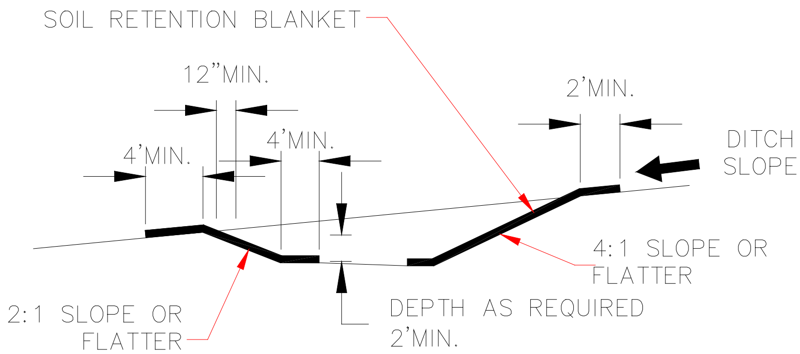
Sediment Trap – Berm/Excavated (continued)

EXCAVATED

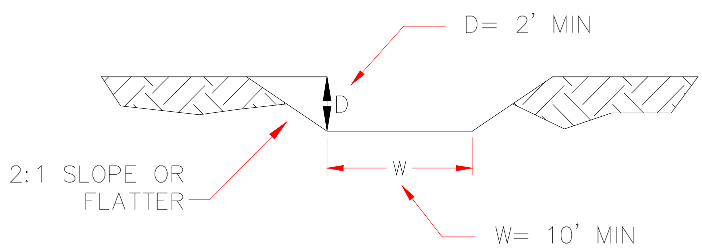


** NOTE: CLASS "B" RIPRAP INCIDENTAL TO PLACEMENT ON TEMPORARY SEDIMENT TRAP.

PLAN



SECTION A–A



SECTION B–B

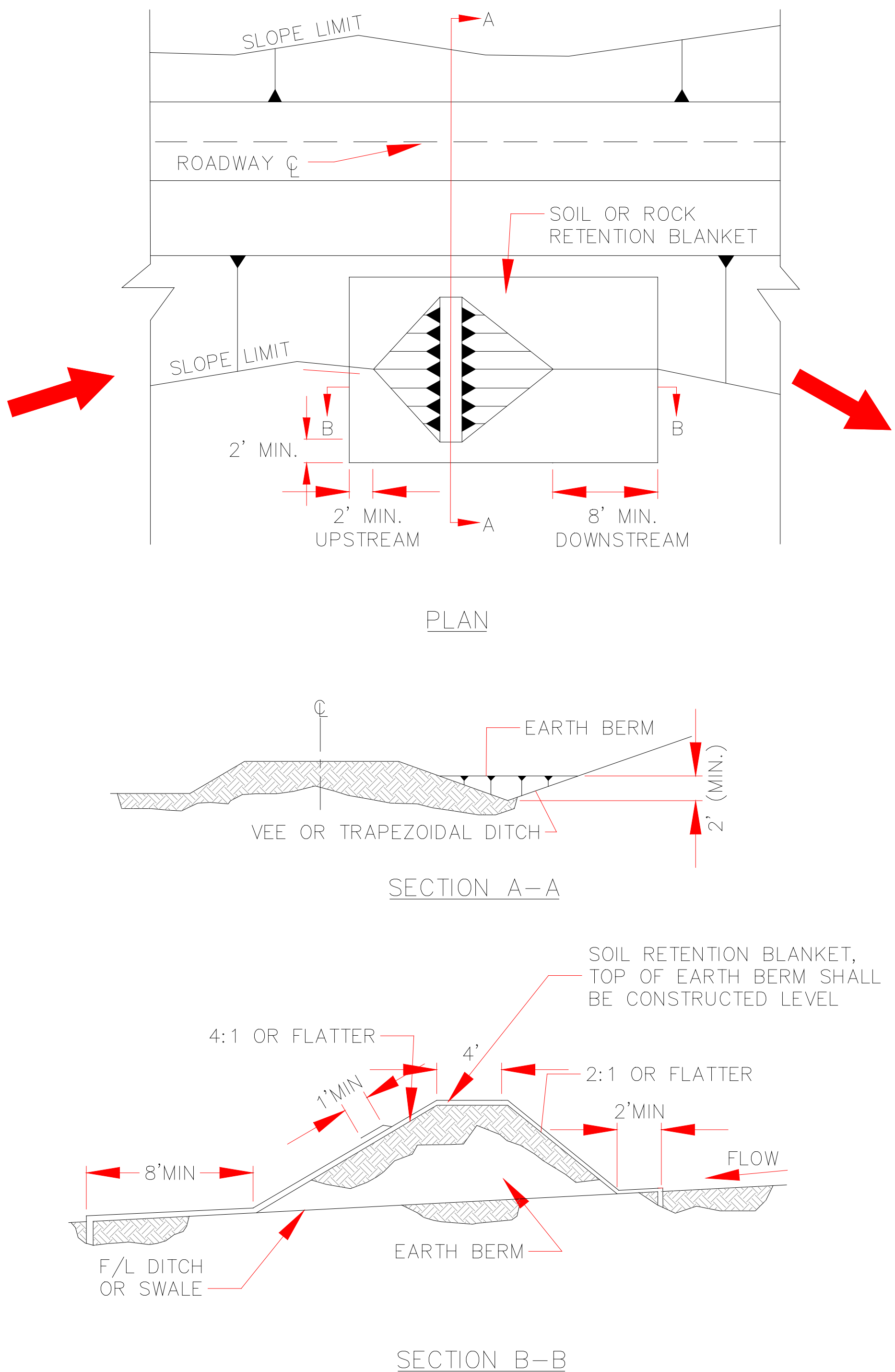
Sediment Trap – Berm/Excavated (continued)

NOTES

- Traps should be located at points of discharge from disturbed areas.
- A rectangular and shallow trap with a length-to-width ratio of 2:1 or greater is recommended.
- Maximum embankment height shall be 5 feet measured on the downstream side. The minimum top embankment width shall be 4 feet. Side slopes for the embankment and the excavated areas shall be 2:1 or flatter.
- The outlet structure shall consist of a stone section in the embankment formed by a combination coarse aggregate/riprap to provide for filtering/detention capability. Riprap shall be 4 inches to 8 inches of rock, while the coarse aggregate shall be ½ inch to ¾ inch.
- The outlet crest shall be at least 1 foot below the top of the embankment.
- The minimum outlet length in feet shall be 1.5 times the contributing drainage area to the trap.
- Sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.
- A geotextile can be placed at the stone-soil interface to act as a separator.
- Sediment shall be removed from the trap when the wet storage volume is reduced by one half.
- Outlet structure should be regularly inspected; rocks clogged with sediment shall be cleaned or replaced.

Sediment Trap – Berm/Excavated (continued)

EARTH BERM



Straw Wattle

DESCRIPTION

Geotextile fabric cylinders filled with rice straw.

PRIMARY USE

Used on bare, steep slopes to control sediment movement.

APPLICATIONS

Use anywhere on slopes to limit the length of flow and velocity to prevent sediment transport.

LIMITATIONS

May be a proprietary product. May not be considered a permanent measure.

MAINTENANCE REQUIREMENTS

Must be periodically replaced for long-term use.

Applications

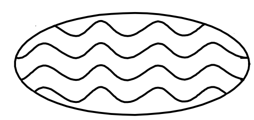
- Perimeter Control
- ✓ Slope Protection
- ✓ Sediment Trapping
- Channel Protection
- ✓ Temporary Stabilization
- Permanent Stabilization
- Waste Management
- Housekeeping Practices

Targeted Constituents

- ✓ Sediment
- Nutrients
- Toxic Materials
- ✓ Oil and Grease
- ✓ Floatable Materials
- Construction Wastes

Impact

- ✓ Significant
- Medium
- Low
- Unknown or Questionable



Straw Wattle (continued)

Straw wattles

Northeast Church Rock 30% Design Report

Appendix F:
Mine Site Stormwater Controls

MWH® now part of Stantec

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LIST OF ATTACHMENTS

Attachment F.1 Hydraulic Analysis of the Mine Site Outlet Channel

LIST OF ACRONYMS / ABBREVIATIONS

AOC	Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery
GSR	Green and Sustainable Remediation
Mine Site	Northeast Church Rock Mine Site
MSOC	Mine Site outlet channel
NECR	Northeast Church Rock
NMDOT	New Mexico Department of Transportation
RA	Removal Action
RAO	Remedial Action Objective

F.1 INTRODUCTION

This appendix presents the design of permanent stormwater controls for the Northeast Church Rock (NECR) Mine Site (Mine Site) proposed as part of the Removal Action (RA). The intent of the proposed stormwater controls are to convey stormwater from the Mine Site in a way that prevents scour of the existing engineered channel and unimproved sections of the downstream Unnamed Arroyo No. 1. These improvements will provide 100-year flood protection to homes located near Unnamed Arroyo No. 1. Upstream of the Mine Site outlet channel and within the Mine Site area following removals, natural channel and arroyo formation would evolve over time. The stormwater controls discussed in this appendix correspond to Section 6 of the Design Drawings.

F.2 TASK SPECIFIC PERFORMANCE STANDARDS

The Performance Standards presented here are defined in the Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site (2011 Action Memo; USEPA, 2011), the Record of Decision, United Nuclear Corporation Site, (USEPA, 2013), and the Administrative Settlement Agreement and Order on Consent for Design and Cost Recovery (AOC; USEPA, 2015) including the Statement of Work attached as Appendix D to the AOC, and were developed to define attainment of the Removal Action and Remedial Action Objectives (RAOs) for the Selected Remedy. The Performance Standards include both general and specific standards applicable to the Selected Remedy work elements and associated work components. Table F.2-1 lists performance standards applicable to stormwater controls at the Mine Site and summarizes how the design accomplishes these standards.

Table F.2-1: Performance Standards Applicable to Mill Site Stormwater Controls

Location of Performance Standard Requirement	Performance Standard	Comments
2011 Action Memo, Section V.A.1, Bullet 8 - Site Restoration	Restoration activities will include the backfilling and regrading of excavation areas for erosion and storm water control. These areas will also be re-vegetated with native species.	Grading plans for the Mine Site are shown in Appendix C and Section 3 Drawings. Revegetation is described in Appendix U.
2015 AOC SOW, Paragraph 27 – Site Restoration	In the Design, Respondents shall include detailed plans and specifications for restoration of the Tailings Disposal Area and borrow areas on the UNC Site and for restoration of the NECR Site. Respondents shall also include plans and specifications for contouring to promote drainage, and for re-vegetation of the Tailings Disposal Area, borrow pits and NECR Site with native species. Respondents shall include plans and specifications for backfilling and regrading of disturbed (e.g., excavated) areas in the NECR Site and the UNC Site for erosion and storm water control, including re-vegetation of those areas with native species.	Grading plans for the Borrow Areas are shown in Appendix H and Section 8 Drawings. Grading for the Tailings Disposal Area is described in Appendix G and the Section 7 Drawings. Revegetation is described in Appendix U.
2015 AOC SOW, Paragraph 28 – Long-term Storm Water Management	In the Design, Respondents shall include detailed plans and specifications for long-term storm water management for the restored NECR Site and for the UNC Site.	Section F.5 describes improvements to the engineered and unimproved reaches of Unnamed Arroyo No.1 from the Mine Site outlet. These improvements are designed to prevent channel overtopping and scour for the 100-year storm event. Long-term stormwater controls for the UNC site are described in Appendix I.
2015 AOC SOW, Paragraph 29 – Green Remediation Best Management Practices	Respondents shall incorporate applicable Best Management Practices for Green Remediation listed in ASTM-E2893-13 consistent with EPA's policy *Superfund Green Remediation Strategy* {2010}, found at http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf.	Section F.6 contains information on Green and Sustainable Remediation considerations. This section also references other appendices that describe best management practices in more detail.

F.3 ENGINEERING DESIGN DRAWINGS

The engineering design drawings for the Mine Site stormwater controls are contained in Volume II – Design Drawings (Section 6). The complete set of Drawings related to the Mine Site stormwater controls are listed in Table F.3-1 and referenced by drawing number in the text.

Table F.3-1: Engineering Design Drawings

Drawing No.	Drawing Title
6-01	Existing Condition
6-02	Outlet Existing Condition
6-03	Outlet Proposed Condition
6-04	Outlet Channel Profile
6-05	Culvert and Downdrain
6-06	Outlet Channel Details
6-07	Cutoff Wall Plan

F.4 STORMWATER CONTROLS DESIGN BASIS

The design basis for the Mine Site stormwater controls are summarized in Table F.4-1. The individual design basis items comply with regulatory requirements and/or generally accepted engineering practice and meet the overall project design criteria described in the NECR RA Design Work Plan (MWH, 2016).

Table F.4-1: Mine Site Stormwater Controls Design Basis

Design Category	Design Basis	Design Reference
Design Flow	100-year peak flow	Appendix I, Attachment I-1 (site hydrology)
Channel Sizing	Capacity for the design storm event plus a channel freeboard of 0.5 feet	Attachment B of MWH (2016), Attachment F.1
Erosion Protection Rock Sizing	Median riprap diameter equal to or greater than minimum required based on shear stress	Johnson (2002), Attachment F.1

As noted in Table F-4.1, the design event for the Mine Site stormwater controls is the 100-year flood (Appendix B of MWH, 2016). The 100-year flood is the base event for flood hazard designations in the Federal Emergency Management Agency's National Flood Insurance Program and the flood protection level used by banks and other lenders to require the purchase of flood insurance. The 100-year flood also meets or exceeds design standards for the New Mexico Department of Transportation (NMDOT) for rural area culverts (25-year storm), roadside ditches (10-year storm), and bridge scour (100-year storm). MWH estimated the 100-year flood as the peak flow from the 100-year storm at the outlet of the Mine Site and computed this value to be 218 cubic feet per second using a numerical rainfall-runoff model (HEC-HMS 4.1) (USACE, 2015). The model development methods and simulation results for the Mine Site stormwater hydrology are presented in Attachment I.1 of Appendix I.

F.5 MINE SITE OUTLET CHANNEL

The design for the Mine Site outlet channel (MSOC) would provide several improvements to the existing engineered and unimproved reaches of Unnamed Arroyo No. 1 downstream of the Mine Site outlet channel (Drawing 6-02). The intent of the improvements is to provide in-channel containment and erosion protection against the peak flow from the 100-year flood between the Mine Site outlet and the downstream arroyo (Unnamed Arroyo No. 2) that drains into the Pipeline Arroyo. The proposed channel improvements include the following:

- MSOC Inlet Structure (Drawings 6-03 and 6-07). The MSOC inlet structure would consist of a concrete grade control structure that would form the head of the MSOC. The structure would also have a flow control berm to direct flow into the MSOC.
- Box Culvert (Drawings 6-05 and 6-06). A 10-foot by 3-foot concrete box culvert would replace the three existing two-foot diameter corrugated metal pipe culverts between approximately Station 16+30 and Station 16+70. The concrete culvert would increase the capacity of the existing channel to allow conveyance of the 100-year storm.
- Containment Berm (Drawings 6-03 and 6-06). A one-foot earthen containment berm would line the top of both banks of the MSOC between approximately Station 9+50 and the culvert crossing (Station 16+30). The berm would tie into the culvert crossing on the north and tie into the existing earthen berm on the east. The containment berm would contain backwater from the culvert during the 100-year flood.
- Upsized Riprap (Drawing 6-06). Median diameter (D_{50}) 16-inch riprap would replace the existing D_{50} 7.5-inch riprap in the channel from approximately station 15+00 to the culvert. The larger riprap is estimated to provide erosion protection against the 100-year peak flow in the MSOC above the culvert with the steepest slopes.
- Rock Chute (Drawing 6-05 and 6-06). The engineered rock chute would provide a stable drop of storm flows up to the 100-year flood between the outlet of the box culvert and the Unnamed Arroyo No. 2 (MSOC Stations 16+35 to 18+35). The riprap size in the chute would have a D_{50} of 24 inches at the outlet of the box culvert and 16 inches in the main chute section.
- Chute Toe Protection (Drawing 6-05 and 6-06). Large riprap at the downstream end of the rock chute would provide protection to the rock chute against scour in Unnamed Arroyo No. 2. The riprap would have a D_{50} of 24 inches and would be keyed-in below the estimated 100-year storm scour depth caused by flow in Unnamed Arroyo No. 2 or by flow down the rock chute.

Attachment F.1 contains a calculation brief demonstrating the estimated effectiveness of these design elements.

F.6 GREEN AND SUSTAINABLE REMEDIATION CONSIDERATIONS

Below are green and sustainable remediation (GSR) considerations for Appendix F – Mine Site Stormwater Controls. GSR principles have been evaluated relating to: 1) construction materials (characteristics and manufacturing considerations), 2) construction methods, and 3) low impact/sustainability measures undertaken during construction.

F.6.1 Construction Materials

GSR considerations involving construction materials include requiring use of green concrete for channels and culverts (via technical specifications) and use of on-site, non-contaminated materials (soil and rock) for riprap and construction of berm sub-grades in order to limit fuel consumption and emissions due to transport of off-site materials.

F.6.2 Construction Methods

GSR considerations involving construction methods include requiring construction contractors to use correctly sized construction equipment to avoid higher greenhouse gas and dust emissions resulting from oversized construction equipment.

F.6.3 Low Impact/Sustainability Measures

Low impact/sustainability measures include using temporary stormwater controls (described in Appendix E and in the Section 5 Drawings) to segregate contaminated water from non-impacted water. Disturbed slopes in work areas would be protected by implementation of best management practices including temporary seeding, erosion control mats and silt fences.

F.7 REFERENCES

Johnson, T.L., 2002. Design of Erosion Protection for Long-Term Stabilization, U.S. Nuclear Regulatory Commission, September.

MWH, Inc. (MWH), 2016. Design Work Plan, Northeast Church Rock Mine Site Removal Action. March 17.

United States Army Corps of Engineers (USACE), 2015. Hydrologic Modeling System (HEC-HMS) Version 4.1, Build: 1628. July 31.

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ATTACHMENT F.1

Hydraulic Analysis of the Mine Site Outlet Channel

Client:	*General Electric/United Nuclear Corporation*	**Sheet:**	*1* of *7*
Project:	*NECR 30% Design*	**Date:**	*05/11/2016*
Description:	*Hydraulic Analysis of the Mine Site Outlet Channel*	**Job No:**	*10508639*

ATTACHMENT F.1: HYDRAULIC ANALYSIS OF THE MINE SITE OUTLET CHANNEL

Revisioning

Rev.	Date	Description	By	Checked	Date
0	*5/11/2016*	*Preliminary (30%) Design*	*J. Erickson*	*C. Michalos*	*5/20/2015*

Revisions

Issue Date	Description
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Location and Format

SharePoint\GE NECR Preliminary Design - Projec\Design\Stormwater_Hydrology_Hydraulics\Hydraulics\Calculations\

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Background 2
Applicable Codes and Standards 2
Methods 2
Results 6
Discussion 6

Objective

The objective of these calculations is to evaluate the suitability of the Mine Site Outlet channel to conveying the 100-year flood.

Background

The existing stormwater facilities at the Northeast Church Rock (NECR) Mine Site (Mine Site) includes a series of collection ponds that retain stormwater on site (see Section 6 Drawings). The existing facilities also include an engineered channel along the Unnamed Arroyo between the Mine Site Outlet and the culvert crossing approximately 1,600 feet to the northeast (see Section 6 Drawings) that was constructed as part of the Interim Removal Action (IRA) performed in 2010 (MWH, 2010). The IRA as-built drawings show that the channel is trapezoidal with bottom widths ranging from 10 to 25 feet (ft), the depth is 2 feet, and the channel has riprap protection with a median stone diameter (D_{50}) of 7.5 inches. At the bridge crossing, the IRA channel conveys flow into three 2-foot diameter corrugated metal pipe (CMP) culverts. Between the culverts and the confluence with the downstream arroyo that is tributary to the Pipeline Arroyo (Unnamed Arroyo No. 2), the Unnamed Arroyo is steep channel and highly eroded. Several residential structures are along the east side of the current IRA channel and one structure is located along the west side of the channel.

The Mine Site Removal Action (RA) includes removing the stormwater collection ponds. Stormwater at the Mine Site outlet would then be routed through the Unnamed Arroyo and discharge into the Unnamed Arroyo No. 2. MWH is proposing an improved Mine Site outlet channel (MSOC) along the alignment of the existing IRA channel and the unprotected section of the Unnamed Arroyo. The design of the MSOC is shown in the Section 6 drawings, and includes the following improvements to the current IRA channel and downstream Unnamed Arroyo:

- Station 0+00 and Station 18+35 - A concrete grade control structure at the head of the MSOC and a riprap grade control structure at the toe of the MSOC
- Station 9+50 to the culvert crossing (Station 16+28) - A 2-foot tall earthen containment berm along both the left and right banks of the MSOC
- Station 16+65 (downstream of the crossing) to Station 18+35 (MSOC outlet) - an engineered rock chute channel
- Station 15+00 to the culvert crossing (Station 16+28) - replacement of the existing median size (D_{50}) = 7.5 inches riprap with D_{50} = 16 inches riprap
- Station 16+28 – replacement of the three existing CMP culverts with a 10 ft wide span by 3 ft tall concrete box culvert (See Table 1)

This calculation brief provides the methods and results for the hydraulic evaluation of the MSOC design using the one-dimensional River Analysis System software developed by the U.S. Army Corps of Engineers – Hydrology Engineering Center (HEC-RAS) version 4.1.0.

Applicable Codes and Standards

The design criteria for the MSOC (Appendix B of MWH, 2016) states that the Mine Site stormwater controls will be designed for stability during the 100-year flood. This criteria does not stipulate a channel freeboard requirement. For this analysis, we have used a minimum freeboard of 0.5 feet.

Methods

Channel Geometry

MWH estimated the existing geometry for the IRA channel and downstream section of the Unnamed Arroyo from an aerial survey completed by Cooper Aerial Surveys Company in 2013. The survey has an expected accuracy of 1-foot horizontal and 0.5 feet vertical (MWH, 2014). MWH used ArcMap and HEC-GeoRAS to extract the channel alignment and cross section information from the survey. Using the extracted geometry, MWH designed the channel improvements to meet the design criteria for the MSOC. MWH also used interpolated cross-sections in the HEC-RAS model between the measured cross sections with a maximum spacing between interpolated cross sections of 20 feet.

Channel Roughness

MWH estimated Manning's roughness values for sections of the MSOC with a channel slope less than 10 percent (Station 0+00 to Station 16+28) using the Strickler equation as presented by USACE (1991).

$$n = Ck_s^{1/6} \qquad \text{Equation 1}$$

Where:

n = Manning's roughness coefficient
C = 0.034 for riprap stability computations; 0.038 for discharge capacity computations
K_s = D_{90} (diameter which is larger than 90 percent of the channel riprap) (feet)
*Riprap D_{90} was assumed to be equal to 1.5 times the riprap median stone diameter (D_{50}).

In sections of the MSOC where the channel slope is greater than 10 percent (Station 16+65 to Station 18+35), the Manning's roughness values was computed using the method by Rice et al. (1998).

$$n = 0.029(D_{50}S_o)^{0.147} \qquad \text{Equation 2}$$

Where:

D_{50} = median stone diameter of channel riprap (mm)
S_o = channel bed slope (ft/ft)

MWH assigned a Manning's roughness value of 0.05 for the overbank area adjacent to the riprap lined channel. This roughness is suggested in Chow (1959) for floodplains with scattered brush and heavy weeds.

Expansion Contraction Losses

The transitions in geometry between cross-sections along the MSOC upstream and downstream of the culvert are gradual and MWH assigned contraction and expansion loss coefficients of 0.1 and 0.3, respectively. The transitions in cross-sectional geometry in the vicinity of the culvert (Station 16+23 to 16+70) are more abrupt, and MWH used cross-section contraction and expansion loss coefficients of 0.3 and 0.5, respectively.

Flow Data and Boundary Conditions

MWH evaluated the capacity and erosional stability of the MSOC using the 100-year flood event. The peak discharge used in this analysis is 218 cubic feet per second (cfs). Calculations of the peak discharge are described in Attachment I-1 of Appendix I.

The HEC-RAS model simulations used a mixed flow regime, modeling both sub-critical and supercritical flows. To facilitate the mixed flow computations, MWH assumed initial boundary conditions at the upstream (Station 0+00) and downstream (Station 18+35) cross sections. The upstream boundary condition was assigned to be normal depth using a bed slope of 1.4 percent. The downstream boundary condition was set by estimating the water surface elevation in the Unnamed Arroyo No. 2 at the MSOC confluence using the normal depth for the coincident 100-year discharge in the Unnamed Arroyo No. 2.

Riprap Sizing

The HEC-RAS simulation results were used to evaluate the channel riprap revetment. For reaches with channel slopes less than 10 percent (Station 0+00 to 16+28), MWH computed the design riprap size using the shear stress method given by Johnson (2002).

$$D_{50} = \frac{t}{4.1} * 12$$ Equation 3

Where:

t = channel shear stress,

$t = \gamma_w * S_e * Y$ (pound per square foot)

γ_w = unit weight of water (62.4 pounds per cubic foot)

Y = maximum water surface depth (feet)

S_e = slope of the energy grade line (feet per feet)

For reaches with a channel slope greater than 10 percent (Station 16+65 to 18+35), MWH computed the design riprap size using the method provided by Robinson et al. (1998).

$$D_{50} = 0.69 * q^{0.529} * S_e^{0.307}$$ Equation 4

Where:

q = unit discharge (cubic feet per second per foot)

$q = V * Y$

V = average channel velocity (feet per second)

MWH determined the required riprap revetment for the earthen berm (D_{50b}) to be constructed from Station 9+50 to Station 16+28 using Equation 3 with replacement of Y with Y_b:

$$Y_b = Y - D$$ Equation 5

Where:

Y_b = maximum water surface depth over the berm (feet)

D = depth of existing riprap revetment (D = 2 feet)

MWH evaluated the riprap for the MSOC outlet toe structure using Equation 3. The maximum water surface depth at the toe structure was determined using Equation 6. The slope of the energy grade line (Se) was assumed to be equal to the channel slope in the Unnamed Arroyo No. 2 (0.009 feet per feet).

$$Y_a = Y_d + Z_g + Z_a$$ Equation 6

Where:

Y_a = potential depth of flow over the toe structure (feet)

Y_d = normal depth of flow in the Unnamed Arroyo No. 2 (feet)

Z_g = general scour depth in the Unnamed Arroyo No. 2 (feet)

Z_a = anti-dune scour depth in the Unnamed Arroyo No. 2 (feet)

MSOC Outlet Toe Depth

Where the MSOC discharges into the Unnamed Arroyo No. 2, MWH designed a riprap toe to mitigate potential scour in the Unnamed Arroyo No. 2 from undermining the MSOC riprap. MWH evaluated the design depth of the riprap toe against the potential scour depth in the Unnamed Arroyo No. 2. The evaluation considered two modes of scour: (1) scour from peak flows in the Unnamed Arroyo No. 2, and (2) impact scour from the flow from the MSOC entering the Unnamed Arroyo No. 2.

MWH estimated the scour depth from flow in the Unnamed Arroyo No. 2 by computing the sum of the estimated general and anti-dune scour in the Unnamed Arroyo No. 2 using the methods from Zeller (1981) for general scour (Equation 7) and the method from Simons, Li and Associates (1986) for anti-dune scour (Equation 8):

$$Z_g = Y_d \left(\frac{0.0685\, {V_d}^{0.8}}{{Y_h}^{0.4} S^{0.3}} - 1 \right) \qquad \text{Equation 7}$$

Where:

- Z_g = general scour depth (feet)
- Y_d = normal depth of flow (feet)
- V_d = average velocity (feet per second)
- Y_h = hydraulic depth (feet)

$$Y_h = \frac{A_d}{T_d}$$

- A_d = cross-sectional area of flow (feet squared)
- T_d = top width of flow (feet)
- S = channel slope (feet per feet)

$$Z_a = 0.0137\, V_d^2 \qquad \text{Equation 8}$$

Where:

- Z_a = anti-dune scour depth in the Unnamed Arroyo No. 2 (feet)

MWH estimated the scour hole caused by flow from the MSOC by approximating the flow from the MSOC as a jet impinging into the bed of the Unnamed Arroyo No. 2 and using the scour hole method presented by Mason (2011):

$$P = K \frac{q^{0.60} H^{0.05} Y^{0.15}}{g^{0.3} \frac{d}{12}^{0.1}} \qquad \text{Equation 9}$$

Where:

- P = Pool depth developed by flow from the MSOC (feet)
- K = 3.27
- H = total channel head (feet)

$$H = Y + \frac{V^2}{2*g}$$

*Value for Y and V were taken from the HEC-RAS model at Station 18+35

- Y = depth of flow in the MSOC (feet)
- V = flow velocity in the MSOC (feet per second)
- g = gravitational acceleration (32.2 feet per second squared)
- d = median particle diameter in the Unnamed Arroyo No. 2 bed, (assumed to be 0.04 inches)

The potential channel bed scour depth caused by flow from the MSOC was determined as follows;

$$Z_m = P - T_d \qquad \text{Equation 10}$$

Where:

- Z_m = scour depth caused by imping jet flow (feet)
- T_d = tailwater depth, water surface depth in the Unnamed Arroyo No. 2 (feet)

$$T_d = Y_d^* + Z_g + Z_a$$

- Y^*_d = normal depth of flow estimated for two thirds the 100-year discharge in the Unnamed Arroyo No. 2 (feet)
- *if Z_m is less than zero, no scour caused by impinging flow from the MSOC is predicted.

MWH estimated the hydraulic parameters in the Unnamed Arroyo No. 2 (V_d, A_d, T_d, Y_d and Y^*_d) by assuming normal depth calculated using the Hydraulic Toolbox version 4.1 developed for the Federal Highways Administration.

Client:	*General Electric/United Nuclear Corporation*	**Sheet:**	*6* of *7*
Project:	*NECR 30% Design*	**Date:**	*05/11/2016*
Description:	*Hydraulic Analysis of the Mine Site Outlet Channel*	**Job No:**	*10508639*

Results

Table 2 summarizes the channel Manning's roughness values assigned in HEC-RAS and the estimated available freeboard in the channel for each channel cross-section. **Figures 1a and 1b** also show the simulated channel water surface elevations.

Table 3 presents the estimated shear stress and minimum required riprap at each channel cross section. The minimum required riprap for the MSOC toe is 16 inches.

The estimated scour depth at the MSOC outlet and the minimum riprap toe depth are summarized in **Table 4** and the calculation worksheet for the scour depth estimates is provided in **Attachment A**.

Discussion

Table 2 shows that the design for the MSOC provides sufficient capacity to convey the 100-year flood with a minimum channel freeboard of 0.5 feet (minimum channel freeboard at Station 6+78) from Stations 0+00 to 17+85. From Station 17+85 to 18+35 the channel would be submerged by backwater from the Unnamed Arroyo No. 2 (see **Figure 1a**). Submergence of the channel in this location would not result in loss of containment of flows.

Table 3 shows that the existing riprap in the MSOC (D_{50} = 7.5 inches) from Stations 0+00 to 15+00 exceeds the minimum required D_{50} riprap size through the reach (minimum required D_{50} = 5.5 inches at Station 7+90) for the post RA conditions. The riprap proposed for stations 14+92 to 16+25 (D_{50} = 16 inches) exceeds the minimum required D_{50} riprap size through the reach (minimum required D_{50} = 12.7 inches at Station 15+59). At the culvert outlet (Station 16+65) riprap with median stone diameter larger than 19 inches would be required for a short distance downstream of the culvert. MWH has proposed riprap with a median stone diameter of 24 inches be placed at the culvert outlet (see Detail 2 of Sheet 6-06). Downstream of Station 16+65 to the channel outlet (Station 18+35), the proposed riprap (D_{50} = 16 inches) exceeds the minimum required D_{50} riprap size (minimum required D_{50} = 13.6 inches at Station 16+73).

Table 3 also shows the minimum required riprap D_{50} for the earthen berm (constructed between Station 9+50 to Station 16+25) is 1.0 inches. MWH has proposed a layer of D_{50} = 1.0 inches on the earthen berms.

Table 4 shows that the minimum required MSOC toe depth is 4.1 feet. This is the sum of 1.7 feet of predicted general scour and 2.4 feet of predicted anti-dune scour in the Unnamed Arroyo No. 2. The predicted tail water depth (T_d) in the Unnamed Arroyo No. 2 (8.8 feet) is greater than the predicted pool depth (8.4 feet) to be created by flow from the MSOC; therefore, no scour in the Unnamed Arroyo No. 2 is predicted as a result of impinging flow from the MSOC. MWH has proposed the toe be buried at a depth of 6 feet using 24 inch (D_{50}) riprap (See Detail 3 on Sheet 6-06).

Attachments

Calculation worksheets are provided in **Attachment A.**

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TABLES

Table 1: Concrete Box Culvert Hydraulic Characteristics

Material & Type	Concrete Box
Span x Rise	10 feet x 3 feet
Length	37 feet
Entrance Loss Coeff.	0.5
Manning's Roughness	0.011
Inlet Type	Sides Extended Straight Chart #8 – Flared wingwalls Scale #3 – Wingwall flared 0 deg.

Table 2: Channel Capacity Evaluation Results

River Sta	Manning's Roughness (Capacity) Slope (ft/ft)	Riprap D50 (in)	Riprap D90 (in)	Channel Roughness n	HEC-RAS Model Results Min Ch El (ft)	W.S. Elev (ft)	Left Bank Elevation (ft)	Right Bank Elevation (ft)	Channel Freeboard Left Bank (ft)	Right Bank (ft)
98	-	7.5	11.25	0.038	7039.6	7041.2	7043.0	7043.0	1.8	1.8
164	-	7.5	11.25	0.038	7038.3	7040.0	7041.0	7041.1	1.1	1.2
261	-	7.5	11.25	0.038	7036.6	7038.5	7039.6	7039.3	1.1	0.8
344	-	7.5	11.25	0.038	7035.8	7037.6	7038.7	7038.6	1.1	1.0
457	-	7.5	11.25	0.038	7034.4	7035.9	7036.8	7036.9	0.8	1.0
513	-	7.5	11.25	0.038	7033.0	7035.2	7035.8	7035.8	0.6	0.6
572	-	7.5	11.25	0.038	7032.8	7034.2	7035.3	7035.4	1.1	1.2
629	-	7.5	11.25	0.038	7031.4	7033.3	7034.0	7034.0	0.7	0.7
678	-	7.5	11.25	0.038	7030.9	7032.6	7033.1	7033.2	0.5	0.6
739	-	7.5	11.25	0.038	7030.1	7031.7	7032.3	7032.3	0.7	0.6
790	-	7.5	11.25	0.038	7029.2	7030.8	7031.8	7031.5	1.0	0.8
844	-	7.5	11.25	0.038	7028.5	7029.9	7031.4	7031.1	1.6	1.2
911	-	7.5	11.25	0.038	7027.2	7028.5	7030.3	7030.3	1.8	1.8
968	-	7.5	11.25	0.038	7026.4	7028.0	7029.5	7029.1	2.6	1.1
1034	-	7.5	11.25	0.038	7025.5	7027.3	7028.6	7028.6	2.3	1.3
1118	-	7.5	11.25	0.038	7024.4	7026.3	7028.0	7028.0	2.7	1.8
1172	-	7.5	11.25	0.038	7023.9	7025.4	7026.8	7026.9	2.4	1.4
1235	-	7.5	11.25	0.038	7022.8	7024.7	7026.0	7026.0	2.3	1.3
1298	-	7.5	11.25	0.038	7022.3	7023.9	7025.3	7025.0	2.4	1.1
1338	-	7.5	11.25	0.038	7021.4	7023.4	7024.7	7024.8	2.3	1.3
1394	-	7.5	11.25	0.038	7020.7	7022.8	7023.9	7023.9	2.1	1.1
1443	-	7.5	11.25	0.038	7020.4	7022.0	7023.1	7022.9	2.1	0.9
1493	-	16	24	0.043	7019.0	7021.0	7022.0	7022.0	2.0	1.1
1544	-	16	24	0.043	7018.0	7019.9	7021.0	7020.4	2.1	0.5
1559	-	16	24	0.043	7017.4	7019.1	7020.7	7020.0	2.6	0.9
1588	-	16	24	0.043	7016.1	7018.8	7020.2	7019.3	2.4	0.4
1600	-	16	24	0.043	7015.2	7018.9	7019.8	7019.4	1.9	0.5
1618	-	16	24	0.043	7014.3	7018.9	7019.8	7020.5	1.9	1.6
1626	-	16	24	0.043	7014.3	7018.6	7020.1	7020.4	2.5	1.8
Box Culvert										
1668	0.142	16	-	0.053	7012.8	7014.5	7015.76	7015.76	1.22	1.22
1673	0.142	16	-	0.053	7012.1	7012.7	7015.05	7015.05	2.40	2.40
1710	0.142	16	-	0.053	7006.8	7007.7	7009.79	7009.79	2.09	2.09
1735	0.142	16	-	0.053	7003.2	7004.0	7006.23	7006.23	2.28	2.28
1760	0.142	16	-	0.053	6999.7	7000.5	7002.67	7002.67	2.16	2.16
1785	0.142	16	-	0.053	6996.1	6996.9	6999.12	6999.12	Channel submerged by backwater	
1810	0.142	16	-	0.053	6992.6	6997.3	6995.56	6995.56	from the Unnamed Arroyo No. 2	

Table 3: Channel Stability Evaluation Results

	Manning's Roughness (Stability)				HEC-RAS Model Results						Riprap Stability				
River Sta	Slope	Riprap D50	Riprap D90	Channel Roughness	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Froude Number	Flow Depth	Max Channel Shear	D50 (Sta. 0+00 to 16+25)	Unit Discharge	D50 (Sta. 16+65 to 18+25)	Earthen Berm Riprap D50b (Sta. 9+50 to 16+25)
	(ft/ft)	(in)	(in)	n	(ft)	(ft)	(ft/ft)	(ft/s)		(ft)	(lbs/ft2)	(in)	(cfs/ft)	(in)	(in)
98	-	7.50	11.25	0.03	7039.62	7041.10	0.01	5.69	0.93	1.48	1.30	3.82	-	-	-
164	-	7.50	11.25	0.03	7038.27	7039.68	0.02	6.44	1.17	1.41	2.10	6.16	-	-	-
261	-	7.50	11.25	0.03	7036.62	7038.41	0.01	5.11	0.82	1.79	1.22	3.58	-	-	-
344	-	7.50	11.25	0.03	7035.77	7037.49	0.01	4.95	0.82	1.72	1.20	3.50	-	-	-
457	-	7.50	11.25	0.03	7034.42	7035.88	0.02	5.50	1.00	1.46	1.59	4.66	-	-	-
513	-	7.50	11.25	0.03	7033.03	7035.11	0.01	4.02	0.62	2.08	0.78	2.29	-	-	-
572	-	7.50	11.25	0.03	7032.82	7034.21	0.02	5.80	0.99	1.39	1.41	4.14	-	-	-
629	-	7.50	11.25	0.03	7031.36	7033.27	0.01	4.02	0.62	1.91	0.70	2.05	-	-	-
678	-	7.50	11.25	0.03	7030.87	7032.51	0.01	4.87	0.80	1.64	1.06	3.11	-	-	-
739	-	7.50	11.25	0.03	7030.14	7031.60	0.02	5.73	0.99	1.46	1.50	4.40	-	-	-
790	-	7.50	11.25	0.03	7029.16	7030.49	0.02	6.36	1.15	1.33	1.89	5.52	-	-	-
844	-	7.50	11.25	0.03	7028.47	7029.88	0.02	5.54	1.01	1.41	1.56	4.57	-	-	-
911	-	7.50	11.25	0.03	7027.16	7028.47	0.01	4.79	0.85	1.31	1.00	2.91	-	-	-
968	-	7.50	11.25	0.03	7026.35	7027.87	0.01	4.36	0.74	1.52	0.87	2.56	-	-	-
1034	-	7.50	11.25	0.03	7025.49	7027.22	0.01	4.48	0.77	1.73	1.06	3.11	-	-	0.00
1118	-	7.50	11.25	0.03	7024.42	7026.20	0.01	5.01	0.81	1.78	1.16	3.40	-	-	0.00
1172	-	7.50	11.25	0.03	7023.89	7025.35	0.01	5.41	0.92	1.46	1.27	3.73	-	-	0.00
1235	-	7.50	11.25	0.03	7022.77	7024.65	0.01	3.95	0.64	1.88	0.77	2.25	-	-	0.00
1298	-	7.50	11.25	0.03	7022.33	7023.90	0.02	5.45	0.98	1.57	1.63	4.76	-	-	0.00
1338	-	7.50	11.25	0.03	7021.40	7023.33	0.01	4.64	0.74	1.93	1.03	3.02	-	-	0.00
1394	-	7.50	11.25	0.03	7020.71	7022.68	0.01	5.28	0.88	1.97	1.56	4.56	-	-	0.00
1443	-	7.50	11.25	0.03	7020.44	7021.98	0.02	5.62	0.98	1.54	1.57	4.59	-	-	0.00
1493	-	16.00	24.00	0.04	7019.04	7020.86	0.02	5.22	0.87	1.82	1.76	5.17	-	-	0.00
1544	-	16.00	24.00	0.04	7018.04	7019.93	0.02	6.13	0.96	1.89	2.15	6.29	-	-	0.00
1559	-	17.00	25.50	0.04	7017.39	7019.05	0.04	8.12	1.41	1.66	4.34	12.70	-	-	0.00
1588	-	18.00	27.00	0.04	7016.09	7018.79	0.01	4.65	0.57	2.70	0.97	2.84	-	-	0.74
1600	-	19.00	28.50	0.04	7015.18	7018.86	0.00	3.24	0.35	3.68	0.49	1.43	-	-	0.65
1618	-	20.00	30.00	0.04	7014.27	7018.88	0.00	2.48	0.25	4.61	0.30	0.87	-	-	0.50
1626	-	21.00	31.50	0.04	7014.25	7018.58	0.00	4.55	0.40	4.33	0.61	1.78	-	-	0.96
Box Culvert															
1668	0.13	16.00	-	0.05	7013.15	7014.94	0.03	7.62	1.00	1.79	-	-	13.64	19.44	-
1673	0.13	16.00	-	0.05	7012.51	7013.12	0.34	11.36	2.65	0.61	-	-	6.93	13.59	-
1710	0.13	16.00	-	0.05	7010.81	7011.69	0.09	7.62	1.49	0.88	-	-	6.71	13.36	-
1735	0.13	16.00	-	0.05	7007.17	7007.99	0.12	8.18	1.65	0.82	-	-	6.71	13.36	-
1760	0.13	16.00	-	0.05	7000.92	7001.72	0.13	8.32	1.69	0.80	-	-	6.66	13.30	-
1785	0.13	16.00	-	0.05	6994.61	6997.29	0.00	2.16	0.25	2.68	-	-	5.79	12.36	-
1810	0.13	16.00	-	0.05	6991.10	6997.33	0.00	0.81	0.06	6.23	-	-	5.05	11.49	-

Table 4: Scour Depth and Minimum Required Riprap Toe Depth

Unnamed Arroyo No. 2 General Scour Depth, Zg (feet)	1.7
Unnamed Arroyo No. 2 Anti-Dune Scour Depth, Za (feet)	2.4
Predicted Tail Water Depth, Td (feet)	8.8
Potential Scour Pool Depth Created by Flow from the MSOC, P (feet)	8.4
*Scour from Flow in MSOC, Zm (feet)	0
Minimum Required Riprap Toe Depth (feet)	4.1
Design Riprap Toe Depth (feet)	6.0
*the predicted tail water depth is greater than the likely pool depth formed from the MSOC; therefore, no scour caused by the MSOC is predicted	

FIGURES

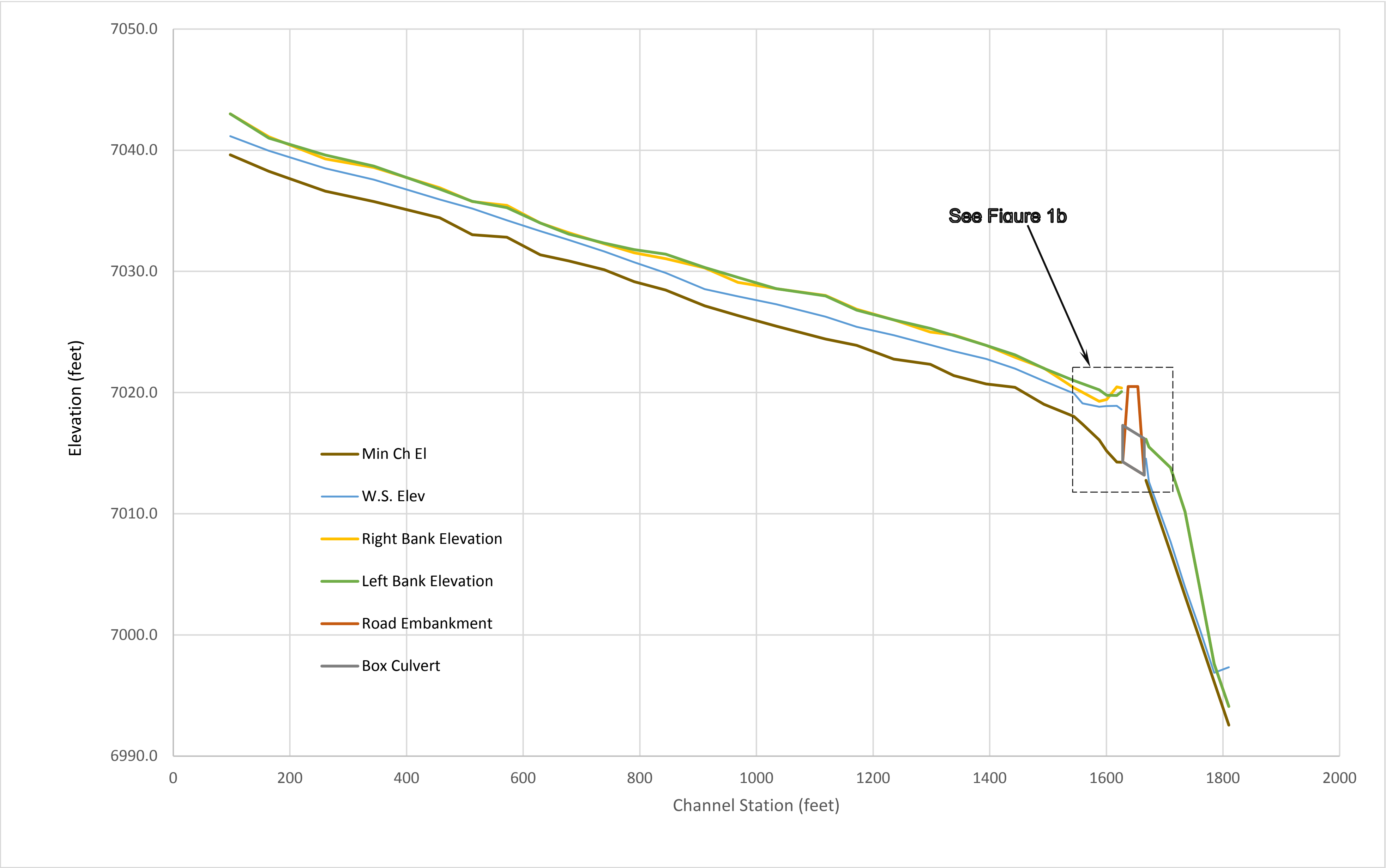

Figure 1a: HEC-RAS Model Results for Capacity

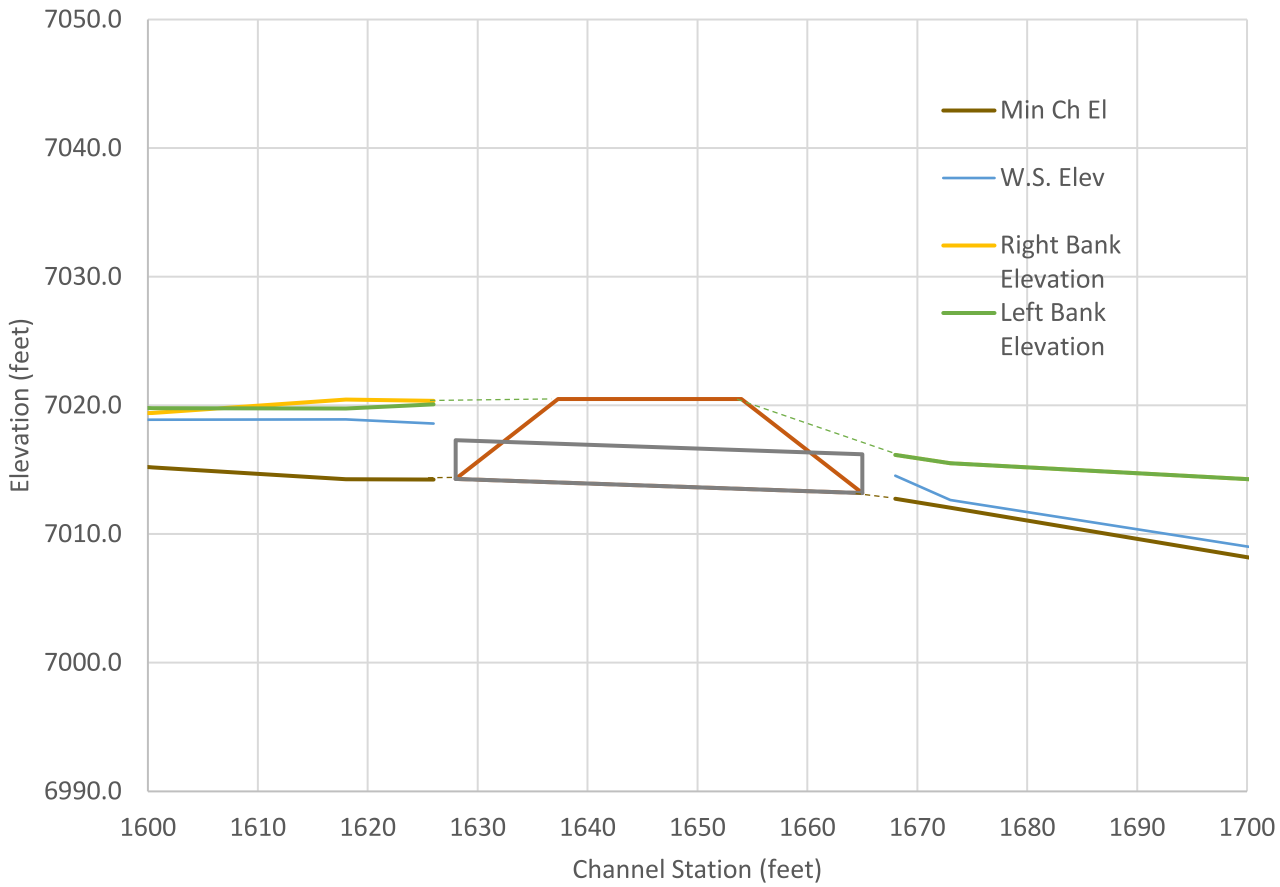

Figure 1b: HEC-RAS Model Results for Capacity in the Vicinity of the Culvert Crossing

ATTACHMENT A
CALCULATION WORKSHEETS

Riprap Toe Depth Calculation Sheet

Estimate of Potential Scour Depth from Flow in the West Fork Arroyo

General Scour from XXX Arroyo		*Zeller, M.E. 1981. Scour Depth Formula for Estimation of Toe Protection*
General scour depth, Zg (ft) :	1.7	Zgs = Ymax*(0.0685*Vm^.8/(Yh^0.4*Se^0.3)-1) (Zeller, 1981)
Average flow velocity, Vm (fps) :	13.2	
Maximum depth of flow, Yd (ft) :	5.63	From xxx arroyo normal depth evaluation using FHWA's hydraulic toolbox
Cross-sectional area of flow, A (ft2) :	154	
Top water surface width, T (ft) :	40	
Hydraulic depth of flow, Yh (ft) :	3.84	Yh = A/T
Slope of energy grade line, S (ft) :	0.009	From survey data

Anti-Dune Scour from XXX Arroyo		*Simons, Li & Associates. 1986. Hydraulic Model Study of Local Scour*
Anti-dune trough depth, Za (ft) :	2.4	Za = 0.0137*Vm^2 (Simons, 1986)

Total Scour from XXX Arroyo		
Total Scour Depth, Zt (ft) :	4.1	Zt = Zg + Za

West Fork Arroyo Normal Depth Calculation

Discharge	2030	cfs
Slope	0.009	
Roughness	0.025	
Depth, Yd	5.6	feet
Area of Flow	153.6	sq ft
Wetted Perimeter	42.8	ft
Hydraulic Radius	3.6	ft
Average Velocity	13.2	fps
Top Width (T)	40.0	ft
Froude Number	1.2	

Estimate of Scour Depth from Flow in the in the MSOC

Scour from MSOC Rock Chute		*Mason, P.J. 2011. Plunge Pool Scour: an Update*
Scour Depth, Z (ft) :	-0.42	Zm = P-Td (If Z<0 then no scour is predicted as a result of MSOC flow)
Tailwater Depth, Td (ft) :	8.78	Depth of flow after general scour (Zg) and Anti-Dune Scour
Scour Hole Pool Depth, P (ft) :	8.36	Scour depth from tail-water level to base of scour hole
Constant, K :	3.27	Constant
Channel Velocity, V (fps) :	8.32	From HEC-RAS Model
Channel Flow Depth, Y (ft) :	0.81	From HEC-RAS Model
Unit Discharge, q (cfs/ft) :	6.74	q = V*Y
Total Channel Head, H (ft) :	1.88	H = Y+V^2/(2*32.2)
DS River Depth, h (ft) :	4.69	Downstream water depth above the river bed
Median Particle Diameter, D50 (in) :	0.04	Assumed Value

West Fork Arroyo Normal Depth Calculation

Discharge, Q^*_d	1353	cfs (Q=2/3*Qp100)
Slope	0.009	
Roughness	0.025	
Depth, Y^*_d	4.7	feet
Area of Flow	116.9	sq ft
Wetted Perimeter	39.8	ft
Hydraulic Radius	2.9	ft
Average Velocity	11.6	fps
Top Width (T)	37.7	ft
Froude Number	1.2	

MSOC Outlet Toe Depth (feet) : 4.1