be required for rock. Soils shall be uncontaminated and free from ore, tailings materials, and rock larger than 6 inches in diameter, debris, roots, branches, stumps, or other organic matter. In the case of materials for the final reclamation cover, soils shall be primarily fine-grained or shall be mixed with other soils to achieve a homogeneous, predominately fine-grained mixture.

Soil to be used in the radon attenuation soil cover shall have a particle size distribution that is within the limits shown on Figure B-1 and classify as a silty clay (CL), clayey sand (SC), silt (ML), or silty sand (SM). The above soil types will be blended during excavation and construction to provide a homogeneous mixture. This soil mixture shall fit within specified gradation envelope to be consistent with the soil-cover design.

## 9.2 Products

Not applicable.

## 9.3 Execution

### 9.3.1 Existing Haul Road Grading

During final reclamation, in areas where the existing haul road alignment passes directly over tailings materials, sufficient soils shall be placed to provide the minimum cover thickness as specified in Section 10.0 - Final Reclamation Excavation and Grading. Additionally, existing haul roads which traverse the embankment shall be removed prior to completion of final reclamation. The final configuration shall meet the lines and grades shown on the Drawings.

Throughout construction operations, haul roads shall be maintained in a satisfactory condition and shall be graded and filled as necessary to allow year-round access.

Prior to completion of final reclamation, the haul roads shall be graded and covered with soil/rock matrix in accordance with Section 12.0 - Final Reclamation Revegetation.

9.3.2 Access Road Grading

Access roads shall be maintained to provide vehicular access via 20-foot minimum width roads in the locations shown on the Drawings, in addition to access provided by the haul roads. The surface of the access roads shall be cleared of obstructions, evenly graded, and maintained in a condition meeting approval. Access roads shall be graded and filled as necessary to allow year-round access.

The access roads shall be graded over and revegetated in accordance with Section 12.0 - Final Reclamation Revegetation, prior to completion of final reclamation.

# 10.0 FINAL RECLAMATION EXCAVATION AND GRADING

## 10.1 General

### 10.1.1 Scope of Work

Unless otherwise specified, labor, materials and required equipment shall be provided, and operations related to final reclamation excavation and grading shall be conducted in accordance with the Drawings and these Specifications.

Work shall include, but not be limited to, the following:

1. Grading for haul/access roads;

2. Excavation and grading for modification of the Pipeline Arroyo;

3. Excavation and grading of other surface water control channels and ditches; and

4. Placement and grading of final reclamation soil cover materials.

Areas subjected to earthwork operations identified herein shall be staked. All surveying necessary to conduct earthwork to the lines and grades specified shall be provided.

### 10.1.2 Related Work

1. Section 7.0 - Mill Decommissioning

2. Section 8.0 - Final Reclamation Clearing and Grubbing

3. Section 9.0 - Final Reclamation Haul Roads/Access Roads

4. Section 11.0 - Final Reclamation Surface Water Control Structures.

10.1.3 Definitions

For the purposes of the work required, the following definitions shall identify the earth materials used during construction.

Soil - Soil consists of all earth materials capable of being excavated with conventional earthwork excavation equipment without the use of rippers, hammers, or blasting as may be required by rock. Soils shall be uncontaminated and free from ore and tailings materials, rocks larger than 6 inches in diameter, debris, roots, branches, stumps, or other organic matter. In the case of materials for final reclamation cover, soils shall be primarily fine-grained or shall be mixed with other soils to achieve a homogeneous, predominantly fine grained mixture.

Soil to be used in the radon attenuation soil cover shall have a particle size distribution that is within the limits shown on Figure B-1 and classify as a silty clay (CL), clayey sand (SC), silt (ML), or silty sand (SM). The above soil types will be blended during excavation and construction to provide a homogeneous mixture. This soil mixture shall fit within the specified gradation envelope to be consistent with the soil-cover design.

Rock - Rock shall consist of all earth materials harder than soils which must be excavated by ripping with a D-9 Caterpillar bulldozer or equivalent equipped with a single shank ripper, by hammering, or by blasting.

Tailings - Tailings consist of milled ore materials, a by-product of the extraction of uranium. The tailings have been hydraulically placed in an acidic solution in the tailings disposal area identified in the Drawings. The tailings, for the purposes of this work, are subdivided into the two categories described below.

Coarse Tailings - Coarse tailings consist of all tailings materials of which the predominant (greater than 50 percent) fraction is sand size, retained on the No. 200 sieve using the procedures outlined by ASTM D 422.

Slimes - Slimes are fine-grained typically wet-to-saturated tailings which consist of all tailings materials of which the predominant (greater than 50 percent) fraction passes the No. 200 sieve using the procedures outlined by ASTM D 422.

Ore - Ore is material which has been mined for uranium extraction. The ore shall be distinguished from tailings through evaluation.

Tailings Cells - The tailings disposal area is divided into three cells designated as the North, Central, and South Cells.

Soil Embankment - The soil embankment located along the west side of the tailings cells between the cells and Pipeline Arroyo.

Pipeline Arroyo - Pipeline Arroyo refers to the ephemeral stream channel located along the east side of State Highway 566 between the highway and the tailings disposal area as shown on the Drawings.

Buried Jetty - Buried jetty refers to a stone-filled trench constructed adjacent to the Pipeline Arroyo to maintain the long-term geomorphic stability of the Pipeline Arroyo.

10.2 Products

Soil for Soil/Rock Matrix - The soil material to be used for the soil/rock matrix shall be a clayey sand to sandy clay from the Pipeline Arroyo alluvium or other borrow areas for the tailings cover material. No more than 25 percent of the soil shall be greater than 1/2 inch in diameter. The soil will be capable of being compacted into the rock mulch portion of the matrix.

Rock for Soil/Rock Matrix - The rock mulch used in the soil/rock matrix shall be free from cracks, seams, and other defects that would tend to increase its destruction by water and frost action. Only approved rock mulch shall be used. Rock mulch shall be well-graded limestone with sizes specified in Table B.2 in these Specifications and on the Drawings unless otherwise approved. Rock mulch shall meet the durability requirements for riprap identified in Section 11.0 - Final Surface Water Control Structures.

10.3 Execution

10.3.1 General

Excavation and grading operations shall begin in undisturbed areas by clearing and grubbing of the work area in accordance with Section 8.0 - Final Reclamation Clearing and Grubbing of these Specifications.

Throughout excavation and grading operations, debris within graded and fill material shall be removed and disposed of prior to placement. Debris shall be disposed of only in designated locations.

Work shall be performed in a manner that minimizes surface water runoff into construction or fill areas.

Slopes and excavations shall be configured by either cutting existing materials to form the design lines and grades or by placing compacted fill to beyond the lines and grades and trimming to the design configuration. The acceptable tolerance limit for earthwork and rock excavation is to within ± 0.3 foot of the lines and grades shown in the Drawings.

Fill shall be placed in maximum 12-inch thick lifts, measured loose, and compacted to at least 95 percent of the maximum dry density obtainable by the Standard Proctor method of compaction (ASTM D 698) at a moisture content of within ± 2 percent of optimum unless otherwise noted.

Adequate water shall be utilized for dust suppression on haul/access roads and all grading and compaction work areas. A water supply shall be available at the mill site as shown in the Drawings.

10.3.2 Tailings/Ore Excavation and Grading

Tailings and ore materials outside the limits of the tailings cells as identified on the Drawings shall be excavated from their present location and placed within the confines of Borrow Pit No. 2. The locations outside of the cell areas from which materials are to be excavated during final reclamation include, but are not limited to, miscellaneous areas as determined in the field. Tailings materials uncovered as part of other excavation activities shall also be excavated and placed within Borrow Pit No. 2.

Tailings and ore materials being graded or placed in fill sections in Borrow Pit No. 2 shall be placed in 18-inch maximum thickness lifts, measured loose, and shall be compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D 698 or tracked into place. Materials which are excessively wet shall be air dried or mixed with dry fill prior to placement in Borrow Pit No. 2 so that no free liquids flow from the backfill materials.

10.3.3 Soil Excavation and Grading

Soil excavation and grading shall include, but not be limited to, soil embankment excavation and grading, completion of the south cell drainage channel excavation, Pipeline Arroyo channel reconfiguration, excavation and grading of surface water control structures, and final soil cover placement.

Slopes and excavations shall be configured by either cutting existing materials to form the design lines and grades or by placing compacted fill to beyond the lines and grades and trimming to the design configuration. The acceptable tolerance limit is to within ± 0.25 foot of the lines and grades shown in the Drawings.

10.3.3.1 Soil Embankment

Soil embankment grading shall consist of operations necessary for removing access roads which traverse the west tailings retention embankment prior to completion of final reclamation. Excavation and grading shall be performed to the lines and grades shown on the Drawings. Excess soils from these grading operations shall be used as final reclamation soil cover or in fill areas as necessary.

In general, the slopes of the soil embankment shall be regraded to a maximum slope of 5H:1V. Fill shall be placed in horizontal lifts as required with a maximum loose lift thickness of 12 inches to attain the lines and grades shown. Each lift shall be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 698. Depressions on slopes shall be filled beyond the lines and grades shown in the drawings and then trimmed to the desired configuration. Acceptable tolerance for the lines and grades shown is to within ± 0.25 foot.

Subsequent to grading operations, areas disturbed on the soil embankment shall be repaired in accordance with the requirements of this section for placement of the soil/rock matrix (Section 9.3.4).

10.3.3.2 South Cell Drainage Channel

The South Cell drainage channel shall be excavated during final reclamation from the South Cell towards the Pipeline Arroyo as shown on the Drawings. Work shall be performed in a manner which prevents surface runoff from exposed tailings grading areas from flowing outside the tailings area. Rock shall be excavated in accordance with Section 10.3.5. The excess excavation materials shall be used in fill sections south of the tailings retention embankment which are required to fill the natural depression to match the lines and grades shown on the Drawings. Portions of the drainage channel which are not excavated into natural rock formations shall be protected by riprap placed in areas as shown on the Drawings in accordance with Section 11.0 - Final Surface Water Control Structures. The channel shall be constructed from the South Cell drainage channel to the Pipeline Arroyo as shown on the Drawings. The exposed soil excavation areas shall be revegetated in accordance with Section 12.0 - Final Reclamation Revegetation.

10.3.3.3 Pipeline Arroyo Channel Modification

The Pipeline Arroyo channel shall be modified during final reclamation to the lines and grades shown on the Drawings to provide a consistent low flow channel. All operations within the channel shall be performed to allow adequate stream flow and safety in the event of a major storm event. Soils excavated shall be used in fill areas between the arroyo and the tailings embankment.

Some areas within and adjacent to the arroyo disturbed by these activities shall be revegetated in accordance with Section 12.0 - Final Reclamation Revegetation.

10.3.3.4 Buried Jetty Construction

Soil shall be excavated as necessary to install the buried jetty adjacent to the arroyo as shown on the Drawings. Riprap shall be installed in accordance with Section 11.0 - Final Surface Water Control Structures. After riprap placement is complete, soil shall be placed in horizontal lifts with a maximum loose lift thickness of 12 inches as required to attain the lines and grades shown on the Drawings. Each lift shall be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 698. Excess soils shall be used in fill sections including the final cover and backfilling of Borrow Pit No. 2. Subsequent to grading operations, areas disturbed by the jetty installation shall be revegetated in accordance with the requirements of Section 12.0 - Final Reclamation Revegetation.

10.3.3.5 Runoff Control Ditch Construction

The Runoff Control Ditch construction shall be performed during final reclamation to the lines and grades as shown on the Drawings. Soils excavated shall be used as soil cover materials for final reclamation.

10.3.3.6 Protective Bench Construction

The Protective Bench construction shall be constructed with the Runoff Control Ditch during final reclamation to the lines and grades shown on the Drawings.

10.3.3.7 North Diversion Ditch Extension

The North Diversion Ditch shall be extended to match the lines and grades shown on the Drawings. Soils excavated shall be used to construct the dikes adjacent to the channel as shown on the Drawings. Excess soil material shall be used as needed for either final

soil cover material or Borrow Pit No. 2 backfill. Rock excavation within the ditch excavation shall be performed in accordance with Section 10.3.5.

10.3.3.8 Soil Cover Material Placement

Soil cover shall be placed over the tailings area during the final reclamation phase using soils from various sources including the modification of the Pipeline Arroyo, excavation of other surface water channels, and from the existing soil stockpile to attain a radon attenuation layer over regraded tailings with a total thickness of 1.5 feet. Final reclamation soil cover shall be placed over the entire extent of the interim stabilization soil cover. The compacted thickness of the complete radon attenuation soil cover shall be 1.5 feet. After clearing and grubbing the existing interim stabilization soil cover (temporarily stockpiling surficial soils for spreading over the final reclamation cover), the remaining interim stabilization soil cover shall be compacted to a minimum of 95 percent of the maximum dry density at a moisture content of within 2 percent above the optimum moisture content as determined by the Standard Proctor compaction method (ASTM D 698). Subsequent soil layers shall be placed and compacted as specified above.

Soils used for final reclamation cover shall be fine-grained clays, silts, and sands, and result in a well-mixed soil having the USCS symbols CL, ML, SC, or SM. A grain-size envelope of acceptable material types for the soil cover was developed. This envelope is presented on Figure B-1. Only those soils with gradations falling within the soil cover gradation limits shown on Figure B-1 shall be used for soil cover construction. No individual soil type, particularly sand (SP) is suitable alone for use as soil cover. Following placement, the entire soil cover shall be covered with a soil/rock matrix in accordance with Section 10.3.4 below.

### 10.3.4 Soil/Rock Matrix Placement

A soil/rock matrix shall be constructed over the entire extent of the soil cover for erosion protection. The rock mulch portion of the soil/rock matrix shall be placed by end or belly dump trucks in a manner that shall minimize degradation and separation of the material. The rock mulch shall be spread with a road grader to achieve the desired thickness of 3 inches.

The soil shall be placed over the rock mulch only after the rock mulch thickness has been tested and documented as being acceptable. The soil shall be placed by end dump or belly dump trucks or self-propelled scrapers. A 4- to 6-inch thick random soil layer shall be spread by a grader. The soil shall be compacted with a vibrator roller/compactor to push the soil into the rock mulch.

The soil shall be forced into the rock mulch voids by passing construction equipment over the soil. The 4- to 6-inch-thick soil lift shall be placed over the rock to maintain an approximate thickness of three inches above the rock layer after compaction. Compaction of the soil shall densify the rock layer by tightly wedging the stones.

## 10.4 Final Reclamation Quality Control

### 10.4.1 Final Reclamation Soil Cover Quality Control Program

The quality control program originally outlined in the specifications for the proposed plan in 1987 represented the design engineer's minimum acceptable program to confirm that the construction meets the design intent. United Nuclear has been conducting interim reclamation of the tailings impoundment and performing quality control monitoring at the direction of the NRC since 1989.

A minimum of one foot of soil cover has been placed over regraded tailings in the North and Central Cells. In placing that cover, United Nuclear has conducted a quality control program that exceeds the minimum acceptable program stipulated by the original design specifications and more closely complies with the guidance provided by NRC's Staff Technical Position (STP) on Testing and Inspection Plans. The NRC has inspected this work on two occasions and has found the field quality control program to be in compliance with the NRC requirements.

However, NRC indicated that greater quality control monitoring in the field would be necessary for the thinner soil cover. Therefore, United Nuclear has agreed to expand the quality assurance/quality control (QA/QC) program for future reclamation activities. Table B.1 summarizes the required testing frequencies in the Field Testing and Inspection Plan (FTIP) for the soil cover. Additionally, as described below, increased testing frequencies are required during final reclamation to attain the testing frequencies in Table B.1 based on an average of all tests taken for the project. United Nuclear may petition the NRC for a license amendment for reduction of required QA/QC activities to those originally proposed if testing and inspection activities consistently meet QA/QC criteria during reclamation.

Accordingly, the quality control program, described in more detail herein, reflects the quality control procedures that shall be implemented in the field beginning in 1991. The tests presented herein shall be implemented for all future reclamation activities and shall be used to verify the criteria used in the design of the radon barrier. The quality control data are expected to be adequate to meet this verification requirement.

Soil Cover Materials

It is not expected that other sources of borrow material will be required other than those identified in this plan. However, if other borrow sources are required, then gradation and

classification tests shall be performed to ensure that these materials meet project specifications. Representative samples shall be obtained by means of borehole drilling and sampling or test pit excavation and sampling and analyses for gradation and classification. The on-site quality assurance engineer shall review and accept or reject the test results prior to placement of imported fill as soil cover material. Additionally, the gradation results for the soil sample shall be compared to the graphical representation of the range of allowable soil types for use in the soil cover to assure consistency with the soil types modeled in the design of the soil cover (Figure B-1).

Standard Proctor Compaction Testing (ASTM D 698)

The frequency of conducting Standard Proctor laboratory tests to confirm the moisture versus density relationship of the soil shall be a minimum of one compaction test for every 15 field moisture/density (i.e., compaction verification) tests performed as recommended by NRC's Testing STP. NRC's Testing STP frequency is one Standard Proctor test for every 10 to 15 field moisture/density tests performed.

One-Point Proctor Testing

NRC's Testing STP specifies that a one-point Proctor test be performed for every five field moisture/density tests. The Standard Proctor testing frequency employed by United Nuclear during North and Central Cell interim stabilization of one full Standard Proctor test for every four field moisture/density tests exceeds the total recommended frequency of testing for both one-point and Standard Proctor compaction tests. One-point tests shall be performed at the minimum frequency of one test for every five field moisture/density tests performed during future reclamation activities.

Field Moisture/Density Verification Test

NRC's Testing STP recommends that one moisture/density (compaction verification) test be performed for every 500 cubic yards (cy) of fill placed and that a minimum of two moisture/density tests be performed each day. During interim stabilization of the North and Central Cells, United Nuclear performed field moisture/density testing at the frequency of one test for every 2,000 cy of fill placed and performing at least two tests daily. This frequency exceeds the design engineer's minimum specification requirements that were included in the proposed plan in 1987 and is in accordance with Bureau of Reclamation (BUREC) dam construction standards.

However, due to NRC's concerns regarding the thinner soil cover being placed at the Church Rock site, the field moisture/density testing frequency will be increased to an average of one test per 500 cy of soil cover placed for the project. During initial interim stabilization activities, a total of 62 moisture/density tests were taken in the interim cover for 125,000 cy of soil cover material placed in the North and Central Cells. This is equivalent to a testing frequency of one test per 2,000 cy, which meets the BUREC frequency. It will be possible to attain the higher testing frequency of one test per 500 cy based on an average of all tests taken for the project. This shall be accomplished when the interim soil cover is conditioned (i.e., moisture adjusted and compacted) immediately prior to placement of the final soil cover. Additional in-place density tests shall be performed at this time with sufficient frequency to meet required project frequencies. This will provide assurance that the material placed meets the requirements modeled in the design.

Nuclear Density Gauge Correlation

As stipulated in NRC's Testing STP, moisture/density compaction verification testing performed by nuclear density gauge methods was correlated to one in-situ field density sand cone test (ASTM D 1556) and one oven-dry moisture test for every 10 nuclear density gauge tests performed. During initial interim stabilization activities, 20 Sand Cone

tests were performed on the interim soil cover in the North and Central Cells. Sand cone tests were used exclusively to verify moisture/density compaction of the North Cell interim cover when a good correlation between the nuclear gauge and Sand Cone tests could not be obtained. Future moisture/density verification testing shall meet the frequency requirement of NRC's Testing STP.

Based on performance-to-date for interim construction activities, it has been determined that test results obtained by the nuclear densimeter are erratic. The as-built report for the North Cell Interim Reclamation Activities documented the erratic nature of the nuclear densimeter testing. Therefore, only the sand cone method of in-place density determinations was used in the 1990 construction activities and shall be used in all future construction.

Gradation and Soil Classification

A detailed evaluation of expected soil types and gradations was performed as part of the reclamation design. This evaluation was based on over 50 gradation analyses of samples obtained from test pits and borings installed within the proposed borrow areas. The test data summarized in Figure B-1 demonstrates the relative uniformity of grain-size distribution of these soil samples. In addition, further uniformity of the soil cover will be achieved through the mixing of soils as the material is removed from the proposed borrow areas and spread and compacted as the soil cover. Therefore, the characteristics of the soil cover are also expected to be relatively uniform.

In initial interim stabilization activities, the testing frequency was one set of gradation and classification tests per 6,500 cy of soil placed. As illustrated on Figure B-1, the gradations of the material placed in the North and Central Cells for interim soil cover construction are uniform and very similar to those samples in the proposed borrow areas.

However, in review, the NRC expressed concern that a thinner soil cover design would be more sensitive to material gradation fluctuations and resultant radon attenuating characteristics. To address this concern, the gradation and Atterberg testing frequency shall be increased to an average of one test per 1,000 cy of soil cover material placed for the project. Testing on the soil cover before 1991 was at the lower frequency of one test per 6,500 cy as specified in the proposed plan in 1987. It will be possible to attain the higher testing frequency of one test per 1,000 cy based on an average of all tests taken for the project. This shall be accomplished when the interim soil cover is conditioned (i.e., moisture-adjusted and compacted) immediately prior to placement of the final soil cover. Additional gradation and Atterberg tests, as well as in-place density tests as identified above, shall be performed at this time with sufficient frequency to meet required project frequencies. This will provide assurance that the material placed meets the requirements of that modeled in the design.

The acceptable soil types for use in the soil cover construction shall classify as silty clay (CL), clayey sand (SC), silt (ML), or silty sand (SM) in accordance with the Unified Soil Classification System (USCS). The gradation limits of the mixed soil to be placed in the soil cover are presented on Figure B-1 as approved by the NRC.

10.4.2 Soil/Rock Matrix Quality Control Program

The thickness of the emplaced rock mulch shall be verified by construction control, staking, and probing. Thickness verification shall be performed by the following procedures:

1. Establish a 100-foot by 100-foot grid over the tailings impoundment,

2. Place a stake at each grid line intersection and mark the stake to indicate the required depth of rock mulch (i.e., 3 inches),

3. Place rock mulch and grade to the grade line marked on each stake,

4. Use a tape measure or surveying equipment to locate and mark the center point of each grid square,

5. Use a spade to make a vertical, straight-edged cut which penetrates the rock mulch at the grid square center point,

6. Place a straight-edge (ruler) on top of the rock mulch at the edge of the cut and measure the distance from the bottom of the straight-edge to the bottom of the rock mulch to the nearest 0.1 inch,

7. Record the thickness measurement from each test location,

8. If the average rock mulch thickness within the grid is 3 inches or greater, the grid is acceptable,

9. If the average thickness within the grid is less than 3 inches, mark the location and add additional rock mulch. Then repeat the test starting with Step 4 above.

The maximum and minimum thickness and adequacy of soil intrusion into the rock mulch shall be verified by using the testing scheme as described above for the rock mulch except that the extent to which the soil is present throughout the rock mulch layer will also be measured. As long as the soil is present throughout the upper two-thirds (i.e., 2 inches) of the rock mulch and is a minimum of 3 inches thick and a maximum of 4.5 inches thick above the rock mulch at three of the five test locations (four grid corners and grid center) in a grid square, the soil layer shall be considered adequate. If the thickness measures less than the minimum, additional soil material will be spread until measurement

verifies the appropriate thickness has been placed. If the thickness measures more than the maximum, additional grading and/or compaction of the excess material shall be performed until measurement verifies that the appropriate thickness has been placed.

Two inches of soil intrusion is considered adequate because this amount, along with the three inches of soil above the rock, will stabilize the rock layer for the short term. Gravity and infiltration of precipitation will cause the soil to fill in the lowest one-third of the rock layer.

# 11.0 FINAL SURFACE WATER CONTROL STRUCTURES

## 11.1 General

### 11.1.1 Scope of Work

Unless otherwise specified, labor, materials and required equipment shall be furnished, and operations related to final reclamation surface water control structures shall be conducted in accordance with the Drawings and these Specifications.

### 11.1.2 Related Work

1. Section 9.0 - Final Reclamation Haul Roads/Access Roads

2. Section 10.0 - Final Reclamation Excavation and Grading.

### 11.1.3 Definitions

Pipeline Arroyo - Pipeline Arroyo refers to the ephemeral stream channel located along the east side of State Highway 566 between the highway and the tailings area as shown on the Drawings.

Buried Jetty - Buried jetty refers to a stone filled trench constructed adjacent to the Pipeline Arroyo near the Nickpoint to maintain the long-term geomorphic stability of Pipeline Arroyo.

Nickpoint - Nickpoint refers to the rock outcrop area within the Pipeline Arroyo as shown on the Drawings.

Runoff Control Ditch - Runoff Control Ditch refers to the ditch along the west toe of the tailings embankment which intercepts runoff from the soil embankment and prevents gullying between the embankment and the low flow arroyo channel as shown on the Drawings.

Drainage Swale - Drainage swale refers to shallow ditches which convey surface water runoff from the tailings cover as shown on the Drawings.

Drainage Ditch - Drainage ditch refers to ditches which convey water to Pipeline Arroyo as shown on the Drawings. Four drainage ditches are used, including the North and South Diversion Ditches and the North and South Cell Drainage Channels.

Riprap - Riprap refers to hard, durable limestone of the size range shown on the Drawings and identified herein.

## 11.2 Products

### 11.2.1 General

Submittals for all of the following products shall be provided for approval.

### 11.2.2 Corrugated Steel Pipe

All corrugated steel pipe shall be 24-inch diameter corrugated (2-2/3-inch x 1/2-inch) galvanized steel pipe with a minimum wall thickness of 0.109 inch. A 10-1/2-inch wide dimpled band connector shall be used on the pipe. Culverts shall have material specifications in accordance with ASTM A 760.

11.2.3 Riprap

Riprap shall be angular, dense, sound limestone, abrasion and weather-resistant and shall be free from cracks, seams, and other defects that would tend to increase its destruction by water and frost action. Only approved riprap shall be used. Riprap shall be well-graded limestone or other suitable rock with the sizes specified for each particular application shown on Tables B.2, B.3, and B.4 in these Specifications and on the Drawings unless otherwise approved.

The exact sources of rock to be used for erosion protection have not been identified at this time. However, based on the economic considerations included in the Reclamation Plan, the following specifications for quality of material shall be used.

The source for rock material used for riprap and rock mulch shall be dense limestone or other suitable rock and shall meet the following minimum criteria:

| | |
|---|---|
| Specific Gravity | 2.6 or greater |
| Absorption | 1.8 percent or less |
| Sodium Sulfate Loss | 10 percent or less |

Alternatively, the rock source shall have a minimum score of 50 using the scoring criteria shown on Table D1 of the August 1990 Staff Technical Position (STP), "Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites," or equivalent, and shall be oversized, if needed, in accordance with the procedures provided in Appendix D of the August 1990 STP.

Additionally, rock used for riprap to be placed in all critical areas (i.e. Buried Jetty, Runoff Control Ditch, North and South Cell Drainage Channels, and existing North Diversion

Ditch) shall have a minimum score of 65 using the scoring criteria shown on Table D1 of the August 1990 STP.

Test methods used to determine these values shall be the standard test methods described in NUREG/CR-2642. These include ASTM C-97, 1958 for specific gravity; ASTM C-97, 1958 and ASTM C-127, modified, 1949 for absorption; and ASTM C-88, 1973 for sodium sulfate loss.

The bedding material shall consist of well-graded angular limestone. The grading of the bedding material shall be such that it will prevent undercutting and piping during periods of surface water runoff as specified in Table B.3.

## 11.3 Execution

### 11.3.1 Pipeline Arroyo Reconfiguration

The existing Pipeline Arroyo shall be regraded during final reclamation to provide a low flow channel as shown on the Drawings. Excavated soil meeting the requirements of Section 9.0 shall be placed on the tailings area as final soil cover. Excavated rock materials shall be placed as backfill within Borrow Pit No. 2. Excavation and placement of materials shall be in accordance with the Drawings and Section 10.0 - Final Excavation and Grading, in these Specifications.

The buried jetty adjacent to the Pipeline Arroyo shall be constructed as shown on the Drawings. Riprap in the buried jetty shall be well-graded and shall meet the requirements previously specified in these Specifications and identified in Tables B.2 and B.3.

11.3.2 South Cell Drainage Channel Construction

The South Cell Drainage Channel shall be constructed during final reclamation to the discharge point in the Pipeline Arroyo as shown on the Drawings. Soil and rock shall be excavated in accordance with Section 10.0 - Final Reclamation Excavation and Grading. The excess excavation materials shall be used in fill sections south of the tailings embankment which are required to match the lines and grades shown on the Drawings. Upstream portions of the drainage channel which are not excavated into natural rock formations shall be protected by riprap placed in the areas as shown on the Drawings. Riprap shall not be required in portions of the channel downstream of the rock cut. Riprap installed in the South Cell Drainage Channel shall be well-graded and shall meet the material and placement requirements outlined in these Specifications and Tables B.2 and B.3.

11.3.3 North Cell Drainage Channel Construction

The North Cell Drainage Channel shall be constructed during final reclamation to the exit section with the North Diversion Ditch as shown on the Drawings. Soil shall be excavated in accordance with Section 10.0 - Final Reclamation Excavation and Grading. The excess excavation materials shall be used in filling Borrow Pit No. 2. The drainage channel shall be protected by riprap placed as shown on the Drawings. Riprap installed in the North Cell Drainage Channel shall be well-graded and shall meet the material and placement requirements outlined in these Specifications and Tables B.2 and B.3

11.3.4 Diversion Ditch Construction

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break

Construction of the North and South Diversion Ditches was substantially completed during mill construction operations. The South Diversion Ditch discharges into a natural drainage leading to the Pipeline Arroyo and shall not require further work.

The North Diversion Ditch currently discharges into the north borrow area as shown on the Drawings. The ditch shall be extended during final reclamation to discharge surface water to the Pipeline Arroyo. The diversion ditch shall be constructed to the lines and grades shown on the Drawings. Excavation of soils and rock materials as required shall be performed in accordance with the requirements of Section 10.0 - Final Reclamation Excavation and Grading. Portions of the ditch shall be protected with riprap at the locations shown on the Drawings. The riprap installed in the ditch shall be well-graded and shall meet the requirements outlined in these Specifications and in Tables B.2 and B.3.

11.3.5 Runoff Control Ditch Construction

The Runoff Control Ditch shall be constructed between the tailings embankment and the protective berm in the location and to the lines and grades shown on the Drawings. Excavation and placement of materials shall be in accordance with Section 10.0 - Final Reclamation Excavation and Grading. Excavated soil meeting the requirements of Section 10.0 shall be placed on the tailings areas as final soil cover. The Runoff Control Ditch shall be protected by riprap as shown on the Drawings. Riprap shall meet the material and placement requirements outlined in these Specifications and Tables B.2 and B.3.

11.3.6 Construction of Drainage Swales

Drainage swales shall be constructed in the locations and to the lines and grades shown on the Drawings and identified in Table B.4. Where swales are placed directly over tailings soil cover materials, the soil cover shall meet or exceed the minimum design

thickness. Additionally, the swales shall be protected by riprap as shown on the Drawings. Riprap shall meet the material and placement requirements outlined in these Specifications and Tables B.2, B.3, and B.4.

11.3.7 Culvert Installation

Culverts shall be placed during final reclamation in locations required for access as approved. Large diameter culverts, as approved, shall be required for installation at any crossing of Pipeline Arroyo. At the completion of final reclamation operations, all culverts shall be removed, and the areas shall be recontoured to provide natural surface drainage.

Culverts may be placed within the Pipeline Arroyo to provide site access subsequent to reconfiguration operations. However, prior to placement, a design for the crossing shall be submitted and certified by a licensed professional engineer. Access to the site from the north borrow area shall also be allowed.

Culverts which are used to carry construction traffic shall be placed in excavations on a base compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor method of compaction (ASTM D 698). Compaction of fill to the final grade around and over the pipe shall also be to at least 95 percent of the soil's maximum dry density (ASTM D 698). Backfill over the culvert shall provide a minimum thickness of 24 inches from the top of the culvert to grade.

11.3.8 Bedding Material

The bedding material shall consist of crushed limestone. The material shall be reasonably free from clay, loam, or deleterious material. The bedding material shall be uniformly graded so as to prevent undercutting and piping during periods of surface water runoff.

Bedding material shall meet the thickness and gradation requirements identified in Table B.3 for each location.

11.3.9 Riprap Placement

All riprap shall be placed to the depth and grades shown on the Drawings. The riprap shall be placed in a manner to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the spaces between the larger rock fragments so that a densely-placed, uniform layer of riprap of the specified thickness will result. Hand placing will be required only to the extent necessary to secure the results specified above. Riprap material shall meet the thickness and gradation requirements identified in Tables B.2 and B.4 for each location.

All riprap shall be placed in a manner that prevents degradation and separation of the material. Riprap material shall be dumped from end dump or belly dump trucks and dozed to the specified depth. Dozed material shall not be pushed more than 50 feet from dumped location.

# 12.0 FINAL RECLAMATION REVEGETATION

## 12.1 General

### 12.1.1 Scope of Work

Unless otherwise specified, labor, materials and required equipment shall be furnished, and operations in connection with final reclamation revegetation shall be performed in accordance with the Drawings and these Specifications. Revegetation efforts shall be directed at all areas disturbed by construction that are not covered with riprap or soil/rock matrix and shall include, but not be limited to, embankment areas, side slopes within excavated channels, final reclamation soil cover, and the regraded mill area.

### 12.1.2 Related Work

1. Section 7.0 - Mill Decommissioning

2. Section 10.0 - Final Reclamation Excavation and Grading

3. Section 11.0 - Final Reclamation Surface Water Control Structures.

## 12.2 Products

Submittals for each of the following products shall be provided.

### 12.2.1 Seed Mixture

All seed shall be fresh, clean, new crop seed. Disturbed areas, as identified above, that will not be covered with riprap or the soil/rock matrix layer in the final reclamation cover

shall be vegetated with a native seed mixture of the following composition by weight of PLS/AC:

| Scientific Name | Common Name | Growth Habit | Pounds PLS/AC |
|---|---|---|---|
| Agropyron smithii | Western Wheat-grass | NS | 5.0 |
| Bouteloua gracilis | Blue Grama | NB | 2.0 |
| Oryzopsis hymenoides | Indian Ricegrass | NB | 4.0 |
| Sporobolus airoides | Alkali Sacaton | NB | 0.5 |
| Bouteloua curtipendula | Sideoats Grama | NB | 2.0 |
| Hilaria jamisii | Galleta | NS | 3.0 |

Notes:

1. NB - Native bunchgrass.
2. NS - Native sodgrass.

The specified application rates are for drill seeding. All seed shall be furnished in original containers showing analysis of seed mixture, percentage of PLS, year of production, net weight, date, and location of packaging. Seed which has become moldy, or otherwise damaged in transit or storage shall not be accepted.

12.2.2 Fertilizer

Fertilizer shall be applied at the rate of 30 pounds of nitrogen and 40 pounds of phosphate per acre. All fertilizer shall be delivered in waterproof bags or other standard containers with the name of material, name of manufacturer, net weight, and analysis on each bag or container.

### 12.2.3 Mulch

Mulch shall be small-grain hay or straw in a dry condition. Mulch shall be free of weeds and foreign matter detrimental to plant life.

## 12.3 Execution

### 12.3.1 General

Revegetation shall be conducted as specified on the embankments, channels, mill area, the arroyo, and any other areas disturbed by the final reclamation activities that are not covered with riprap or soil/rock matrix.

### 12.3.2 Soil Preparation

The soil to be revegetated shall be prepared by first cultivating to a minimum depth of 6 inches. Fertilizer shall be added to the soil at an application rate to be determined after soil analyses are conducted and shall be worked into the upper 6 inches of soil by disking along the contours to the extent practical. This application shall not precede seeding by more than one day.

### 12.3.3 Seeding

Seeding shall be conducted by drill seeding the specified seed mixture at the specified application rate along the contours or opposite the direction of the prevailing wind. Hydroseeding may be allowed on steep slopes or broadcast seeding on gentle slopes upon approval using twice the application rate specified for drill seeding. Seeding shall not be performed immediately following a heavy rain, during windy periods, or when the ground is too dry. Drill seeding shall use a roller attachment, or its equivalent, attached

behind the drill to inhibit movement of seeds previously sown. Prior to mulching, water, free from oils, acids, alkalis, and salt which may inhibit grass growth, shall be applied with a fine spray after an area has been seeded. No seeding shall be performed in areas in excess of that which can be mulched the same day. If broadcast seeding is conducted, seed application rates shall be twice the rate specified previously.

### 12.3.4 Mulching

Mulch shall be applied to seeded areas at the application rate of two tons per acre and crimped into the surface utilizing dozer tracks or other approved means.

### 12.3.5 Restoration

Planted areas damaged during execution of this work shall be restored. The areas which fail to show a "catch" or uniform stand, for any reason whatsoever, shall be reseeded during the next growing season with the specified seed mixture and methodology.

# 13.0 FENCING

## 13.1 General

### 13.1.1 Scope of Work

Unless otherwise specified, labor, materials and required equipment shall be furnished, and operations related to construction of fence shall be conducted in accordance with the Drawings and these Specifications.

Work shall consist of installation of a barbed wire fence to preclude unauthorized access to the reclaimed tailings area. Work associated with the barbed wire fence shall include installation of steel T-posts and three strands of barbed wire where necessary to form a complete perimeter fence around the tailings area.

### 13.1.2 Related Work

Not applicable.

## 13.2 Products

Submittals for the following products shall be provided for approval prior to use. Submittals shall include shop drawings showing, at a minimum, brace sections, gate details, and any details pertinent to the long-term effectiveness of the fences.

13.2.1 Barbed Wire Fence

The three-strand barbed wire fence shall consist of 12-1/2 gauge galvanized steel wire with zinc coating which shall meet the requirements of ASTM A 121 and standard steel T-posts.

13.2.2 Concrete Foundations

Concrete used in the installation shall conform to

1. Portland Cement: ASTM C 150, Type I

2. Aggregates: Fine and coarse, ASTM C 33 and

3. Water: Clean, potable, and free of oil, strong acids, salt, or organic matter.

13.3 Execution

13.3.1 Fence Installation

Fence and gates shall be installed as directed and specified herein.

13.3.2 Barbed Wire Fence Installation

Barbed wire strands shall be fastened to T-posts with wire that shall not be less than nine-gauge, galvanized, preformed steel wire. Maximum spacing for posts shall be 15 feet from center to center. All T-posts shall extend at least 18 inches into the ground.

The finished fence shall be plumb, taut, true-to-line, and complete in every detail.

# TABLES

# TABLES

TABLE B.1

SUMMARY OF THE FIELD TESTING AND INSPECTION PLAN

| Quality Control Activity | NRC Staff Technical Position Frequency (a) |
|---|---|
| Full Proctor tests (ASTM D 698) | One test per every 15 field density tests |
| One-point Proctor tests | One test per every 5 field density tests |
| Field test for moisture/density | One test for each 500 cubic yards (cy) of cover soil or a minimum of two tests for each day of cover soil in excess of 150 cy |
| Nuclear density guage correlation (if appropriate) | One sand cone test and one oven-dry test per every 10 nuclear density tests |
| Gradation and classification testing of cover soil (includes Atterberg limits) | Minimum of one test each day of cover soil in excess of 150 cy and one test per 1,000 cy |
| Rock durability tests (specific gravity, absorption, soundness, L.A. Abrasion) | One test series at 10,000 cy and 20,000 cy riprap placed, then one test series per 10,000 cy of riprap placed in excess of 30,000 cy |

(a) The August 1990 NRC Staff Position Paper is officially titled "Testing and Inspection Plans during Construction of DOE's Remedial Action at Inactive Uranium Mill Tailings Sites."

# TABLE B.2

## RIPRAP MATERIAL GRADATION REQUIREMENTS (a)

| Location | D 50 (b) (inches) | Layer Thickness (inches) | Sieve Size: | Percent Passing by Weight | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 20 Inch | 15 Inch | 12 Inch | 10 Inch | 6 Inch | 5 Inch | 4 Inch | 3 Inch | 1 Inch | No. 4 |
| Upper Section South Cell Drainage Channel | 15 | 23 | | 100 | | 28-40 | | 8-21 | | 2-14 | 0-10 | | |
| North Cell Drainage Channel | 9 | 15 | | | 100 | | 45-58 | | 10-33 | | 0-23 | | |
| North Diversion Ditch | 6.0 | 10 | | | | | 100 | 28-51 | | 13-36 | | 0-9 | |
| Buried Jetty | 6.0 | 96 | | | | | 100 | 28-51 | | 13-36 | | 0-9 | |
| Branch Swales H and I, Lower Reach of Runoff Control Ditch | 3.0 | 6 | | | | | | 100 | | 45-67 | | 0-22 | |
| Soil/Rock Matrix, Branch Swales, Upper Reach of Runoff Control Ditch | 1.5 | 3 | | | | | | | | | 100 | 8-37 | 0-8 |

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(a) The rock quality will be determined in accordance with Appendix D of the NRC's Staff Technical Position (STP) on "Design of Erosion Protection Covers" dated August 1990.

(b) Rock sizes shown will be oversized, if required, based on their rock quality rating by the methods provided in Appendix D of the NRC's STP.

(c) See Table B.3 for bedding material requirements.

# TABLE B.3

Revised: July 8, 1992

## BEDDING MATERIAL REQUIREMENTS

| Location | Bedding Layers | Bedding D 50 (inches) | Thickness (inches) |
|---|---|---|---|
| Upper Section South Cell Drainage Channel | Layer 1 | 0.02 | 3 |
| | Layer 2 | 0.35 | 3 |
| North Cell Drainage Channel | Layer 1 | 0.02 | 3 |
| | Layer 2 | 0.35 | 3 |
| North Diversion Ditch | Layer 1 | 0.02 | 3 |
| | Layer 2 | 0.35 | 3 |
| Buried Jetty | None | NA | NA |
| Branch Swales H and I and Lower Reach of Runoff Control Ditch | Layer 1 | 0.02 | 3 |
| | Layer 2 | 0.35 | 3 |
| Soil/Rock Matrix | None | NA | NA |
| Branch Swales and Upper Reach of Runoff Control Ditch | Layer 1 | 0.02 | 3 |

| Sieve Size: | Bedding D 50 (inches) | Bedding Material Gradation | | | | | |
|---|---|---|---|---|---|---|---|
| | | 3-inch | 3/4 inch | No. 4 | No. 10 | No. 40 | No. 200 |
| Bedding Layer 1 | 0.02 | 100 | 85-100 | 65-100 | 47-94 | 23-70 | 15-30 |
| Bedding Layer 2 | 0.35 | 65-100 | 43-80 | 22-60 | 15-38 | 5-12 | 0-10 |

TABLE B.4

BRANCH SWALE CHARACTERISTICS

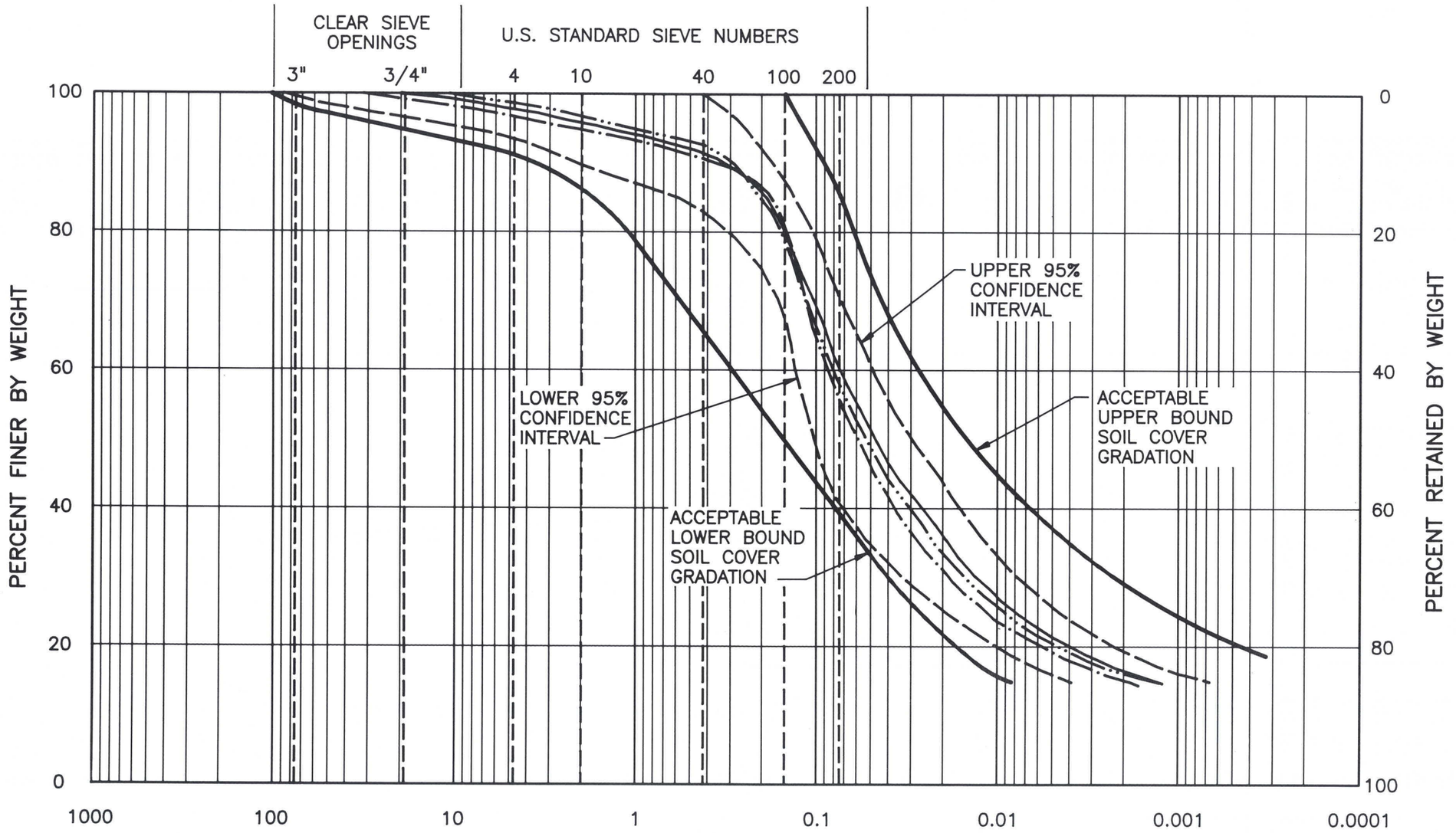
| Swale Designation | Length (ft) | Slope (ft/ft) | Bottom Width (ft) | Peak Discharge (cfs) | Depth of Flow (ft) | Minimum Swale Depth (ft) | Riprap D 50 (in) | Riprap Thickness (in) |
|---|---|---|---|---|---|---|---|---|
| A | 2,600 | 0.0038 | 10 | 40 | 0.98 | 2.0 | 1.5 | 3.0 |
| B | 3,600 | 0.0083 | 20 | 97 | 0.97 | 2.0 | 1.5 | 3.0 |
| C | 3,400 | 0.0050 | 10 | 75 | 1.38 | 2.0 | 1.5 | 3.0 |
| D | 3,200 | 0.0028 | 10 | 68 | 1.43 | 2.0 | 1.5 | 3.0 |
| E | 1,350 | 0.0037 | 10 | 85 | 1.53 | 2.5 | 1.5 | 3.0 |
| F | 1,600 | 0.0031 | 10 | 126 | 2.00 | 2.5 | 1.5 | 3.0 |
| G | 1,400 | 0.0021 | 10 | 99 | 1.88 | 2.5 | 1.5 | 3.0 |
| H | 2,550 | 0.0085 | 20 | 284 | 1.90 | 2.5 | 3.0 | 6.0 |
| I | 550 | 0.0040 | 20 | 385 | 2.65 | 3.5 | 3.0 | 6.0 |
| J | 1,900 | 0.0047 | 10 | 101 | 1.66 | 2.5 | 1.5 | 3.0 |

Note: See Figures 5-1 and 5-2 for swale locations.

# FIGURES

# FIGURES

DRAWING NUMBER 86-060-B591




## NOTES:

1. AVERAGES DERIVED FROM AVAILABLE FIELD AND LABORATORY TEST DATA TO DATE IN DESIGNATED BORROW AREAS.
2. AFTER DRAWING NO. 86-060-B497 (FIGURE 1) IN THE MARCH 4, 1991 RESPONSE TO NRC COMMENTS.

## LEGEND:

- AVERAGE PIPELINE ARROYO BORROW SOILS
- AVERAGE NORTH AND CENTRAL CELLS INTERIM COVER SOILS
- AVERAGE EXISTING SOIL STOCKPILE SOILS

| No. | DATE | ISSUE / REVISION | DWN. BY | CK'D BY | AP'D BY |
|---|---|---|---|---|---|
| 1 | 8-24-91 | ISSUED FOR 1991 RECLAMATION PLAN | R.H. | DWK | DHG |

ACCEPTABLE SOIL COVER
GRAIN SIZE ENVELOPE

PREPARED FOR

UNC MINING AND MILLING
GALLUP, NEW MEXICO

Canonie Environmental

| DATE: 6-21-91 | FIGURE B-1 | DRAWING NUMBER 86-060-B591 |
|---|---|---|
| SCALE: AS SHOWN | | |

1