Pre-Design Studies

Northeast Church Rock Mine Site Removal Action

Church Rock Mill Site

October 31, 2014

Prepared for:

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials (ASTM International)
CPT	cone penetration test
cm/sec	centimeters per second
cy	cubic yard
GE	General Electric
m	meter
mm	millimeter
NECR	Northeast Church Rock
NRC	United States Nuclear Regulatory Commission
NUREG	NRC Regulatory Guidelines
ohm-m	ohm-meter
PDS	Pre-Design Studies
RA	Removal Action
ROD	Record of Decision
SBT	soil behavior type
SOP	Standard Operating Procedure
tsf	tons per square foot
UNC	United Nuclear Corporation
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This Pre-Design Studies Report summarizes pre-design studies (PDS) conducted at the Church Rock Mill Site (Mill Site) in preparation for the Northeast Church Rock (NECR) Mine Removal Action (RA), which consists of removal of mine soil and waste materials and placement in a repository constructed at the Mill Site. The Mill Site is located approximately 16 miles northeast of Gallup, NM, as shown on Figure 1-1, *Site Location Map.* Figure 1-2, *Regional Map*, shows the location of the Mill Site and the NECR Mine Site, which is located approximately one-half mile northwest of the Mill Site. The Mill Site features are shown in Figure 1-3, *Church Rock Mill Site Layout*.

The PDS described in this report were conducted in accordance with the *Northeast Church Rock Mine Site Removal Action, Volume I: Pre-Design Studies Work Plan, Church Rock Mill Site* (MWH, 2013), hereafter referred to as the Work Plan. The scope and objectives of the PDS were described in the Work Plan. The goal of the PDS was to collect pre-design data necessary to design the RA in accordance with the proposed performance standards and United States Environmental Protection Agency's Region 9 (USEPA) *Action Memorandum: Request for Non-Time Critical Removal Action at the Northeast Church Rock Mine Site* (Action Memo) (USEPA, 2011a) and the USEPA Region 6's *Proposed Plan* (USEPA, 2012) and the *Record of Decision* (ROD) for the United Nuclear Corporation (Church Rock Mill Site) Surface Soil Operable Unit National Priorities List Site (USEPA, 2013).

1.1 REPORT BACKGROUND

As part of the pre-design data needs evaluation, MWH identified the major RA design elements and reviewed available site data. The existing data were evaluated for completeness with respect to the level of detailed information necessary to design each element of the RA. MWH (2013) identified data needs and presented field sampling plans to obtain the data necessary for design of the RA. This PDS report is one of two separate reports for the NECR RA, and describes results of the PDS conducted at the Mill Site. Results of the PDS conducted at the NECR Mine Site will be submitted separately.

1.2 REPORT OBJECTIVES AND SCOPE

The overall PDS objective was to collect data necessary to design the RA. This report summarizes the sampling activities and results of the PDS investigation at the Mill Site, as well as results of previous investigations at the Mill Site. Specifically, this report presents the following information:

- A summary of previous investigations conducted at the Mill Site
- A summary of the PDS performed at the Mill Site and results of the investigations
- A narrative interpretation of PDS data and results for the Mill Site

The report contents include the following:

- Section 1 – Background and objectives
- Section 2 – Summaries of previous investigations and pre-design data needs
- Section 3 – Summary of the results of the PDS
- Section 4 – Conclusions and remaining data needs
- Section 5 – References

Laboratory data reports, drilling logs, and field photographs documenting the PDS activities at the Mill Site are included in the appendices.

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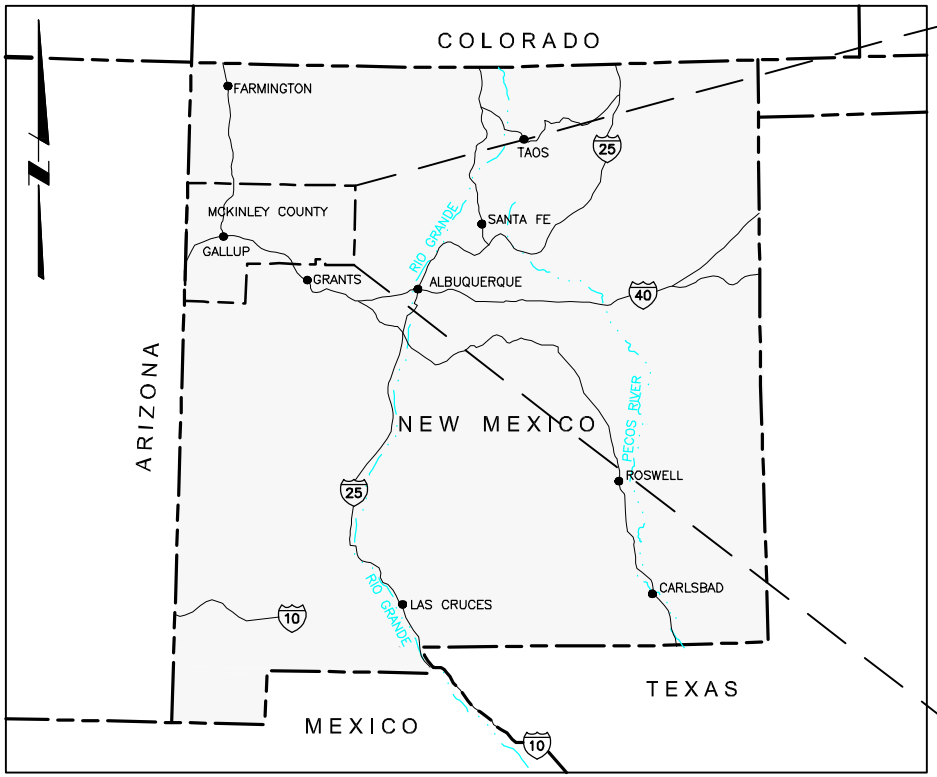

LOCATION MAP
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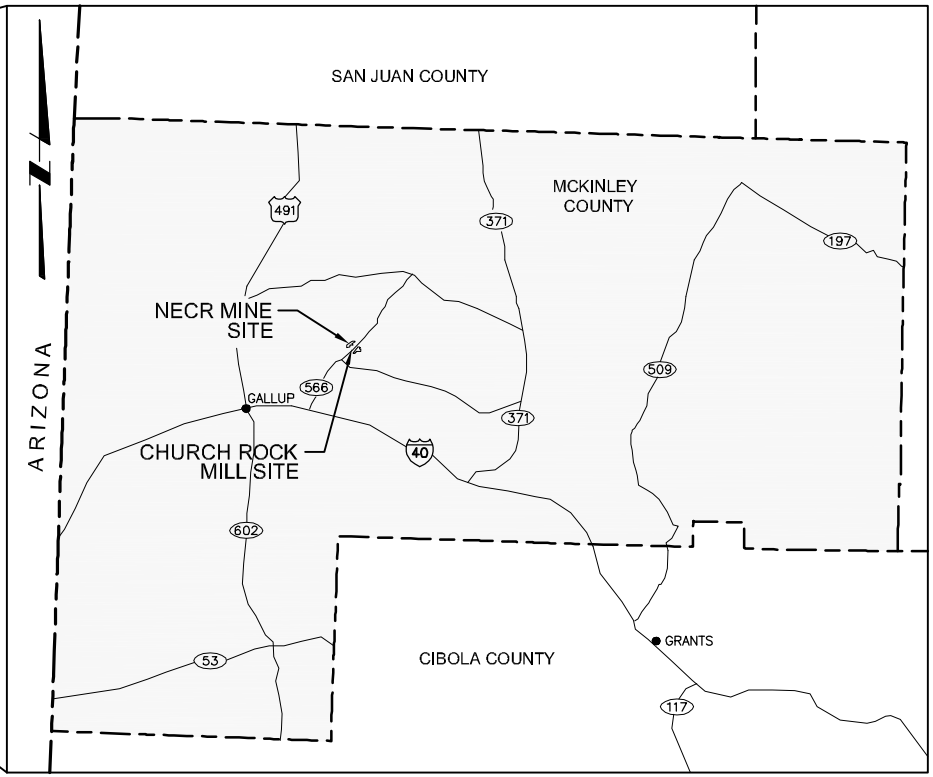

VICINITY MAP
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					DRAWN BY	K TULLAR	07-14
					CHECKED BY	C STRACHAN	07-14
					APPROVED BY	E DORNFEST	07-14
					PROJECT MANAGER	T LEESON	07-14
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ISSUE REV	DESCRIPTION	TECH	ENG	DATE	CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: SITE LOCATION MAP
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FIGURE: 1-1
REVISION: 0
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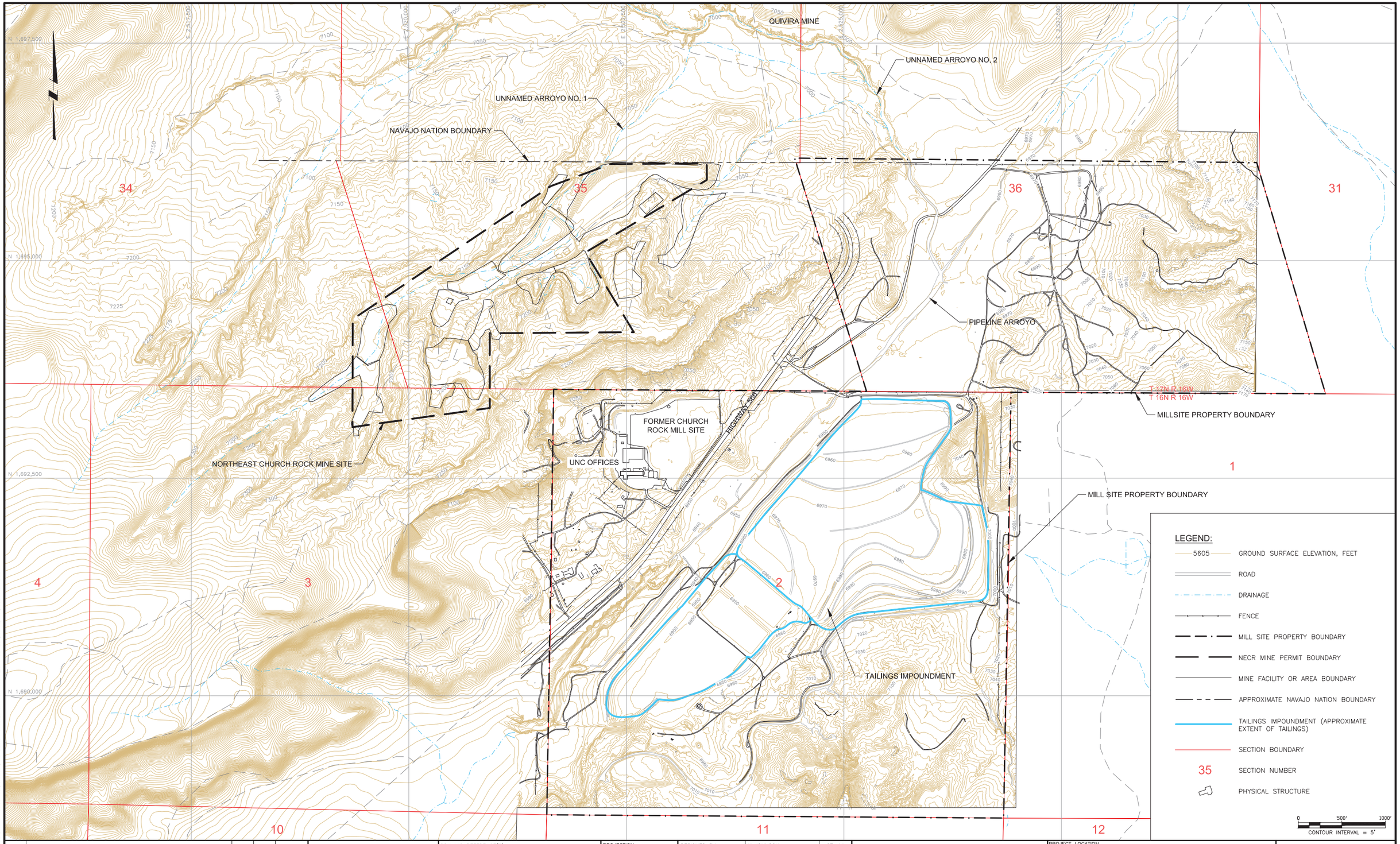

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PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07-14
DRAWN BY	C FOWLER	07-14
CHECKED BY	E DORNFEST	07-14
APPROVED BY	T LEESON	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: REGIONAL MAP

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FIGURE 1-2 | REVISION 0
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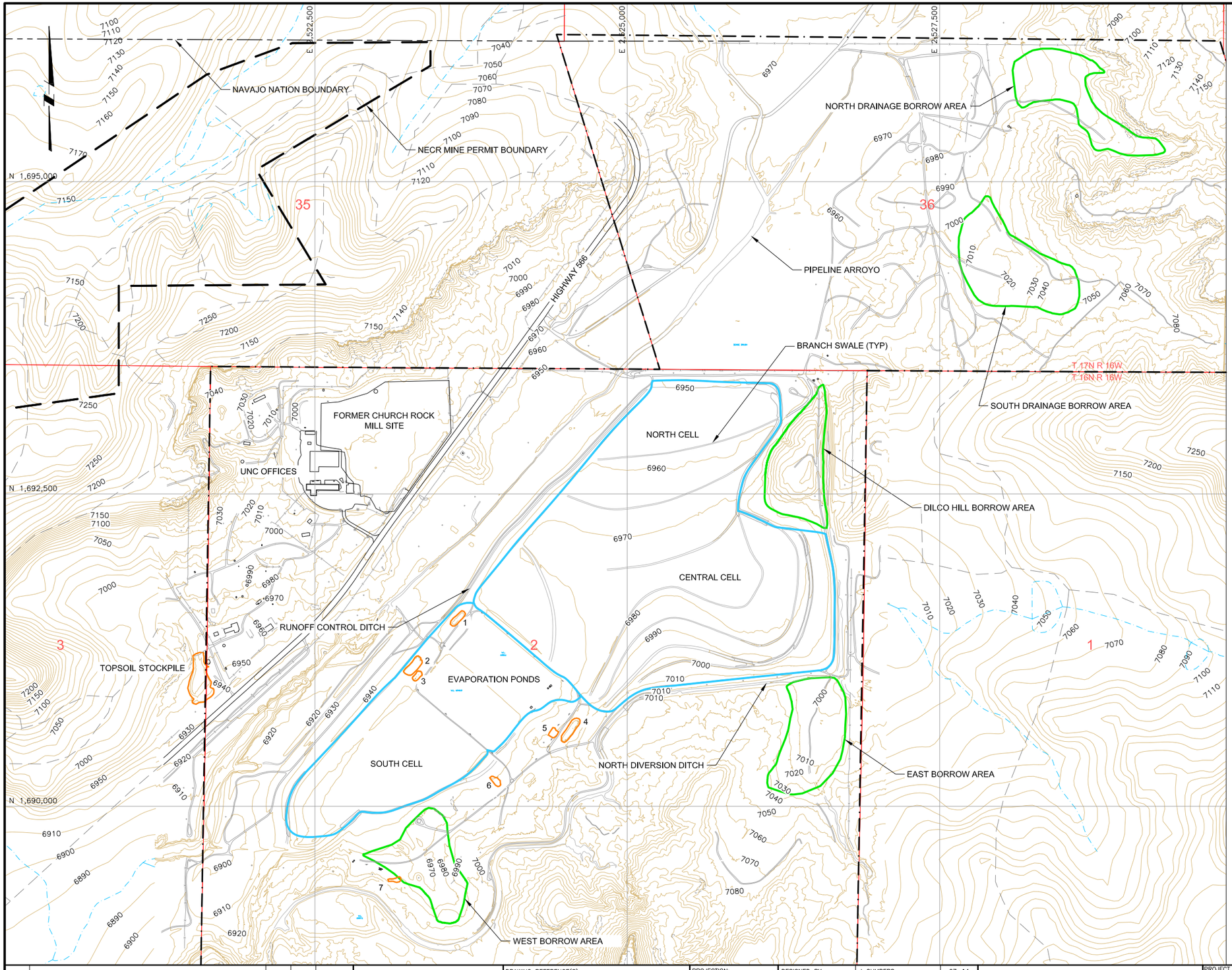

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- ROAD
- DRAINAGE
- FENCE
- TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)
- POTENTIAL BORROW AREAS
- MILL SITE PROPERTY BOUNDARY
- APPROXIMATE NAVAJO NATION BOUNDARY
- NECR MINE PERMIT BOUNDARY
- SECTION BOUNDARY
- 35 — SECTION NUMBER
- 4 — MATERIAL STOCKPILE AND DESIGNATION
- PHYSICAL STRUCTURE

NOTE:

1. STOCKPILE 1 IS CRUSHER FINES, STOCKPILE 3 IS ROAD BASE, AND THE REMAINING STOCKPILES (2, 4–7) ARE CRUSHED BASALT RANGING IN SIZE FROM 1 TO 15 INCHES.

0 400' 800'
CONTOUR INTERVAL = 10'

ISSUE REV	DESCRIPTION	CF TECH	ED ENG	DATE
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DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

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CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: CHURCH ROCK MILL SITE LAYOUT
FIGURE: 1-3
REVISION: 0
FILE NAME: 10504918 PDS3

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2.0 INVESTIGATIONS CONDUCTED AT THE MILL SITE

As part of the pre-design data needs evaluation, MWH identified major RA design elements and reviewed available data for the Mill Site, specifically data related to the tailings impoundment. MWH evaluated geotechnical, geological, and hydraulic data for the tailings and underlying materials in the vicinity of the repository for mine spoils proposed as part of the RA. Specifically, the tailings data were evaluated with respect to the placement of mine spoils on top of the reclaimed tailings impoundment, in order to develop a focused PDS geotechnical investigation program. Section 2.1 summarizes previous investigations conducted at the Mill Site.

2.1 SUMMARY OF PREVIOUS INVESTIGATIONS

Several geotechnical investigations have been conducted at the Mill Site since operation of the tailings impoundment began in 1977. A memorandum summarizing existing information about available borrow materials, tailings and underlying alluvium, and the Zone 3 Sandstone in the area of the impoundment is included in Appendix A1. The following paragraphs summarize the sources of material specific information for the Mill Site.

2.1.1 Borrow Materials

MWH identified 19 boreholes previously drilled in or near the East and West Borrow Areas. These include ten boreholes in the East Borrow Area (Sergent, Hauskins & Beckwith (SHB), 1978b and Civil Systems Inc. (CSI), 1980) and eight boreholes in or near the West Borrow Area (SHB, 1978a and CSI, 1980). Borrow material was later excavated from these areas and used for construction of the existing tailings impoundment cover. These areas were subsequently sampled and characterized (post-excavation) in 2008. These borrow areas are under consideration for repository cover material, and a MWH borrow characterization memorandum for these areas is provided in Appendix A2.

A topsoil stockpile containing approximately 20,000 cubic yards (cy) of material exists on UNC property west of Highway 566 and south of the UNC offices. Dwyer Engineering, LLC summarized the available geotechnical information for the site in 2012, which included limited geotechnical test data for the topsoil stockpile from 2008. These results are provided in the memorandum in Appendix A3.

2.1.2 Tailings

The preliminary geotechnical investigation for the tailings impoundment was conducted in 1974 (SHB, 1974). A subsequent geotechnical investigation in 1978 (SHB, 1978a) included drilling boreholes through the embankment and through the tailings within the impoundment. In 1979, UNC conducted a stability and integrity assessment of the tailings dam, which included information about the interior dikes and the south cell (SHB, 1979). Additional boreholes were drilled through the tailings impoundment in the Central Cell, in Borrow Pit No. 1, and in the

South Cell in 1985. These borehole logs are included as attachments to a UNC memorandum (UNC, 1986) and the geotechnical data is partially summarized in the impoundment Reclamation Plan (Canonie, 1991). Interim stabilization of the Central Cell was completed in 1991, and a series of shallow boreholes were drilled in the Central Cell in 1992 (UNC, 1993). These boreholes appear to have been drilled through the interim cover surface. The 1992 tailings data is included in Appendix B of the Central Cell Final Reclamation As-Built Report (Canonie, 1995). A more detailed summary of historical tailings investigations and results is included in Appendix A1.

2.1.3 Alluvium

The SHB investigations (SHB, 1974, 1976, 1978a, 1978b, 1979) include laboratory testing of more than 200 samples of alluvium taken from the vicinity of the North and Central Cells. A summary of historical investigations and properties of the alluvium beneath the tailings is included in Appendix A1.

2.2 PRE-DESIGN STUDIES

Following USEPA approval of the PDS work plan in 2013, the field portion of the PDS was conducted at the Mill Site from October through December 2013. PDS field activities at the Mill Site consisted of surveying; cone penetration tests (CPTs); drilling, excavation and soil sampling; characterization of existing site features and surrounding flora and fauna; and a cultural resources survey. Specifically, the PDS included the following, which are described in Section 3.0:

- Topographic survey of the impoundment cells and surrounding areas
- Geotechnical evaluation of tailings impoundment and underlying geologic units
- Borrow material investigation
- Volume and characteristics of on-site erosion protection materials
- Revegetation study
- Biointrusion evaluation
- Cultural resources survey
- Visual inspection and survey of branch swales and North Upstream Diversion Channel
- Debris inventory
- Soil analog studies (ongoing, results to be provided in a future addendum)

All activities were conducted in accordance with the Work Plan and the applicable SOPs included in the Work Plan. Some minor changes were implemented due to field conditions, as described in Section 3.0. Because excavation, drilling and CPT were conducted through the existing tailings impoundment cover into and through the tailings, procedures were implemented to minimize disturbance and radiological exposure, as well as to restore the cover system after sampling was complete. These procedures are outlined in the Work Plan.

3.0 SUMMARY OF MILL SITE PRE-DESIGN STUDIES

A description of each PDS task and associated results are provided below.

3.1 TOPOGRAPHY

Cooper Aerial Surveys Co. (Tucson, AZ) completed an aerial survey to update topographic information at the impoundment to an accuracy of 1 foot horizontally and 0.5 foot vertically. Ground control survey data was also collected on 100-foot intervals along Pipeline Arroyo, along the drainage swales on the existing cover, and in select locations along the north upstream diversion channel. The drilling and CPT locations were surveyed after completion. The figures provided in this report include the updated topographic information.

3.2 GEOTECHNICAL EVALUATION OF TAILINGS IMPOUNDMENT AND UNDERLYING UNITS

3.2.1 Cover Material

The existing tailings cover was sampled to evaluate the existing gravel admixture layer and underlying radon barrier, as described in the sections below. Specifically, these evaluations included geotechnical characteristics and volume of the existing gravel admixture layer and remolded saturated hydraulic conductivity of the underlying radon barrier.

3.2.1.1 Summary of Field Investigation and Sampling

On November 12 and 13, 2013, Mill Site personnel excavated twelve test pits (CS-1 through CS-12) on the existing tailings impoundment using a backhoe. The test pit locations are shown on Figure 3-1, *PDS Tailings Impoundment Sampling Locations*. The test pits were 2.5 feet wide (the width of the backhoe bucket) and ranged in length from approximately 4 to 6 feet. Excavation depths ranged from 14 inches to 2 feet. The materials excavated from the test pits were temporarily stockpiled on plastic sheeting. The table below summarizes the materials and cover layer thicknesses encountered in each test pit.

Materials encountered during the excavation were logged, and photographs of the test pit walls were taken. Photographs were also taken before and after each excavation. The test pit logs are provided in Appendix B2, along with photographs of the open excavations and representative photographs showing typical “before” and “after” conditions. Photographs showing typical backhoe excavation and backfill compaction are also included in Appendix B2.

Ten of the test pit locations (CS-1 through 6 and CS-8 through 11), exhibited three distinct material types. An upper, soft layer of sandy clay material was observed, ranging in thickness from 3 to 8 inches. A bag sample of this material was collected at each test pit location. Below the upper sandy clay layer, a layer of rock mulch was observed, ranging in thickness from 3 to 4

inches. The rock consisted of crushed basalt ranging in size from ½ inch to 3 inches. Composite bucket samples of the upper sandy clay and the rock mulch material were collected. The combined sandy clay and rock mulch layer is considered the admixture layer of the existing cover. Below the rock mulch layer, a clay material was encountered. This layer is considered the radon barrier layer of the existing cover. The test pits extended between 13 and 20 inches into the radon barrier, but did not extend through it. Bag samples and bucket samples of this material were collected.

At CS-7, a rock mulch layer was not present. Only sandy clay was observed, extending from the ground surface to the total excavation depth. Bag and bucket samples of the material were collected. This test pit is outside of the tailings impoundment on undisturbed natural ground. At CS-12, only the soft sandy clay material was observed. This material extended to a depth of 14 inches where sandstone bedrock was encountered. Both a bag sample and bucket samples were collected at this location. This test pit is likely outside of the extent of tailings deposition.

After excavation, the stockpiled cover materials were placed back in the test pit and compacted with the backhoe bucket and by wheel tracking with the backhoe. The final excavated area was graded to match the surrounding area. A stake was placed at each test pit location for subsequent gamma and location/elevation surveying. The radiological survey data is included in Appendix C. The collected cover material samples were transported to the Mill Site office area for storage and laboratory testing.

3.2.1.2 Laboratory Testing

Selected samples were submitted for geotechnical, analytical, and agronomic testing, in accordance with the Work Plan. The laboratory testing results are summarized in Table 3-1, *Summary of Geotechnical Laboratory Data – Cover Samples* and Table 3-2, *Summary of Agronomic and Analytical Laboratory Data – Impoundment Cover, Stockpiles, and Borrow Areas*. The data are provided in Appendix B1.

3.2.1.3 Volume and Composition of Admixture Material

The conceptual repository design includes the removal of the admixture material (combined rock mulch and overlying sandy clay) from within the footprint of the repository for use in RA construction. Based on the three conceptual repository alternatives, the repository footprint area could range from approximately 55 to 70 acres.

Summary of Cover Test Pit Depths and Layer Thicknesses

CS-1	24	8	3	11
CS-2	24	7	3	10
CS-3	24	3	3	6
CS-4	24	6	4	10
CS-5	24	6	3	9
CS-6	24	4	3	7
CS-7	20	N/A	N/A	N/A
CS-8	28	4	4	8
CS-9	26	5	4	9
CS-10	25	3	4	7
CS-11	24	6	3	9
CS-12	14	14	N/A	N/A

Notes:

1. Radon barrier was encountered in test pits below the depth of the rock mulch.
2. Combined thickness of the upper sandy clay layer and rock mulch layer
3. N/A = material not encountered at the test pit location

The admixture material observed during the field excavations (including the upper sandy clay and the rock mulch layer) ranged in thickness from 6 to 11 inches, with an average thickness of approximately 8.5 inches. These values exclude the observations made at CS-7 and CS-12 where the rock mulch layer was not present. Using the range of repository footprint areas of 55 to 70 acres, and assuming an average admixture thickness of 8.5 inches, the corresponding volume of admixture material excavated from the existing cover would range from approximately 63,000 to 80,000 cubic yards.

The excavated admixture material would be comprised of mixed sandy clay soil and crushed basalt rock. Based on laboratory gradation testing, the average soil/rock mixture would be comprised of approximately 60 percent soil and 40 percent rock (by dry weight) and the rock fraction would consist of 1/4-inch to 3-inch crushed basalt material. The fines content of the soil fraction of the mixture would be approximately 57 to 73 percent and would be low-plasticity clay.

3.2.1.4 Rock Quality Scoring of Gravel in Impoundment Cover Admixture Layer

Gradations were conducted on samples of the soil-rock admixture layer of the existing impoundment cover. The median diameter (D_{50} value) of the samples tested (CS-2, CS-6, and CS-9) ranges from 0.1 to 13 mm (less than or equal to 0.5 inches). The gravel fraction of these samples was then evaluated for potential reuse as erosion protection at the site. The gravel was tested for durability in general accordance with guidelines for long-term performance outlined by

the US Nuclear Regulatory Commission (NRC). These guidelines are for rock to be used for erosion protection material on exposed surfaces and utilize a rock scoring value (Johnson, 2002). In order to develop the scoring criteria, specific gravity, absorption, sodium sulfate soundness, and L.A. Abrasion tests were performed in accordance with ASTM guidelines. Durability testing results are provided in Appendix B1. The table below summarizes the durability score of the gravel fraction of the cover material.

Based on information provided in NUREG-1623 (NRC, 2002), rock for use in areas defined as critical areas must meet a score of 65 percent or greater and require oversizing if the score is less than 80 percent. The basalt samples tested from the existing cover scored 94 percent and therefore would not require oversizing for reuse as erosion protection rock.

Summary of Durability Scoring Criteria for Impoundment Cover Gravel

Bulk Specific Gravity (ASTM C127)	2.78	10	9	90	90
Absorption, % (ASTM C127)	1.55	4	2	8	20
Sodium Sulfate, % (ASTM C88)	0.37	10	11	110	110
LA Abrasion (100 revs.[2]), % (ASTM C535)	5.1	8	1	8	10
TOTALS				208	220
		Score:		**94 %**	
		Oversizing required:		**none**	

Notes:

1. Test results provided by Advanced Terra Testing and CTC Geotek (2014), results presented are the median of three values.
2. Test conducted for 100 revolutions per NUREG-1623
3. Based on a range of 0 to 10, rock strength scores based on DePuy (1965 (Table 1))
4. Weighting factors for igneous rock, NUREG-1623 and DePuy (1965)

3.2.1.5 Clay (Radon Barrier) Layer

The clay layer beneath the admixture layer on the existing impoundment cover was sampled and tested for geotechnical properties. Clay layer samples are classified as low-plasticity clay (CL) with fines contents ranging from 51 to 69 percent. Water contents of the samples tested are between 6 and 11 percent (by mass) and up to 4 to 6 percent below the optimum water contents measured from the standard Proctor tests. Saturated, hydraulic conductivity tests were conducted on samples remolded to 90 percent, 95 percent, and 100 percent of the standard Proctor density for the material. Resulting conductivities range from 7.6E-08 cm/sec to 3.0E-04 cm/sec, with the lowest values of saturated hydraulic conductivity generally corresponding to the

samples remolded to the greatest percent compaction. The specimens were tested at two initial confining stresses (8 and 24 psi) to replicate the range of conditions under future fill placement.

3.2.2 Tailings and Underlying Units

3.2.2.1 Cone Penetration Tests

ConeTec conducted the CPTs at the Mill Site impoundment on November 5-10, 2013 to aid in characterization of the subsurface materials. CPT is a method used to obtain in-situ soil data (e.g., soil type, moisture conditions and stratigraphy) without collecting soil samples. The raw data generated during CPT includes tip resistance, sleeve friction, friction ratio, pore pressures, and bulk resistivity. The tailings materials are not a natural deposit and therefore it is difficult to correlate CPT data obtained in tailings to published CPT-soil correlations. Therefore, the CPT investigation was intended to provide a general understanding of subsurface conditions and tailings stratigraphy in the impoundment. These conditions were then verified and further evaluated by logging boreholes and performing laboratory testing on samples obtained in the boreholes. The CPT investigation is described below. The borehole investigation and laboratory testing program are described in Sections 3.2.2.2 and 3.2.2.7.

Completed CPT locations are shown on Figure 3-1. The Work Plan specified that CPTs be conducted at 12 locations within the impoundment. However, based on conditions encountered during the field investigation, CPTs were conducted at an additional 20 locations to further characterize specific areas of the impoundment. CPTs were conducted at a total of 32 CPT locations within the impoundment. CPTs were conducted at 12 additional locations in the Central Cell, six locations in the North Cell, and two locations in the South Cell. The CPTs extended to depths ranging from 2.5 to 119 feet below the ground surface, depending on the materials encountered. A summary of the materials and the thicknesses of the layers encountered is included in Table 3-3 *Summary of Borehole and CPT Profiles*. The CPT program included tip and shear resistance measurements, dynamic pore pressure measurements, pore pressure dissipation tests, resistivity measurements, and shear wave velocity measurements.

After drilling and sampling, CPT holes were backfilled with bentonite grout, and a stake was placed at each location for subsequent gamma and location/elevation surveying. The radiological survey data are included in Appendix C. The CPT logs, pore pressure dissipation plots, and shear wave velocity calculations are included in Appendix B2.4.

3.2.2.2 Drilling and Sampling

Drilling in the tailings impoundment was performed on November 19-21, November 26-27 and December 2-4, 2013 by National Exploration, Wells & Pumps. The Work Plan included six boreholes; five in the impoundment, and one through the embankment. Two additional boreholes were drilled during field work; one in the North Cell (B-23) and one in the Central Cell (B-15). A total of eight boreholes were drilled, including one drilled through the embankment,

four in the Central Cell and three in the North Cell. Figure 3-1 shows completed borehole locations. The boreholes were all paired with a CPT location.

Hollow-stem auger drilling methods were used to drill each borehole and samples were collected by various methods through the borehole lengths. A CME-85 auger rig was used to perform the drilling. Drilling depths ranged from 39 to 109 feet depending upon the conditions encountered and the presence or absence of bedrock.

Continuous (dry-core) samples were collected as the primary sampling method. Dry-core samples were logged, placed in labeled core boxes, photographed, and stored in the Mill Site office area away from the work areas. Acrylic liners were used to collect dry-core samples of the tailings. A 2.5-inch (outside diameter) California split-spoon sampler was used to obtain 2-inch diameter samples at select locations. Three-inch diameter Shelby tube samples were also collected during drilling.

After drilling and sampling, boreholes were backfilled with bentonite grout, and a stake was placed at each location for subsequent gamma and location/elevation surveying. The radiological survey data are included in Appendix C. Borehole logs, photographs of the core, and other representative photographs of drilling operations are provided in Appendix B2.

3.2.2.3 Material Contacts

The CPT data combined with the profiles from the borehole logs were used to determine the thickness and texture of the tailings layers, as well as the location of the contact between the tailings and underlying alluvium. Seven of the CPTs were paired with boreholes to correlate CPT results with direct observation of the materials encountered. The relationships used to determine the tailings-alluvium contact are described below.

Data collected from the CPTs, such as cone resistances (tip and sleeve), dynamic pore pressures, and electrical resistivity measurements, were used to identify contact locations between the tailings and underlying alluvium. Nineteen of the 32 CPTs encountered fine-grained tailings in contact with the alluvium. Four of the 19 CPTs were paired with boreholes to determine the CPT expression of the contact between fine tailings and alluvium. Typically the cone tip resistance increased by a factor of 4 to 6 from the fine tailings to the alluvium, with values increasing from approximately 10-20 tons/square foot (tsf) to a range of 40-150 tsf. Sleeve friction increased to 1.8-2.2 tsf from approximately 0 tsf within the tailings. Resistivity readings increased from approximately 0 ohm-meter (ohm-m) in the tailings to 500-650 ohm-m in the alluvium. Dynamic pore pressure measurements did not exhibit a consistent pattern during the transition from tailings to alluvium.

A different pattern delineated the contact between coarse-grained tailings and underlying alluvium. In three of the 32 CPTs, coarse-grained tailings were in contact with the alluvium. Two of these three CPTs were paired with boreholes to determine the CPT pattern of the contact

between fine tailings and alluvium. The cone resistance (tip and sleeve) and the normalized soil behavior exhibited a distinct pattern at the transition from coarse-grained tailings to alluvium. Sleeve resistance increased by a factor of 3 to 5, from a range of approximately 0.3-1.0 to 2.2-6.1 tsf. Tip resistance increased from a range of approximately 30-50 to 75-250 tsf. A normalized soil behavior type (SBT) of zones 5 to 7 (clayey silt, silt, and sandy silt) were typically observed in the tailings and SBTs of 3 to 4 (clay and silty clay) were observed in the underlying alluvium.

3.2.2.4 Dynamic Pore Pressures and Pore Pressure Dissipation Tests

Dynamic pore pressures were measured during the CPTs. Eight pore pressure dissipation (PPD) tests were performed (CPT-10 (2 depths), CPT-7, CPT-8, CPT-9, CPT-11, CPT-18, and CPT-19) within the tailings impoundment. Results of the dissipation tests and dynamic pore pressure measurements indicate elevated, quasi-steady-state pore pressures in the fine-grained tailings. The pore pressure dissipation plots are included in Appendix B2.4

The resulting quasi-steady-state pore pressures from the two tests conducted within the tailings at CPT-10 showed pressure heads of about 21 and 31 feet at test depths 15 feet apart vertically. These results indicate increasing quasi-steady-state pore pressure results with depth in the tailings at that location. Other pore pressure dissipation tests conducted in Borrow Pit No. 1 at CPT-8, CPT-9, CPT-18, and CPT-19 show a range of quasi-steady-state pore pressures, without a trend of increasing quasi-steady-state pore pressures as test depths increased. The results indicate the presence of a series of depositional layers with different textures, degrees of saturation, and varying quasi-steady-state pore pressures, rather than a static water level.

The dissipation test conducted in the tailings at CPT-11 (located in Borrow Pit 2) showed a quasi-steady-state pressure head condition at about 49.5 feet below ground surface (bgs) or 4.5 feet above the bottom of the tailings. Due to the short test duration (1 hour) in this fine-grained material, this result likely overestimates the actual pressure head at this location. However, CPT-11 did exhibit the highest dynamic pore pressures throughout the impoundment, exceeding 350 feet at approximately 48 feet in depth. The dynamic pore pressures (u) measured during the CPTs within the tailings throughout the rest of the impoundment typically ranged from zero to approximately 200 feet. While these results at CPT-11 could indicate near-saturated conditions at this location, free water was not observed during drilling at this location. Additionally, the Shelby tube collected from 51.5 to 52.5 feet was not wet upon recovery, and the laboratory test results (Table 3-4, borehole TI-B11) from that sample do not indicate saturation.

The ConeTec report includes a table summarizing the data collected during the CPT investigation. The table contains a column listing depths for “Apparent Water Table”. These depths were calculated based on quasi-steady-state pore pressure measurements obtained during PPD testing. The quasi-steady-state pore pressure is typically taken to be the pore pressure measurement recorded at the end of the PPD test. In cases where a hydrostatic

groundwater condition exists (i.e. no vertical flow component) and where the pore pressures at the end of PPD testing have truly dissipated to static levels, the depth of the water table at the CPT location can be calculated by subtracting the static pressure from the depth at which the PPD test was performed. ConeTec used these assumptions and procedures to estimate the Apparent Water Table depths presented in the ConeTec report.

In cases of multiple saturated or nearly-saturated fine-grained zones (as is often the case in tailings after cessation of operations), or where there is a component of flow in the vertical direction, the procedure ConeTec used to define the depth for the "Apparent Water Table" is not appropriate. In addition, when positive dynamic pore pressures are generated during CPT soundings in finer-grained materials, quasi-steady-state pore pressures measured at the time of PPD test termination are often higher than true "static" pore pressures. This overestimation of static pore pressures results in underestimation of the depth to the water table and overestimation of saturated thicknesses.

At Church Rock, and specifically in the borrow pits, the CPT results and the borings indicate the presence of coarse-grained materials above, and in some cases interlayered with, fine-grained materials. The laboratory data indicate the upper coarse-grained materials have low water contents and are partially saturated, even though many of the test specimens were obtained from zones that are below the "Apparent Water Table" depths identified by ConeTec. Likewise, laboratory testing of finer grained samples indicated that, although they were at a higher moisture content and degree of saturation, many of these materials were also partially saturated even though they are below the "Apparent Water Table" defined by ConeTec. Therefore, the elevated dynamic and quasi-steady-state pore pressures are interpreted to indicate compressible fine-grained materials that are near saturation, rather than a static water level. This is consistent with the properties of tailings placed hydraulically during milling.

3.2.2.5 Standpipe Piezometers and Free Water Assessment

A description of free water encountered during the subsurface investigation within the impoundment is presented below. In summary, free water was encountered in three boreholes: TI-B3 (in the dam), TI-B10 (Borrow Pit No. 1), and TI-B11 (Borrow Pit No. 2). The water was present in the alluvium underlying the dam at TI-B3 and in the alluvium underlying the tailings at TI-B10 and TI-B11. No free water was identified in the tailings during the drilling program.

Temporary Standpipe Piezometers

On November 9, 2013, temporary standpipe piezometers were installed by hand in the open CPT holes at CPT-10 and CPT-18. The piezometers were constructed with 1-inch diameter, flush-threaded PVC screen and casing. Each piezometer consisted of a 5-foot section of slotted screen at the bottom (including a bottom cap), and PVC casing extending to the ground surface. The piezometers were installed to depths of 62.8 and 49.6 feet bgs at CPT-10 and CPT-18, respectively.

A water level probe was used to check for the presence of water in the piezometers. Measurements were made periodically at CPT-10 from November 9 through 25, 2013. Measurements were made at CPT-18 from November 9 through December 9, 2013. Both piezometers were dry during the entire monitoring period.

The piezometer casing at CPT-10 was removed on November 25, 2013 and the casing at CPT-18 was removed on December 9, 2013. Both piezometers were removed by hand with minimal effort, indicating the CPT holes did not cave in during the monitoring period. Upon removal, the casing from both piezometers was observed to be dry, with no visible water present on the surface of the casing or slotted screen. Following casing removal, the holes were backfilled with bentonite grout.

Free Water Encountered During Drilling

Free water was encountered during drilling at TI-B3, TI-B10 and TI-B11. Water was encountered during drilling at TI-B3 below approximately 55 feet bgs (approximate elevation of 6,914) in the alluvium. The borehole was left open overnight, and the water level measured through the hollow-stem augers the next morning was approximately 66 feet bgs, or near elevation 6,903 feet within the alluvium.

Free water was encountered during drilling at TI-B10. Field observations indicated that the sampler was wet upon retrieval from within the alluvium at a depth near 90 feet bgs (approximate elevation of 6,883 feet). The augers were left in-place overnight and the water level was measured again at about 90 feet bgs the following morning.

Free water was encountered during drilling at TI-B11. Field observations indicated that the cuttings became wet at a depth of approximately 90 feet bgs (approximate elevation of 6,887) and the sampler was wet upon retrieval from within the alluvium at a depth near 92 feet bgs (approximate elevation of 6,885). Very moist to wet alluvium was encountered at TI-B1 below 34 feet bgs (approximate elevation of 6,935); however static water was not present in the borehole after drilling. TI-B1 was grouted and abandoned immediately following drilling.

3.2.2.6 Impoundment Stratigraphy

Information collected from the PDS investigation within the tailings impoundment significantly augments the existing information. The comprehensive dataset was used to update the impoundment thickness map and cross sections shown in the Work Plan. Using this dataset, Figure 3-2, *Tailings Impoundment Thickness Isopach Map*, and Figure 3-3, *Distribution and Thickness of Fine-grained Tailings,* were developed to show variation of thickness across the impoundment, as well as the thickest zones of fine-grained tailings. Table 3-3, presents information on material properties and thicknesses encountered in the impoundment during the CPT and borehole investigation.

The revised cross sections are shown in Figures 3-4 and 3-5, *Impoundment Cross Sections 1 and 2*, and *Impoundment Cross Sections 3 and 4*, respectively. A new cross section was added to the set included in the Work Plan, and the orientations of the sections were changed slightly to intercept locations of thick tailings and better illustrate subsurface conditions within the area of the proposed repository.

The previously-developed bedrock surface used to generate the maps and sections shown in the Work Plan was updated in areas where new information was obtained. Bedrock surface information was used to create the maps shown in both the Work Plan and in this report, but the bedrock surface itself is not shown in any figures other than the cross sections (Figures 3-4 and 3-5). Depressions in the bedrock surface previously interpreted in the Work Plan to be isolated depressions are now interpreted to be paleochannels. One paleochannel is in general alignment with the present day Pipeline Arroyo, and another is a tributary to that paleochannel that trends east-west through Borrow Pits 1 and 2 in the impoundment. The paleochannels are represented by a deeply eroded bedrock surface and thick alluvial deposits underlying Pipeline Arroyo and the Central Cell. The general location of the paleochannels is shown on Cross Section 2 (Figure 3-4) and Cross Section 4 (Figure 3-5).

The borehole and CPT logs included in Appendix B2 provide details to support the identification of these channels. In particular, CPT-10 encountered refusal at elevation 6,910 feet within the alluvium. However, the paired borehole TI-B10 was able to penetrate through that sandstone obstruction at elevation 6,910, and again through a second sandstone obstruction 20 feet lower before encountering competent rock near elevation 6,868 feet. A similar obstruction was encountered in TI-B15 and CPT-15. Based on the depth to rock in boreholes near CPT-9 and CPT-27, it appears those locations may also have encountered refusal on boulders or a hard clay layer within the alluvium, above the actual bedrock surface. The sandstone encountered at TI-B10 appeared to be alluvial boulders in the paleochannel.

The cross sections shown in Figures 3-4 and 3-5 are for illustrative purposes and are not presented at a large enough scale to show details such as lateral variations in impoundment cover thickness or interlayering of fine and coarse tailings. Detailed information about interlayering of fine and coarse tailings is provided in Table 3-3. The contacts shown in the cross sections were generated from topographic surfaces developed for each material type in the impoundment. Boreholes and CPT locations shown in Figures 3-4 and 3-5 are projected onto the sections; therefore the elevations of contacts shown at projected borehole or CPT locations are only the true elevation at that location when the section passes through the borehole or CPT location.

3.2.2.7 Laboratory Testing

Selected samples from the impoundment boreholes were submitted for geotechnical testing, in accordance with the Work Plan. The laboratory testing is summarized in Table 3-4, *Summary of*

Geotechnical Laboratory Data – Mill Site Impoundment, and the data are provided in Appendix B1.

3.2.2.8 Geochemical Properties of the Tailings

The acid leach milling process used at the Mill Site introduced a significant amount of sulfate into the tailings (from the sulfuric acid used for acidification). Gypsum was the primary by-product of the milling process in the 1981 Mill License Renewal Application (D'Appolonia, 1981). The concentration of gypsum in the tailings varies with grain size, with the greatest amount of gypsum likely present in the fine-grained tailings. The paragraphs below describe the processes that lead to gypsum formation and the influence of the gypsum on the tailings.

Calcium-bearing minerals naturally occur in the sedimentary rock and ore body in the region of the Mill Site. The ore milling process dissolved many of the calcium-bearing minerals, resulting in free calcium ions available in the mill circuit. Sulfate was added during the milling process in the form of sulfuric acid (H_2SO_4) to aid in the dissolution of uranium. Gypsum ($CaSO_4 \bullet 2H_2O$) may precipitate in systems when excess Ca^{2+} and SO_4^{2-} are present in aqueous solutions. As a result of the milling processes, free calcium and sulfate ions in the tailings solution precipitated in the form of gypsum after the tailings and solution were deposited in the impoundment.

The presence of gypsum is known to affect certain geotechnical laboratory test results, specifically particle-size distribution and water content. Per ASTM 2216-10, soil water content is determined by heating a soil sample to 110°C and measuring the mass of water removed by evaporation. When a sample containing gypsum is heated to 110°C, the gypsum loses its molecular water and becomes bassenite ($CaSO_4 \bullet 0.5H_20$) and anhydrite ($CaSO_4$). Since molecular water accounts for about 20 percent of the mass in gypsum, this loss of molecular water manifests itself as elevated soil water content when samples containing gypsum are dried at 110°C. For this reason, ASTM 2216-10 (ASTM, 2010) suggests drying soil samples containing gypsum at a lower oven temperature (60°C) to determine the water content. Using a lower oven temperature allows the soil (pore) moisture to evaporate without removing the molecular water from the system.

3.2.2.9 Effect of Gypsum on Geotechnical Properties of the Tailings

MWH assessed the potential for gypsum in the tailings samples upon initial review of test results, after a significant portion of the laboratory testing had already been completed. However, to properly account for the presence of gypsum in the tailings samples, the laboratory testing program was revised to obtain the water content for remaining specimens using both drying temperatures. The remaining specimens, which included 15 tailings samples, were initially dried at 60°C and weighed to calculate water content. The oven temperature was then increased to 110°C, and the same specimens were weighed a second time to calculate the water content corresponding to the 110°C oven temperature. This information provided a comparison set of data for the water contents measured at the two oven temperatures. The

relationship between the water contents measured at 60°C and those measured at 110°C was then used to develop a correlation between the two values and to adjust the initial test results in samples that were heated to 110°C only. Water contents measured at 60°C, were generally about 0.5 percent to 3.0 percent lower than water contents measured at 110°C. The reduction in percent water content represents the fraction of the water in the tailings that is chemically bound in the form of gypsum, and not within pore spaces. This information, along with the SWCC data, helped to further define the volume of pore water within the tailings that would be affected by additional loading. The results of geotechnical laboratory testing on tailings impoundment samples are included in Table 3-4. Table 3-4 also includes a series of water contents measured for both oven temperatures as well as water content, specific gravity, and dry density results adjusted to reflect a 60°C water content.

The hydrometer test results for specimens containing fine-grained tailings were also likely affected by gypsum. Gypsum influences the results of particle-size analysis in two ways: 1) gypsum is a flocculant for clay minerals; and 2) gypsum has a lower density than soil, both of which can skew the fine-grained particle distributions during measurement using the hydrometer method (Arnett, 2009). Particle-size distribution tests were conducted using the standard amount of sodium hexametaphosphate as a deflocculant. Because additional deflocculant was not added to account for the presence of gypsum, the hydrometer results presented in Table 3-4 may not be representative of the actual particle sizes. The presence of gypsum in the test solution would reduce the effectiveness of the deflocculant resulting in a higher measured percentage of larger (silt-size) particles.

Results of the laboratory testing indicated that as the percentage of silt-size material in the tailings increases, the difference between the water contents measured at 60°C and 110°C also increases. The geochemical properties described above do not alter the conceptual repository design, nor do they require any additional investigation. The calculation of water content and the volume of water molecularly bound in gypsum, combined with the results of the SWCC data and the rest of the geotechnical laboratory test results, provide a comprehensive dataset for the repository design.

3.3 BORROW MATERIAL INVESTIGATION

Five potential borrow areas were investigated to determine the volume of suitable material available for use in repository cover construction and general RA regrading activities. The borrow material investigation involved borehole drilling and sampling in all five potential borrow areas. The borrow area locations are shown on Figure 3-6, *Drilling Locations and Preliminary Grading, East and West Borrow Areas*, and Figure 3-7, *Drilling Locations and Preliminary Grading, North, South, and Dilco Hill Borrow Areas*, and include the following:

- West Borrow Area
- East Borrow Area

- Dilco Hill Borrow Area
- South Drainage Borrow Area
- North Drainage Borrow Area

3.3.1 Summary of Field Investigation and Sampling

Drilling was performed November 14-18 and December 10-12, 2013 by National Exploration, Wells & Pumps. Up to five boreholes were drilled within each borrow area, in accordance with the Work Plan. Hollow-stem auger drilling methods were used at each location. A CME-85 auger rig was used to perform the drilling. Drilling depths ranged from 10 to 60 feet and varied depending upon the borrow area being investigated, the location of the borehole within the borrow area, and the presence or absence of bedrock.

Continuous (dry-core) samples were collected as the primary sampling method. Dry-core samples were logged, placed in labeled core boxes, photographed, and stored in the Mill Site office area. A 2.5-inch (outside diameter) California split-spoon sampler was used to obtain 2-inch diameter samples at typical sampling depths of 2.5, 5 and 10 feet bgs, and at additional depths depending on the materials encountered. Bulk composite samples of the cuttings were collected from a variety of depth intervals, depending on the volume of cuttings produced and the materials encountered.

After drilling and sampling, the boreholes were backfilled with drill cuttings and/or clean fill material from the borehole area, and a stake was placed at each location for subsequent location/elevation surveying. Borehole logs, core photographs, and other representative photographs of drilling operations are provided in Appendix B2.

3.3.2 Laboratory Testing

Selected samples were submitted for geotechnical, analytical, and agronomic testing. Laboratory testing is summarized in Section 3.3.3 and the results are provided in Table 3-2 and Table 3-5, *Summary of Geotechnical Laboratory Data – Borrow Areas,* and Appendix B1.

3.3.3 Summary of Results

Field investigation and geotechnical laboratory test results for each borrow area are summarized below. The table below lists the depth drilled at each borehole location, and the depth of soil encountered above bedrock.

Summary of Borrow Area Borehole Depths and Soil Thicknesses

Borehole	Total Depth (ft)	Thickness of Soil Above Bedrock (ft)
West Borrow Area		
WB-B1	36.5	>36.5
WB-B2	35.0	>35.0
WB-B3	30.0	None
WB-B4	38.7	1.0
WB-B5	24.7	22.5
East Borrow Area		
EB-B1	10.0	None
EB-B2	15.0	3.0
EB-B3	25.0	15.0
EB-B4	20.0	>20.0
EB-B5	10.8	8.5
EB-B6	17.6	11.5
Dilco Hill Borrow Area		
DH-B1	60.0	15.0
DH-B2	40.0	2.0
DH-B3	40.0	2.5
South Drainage Borrow Area		
SB-B1	25.0	>25.0
SB-B2	15.0	14.1
SB-B3	15.0	7.8
SB-B4	30.0	>30.0
North Drainage Borrow Area		
NB-B1	20.0	>20.0
NB-B2	20.0	>20.0

Based on field investigation results, preliminary grading plans were developed for each borrow area to estimate the volume of material available for repository cover construction. Grading plans were developed to avoid nearby cultural resource sites while adhering to the approximate borrow area boundaries delineated in the Work Plan. The borrow areas will be graded to drain similarly to the conceptual designs shown on Figures 3-6 and 3-7. However, final grading configurations of the borrow areas will depend on the material volumes required, the locations of the cultural resource sites, efforts to limit unnecessary disturbance to vegetation, and depths of suitable and available materials. The table below summarizes the approximate volume and predominant material types available from each borrow area.

Summary of Borrow Material Volumes and Material Types

Borrow Area	Predominant Material Types		Approximate In-Place Volume (cy)
	Soil Description	USDA Classification	
West Borrow	Clayey Sand and Silty, Clayey Sand	Sandy Loam	100,000
East Borrow	Sandy Clay and Clayey Sand	Sandy Loam	50,000
Dilco Hill	Sandy, Silty Clay	Sandy Loam	5,000
	Mixed Sandstone, Shale and Coal (Rock)	–	370,000
South Drainage Borrow	Sandy Clay and Clay with Sand	Sandy Clay Loam	170,000
North Drainage Borrow	Sandy, Silty Clay and Silty, Clayey Sand	Sandy Loam	80,000
available soil from borrow areas			405,000
available rock from borrow areas[1]			370,000

Notes:

1. Estimated volume of rock available from Dilco Hill

3.3.4 West Borrow Area

Five boreholes were drilled in the West Borrow Area to depths ranging from 24 to 39 feet. Drilling was generally performed at the locations shown in the Work Plan, except for WB-B4, which was moved due to access constraints. Boreholes WB-B1 and WB-B2 were drilled in the central, lower portion of the borrow area where most of the available borrow material is located. At these locations, clayey sand was encountered to the greatest depths drilled. Boreholes WB-B3, WB-B4 and WB-B5 were drilled around the perimeter of the borrow area. At WB-B3 and WB-B4, bedrock comprised of claystone, sandstone, and/or coal was encountered near the ground surface. At WB-B5, silty, clayey sand was encountered to a depth of 22.5 feet, where sandstone bedrock was encountered.

Based on the borehole logs and results of geotechnical laboratory testing, the predominant material available from the West Borrow Area is relatively homogeneous and consists of clayey sand and silty, clayey sand. The laboratory-measured sand content ranged from 46.3 to 61.6 percent for all samples tested. The fines content ranged from 37.9 to 48.6 percent and was comprised of low plasticity clay or silty clay. A small amount of gravel (less than 10 percent) was encountered in some samples. The corresponding USDA classification of the material is “sandy loam.”

Based on the field investigation and the preliminary grading contours shown in Figure 3-6, approximately 100,000 cubic yards of material consisting of clayey sand and silty, clayey sand is available in the West Borrow Area.

3.3.4.1 East Borrow Area

Six boreholes were drilled in the East Borrow Area to depths ranging from 10 to 25 feet. Borehole EB-B6 was added to the drilling program presented in the Work Plan to better characterize the depth and extent of potential borrow material in the East Borrow Area. Boreholes EB-B1 and EB-B2 were drilled in the western portion of the borrow area and sandstone bedrock was encountered at or near the ground surface at both locations. Boreholes EB-B3 and EB-B4 were in the southern portion of the borrow area. At EB-B3, sandy clay was encountered to a depth of 15 feet, where sandstone bedrock was encountered. At EB-B4, sandy clay and silty, clayey sand was encountered to the maximum depth drilled (20 feet). Boreholes EB-B5 and EB-B6 were in the central portion of the borrow area. At EB-B5, sandy clay and clayey sand was encountered to a depth of 8.5 feet, where shale bedrock was encountered. At EB-B6, sandy clay was encountered to a depth of 11.5 feet, where shale bedrock was encountered.

Based on borehole logs and results of geotechnical laboratory testing, the predominant material available from this borrow area is relatively homogeneous and consists of sandy clay and clayey sand, with nearly equal portions of sand and fines in most samples tested. The sand content ranged from 26.6 to 50.5 percent for all samples, and the fines content ranged from 45.5 to 73.4 percent and was comprised of low plasticity clay or silty clay. A small amount of gravel (less than 10 percent) was encountered in one sample. The corresponding USDA classification of the predominant material type is “sandy loam.”

Based on the field investigation and the preliminary grading contours shown in Figure 3-6, approximately 50,000 cubic yards of material consisting of clayey sand and sandy clay is available in the East Borrow Area.

3.3.4.2 Dilco Hill Borrow Area

Three boreholes were drilled in the Dilco Hill Borrow Area to depths ranging from 40 to 60 feet. At each borehole location, a relatively thin veneer of unconsolidated soil overlying bedrock was observed. The bedrock consisted of sandstone, shale, coal, and interbedded sandstone and shale. Borehole DH-B1 was drilled in the northern portion of the top of the hill. At this location, silty clay with sand, silty sand, and silty clay was encountered to a depth of 15.0 feet, where bedrock was encountered. DH-B2 was drilled in the central portion of the top of the hill. Silty clay with sand was encountered to a depth of 2.0 feet, where bedrock was encountered. DH-B3 was drilled in the southern portion of the top of the hill. Silty clay with sand was encountered to a depth of 2.5 feet, where bedrock was encountered.

Based on borehole logs and results of the geotechnical laboratory testing, a small amount of unconsolidated soil is available from the top of the hill. Material ranges in depth from approximately 2 to 15 feet, and consists of sand and sandy, silty clay. The corresponding USDA classification of this material is “sandy loam.”

Most of the available material from the Dilco Hill Borrow Area is comprised of sedimentary bedrock. Above a depth of approximately 25 to 30 feet, the predominant material type is sandstone, shale, and interbedded sandstone and shale. Below a depth of 25 to 30 feet, the predominant material is comprised of shale and coal.

Based on the field investigation and the preliminary grading contours shown in Figure 3-7, approximately 5,000 cubic yards of sandy, silty clay is available from the top 2 to 15 feet of the Dilco Hill Borrow Area. In addition, approximately 370,000 cubic yards of mixed sandstone, shale and coal is also available. Since auger refusal was not encountered in any of the boreholes drilled, it is expected that this bedrock material can be ripped using conventional excavation equipment, such as a Caterpillar D-8 or heavier dozer, with a single tooth ripper.

3.3.4.3 South Drainage Borrow Area

Four boreholes were drilled in the South Drainage Borrow Area to depths ranging from 15 to 30 feet. Borehole SB-B4 was added to the drilling program presented in the Work Plan to better characterize the depth and extent of potential borrow material in the South Drainage Borrow Area. Borehole SB-B1 was drilled in the eastern portion of the borrow area, where sandy clay was encountered to the total borehole depth of 25.0 feet. SB-B2 was drilled in the northern portion of the borrow area. At this location, clay with sand was encountered to a depth of 14.1 feet, where sandstone bedrock was observed. SB-B3 was drilled in the southwestern portion of the borrow area. Clay with sand was encountered to a depth of 7.8 feet, where sandstone bedrock was observed. SB-B4 was drilled in the central portion of the borrow area. Sandy clay was observed to a depth of 28.5 feet, where gravelly clay was encountered.

Based on borehole logs and results of the geotechnical laboratory testing, the predominant material available from this borrow area is relatively homogeneous and consists of sandy clay and clay with sand. The sand content ranged from 21.6 to 46.7 percent for all samples tested, and the fines content ranged from 53.3 to 78.4 percent and was comprised of low plasticity clay. The corresponding USDA classification of the predominant material type is “sandy clay loam.”

Based on the field investigation and the preliminary grading contours shown in Figure 3-7, approximately 170,000 cubic yards of material consisting of sandy clay and clay with sand is available in the South Drainage Borrow Area.

3.3.4.4 North Drainage Borrow Area

Two boreholes were drilled in the North Drainage Borrow Area. NB-B1 was drilled to a depth of 20.0 feet in the northwestern portion of the borrow area. At this location, silty clay with sand and silty sand was encountered to a depth of 18.0 feet, where gravelly sand was observed. NB-B2 was drilled to a depth of 20.0 feet in the southeastern portion of the borrow area. At this location, silty sand, silty clay, and sandy clay/clayey sand was encountered to the total depth drilled.

Based on borehole logs and results of the geotechnical laboratory testing, the predominant material available from this borrow area is relatively homogeneous and consists of nearly equal portions of sand and clay or silty clay. The laboratory-measured sand content ranged from 49.0 to 55.6 percent for all samples tested. The fines content ranged from 44.4 to 51.0 percent and was comprised of low plasticity silt or silty clay. The corresponding USDA classification of the predominant material type is “sandy loam.”

Based on the field investigation and the preliminary grading contours shown in Figure 3-7, approximately 80,000 cubic yards of material consisting of sandy, silty clay and silty, clayey sand is available in the North Drainage Borrow Area.

3.4 STOCKPILE MATERIAL INVESTIGATION

On-site stockpiles of topsoil, bedding material, and erosion protection material were characterized to determine the volume, composition, and geotechnical and agronomic properties of the materials. The stockpile locations are shown on Figure 1-3. Photographs of the stockpiles are provided in Appendix B2.

3.4.1 Topsoil Stockpile

The topsoil stockpile is located southwest of the Mill Site office area, west of Highway 566. On November 21, 2013, two bulk samples of the material were collected with a shovel from the stockpile. The samples were collected by scraping away material from the surface of the pile and collecting material from the interior of the pile. During the sampling, the material was visually classified as sandy clay.

The topsoil stockpile was surveyed with a hand-held GPS unit during the investigation, and the survey information was used to estimate the volume of the material. The stockpile volume is shown in the table below.

3.4.2 Stockpiles of Bedding and Erosion Protection Material

Seven separate stockpiles consisting of bedding and erosion protection material were observed near the tailings impoundment. The crushed basalt rock stockpiles are surplus materials from previous reclamation construction activities at the site.

At each stockpile location, the material was visually classified. Stockpile 1 was identified as crusher fines material. Stockpile 3 was identified as road base material. Stockpiles 2, 4, 5, 6 and 7 were identified as crushed basalt erosion protection material. The nominal D_{50} of each of the stockpiled materials was taken from the previous project specifications, as shown in the table below.

On November 13, 2013, composite bulk samples were collected from Stockpiles 1 through 5 for laboratory testing. Samples were collected by scraping away material from the surface of the pile and collecting material from the interior of the pile. At Stockpiles 2 and 3, samples were collecting using a backhoe. At Stockpiles 1, 4, and 5, samples were collected with a shovel. Samples from Stockpiles 6 and 7 were not collected because of the large size of the material.

The stockpiles were surveyed during the investigation, and the survey information was used to estimate the volume of material in each pile. The below above lists the material types and the approximate stockpile volumes.

Volume and Type of Stockpiled Materials

Stockpile Designation	Material Type[1]	Approximate Volume (cubic yards)	Measured Median Particle Size (D_{50}) inches (mm)[2]
Topsoil Stockpile	Sandy Clay	20,000	<0.075 mm (Note 3)
Stockpile 1	Crusher Fines	1,300	0.03 (0.7)
Stockpile 2	1.5-inch Erosion Protection Rock	2,850	0.94 (24.0) 0.89 (22.5)
Stockpile 3	Road Base	680	0.50 (12.8)
Stockpile 4	1.5-inch Erosion Protection Rock	2,920	1.2 (29.8)
Stockpile 5	6-inch Erosion Protection Rock	470	Note 4
Stockpile 6	9-inch Erosion Protection Rock	260	Note 4
Stockpile 7	15-inch Erosion Protection Rock	280	Note 4

Notes:

1. Descriptions based on gradation specifications from previous construction activities
2. Measured as a portion of this investigation
3. Hydrometer tests not performed
4. Large riprap samples were not tested for gradations.

3.4.3 Laboratory Testing

Selected samples from Stockpiles 1, 2, 3, and 4 were submitted for geotechnical and agronomic testing. Laboratory test results for the stockpile samples are provided in Table 3-2 and Table 3-6, *Summary of Geotechnical Laboratory Data – Site Stockpiles*, and Appendix B1.

3.4.4 Rock Quality Scoring

Samples from stockpiles 2, 4 and 6 were evaluated as potential sources for reuse as riprap and erosion protection at the site. The gradations from stockpiles 2 and 4 indicate D_{50} values ranging from 0.9 to 1.2 inches for the three samples tested. Samples were tested for durability based on guidance for long-term performance outlined by the NRC. The guidance is for rock to be used for erosion protection on exposed surfaces and utilize a rock scoring value (Johnson, 2002). In order to develop the scoring criteria, specific gravity, absorption, sodium sulfate soundness, L.A. Abrasion, unconfined compressive strength, and splitting tensile strength tests were performed in accordance with ASTM guidelines. Strength tests were performed on core samples from larger specimens of the rock. Results of the durability testing are provided in Appendix B1 and summarized in the table below.

Based on information provided in NUREG-1623 (NRC, 2002), rock for use in areas defined as critical areas must meet a score of 65 percent or greater and require oversizing if the score is less than 80 percent. Based on the test results (rock score of 69 percent), the basalt from the stockpiles tested would require 11 percent oversizing if it were to be used as erosion protection rock in critical areas.

Summary of Durability Scoring Criteria for Stockpiled Nominal 1-inch Basalt

Laboratory Test[1]	Result	Score[3]	Weighting Factor[4]	Weighted Score	Maximum Possible Score
Bulk Specific Gravity (ASTM C127)	2.77	10	9	90	90
Absorption, % (ASTM C127)	1.98	3	2	6	20
Sodium Sulfate, % (ASTM C88)	9.37	5.6	11	62	110
LA Abrasion (100 revs.[2]), % (ASTM C535)	5.9	8	1	8	10
Unconfined Compressive[e] Strength, psi (ASTM D7012, method C)	14,440	3	7	21	70
Splitting Tensile Strength [5], psi (ASTM D3967)	1,320	9	10	90	100
TOTALS				277	400
			Score:	**69%**	
			Oversizing required:	**11%**	

Notes:

1. Test results provided by Advanced Terra Testing and CTC Geotek (2014), table includes the average of 2 results.
2. Test conducted for 100 revolutions per NUREG-1623
3. Based on a range of 0 to 10, rock strength scores based on (DePuy, 1965 (Table 1))
4. Weighting factors for igneous rock, NUREG-1623 and DePuy (1965)
5. Tests conducted on core samples from the D_{50} = 9-inch stockpile.

3.5 VEGETATION EVALUATION

Cedar Creek Associates, Inc. conducted vegetation analog and baseline surveys on October 19-23, 2013 to evaluate the following information: 1) successive vegetative communities on undisturbed ground near the impoundment (vegetation analogs), to provide information necessary to design a long-term and low-maintenance vegetated repository cover, and 2) baseline surveys of the borrow areas to quantify the plant and animal communities at the proposed borrow areas that will be disturbed during construction.

3.5.1 Revegetation of Repository Cover

Identified vegetation communities that are projected to colonize and occupy the repository cover during the design life are as follows: 1) early to mid-successional (also termed "reclaimed"); 2) grassland (mid-successional); and 3) shrubland (late-successional or climax community). The ecological succession among the projected repository cover communities is expected to follow this same sequence of reclaimed, grassland and shrubland. Although highly dependent on land management practices and climatic factors, vegetation succession is expected to progress through the communities listed above, over the following approximate durations:

- Reclaimed Community: 0 - 50 years
- Grassland Community: 25 - 100 Years
- Shrubland Community: 50 - 1,000 Years

Vegetation surveys were conducted at the three vegetation communities. Cedar Creek used methods that quantified the vegetative parameters of the local vegetation analogs. Information collected as part of this analysis will be used during design of the RA. The vegetation communities identified and results of the revegetation evaluation are included in Appendix D.

3.5.2 Baseline Evaluation of Borrow Areas

Results of the vegetation and wildlife surveys at the borrow areas indicate that no rare, threatened or endangered species occur within any of the potential borrow sites. Additionally, noxious weeds, musk thistle, and tamarix were all observed in the East Borrow area during the vegetation surveys. If soils from the East Borrow Area are used to construct the repository cover, the noxious weeds in the East Borrow Area should be managed via chemical control prior to construction. This will minimize or prevent the spread of noxious weeds as a result of construction.

Further results of the baseline and analog surveys indicate that the baseline and analog sites are comparable. Therefore, the analog sites can be used as a reference for post-construction revegetation success criteria. Survey results indicate which species will likely prove successful during revegetation. These results, coupled with other project experience in the arid west, will be used to develop an effective and efficient revegetation plan for the repository cover and the borrow areas disturbed during construction. Additional details about the baseline surveys are included in Appendix D2.

3.6 BIOINTRUSION EVALUATION

Cedar Creek Associates, Inc. conducted biointrusion (animal and plant) surveys on October 19-23, 2013 for each vegetation community identified in the Work Plan. An animal biointrusion evaluation was performed to determine the presence of burrowing animals in the Mill Site vicinity. Animal biointrusion sampling occurred as small mammal trapping and incidental wildlife

observation transects. Pocket gophers, prairie dogs, and badgers were not identified on the existing impoundment cover, but they were identified in the vicinity of the Mill Site. Discussions with UNC personnel indicate that evidence of prairie dogs and badgers has not been observed on the existing cover, and evidence of pocket gophers on the cover has not been observed in 10-15 years (L. Bush, pers. comm., July 9, 2014). Results of Cedar Creek's biointrusion evaluation are included in Appendix D1.

Plant biointrusion survey results indicate the presence of a zone of calcium carbonate accumulation at depths ranging from 50 to 70 cm (1.6 to 2.3 feet) at the three vegetation communities projected to colonize the repository cover. The calcium carbonate zone can restrict water infiltration and plant root depth and cause roots to spread laterally. As part of the design process, further characterization of the borrow area soils may be necessary to investigate the concentration of calcium carbonate throughout the depth of the excavations proposed in the borrow areas. Additional information about plant biointrusion and the presence of calcium carbonate in the soils is included in Appendix D1.

3.7 KNOWN CULTURAL RESOURCES AT THE MILL SITE

Dinetahdoo Cultural Resources Management (Dinetahdoo) conducted a cultural resources inventory at each of the borrow areas between October 22-24, 2014. The inventory was performed prior to drilling, to identify archeological sites located within the borrow investigation areas. The survey was conducted under New Mexico State Historic Preservation Office permit number NM-13-236-SM. Prior to the field survey, Dinetahdoo personnel also interviewed nearby residents about the location of any sacred places, burials, or traditional cultural places that might be affected by the PDS investigation.

The survey covered a total area of approximately 72 acres, including a buffer zone extending about 50 feet beyond the proposed limits of each of the borrow areas shown in the Work Plan. Dinetahdoo demarcated cultural resources sites in the field at the time of the survey, and recommended a 50-ft buffer be maintained around each site to ensure that the sites were not disturbed during the PDS.

No previously-recorded archeological sites were identified near the borrow areas. Four new documented sites and seventeen isolated occurrences were identified and evaluated by Dinetahdoo during the inventory. One of the four archeological sites is the location of an Anasazi artifact scatter. The other three archeological sites were Anasazi habitations. The exact locations of the cultural resources sites have been redacted in order to preserve confidentiality. No traditional cultural places were identified in the area of interest.

Dinetahdoo recommended archeological clearance for the PDS field work activities and subsequent construction activities in the areas surveyed, provided the following stipulations are met:

- Construction activities in the borrow areas shall be confined to the five inventoried areas. The limits of the inventoried areas extend up to 270 feet beyond the proposed limits of grading in some locations, due to borrow area modifications as a result of the PDS.

- Any new discoveries shall be immediately reported to the New Mexico State Historic Preservation Office

Further recommendations include the following:

- Re-flag and avoid sites LA177467/NM-Q-21-123 (inside the South Drainage Borrow Area) and LA177468/NM-Q-21-124 (inside the East Borrow Area).

- Re-flag and monitor ground disturbing activities within 50-ft of sites LA177466/NM-Q-21-122 (outside the North Drainage Borrow Area) and LA177469/NM-Q-20-61 (inside the West Borrow Area).

The recommendations from Dinetahdoo will be implemented during RA construction. As part of the design process, a cultural resources inventory will be performed for the remaining areas planned to be impacted during construction of the RA. Results of the cultural resources inventory of the borrow areas are included in Appendix E.

3.8 INVENTORY OF THE LOCATION, NATURE AND VOLUME OF MILL SITE SURFACE DEBRIS

An inventory of observable surface debris and solid waste was conducted at the Mill Site to quantify the volume and type of debris present. The Mill Site survey included surficial debris located in the southwest area of the Mill Site, materials and wastes located near the tailings impoundment, the tailings impoundment evaporation sprinkler system, and other materials observed while traversing the site. The debris located near the Mill Site office buildings and shaft construction yard were also inventoried and are included in the volume estimates below. Based on site information, some but not all, of these materials were used during mill operations and should be assumed to have elevated concentrations of radionuclides. The management approach for these materials will be developed during design of the RA.

A written description, photographic record, estimate of the size and quantity, and survey coordinates of the debris locations were recorded for each object or area containing debris that was identified during the PDS. This information is included in Appendix B4. The locations, material types, whether or not the material was fixed to the surface, and, in some cases, length or area of the debris are shown on Figure 3-13, *Mill Site Debris Overview*. Each distinct pile or piece of debris is identified by a unique identification number in Figures 3-14 through 3-16. The numbers correspond to the descriptions listed in the table in Appendix B4.1. The debris observed was composed of metal, concrete, plastic, fiberglass/rubber, and/or wood.

An estimate of the volume of material present for each item of debris observed was made based on field observation and, in some cases, the length or area of the item was measured using the GPS. The estimated total volume for large items such as buildings and large tanks excludes the void space within the structure. Some items contained more than one type of material (i.e., the buildings located on the southeast side of the tailings ponds are metal and wood, and also contain insulation and miscellaneous parts/debris). For material type volume calculations, the volume of the mixed material debris was classified by the predominant material. A burial pit located northeast of the office building is estimated to contain about 3,700 cy of trash and debris. The table below summarizes the estimated total volume of debris based on the material type. Total estimated volume of debris at the Mill Site is approximately 6,870 cy. The most prominent debris material is metal. The second largest volume of material on the site is concrete which includes foundations, vaults, and loading docks located in the shaft construction yard and near the office buildings. The volume totals are based on the final volumes for debris that is anticipated to be compressible.

Summary of Debris Volume by Material Type

Material	Volume (cu. yds.)
Metal	1,870
Concrete	615
Plastic	450
Wood	175
Fiberglass/Rubber	60
Misc. Buried Debris	3,700
Total	**6,870**

Note: The volume of miscellaneous buried debris is an estimate of the buried trash and debris located northeast of the Mill Site office building.

A similar debris assessment was conducted at the mine site and identified approximately 25,600 cy of debris. The results are presented in the NECR Mine Site PDS Report.

3.9 VISUAL INSPECTION AND SURVEY OF BRANCH SWALES AND NORTH DIVERSION CHANNEL

Several impoundment branch swales (Branch Swales A through H) and the North Upstream Diversion Channel were visually inspected to document existing conditions, in order to provide data necessary for design of the RA. The swale and channel locations are shown on Figure 3-8, *Branch Swales and North Upstream Diversion Channel Section Locations*. The evaluations were performed on November 27, December 7, and December 14, 2013, and included a

qualitative evaluation of the physical condition of the materials used for construction, the physical condition of the drainage rock or channel bottom, and the amount of sediment and vegetation accumulation. For the North Diversion Channel, the evaluation also included qualitative evaluation of the condition of the berm located west and north of the channel (the roadway berm).

Based on the field observations, sections of swales or the channel with similar characteristics were identified and grouped together. These groupings are shown on Figure 3-8. The existing conditions were summarized for each of these sections. Table 3-7, *Summary of Branch Swale Conditions* presents a summary of the condition of the branch swales, and Table 3-8, *Summary of North Upstream Diversion Channel Conditions* presents a summary of the conditions of the North Diversion Channel. Representative photos for each swale or channel section are provided in Appendix B3.

In addition to the qualitative evaluations, cross sections were surveyed across each branch swale and channel in several locations. Cross sections were surveyed along the entire length of Branch Swales A, E, F, G and H and portions of Branch Swales B, C, and D and the North Upstream Diversion Channel. Representative cross sections through the branch swales are shown on Figures 3-9 through 3-11, *Branch Swale Cross Sections*. Representative cross sections through the diversion channel are shown on Figure 3-12, *North Upstream Diversion Channel Cross Sections*. The corresponding locations of the representative cross sections are shown on Figure 3-8. The existing drainage swales and the north diversion can be incorporated into the RA design. Some localized areas may require maintenance or improvements during construction to remove vegetation or siltation. The sizes of the existing swales and diversion channel may require adjustments to accommodate design flows. This evaluation will be completed during RA design.

Table 3-1 Summary of Geotechnical Laboratory Data - Cover Samples

Cover Layer	Sample	Sample Type [1]	Sample Depth Interval (in)		Material Description [2]	USCS [2]	USDA Classification [3]	Water Content (by mass) (%)	Specific Gravity	Standard Proctor (max. dd@opt. w.c.) (pcf @ %)	Atterberg Limits (%) [5]			USCS % Gravel	USCS % Sand	% Passing No. 200 Sieve (fines)	% Silt	USDA % Clay (<0.002 mm)	L.A. Abrasion [6] (% loss)	Sodium Soundness [7] (% loss)	Absorption [8] (%)	Pinhole Dispersion [9]	Remolded Saturated Hydraulic Conductivity (cm/sec) [10]			Confining Stress (psi)	SWCC: -5 bar Water Content (by mass) (%) [10]	SWCC: Saturated Water Content (by mass) (%) [11]
											LL	PL	PI										90%	95%	100%			
Admix. (Gravel/ Soil Mixture)	TI - CS01 - 02A	Bulk	0	11	Clayey Gravel with Sand		Loam							33.3	23.4	43.3	28.0	15.3										
	TI - CS02 - 02A	Bulk	0	10	Clayey Gravel with Sand		Clay Loam		2.81 [4]					36.9	17.0	46.1	28.8	17.3	3.8	0.37	1.06							
	TI - CS03 - 02A	Bulk	0	6	Clayey Gravel with Sand		Loam							53.6	18.7	27.7	18.1	9.6										
	TI - CS04 - 02A	Bulk	0	10	Clayey Gravel with Sand		Loam							53.6	18.2	28.2	18.0	10.2										
	TI - CS05 - 02A	Bulk	0	9	Sandy Lean Clay		Loam							13.9	34.4	51.7	31.2	20.5										
	TI - CS06 - 02A	Bulk	0	7	Clayey Gravel with Sand		Loam		2.77 [4]					48.4	18.5	33.1	23.4	9.7	5.7	0.14	1.91							
	TI - CS07 - 02A	Bulk	0	20	Sandy Lean Clay	CL	Loam	7.8			28	13	15	1.1	41.0	60.9	42.4	18.5										
	TI - CS08 - 02A	Bulk	0	8	Clayey Gravel with Sand		Loam							56.7	18.5	24.8	17.2	7.6										
	TI - CS09 - 02A	Bulk	0	9	Clayey Gravel		Loam		2.78 [4]					53.6	14.2	32.2	21.2	11.0	5.1	1.17	1.55							
	TI - CS10 - 02A	Bulk	0	7	Clayey Gravel with Sand		Loam							41.4	19.7	38.9	26.1	12.8										
	TI - CS11 - 02A	Bulk	0	9	Clayey Gravel with Sand		Sandy Loam							30.7	30.1	39.2	26.1	13.1										
	TI - CS12 - 02A	Bulk	0	14	Sandy Lean Clay	CL	Loam	9.1			33	13	20	1.3	28.8	69.9	43.5	26.4										
Radon barrier (clay layer)	TI - CS03 - 04A	Bulk	6	24	Sandy Lean Clay	CL	Loam	6.0			28	14	14	6.3	38.7	55.0	36.1	18.9										
	TI - CS06 - 04A	Bulk	7	24	Sandy Lean Clay	CL	Loam	11.0			30	13	17	6.7	34.2	59.1	40.2	18.9										
	TI - CS10 - 04A	Bulk	7	25	Sandy Lean Clay	CL	Loam	7.7			29	14	15	2.3	39.5	58.2	36.9	21.3										
	TI - CS08 - 04A	Bulk	8	28	Sandy Lean Clay	CL	Loam	8.1	2.67	119.4 @ 11.9	27	12	15	11.3	35.0	53.7	36.7	17.0					9.1E-06	1.1E-05	1.5E-06	24		
	TI - CS05 - 04A	Bulk	9	24	Sandy Lean Clay	CL	Loam	9.6			29	12	17	1.3	37.3	61.4	42.0	19.4										
	TI - CS09 - 04A	Bulk	9	26	Sandy Lean Clay	CL	Loam	7.7			28	13	15	4.0	38.1	57.9	40.0	17.9										
	TI - CS11 - 04A	Bulk	9	24	Sandy Lean Clay	CL	Clay Loam	8.6	2.68	115.0 @ 14.9	32	13	19	5.1	28.4	66.5	40.7	25.8					7.6E-08	1.4E-07	1.0E-07	24		
	TI - CS02 - 04A	Bulk	10	24	Sandy Lean Clay	CL	Sandy Clay Loam	11.4			28	12	16	3.6	44.7	51.7	30.4	21.3										
	TI - CS04 - 04A	Bulk	10	24	Sandy Lean Clay	CL	Clay Loam	15.0	2.68	113.5 @ 15.0	35	15	20	0.9	35.0	68.2	37.2	26.9					4.6E-06	6.2E-06	2.3E-07	8		
	TI - CS01 - 04A	Bulk	11	24	Sandy Lean Clay	CL	Loam	9.2	2.68	117.3 @ 13.0	29	15	14	2.0	39.8	58.2	39.0	19.2				ND3	3.0E-04	4.6E-05	7.8E-07	8	8.6 / 9.6	21.7 / 19.0

Notes: 1. Sample Types: Bulk = bucket/grab sample

2. USCS = Unified Soil Classification Sysytem, material descriptions are based on field observations, and refined with laboratory data, if available. USCS classifications are provided only where sufficient laboratory data are available. CL = low plasticity clay
3. USDA = United States Department of Agriculture, USDA classifications are based on the sand/silt/clay fraction of the sample and on USDA grain-size designations.
4. Bulk saturated surface dry (SSD) specific gravity of the gravel fraction, average of three results (ASTM C127).
5. LL = liquid limit, PL = plastic limit, PI = plasticity index
6. L.A. abrasion results are percent loss, by mass, for 100 revolutions.
7. Weighted percent loss for the 3/4-inch to 3/8-inch size range
8. Average of three results for the gravel fraction of the cover gravel/soil mixture samples
9. Pinhole dispersion test (ASTM method A) conducted on a specimen remolded to approximately 95% of the maximum standard Proctor density at optimum water content. ND3 = slightly to moderately dispersive clays that erode slowly under 2-inch or 7-inch head.
10. Flexible wall permeameter tests conducted on specimens remolded to approximately 90, 95 and 100% of the maximum standard Proctor density and tested at the confining stresses shown in the table.
11. SWCC test conducted on material passing the No. 10 sieve, remolded to approximately 95% of the maximum standard Proctor density and optimum water content. SWCC tests performed with pairs of specimens for each test.

Table 3-2 Summary of Agronomic and Analytical Laboratory Data - Impoundment Cover, Stockpiles, and Borrow Areas

Area	Sample	Sample Type [1]	Sample Depth Interval (in)		Calcium, sat. paste (meq/L)	Cation Exchange Capacity (meq/100g)	Conductivity, sat. paste (mmhos/cm)	Exchangeable Sodium (%)	Lime as $CaCO_3$ (%)	Magnesium, sat. paste (meq/L)	Organic Matter (% by mass)	pH, sat. paste	Phosphorus, Olsen (mg/kg)	Potassium (mg/kg)	Potassium, sat. paste (meq/L)	Sodium (mg/kg)	Sodium Adsorption Ratio (SAR)	Sodium, sat. paste (meq/L)	Sodium, soluble (mg/kg)	Total (Kjeldahl) Nitrogen (mg/kg)	Radium 226 (pCi/g)
Borrow Areas	WB-B2-04	Bulk	0	120	27.30	25.2	2.63	0.3	2.8	9.50	1.5	7.4	6.0	94	0.26	23	0.2	0.87	7.3	280	1.0 ± 0.5
	EB-B4-03	Bulk	0	120	27.90	25.5	3.30	0.8	2.3	13.10	0.9	7.7	6.0	178	0.46	83	0.7	3.35	33.1	280	1.1 ± 0.5
	NB-B1-04	Bulk	0	180	5.34	20.4	1.01	1.0	6.6	3.18	0.4	8.0	7.0	136	0.16	69	1.1	2.37	20.9	280	0.8 ± 0.5
	SB-B4-01	Bulk	0	180	26.10	24.5	2.66	0.6	6.1	10.30	0.8	7.8	7.0	292	0.72	49	0.3	1.20	13.2	336	1.0 ± 0.5
	DH-B3-02	Bulk	0	120	7.07	10.3	1.84	3.3	0.4	4.26	0.2	7.8	6.0	42	0.05	155	4	9.61	75.6	168	1.3 ± 0.6
Cover Samples	TI-CS02-01	Bulk	0	7	30.40	30.5	2.95	0.4	2.5	8.36	1.5	7.7	7.0	309	0.87	40	0.2	1.04	10.5	448	1.5 ± 0.6
	TI-CS07-01	Bulk	0	6	6.27	24.8	0.81	0.1	2.1	1.94	1.5	7.8	8.0	251	0.40	10	0.1	0.29	2.6	392	1.7 ± 0.5
	TI-CS11-01	Bulk	0	6	23.90	22.0	2.81	0.9	3.4	8.23	1.3	7.7	7.0	268	0.95	80	1	4.19	36.2	336	1.0 ± 0.6
Stockpiles	Topsoil Stockpile	Bulk	-	-	11.10	33.5	2.30	1.9	1.9	7.99	0.4	7.9	4.0	196	0.20	228	2.3	7.16	84.1	224	1.0 ± 0.6

Note: 1. Sample Type: Bulk = bucket/grab sample

Table 3-3 Summary of Borehole and CPT Profiles

Site Location:	North Cell									
	Dam									
Hole Number:	3	28	1	29	2	4	24	13	23	25
Surface Elevation (ft):	6969	6962	6970	6957	6960	6965	6962	6969	6962	6969
CPT or Paired CPT/Borehole[1] :	paired	cpt only	paired	cpt only	paired	cpt only	cpt only	cpt only	paired	cpt only
Embankment (thickness in feet):	47	-	-	-	-	-	-	-	-	-
Cover/Fill (thickness in feet):	-	10	18	9	12.5	13	7	4	13	2.5
Coarse Tailings (thickness in feet):	-	16	17	-	0	2	-	-	2	-
Interlayered Coarse/Fine Tailings (thickness in feet):	-	-	-	-	0	4.5	-	-	-	-
Fine Tailings (thickness in feet):	-	1	-	1	2	-	-	-	1	-
Bottom of Tailings Elevation (ft):	-	6935	6935	6947	6945	6945	6955	6965	6946	6967
Alluvium (thickness in feet):	23	57	53	93	19	6	15	-	27	-
Sandstone (Zone 3) (thickness in feet):	*	-	*	-	5	2	-	-	22.5	-
Sandstone/Shale (Zone 2) (thickness in feet):	-	-	-	-	-	-	-	-	5	-
CPT Footage:	9	84	88	103	34	27.5	22	4	43	2.5
Borehole Footage:	70	-	70	-	38.5	-	-	-	70.5	-

Site Location:	Borrow Pits													
	Perimeter of Borrow Pit 1				Borrow Pit 1							Borrow Pit 2		
Hole Number:	5	14	20	17	6	9	10	8	16	18	19	11	27	12
Surface Elevation (ft):	6973	6980	6979	6975	6974	6976	6973	6976	6973	6972	6975	6978	6977	6979
CPT or Paired CPT/Borehole[1] :	cpt only	cpt only	cpt only	cpt only	cpt only	cpt only	paired	paired	cpt only	cpt only	cpt only	paired	cpt only	cpt only
Cover/Fill (thickness in feet):	5	6	7	7	7	7	8	9	8	6	5	43	15	43
Coarse Tailings (thickness in feet):	-	11.5	14	8	8	15	14	16	7	6	23	-	-	-
Interlayered Coarse/Fine Tailings (thickness in feet):	-	-	7	-	-	23	-	-	18	0	-	-	-	-
Fine Tailings (thickness in feet):	-	3.5	5	6	19	0	22	19	10	30	17	11.5	-	2
Bottom of Tailings Elevation (ft):	6968	6959	6946	6954	6940	6931	6929	6932	6930	6930	6930	6924	6962	6934
Alluvium (thickness in feet)[2] :	33	14.5	13	27	2	24	61	17	12	8	13	42.5	65	7
Sandstone (thickness in feet) (Zone 3):	-	-	-	-	-	++	++	-	-	-	-	-	++	-
Sandstone/Shale (thickness in feet) (Zone 2):	-	-	-	-	-	-	-	5	-	-	-	-	-	-
Sandstone (thickness in feet) (Zone 1):	-	-	-	-	-	-	3	-	-	-	-	6	-	-
CPT Footage:	38	35.5	46	48	36	69	63	61	55	50	58	97	80	52
Borehole Footage:	-	-	-	-	-	-	108	66	-	-	-	103	-	-

Site Location:	West Side of Central Cell and South Cell [3]							
	Central Cell				South Cell			
Hole Number:	15	26	7	21	22	30	31	32
Surface Elevation (ft):	6977	6973	6972	6966	6968	6962	6951	6950
CPT or Paired CPT/Borehole[1] :	paired	cpt only	cpt only	cpt only	cpt only	cpt only	cpt only	cpt only
Cover/Fill (thickness in feet):	3	6	7	5	6	6	6	5
Coarse Tailings (thickness in feet):	27	8	8	-	25	21	20	35
Interlayered Coarse/Fine Tailings:	-	-	26	-	-	-	-	-
Fine Tailings (thickness in feet):	-	1	0	-	2	1	4	-
Bottom of Tailings Elevation (ft):	6947	6958	6931	6961	6935	6934	6921	6910
Alluvium (thickness in feet):	41.5	13	29	16	61	47	50	79
Sandstone (thickness in feet):	*, ++	-	+	-	-	-	-	+
CPT Footage:	55	28	70	21	94	75	80	119
Borehole Footage:	71.5	-	-	-	-	-	-	-

Notes:

1. Profiles for "CPT only" holes interpreted based on cpt/borehole pairs and CPT signatures are described in Section 3.2.2.
2. Wet alluvial soils encountered at about 90 feet below the ground surface at borings B10 and B11.
3. CPT soundings only (no boreholes) along the west side of the central cell and the south cell.

(*) Boring terminated in alluvium, prior to refusal
(+) CPT terminated in alluvium, prior to refusal
(++) CPT refusal likely on a boulder, or hard clay layer within the alluvium
(-) Material type not encountered, or CPT footage only

Table 3-4 Summary of Geotechnical Laboratory Data - Mill Site Impoundment

Area	Boring	Sample Type [9]	Sample Depth Interval (ft.)		Material Description [1]	USCS [1]	Water content (by mass, %) 110C	Water content (by mass, %) 60C	SWCC - Saturated water content (by mass, %)[2]	SWCC - Specimen dry density (pcf) [2]	Dry density (pcf), 110C	Dry density (pcf), 60C	Specific gravity, 110C	Specific gravity, 60C	Atterberg limits (%) LL	PL	PI	USCS % gravel (size)	USCS % sand (size)	% Passing No. 200 sieve	% Silt (size)	USDA % clay (size <0.002 mm)	Saturated Hydraulic conductivity (cm/sec) [3]	Hydraulic conductivity confining stress (psi)	Consolidation (Cc) [7]	Collapse potential (%) (inundation load (psf))	Triaxial [12] (peak friction angle (ϕ) (degrees), cohesion (psf), where applicable)
CENTRAL CELL	TI-B1	CA	16	16.5	Lean Clay with Sand (Fill)	CL	16.2				104.7				33	13	20	0.3	27.2	72.5	42.9	29.6					
	TI-B1	CA	20.5	21	Coarse Tailings		6.1	5.7																			
	TI-B1	CA	21	21.5	Coarse Tailings		7.5		21.9 / 19.8	96.5 / 99.6	105.5							0.0	90.7	9.3	5.5	3.8	3.7E-04	18	0.024		
	TI-B1	ST	27	27.5	Coarse Tailings	SP	4.0				97.6		2.67		NP			0.0	92.7	7.3	5.2	2.1	2.9E-03	14			34.9
	TI-B1	CA	30	30.5	Coarse Tailings		13.9	13.5																			
	TI-B1	CA	30.5	31	Coarse Tailings		14.6		29.6 / 33.8	84.2 / 83.6	91.6												3.0E-07	25	0.092		
	TI-B1	CA (top)	31	31.5	Coarse Tailings		0.8	0.4																			
	TI-B1	CA (bottom)	31	31.5	Fine Tailings	CL		41.6				76.5	2.68	*2.69*	44	17	27	0.0	30.9	69.1	54.6	14.5					33.3
	TI-B1	CC-AC	32	33	Coarse/Fine Tailings	CL	29.3	*27.8*							33	16	17	0.0	46.7	53.3	37.4	15.9					
	TI-B1	CA	36	36.5	Clayey Sand		21.0	19.9	36.3 / 33.2	85.2 / 88.0	97.3		2.73					0.0	62.5	37.5	32.8	4.7	1.7E-06	32	0.059		
	TI-B1	CA	41	41.5	Lean Clay with Sand	CL	26.7				98.6				31	15	16	0.0	18.2	81.8	54.7	27.1	1.2E-07	35			
	TI-B1	ST	45	46	Clayey Sand		22	21.2			106.0														0.058		34.4
CENTRAL CELL - BORROW PIT 1	TI-B10	ST (top)	10	11	Coarse Tailings		9.7	9.1			110	110.5	2.63	2.65													
	TI-B10	ST (bottom)	10	11	Coarse Tailings		9.0		20.7 / 21.5	102.6 / 101.2	96.8							0.2	71.9	27.9	16.6	11.3	4.3E-04	34	0.094		
	TI-B10	CC-AC [4] (top)	12.5	14	Coarse Tailings		6.7	6.3					2.61	2.64													
	TI-B10	CC-AC [4] (bot)	12.5	14	Coarse Tailings		7.5		31.3 / 31.4	85.0 / 85.0	99.1							0.7	71.5	27.8	18.9	8.9	6.7E-05	36			
	TI-B10	CA	15	15.5	Coarse Tailings		9.3				103.0																
	TI-B10	CA	16	16.5	Coarse Tailings	SM	6.5				100.0		2.65		NP			2.4	82.3	15.3	10.2	5.1					
	TI-B10	ST	21.5	22.5	Coarse/Fine Tailings	CL	28.1	*26.7*			91.9	*92.9*			43	19	24	0.0	43.0	57.0	51.4	5.6			0.111		
	TI-B10	CA	25.75	26	Fine Tailings		43.7	41.0																			
	TI-B10	CA	26	26.5	Fine Tailings	CH	60.4	*57.4*			63.1	*64.3*	2.71	*2.80*	74	27	47	0.0	10.0	90.0	82.6	7.4					
	TI-B10	ST	30.3	30.7	Fine Tailings	CH	47.7	*45.3*			72.2	*73.4*	2.71	*2.78*	57	22	35	0.0	24.3	75.7	68.4	7.3					
	TI-B10	ST	32	32.5	Coarse Tailings	SM	15.4				100.1		2.67		NP			0.0	83.1	16.9	12.6	4.3					
	TI-B10	CA	35	35.5	Fine Tailings		50.2	*47.7*			71.3	*72.5*															
	TI-B10	CA	35.5	36	Fine Tailings		54.2	51.4																			
	TI-B10	CA	36	36.5	Coarse/Fine Tailings	SC/CL	33.9	*32.2*			86.7	*87.8*	2.68	*2.72*	36	16	20	0.0	50.6	49.4	31.1	18.3					
	TI-B10	ST (top)	40	41	Fine Tailings		47.3	45.7			70.5	73.7	2.54	2.56													
	TI-B10	ST (bottom)	40	41	Fine Tailings	CH	49.7	*47.2*	47.7 / 55.7	75.3 / 67.9	73.3	*74.5*			61	21	40	0.0	20.7	79.3	46.5	32.9	2.9E-08	58	0.315		
	TI-B10	CA	46	46.5	Silty Sand		9.9				95.4		2.74					0.0	65.8	34.2	23.4	10.8					
	TI-B10	ST	55	56	Silty Sand		14.1		25.7 / 24.8	98.0 / 99.9	100.8												2.4E-05	72	0.139		
	TI-B10	CA	66	66.5	Silty Sand / Sandy Silt	SM/ML	13.8				94.5				NP			0.0	50.1	49.9	33.4	16.5					
	TI-B10	CA	71	71.5	Silty Sand		18.1				100.8																
	TI-B10	CA	91	91.5	Clayey Sand		18.6				105.6		2.66														
	TI-B10	CC	106.9	107.3	Sandstone		14.2				109.1												1.4E-07	115			
CENTRAL CELL - BORROW PIT 2	TI-B11	CA	6	6.5	Sandy Clay (Fill)		8.6				93.5																
	TI-B11	ST	15	16	Clayey Sand (Fill)		8.2		16.0 / 16.3	117.7 / 116.6	110.4		2.67					3.9	57.6	38.5	24.6	13.9	2.5E-05	38	0.085		
	TI-B11	CA	21	21.5	Sandy Clay (Fill)		12.3				107.6																
	TI-B11	ST	30.5	31.5	Sandy Clay (Fill)	CL	13.7				112.4				30	13	17	7.1	41.3	51.6	33.9	17.7	9.0E-07	51	0.059		
	TI-B11	CA	45.5	46	Fine Tailings		117.2	88.7																			
	TI-B11	ST	51.5	52.5	Fine Tailings	CH	63.0	*59.9*			62.5	*63.7*	2.75	*2.84*	91	30	61	0.0	2.7	97.3	90	7.3	3.1E-08	67	0.482		
	TI-B11	ST	56	57	Silty Sand	SM	16.2		31.0 / 30.8	90.6 / 92.8	77.9		2.64		NP			0.0	60.4	39.6	31.9	7.7	5.6E-04	72	0.129		
	TI-B11	CA	61	61.5	Sandy Clay		16.0				95.4							0.0	38.7	61.3	44.1	17.2					
	TI-B11	CA	66	66.5	Silty Sand		14.2				96.2																
	TI-B11	CA	81	81.5	Clayey Sand with Gravel		11.0				107.6		2.76					12.9	65.6	21.5	9.9	11.6					
	TI-B11	CA	100	100.2	Sandstone		21.1				103.9												1.3E-05	112			
CENTRAL CELL - BORROW PIT 1	TI-B8	CA	25	25.5	Coarse Tailings		9.0	8.4			103.7	104.2	2.72	2.72													
	TI-B8	CA [5]	25.5	26	Coarse Tailings		6.2		25.7	94.6	99.6							0.0	87.9	12.7	7.9	4.8	3.6E-04	46			
	TI-B8	CA [5]	26	26.5	Coarse Tailings	SM	16.8		27.0	94.8	91.7				NP			0.0	76.0	24.0	19.0	5.0					
	TI-B8	ST	30	31	Fine Tailings	CH	65.1	*61.8*			61.5	*62.7*			74	25	49	0.0	9.2	90.8	81.2	9.6			0.426		
	TI-B8	ST	31	31.5	Fine Tailings		44.3	41.4																			
	TI-B8	ST (top)	35	36	Coarse Tailings		14.3	13.6			90.9	91.4	2.66	2.67													
	TI-B8	ST (bottom)	35	36	Coarse Tailings		16.5		31.2 / 39.3	89.3 / 82.3	89.6		2.67										1.6E-05	43			
	TI-B8	ST (top)	41	42	Fine Tailings		41.8	*39.7*			79.2	*80.4*	2.60	2.63													
	TI-B8	ST (bottom)	41	42	Coarse/Fine Tailings	SC/CL	35.6	34.3	33.1 / 31.6	88.7 / 90.7	82.8	83.6			35	16	19	0.0	51.2	48.8	40.7	8.1	1.3E-07	53	0.262		
	TI-B8	CC-AC (top)	43.5	44.5	Coarse/Fine Tailings		31.2	29.3			91.0	92.3															
	TI-B8	CC-AC [6] (bot)	43.5	44.5	Fine Tailings		45.6	*43.3*	47.9 / 49.0	74.4 / 73.6	73.6	*74.8*						0.0	14.5	85.5	74.7	10.8	3.0E-08	61			

Table 3-4 Summary of Geotechnical Laboratory Data - Mill Site Impoundment (continued)

Area	Boring	Sample Type [9]	Sample Depth Interval (ft.)		Material Description [1]	USCS [1]	Water content (by mass, %) 110C	Water content (by mass, %) 60C	SWCC - Saturated water content (by mass, %)[2]	SWCC - Specimen dry density (pcf) [2]	Dry density (pcf), 110C	Dry density (pcf), 60C	Specific gravity, 110C	Specific gravity, 60C	Atterberg limits (%) LL	PL	PI	USCS % gravel (size)	USCS % sand (size)	% Passing No. 200 sieve	% Silt (size)	USDA % clay (size <0.002 mm)	Saturated Hydraulic conductivity (cm/sec) [3]	Hydraulic conductivity confining stress (psi)	Consolidation (Cc) [7]	Collapse potential (%) (inundation load (psf))	Triaxial [12] (peak friction angle (ϕ) (degrees), cohesion (psf), where applicable)
BORROW PIT 1 (cont.)	TI-B8	CC-AC	44.5	45	Fine Tailings								2.59	2.60														
	TI-B8	CA	46	46.5	Lean Clay with Sand	CL	21.9				95.2		2.72		30	16	14	0.0	27.9	72.1	55.6	16.5						
	TI-B8	CA	56	56.5	Silty Sand	SM	12.6				97.6		2.70			NP		0.0	57.0	43.0	30.9	12.1						
	TI-B8	BULK	63.5	64	Shale		X				X												X	X			
CENTRAL CELL	TI-B15	CA	6	6.5	Coarse Tailings		5.4				101.1							0.0	87.5	12.5	9.8	2.7						
	TI-B15	CA	11	11.5	Coarse Tailings		6.8				93.8																	
	TI-B15	CC-AC	13.5	14	Coarse Tailings	SM	19.0	18.4					2.68			NP		0.0	69.6	30.4	22.6	7.8						
	TI-B15	ST	15.5	16	Coarse Tailings	SM	14.2				90.4		2.66			NP		0.0	54.9	15.1	10.1	5.0	8.3E-04	38	0.126			
	TI-B15	CA	21	21.5	Coarse Tailings	SM	12.7				99.8		2.68			NP		0.0	80.6	19.4	13.3	6.1						
	TI-B15	CC-AC	28.5	29.5	Coarse Tailings	SM	19.3						2.66			NP		0.0	65.4	34.6	24.4	10.2						
	TI-B15	CA (top)	31	31.5	Silty Sand		22.3	21.3																				
	TI-B15	CA (bottom)	31	31.5	Silty Sand	SM	17.1				101.8		2.71			NP		6.2	51.9	41.9	25.9	16.0						
	TI-B15	CA	41	41.5	Clayey Sand		11.4	10.1			87.1	88.1																
	TI-B15	CA (top)	46	46.5	Sandy Silt		25.8	24.0																				
	TI-B15	CA (bottom)	46	46.5	Sandy Silt	ML	17.3				99.3		2.81			NP		0.0	37.0	63.0	55.7	7.3						
	TI-B15	CA	56	56.5	Silty Clay		11.7	10.5			104.2	105.3																
	TI-B15	CA	66	66.5	Clayey Sand		12.7	11.8			100.7	101.5																
NORTH CELL	TI-B23	ST	15.5	15.75	Coarse Tailings		20.7	19.6			87.7		2.77					0.0	62.8	37.2	34.1	3.1						
	TI-B23	ST	17.25	17.5	Sandy Clay		22.5				101.9		2.73					0.0	31.1	68.9	46.5	22.5						
	TI-B23	ST	26	27	Lean Clay	CL	21.6				101.7		2.73		49	18	31	0.0	8.8	91.2	43.8	47.5			0.046			
	TI-B23	CA	45.2	45.7	Sandstone		13.8				108.7												2.4E-07	43				
	TI-B23	CA [8]	65.5	66	Shale		10.2				103.0												9.7E-08	62				
	TI-B2	CA	6	6.5	Silty Sand with Gravel (Fill)		7.7				100.4		2.68					26.9	29.9	43.2	30.7	12.5						
	TI-B2	CA	11	11.5	Clayey Sand (fill)		24.5				75.9		2.73					0.0	65.4	34.6	30.3	4.3						
	TI-B2	CC-AC	13.5	14.5	Fine Tailings		41.7	*39.6*										0.0	23.1	76.9	49.2	27.7						
	TI-B2	CA	15	15.5	Silty Sand		6.9				90.4		2.68															
	TI-B2	CA	21	21.5	Silty Sand		7.0				91.4		2.74					0.0	82.9	17.1	11.5	5.6						
	TI-B2	CA	26	26.5	Lean Clay with Sand	CL	23.5				93.2				34	16	18	0.0	20.9	79.1	51.5	27.6						
	TI-B2	BULK	38.4	38.7	Sandstone		13.5				X																	
DAM	TI-B3	CA	11	11.5	Silty Sand (dam)		5.1				108.4		2.64					5.4	74.7	19.9	13.5	6.4						
	TI-B3	CA	16	16.5	Silty Sand (dam)		4.7				105.3															-2.8 (2,236)		
	TI-B3	ST	21	22	Sandy Clay (dam)	CL	16.0				111.1				30	12	18	0.0	32.8	67.2	41.7	25.5				-0.03 (2,709)	32.2, 195	
	TI-B3	CA	26	26.5	Sandy Clay (dam)		12.0				106.8				25	13	12											
	TI-B3	CA	31	31.5	Sandy Clay (dam)		16.1				108.4																	
	TI-B3	ST (top)	35	36	Clayey Sand (dam)		10.5	10.2																				
	TI-B3	ST (bottom)	35	36	Clayey Sand (dam)	SC	14.7				102.2		2.67		23	14	9	2.1	50.2	47.7	30.9	16.8			nc	-0.7 (4,608)	33.7, 135	
	TI-B3	CA	41	41.5	Sandy Clay (dam)		21.5				90.6							0.0	33.8	66.2	41.7	24.5						
	TI-B3	CA	45.5	46	Sandy Clay (dam)		17.0	17.7			110.1	109.4															29.3, 293	
	TI-B3	CA	46	46.5	Sandy Clay (dam)		18.0				104.8				28	13	15											
	TI-B3	ST	56	57	Lean Clay	CL	22.1	21.1			105.3	106.2	2.72		43	14	29	0.0	11.7	88.3	48.4	39.9				-1.5 (7,204)	22.2, 494	
	TI-B3	CA	61	61.5	Silty Clay		25.8				99.0							0.0	22.0	78.0	54.9	23.1						

Notes: 1. Material descriptions are based on field observations, and refined with laboratory data, if available. USCS classifications are provided only where sufficient laboratory data are available.
2. SWCC tests conducted with pairs of specimens for each test.
3. Flexible wall permeameter tests conducted at confining pressures representing confining stresses for the proposed design fill. Confining stresses were estimated as the existing overburden stress on the specimens (depth times total unit weight of material above) plus the maximum anticipated fill height for the location times the estimated unit weight of fill.
4. Specimen remolded to the in-situ water content and density of the Shelby tube sample from 10-12.5 for the SWCC.
5. Remolded SWCC and permeability tests conducted on a 50-50 mixture of the materials from these two specimens, remolded to the average measured density of the two CA samples.
6. SWCC specimen remolded to the in-situ water content and density of the Shelby tube sample from 41-42 feet.
7. Compression indices estimated using the maximum anticipated loading during fill placement and the range of loading during testing. Initial void ratios are calculated using the average specific gravity for all samples of 2.70.
8. Shale sample had multiple horizontal fractures and was likely disturbed during sampling.
9. Sample Types: CC = continuous core, CC-AC = continuous core in acrylic liner, top/bottom indicates the specimen was taken from the top or bottom of the sample interval
10. Values in italics were calculated based on the relationship (WC60=0.951(WC110)-.0611) between the water content results measured for 15 tailings samples at the two oven temperatures.*
11. Shaded cells are alluvium.
12. Consolidated undrained (CU) triaxial shear, staged loading of one specimen with pore pressure measurements

ST = 3" diam. Shelby tube, CA = California sample
R = remolded, nc = Cc not calculated, because fill will not be placed in this location
X = testing not possible due to sample disturbance
LL = liquid limit, PL = plastic limit, PI = plasticity index

Table 3-5 Summary of Geotechnical Laboratory Data - Borrow Areas

Area	Sample	Sample Type (1)	Sample Depth Interval (ft)		Material Description (2)	USCS (2)	USDA Classification (3)	Water Content (by mass, %)	Dry Density (pcf)	Porosity	Specific Gravity	Standard Proctor (max. dd@opt. w.c.), (pcf @ %)	Atterberg Limits (%) (4)			USCS % Gravel	USCS % Sand	% Passing No. 200 Sieve (fines)	% Silt	USDA % Clay (<0.002 mm)	Pinhole Dispersion (5,6)	Remolded Saturated Hydraulic Conductivity (cm/sec) (7)			SWCC: -5 bar Water Content (by mass, %) (8)	SWCC: Saturated Water Content (by mass, %) (8)
													LL	PL	PI							80%	85%	90%		
West Borrow	WB-B1-01A	CA	3.0	3.5	Clayey Sand			3.8	88.8	46.7	2.67															
	WB-B1-03A	CA	11.0	11.5	Clayey Sand	SC	Sandy Loam	6.4	111.0	33.3	2.67		28	18	10	2.8	48.6	48.6	32.8	15.8						
	WB-B1-06	Bulk	5.0	10.0	Silty, Clayey Sand	SC-SM	Sandy Loam				2.64	112.5 @ 13.7	26	20	6	0.8	52.3	46.9	31.0	15.9	ND3	7.2E-04	5.8E-04	2.1E-04	6.6 / 6.2	31.7 / 32.4
	WB-B2-02A	CA	5.5	6.0	Clayey Sand	SC	Sandy Loam	5.6	87.1	47.8	2.67					8.6	53.5	37.9	23.8	14.1						
	WB-B2-05	Bulk	10.0	20.0	Clayey Sand	SC	Sandy Loam						26	17	9	9.9	46.3	43.8	27.7	16.1	ND3	8.5E-05	1.2E-04	6.4E-05	6.4 / 6.7	30.9 / 33.7
	WB-B5-001B	CA	3.0	3.5	Clayey Sand			3.7	92.5	44.3	2.66															
	WB-B5-002A	CA	6.0	6.5	Silty, Clayey Sand	SC-SM	Sandy Loam	5.1	86.9	47.7	2.66		24	17	7	0.0	56.3	43.7	27.8	15.9						
	WB-B5-005	Bulk	0.0	10.0	Silty, Clayey Sand	SC-SM	Sandy Loam					117.3 @ 12.7				0.0	61.6	38.4	22.8	15.6						
East Borrow	EB-B2-001A	CA	3.0	3.5	Weath. Sandstone			5.8	107.1	35.8	2.67															
	EB-B3-003B	CA	10.5	11.0	Sandy Lean Clay	CL	Sandy Loam	6.0	83.1	50.7	2.70		26	15	11	0.0	46.3	53.7	34.9	18.8						
	EB-B4-02A	CA	6.0	6.5	Sandy Lean Clay	CL	Sandy Loam	5.4	80.7	51.2	2.65					0.0	48.5	51.5	33.9	17.6						
	EB-B4-06	Bulk	10.0	20.0	Silty, Clayey Sand	SC-SM	Sandy Loam				2.67	117.1 @ 12.9	23	17	6	0.0	50.5	49.5	32.0	17.5	ND3	8.7E-04	9.0E-04	4.4E-04	4.6 / 4.2	30.8 / 29.8
	EB-B5-02B	CA	5.5	6.0	Clayey Sand	SC	Sandy Loam	6.7	93.8	44.4	2.71		27	15	12	8.8	45.7	45.5	28.8	16.7						
	EB-B6-01B	CA	3.0	3.5	Sandy Clay			7.6	91.2	46.1	2.71															
	EB-B6-03	Bulk	0.0	10.0	Lean Clay with Sand	CL	Clay Loam					114.8 @ 14.1				0.0	26.6	73.4	44.3	29.1	ND3	2.3E-04	3.6E-05	2.9E-05	9.4 / 9.3	32.8 / 32.2
	EB-B6-04A	CA	11.0	11.5	Sandy Lean Clay	CL	Sandy Clay Loam	8.6	95.2	43.3	2.69		31	13	18	0.0	31.1	68.9	43.8	25.1						
South Borrow	SB-B1-01A	CA	3.5	4.0	Sandy Lean Clay	CL	Sandy Loam	7.1	91.4	49.3	2.89					0.0	43.1	56.9	39.2	17.7						
	SB-B1-03A	CA	11.0	11.5	Sandy Lean Clay	CL	Sandy Clay Loam	6.6	82.6	50.7	2.69		31	15	16	0.0	46.7	53.3	32.9	20.4						
	SB-B1-04	Bulk	0.0	25.0	Sandy Lean Clay	CL	Sandy Clay Loam				2.70	115.5 @ 14.2	33	14	19	0.0	42.6	57.4	30.7	26.7	ND1	2.3E-04	5.7E-05	1.4E-04	6.4 / 5.9	31.9 / 30.3
	SB-B2-02B	CA	5.5	6.0	Sandy Lean Clay	CL	Loam	7.7	80.1	52.6	2.70		36	15	21	0.0	29.8	70.2	45.4	24.8						
	SB-B3-02A	CA	6.0	6.5	Lean Clay with Sand	CL	Clay Loam	10.2	84.3	49.7	2.69		40	17	23	0.0	21.6	78.4	46.2	32.2						
	SB-B4-01	Bulk	0.0	15.0	Sandy Lean Clay	CL	Sandy Clay Loam	7.1			2.67	114.1 @ 14.4	33	15	18	0.8	39.6	59.6	35.7	23.9	ND3	3.4E-04	2.0E-04	7.4E-05	9.1 / 8.6	29.6 / 33.5
North Borrow	NB-B1-03B	CA	10.5	11.0	Silty Sand	SM	Sandy Loam	5.4	84.4	49.5	2.68		25	22	3	0.0	55.6	44.4	30.3	14.1						
	NB-B2-01B	CA	3.0	3.5	Silty Sand	SM	Sandy Loam	4.9	81.9	50.3	2.64		27	23	4	0.0	51.2	48.8	33.9	15.0						
	NB-B2-04	Bulk	0.0	10.0	Sandy, Silty Clay	CL-ML	Sandy Loam					113.9 @ 14.5	26	19	7	0.0	49.0	51.0	32.5	18.5	ND3	4.0E-04	2.7E-04	7.5E-05	4.9 / 4.7	29.5 / 29.9
Dilco Hill	DH-B1-01B	CA	3.0	3.5	Silty Sand			3.5	88.8	46.6	2.66															
	DH-B1-03	Bulk	0.0	10.0	Sandy, Silty Clay	CL-ML	Sandy Loam	5.4			2.67	117.5 @ 13.8	25	19	6	2.0	47.4	50.6	35.0	15.6	ND4	6.3E-04	7.1E-04	2.5E-04	4.2 / 4.1	39.6 / 35.0
	DH-B1-10	Bulk	35.0	45.0	Lean Clay with Sand	CL	Loam	10.3			2.38					1.5	20.9	77.6	60.9	16.7	ND3	1.6E-04	2.5E-05	3.2E-06	5.8 / 6.0	25.7 / 24.5
	DH-B2-03	CA	15.0	15.5	Silty Clay with Sand	CL-ML	Sandy Loam	10.5	96.7	39.2	2.55		29	24	5	0.0	27.7	72.3	66.9	5.4						
	DH-B3-05	Bulk	20.0	30.0	Sandy Lean Clay	CL	Loam	7.3			2.66	116.3 @ 13.0	29	18	11	2.5	34.6	62.9	45.5	17.4						

Notes: 1. Sample Types: CA = California sample, Bulk = bucket/grab sample

2. USCS = Unified Soil Classification Sysytem, material descriptions are based on field observations, and refined with laboratory data, if available. USCS classifications are provided only where sufficient laboratory data are available. CL = low plasticity clay

3. USDA = United States Department of Agriculture, USDA classifications are based on the sand/silt/clay fraction of the sample and on USDA grain-size designations.

4. LL = liquid limit, PL = plastic limit, PI = plasticity index

5. With the exception of DH-B1-03, which was tested at a density based on the natural in-situ density measured from the CA samples, specimens were remolded to approximately 85% of standard Proctor density and between the estimated natural and optimum water contents for the soil.

6. ND1 = nondispersive clay with very slight to no colloidal erosion under 15-inch or 40-inch head; ND4, ND3 = slightly to moderately dispersive clays that erode slowly under 2-inch or 7-inch head (ASTM test method A)

7. Specimens remolded to approximately 80%, 85%, and 90% of maximum standard Proctor dry density and between the estimated natural and optimum water contents for the soil.

8. Specimens remolded to approximately 85% of maximum standard Proctor dry density and between the estimated natural and optimum water contents for the soil. SWCC tests performed with pairs of speciments for each test.

Table 3-6 Summary of Geotechnical Laboratory Data - Site Stockpiles

Area	Sample	Sample Type [1]	Material Description	USCS [2]	Specific Gravity	Atterberg Limits (%) [4]			USCS % Gravel	USCS % Sand	% Passing No. 200 Sieve (fines)	L.A. Abrasion (% loss) [5]	Sodium Sulfate Soundness (% loss) [6]	Absorption (%) [7]	Unconfined Compressive Strength (psi) [8]	Splitting Tensile Strength (psi) [8]
						LL	PL	PI								
Stockpiles	Topsoil-01	Bulk	Sandy Clay	CL	2.68	33	10	23	2.6	32.4	65.0					
	Topsoil-02	Bulk	Sandy Clay	CL	2.71	39	12	27	0.5	26.8	72.7					
	TI-SP1-01	Bulk	Crusher Fines						1.9	80.8	17.3					
	TI-SP2-01A	Bulk	Erosion Protection Gravel		2.78 [3]				93.0	6.3	0.7	5.7	8.26	1.868		
	TI-SP2-01C	Bulk	Erosion Protection Gravel						83.3	4.9	11.8					
	TI-SP3-01A	Bulk	Road Base (gravel with sand)						67.4	24.6	8.0					
	TI-SP4-01A	Bulk	Erosion Protection Gravel		2.75 [3]				98.0	1.2	0.8	6.1	10.47	2.091		
	TI-SP6 (56A)	Bulk	9-inch riprap												20,780 and 23,630	1,320 and 1,400
	TI-SP6 (56B)	Bulk	9-inch riprap												19,100 and 14,440	1,530 and 1,720

Notes: 1. Bulk = bucket/grab sample

2. USCS = Unified Soil Classification Sysytem, material descriptions are based on field observations, and refined with laboratory data, if available. USCS classifications are provided only where sufficient laboratory data are available. CL = low plasticity clay

3. Average of three bulk saturated surface dry (SSD) specific gravity results for the rock samples (ASTM C127)

4. LL = liquid limit, PL = plastic limit, PI = plasticity index

5. L.A. Abrasion results are percent loss, by mass, for 100 revolutions.

6. Weighted percentage loss for 0.75 to 1.5-inch size range

7. Average of three absorption results

8. Specimens were collected from the 9-inch stockpile and cored for strength testing.

Table 3-7 Summary of Branch Swale Conditions

Swale Section[1]	Observation Date	Sedimentation[2]	Approx. Depth of Sediment Accumulation Above Rock	Vegetation Accumulation[3]	Other Observations
Branch Swale A					
A-1	11/27/2013	Moderate	Up to 3"	Moderate to Heavy	
A-2	11/27/2013	Heavy	Up to 12"	Moderate to Heavy	Sediment accumulation appears to be from erosion of the south slope of the swale.
A-3	11/27/2013	Light	< 1/2"	Light to Moderate	
A-4	11/27/2013	Moderate	Up to 2"	Moderate	Low area, with standing water present.
A-5	12/7/2013	Moderate	Up to 3"	Moderate to Heavy	
Branch Swale B					
B-1	11/27/2013	Moderate	Up to 2"	Moderate	Sediment accumulation appears to be from erosion of east slope of the swale.
B-2	11/27/2013	Light	< 1/2"	Moderate	
Branch Swale C					
C-1	12/7/2013	Heavy	Up to 8"	Moderate	Sediment accumulation appears to be from erosion of the east slope of the swale.
C-2	12/7/2013	Light	< 1/2"	Moderate	
C-3	12/7/2013	Moderate	Up to 1"	Moderate	
C-4	12/7/2013	Heavy	Up to 12"	Moderate	Sediment accumulation appears to be from erosion of the south slope of the swale.
C-5	12/7/2013	Light	< 1/2"	Light to Moderate	
C-6	12/7/2013	Moderate	Up to 2"	Light to Moderate	
Branch Swale D					
D-1	12/7/2013	Heavy	Up to 8"	Moderate	Sediment accumulation appears to be from erosion of the east slope of the swale.
D-2	12/7/2013	Moderate	Up to 2"	Moderate	
D-3	12/7/2013	Light	< 1/2"	Moderate to Heavy	
D-4	12/7/2013	Moderate	Up to 1"	Light	Low area, with standing water present.
D-5	12/7/2013	Moderate	Up to 2"	Light	
D-6	12/7/2013	Moderate	Up to 2"	Heavy	
Branch Swale E					
E-1	12/7/2013	Heavy	Up to 6"	Moderate to Heavy	Partial erosion of side rock to bottom in places.
E-2	12/7/2013	Light	< 1/2"	Moderate to Heavy	Partial erosion of side rock to bottom in places.
Branch Swale F					
F-1	12/14/2013	Minimal	None	Moderate	
F-2	12/14/2013	Minimal	None	Light	Partial erosion of side rock to bottom in places.
Branch Swale G					
G-1	12/14/2013	Minimal	None	Moderate	Partial erosion of side rock to bottom in places.
G-2	12/14/2013	Minimal	None	Light	
Branch Swale H					
H-1	12/7/2013	Light to Moderate	Up to 2"	Moderate	
H-2	12/7/2013	Light	< 1/2"	Moderate	

Notes: 1. Swale sections are shown on Figure 3-8.

2. Sedimentation:

Minimal = Erosion protection rock is entirely visible, with little to no accumulation of sediment

Light = Erosion protection rock is mostly visible, with less than 1/2 inch sediment accumulation above the rock in places

Moderate = Erosion protection rock is not visible, or only partially visible, with accumulation of sediment up to approximately 3 inches above the rock

Heavy = Erosion protection rock is not visible, with accumulation of sediment up to approximately 6 inches or greater

3. Vegetation:

Minimal = None, or only occasional vegetation present

Light = Some light vegetation present (grasses/small shrubs), covering up to approximately 1/3 of the surface

Moderate = Up to approximately 2/3 of the surface covered with vegetation and/or tumbleweeds

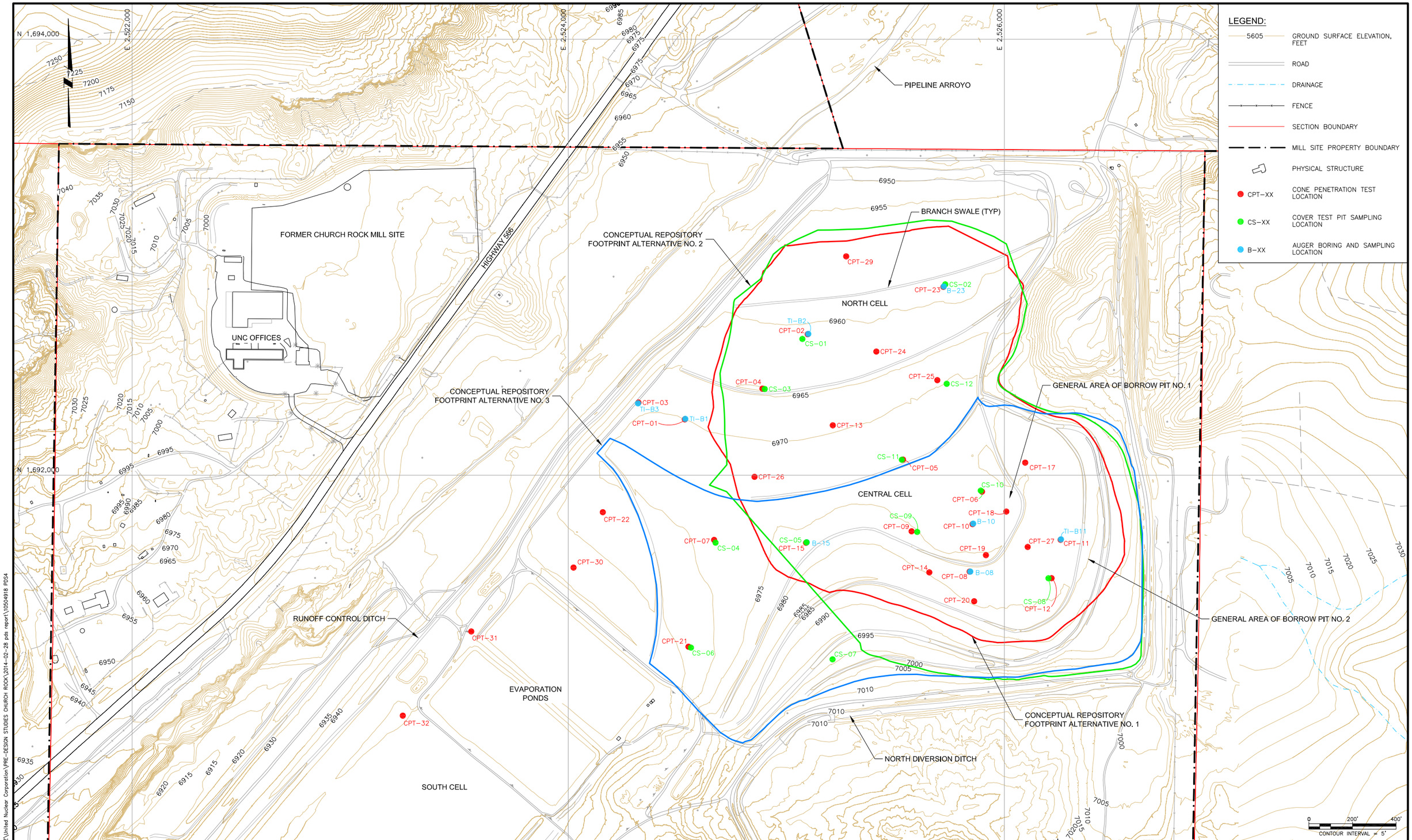
Heavy = Nearly entire surface covered with heavy vegetation and/or tumbleweeds

Table 3-8 Summary of North Upstream Diversion Channel Conditions

Channel Section[1]	Observation Date	Sedimentation[2]	Approx. Depth of Sediment Accumulation	Vegetation Accumulation[3]	Condition of Roadway Berm	Other Observations
NDC-1	12/14/2013	Light	Up to 6"	Moderate	Steep, comprised of sandstone and fill, some minor erosional rills present in fill material, lightly vegetated.	No erosion protection rock is present on bottom or sides.
NDC-2	12/14/2013	Minimal	None	Light to Moderate	Less steep, covered with erosion protection rock, little or no vegetation.	Erosion protection rock is present on bottom and sides.
NDC-3	12/14/2013	Minimal	None	Moderate	Steep, comprised of sandstone and fill, heavily vegetated.	No erosion protection rock is present on bottom, some small rock on sides.
NDC-4	12/14/2013	Minimal to Light	Up to 2"	Light to Moderate	Less steep than previous section, erosion protection rock extends about 2/3 up the slope, lightly vegetated.	Erosion protection rock is present on bottom and east slope, and 2/3 up west slope.
NDC-5	12/14/2013	Light to Moderate	Up to 12"	Moderate to Heavy	Steep, comprised of sandstone and fill, some minor erosional rills present in fill material.	No erosion protection rock is present on bottom or sides.
NDC-6	12/14/2013	Moderate to Heavy	Up to 18"	Heavy	Less steep than previous section, comprised of sandstone and fill, some minor erosion rills present in fill material with sediment accumulation at the toe, heavily vegetated.	No erosion protection rock present. Sediment accumulation appears to be from East Borrow Area. Channel is less well-defined in this area.
NDC-7	12/14/2013	Light	Up to 6"	Moderate to Heavy	Comprised of fill, some minor erosion rills present, heavily vegetated.	No erosion protection rock is present on bottom or sides, east slope of channel becomes increasingly shallow (moving south to north).
NDC-8	12/14/2013	Moderate to Heavy	Up to 18"	Heavy	Comprised of fill, some erosion rills present, with some sediment accumulation at the toe, heavily vegetated.	No erosion protection rock is present on bottom or sides. Sediment accumulation appears to be from area east of channel. East embankment becomes increasingly shallow toward the north.
NDC-9	12/14/2013	Moderate to Heavy	Up to 18"	Heavy	Comprised of fill, some minor erosion rills present, lightly vegetated.	No erosion protection rock is present on bottom or sides. An incised erosional cut is present at the bottom of the channel, in what appears to be shale.

Notes:

1. Channel sections are shown on Figure 3-8.
2. Sedimentation:
   - Minimal = Little to no accumulation of sediment on channel bottom
   - Light = Accumulation of sediment up to approximately 6 inches in portions of channel bottom
   - Moderate = Accumulation of sediment up to approximately 12 inches in portions of channel bottom
   - Heavy = Accumulation of sediment up to approximately 18 inches or greater in portions of channel bottom
3. Vegetation:
   - Minimal = None, or only occasional vegetation present
   - Light = Some light vegetation present (grasses/small shrubs), covering up to approximately 1/3 of the surface
   - Moderate = Up to approximately 2/3 of the surface covered with vegetation and/or tumbleweeds
   - Heavy = Nearly entire surface covered with heavy vegetation and/or tumbleweeds



ISSUE REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10–14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07–14
DRAWN BY	D MIRANDA	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: PDS TAILINGS IMPOUNDMENT SAMPLING LOCATIONS
FIGURE: 3-1
REVISION: 0
FILE NAME: 10504918 PDS4

MWH

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N 1,694,000

N 1,692,000

E 2,522,000

E 2,524,000

E 2,526,000

PIPELINE ARROYO

FORMER CHURCH ROCK MILL SITE

UNC OFFICES

HIGHWAY 566

CONCEPTUAL REPOSITORY FOOTPRINT ALTERNATIVE NO. 2

CONCEPTUAL REPOSITORY FOOTPRINT ALTERNATIVE NO. 3

BRANCH SWALE (TYP)

NORTH CELL

CENTRAL CELL

SOUTH CELL

EVAPORATION PONDS

RUNOFF CONTROL DITCH

NORTH DIVERSION DITCH

GENERAL AREA OF BORROW PIT NO. 1

GENERAL AREA OF BORROW PIT NO. 2

CONCEPTUAL REPOSITORY FOOTPRINT ALTERNATIVE NO. 1

CPT-01, CPT-02, CPT-03, CPT-04, CPT-05, CPT-06, CPT-07, CPT-08, CPT-09, CPT-10, CPT-11, CPT-12, CPT-13, CPT-14, CPT-15, CPT-16, CPT-17, CPT-18, CPT-19, CPT-20, CPT-21, CPT-22, CPT-23, CPT-24, CPT-25, CPT-26, CPT-27, CPT-28, CPT-29, CPT-30, CPT-31, CPT-32

TI-B1, TI-B2, TI-B3, TI-B8, TI-B10, TI-B11, TI-B15, TI-B23

SHB78a-24, SHB78a-25, SHB78a-26

SHB79-12, SHB79-13, SHB79-14, SHB79-15, SHB79-16, SHB79-17, SHB79-18

658, 659, 660, 662

1, 2, 3, 4

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- ROAD
- DRAINAGE
- FENCE
- SECTION BOUNDARY
- CROSS SECTION LOCATIONS
- MILL SITE PROPERTY BOUNDARY
- SHBXX–XX — HISTORIC GEOTECHNICAL BORINGS WITH TAILINGS INFORMATION (SERGENT, HAUSKINS AND BECKWITH, 1978–1979)
- 6XX — HISTORIC BORINGS WITH TAILINGS INFORMATION (UNC, 1986)
- TI–BXX — AUGER BOREHOLE SAMPLING LOCATION (MWH, 2013)
- CPT–XX — CPT LOCATION (MWH, 2013)
- PHYSICAL STRUCTURE

IMPOUNDMENT THICKNESS (EXISTING GROUND SURFACE TO BOTTOM OF TAILINGS)

0'	–	10'	
10'	–	15'	
15'	–	20'	
20'	–	25'	
25'	–	30'	
30'	–	35'	
35'	–	40'	
40'	–	45'	
45'	–	50'	
50'	–	55'	

NOTES:

1. CROSS SECTIONS SHOWN ON FIGURES 3–4 AND 3–5.

0 200' 400'
CONTOUR INTERVAL = 5'

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10–14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.
- THE GROUND SURFACE ELEVATIONS SHOWN ON THE BORING LOGS IN THE SERGENT, HAUSKINS AND BECKWITH (SHB) (1978 AND 1979) REPORTS WERE ADJUSTED BY MINUS 5 FEET VERTICAL, BASED ON A COMPARISON BETWEEN THE 2013 TOPOGRAPHY AND THE TOPOGRAPHY SHOWN IN THE OCTOBER 1978 REPORT PREPARED BY SHB.
- BORROW PIT CONFIGURATIONS BASED ON TOPOGRAPHY INCLUDED WITH UNC (1993) AND OPERATIONAL AERIAL PHOTOGRAPHS.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07–14
DRAWN BY	D MIRANDA	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: TAILINGS IMPOUNDMENT THICKNESS (COVER AND TAILINGS) ISOPACH MAP
FIGURE: 3-2
REVISION: 0
FILE NAME: 10504918 PDS5

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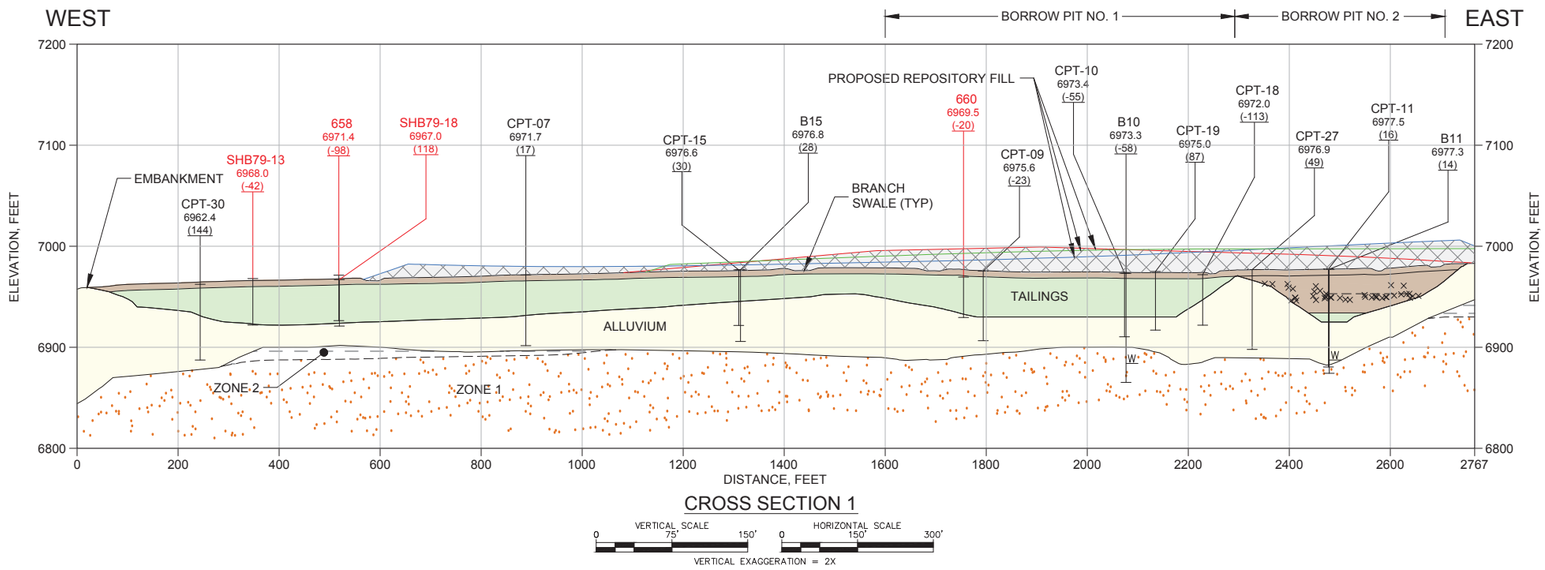
LEGEND:

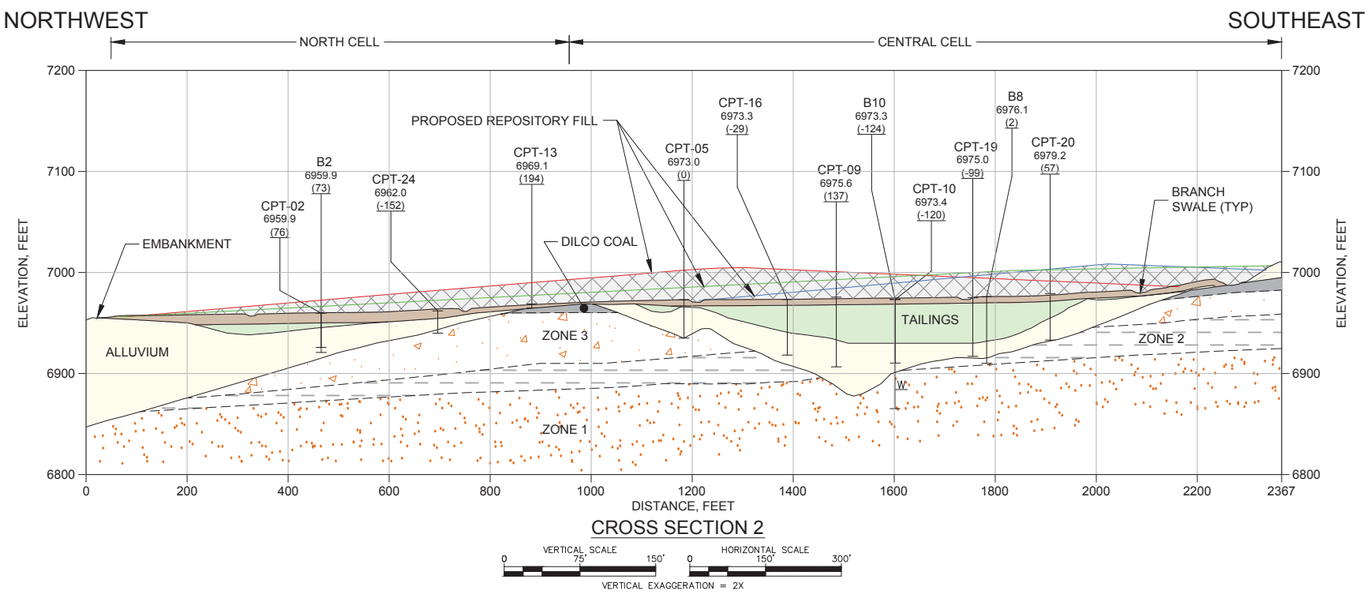
- ⊗ TAILINGS NOT ENCOUNTERED
- ○ FINE-GRAINED TAILINGS 5 FT THICK OR LESS
- ● FINE-GRAINED TAILINGS GREATER THAN 5 FT THICK

NOTE: 2013 CPT LOCATIONS SHOWN ON AERIAL PHOTO DATED NOVEMBER 4, 1980, TAKEN FROM CHESTER ENGINEERS (2012).

PROJECT LOCATION	CHURCH ROCK MILL SITE
PROJECT	PRE-DESIGN STUDIES REPORT
TITLE	DISTRIBUTION AND THICKNESS OF FINE-GRAINED TAILINGS
FIGURE	3-3
REVISION	0
FILE NAME	10504918 PDS6

MWH





LEGEND:

- PROPOSED REPOSITORY FILL
- EXISTING COVER/FILL
- TAILINGS (UNDIFFERENTIATED FINE AND COARSE)
- ALLUVIUM
- DILCO COAL
- ZONE 3 SANDSTONE
- ZONE 2 SHALE AND COAL
- ZONE 1 SANDSTONE
- REPOSITORY ALT 1 NORTH AND CENTRAL CELL
- REPOSITORY ALT 2 NORTH AND CENTRAL CELL
- REPOSITORY ALT 3 CENTRAL CELL
- × BURIED MILL DEMOLITION DEBRIS
- ×—×—× DEBRIS AREAS (CONCRETE, STEEL, EXCAVATED MILL MATERIAL)
- CONTACT, SOLID WHERE APPROXIMATE, DASHED WHERE UNCERTAIN
- W WATER ENCOUNTERED DURING DRILLING (MWH, 2013)

SHB79-14 (BOREHOLE DESIGNATION)
6968 (ELEVATION)
(467) (OFFSET)
EXISTING GROUND SURFACE
BORING EXTENT

PDS 2013 BORING AND/OR CPT LOCATIONS (SHOWN IN BLACK)

HISTORIC BORINGS (SHOWN IN RED)

DIMENSIONS AND ELEVATIONS IN FEET

NOTES:

1. CROSS SECTION LOCATIONS SHOWN ON FIGURE 3–1.
2. CROSS SECTIONS WERE GENERATED FROM TOP–OF–UNIT SURFACES DEVELOPED FROM MWH BOREHOLE AND CPT INFORMATION AND SELECT HISTORIC BOREHOLES THAT PROVIDE INFORMATION ABOUT TAILINGS, THE EMBANKMENT, AND/OR ALLUVIUM. ADDITIONAL INFORMATION ON ZONE 1, ZONE 2, ZONE 3 AND DILCO COAL IS FROM TOP–OF–UNIT SURFACES DEVELOPED BY CHESTER ENGINEERS. LOCATIONS OF BOREHOLES PROJECTED ONTO CROSS–SECTIONS ARE FOR LOCATION REFERENCE ONLY.
3. LOCATIONS OF DEBRIS IN BORROW PIT 2 WERE SURVEYED DURING MILL DECOMMISSIONING.
4. HISTORIC BOREHOLE AND DEBRIS ELEVATIONS ARE BASED ON THE BEST AVAILABLE INFORMATION. DUE TO SURVEY ERROR AND DATUM CORRECTIONS, THE ELEVATIONS OF THE BOREHOLES, DEBRIS AND CONTACTS SHOWN ARE APPROXIMATE.
5. EXISTING COVER/FILL THICKNESS IS SHOWN AS AN ESTIMATED AVERAGE THICKNESS OF 10 FEET FOR THE NORTH CELL AND 6 FEET FOR THE CENTRAL CELL.
6. WATER ENCOUNTERED DURING DRILLING AND SHOWN HERE IS WITHIN ALLUVIUM.
7. TABLE 3–5 AND FIGURE 3–3 PROVIDE MORE DETAILED INFORMATION ON LOCATION OF FINE AND COARSE TAILINGS.

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10–14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07–14
DRAWN BY	D MIRANDA	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: IMPOUNDMENT CROSS SECTIONS 1 AND 2
FIGURE: 3-4
REVISION: 0
FILE NAME: 10504918 PDS7

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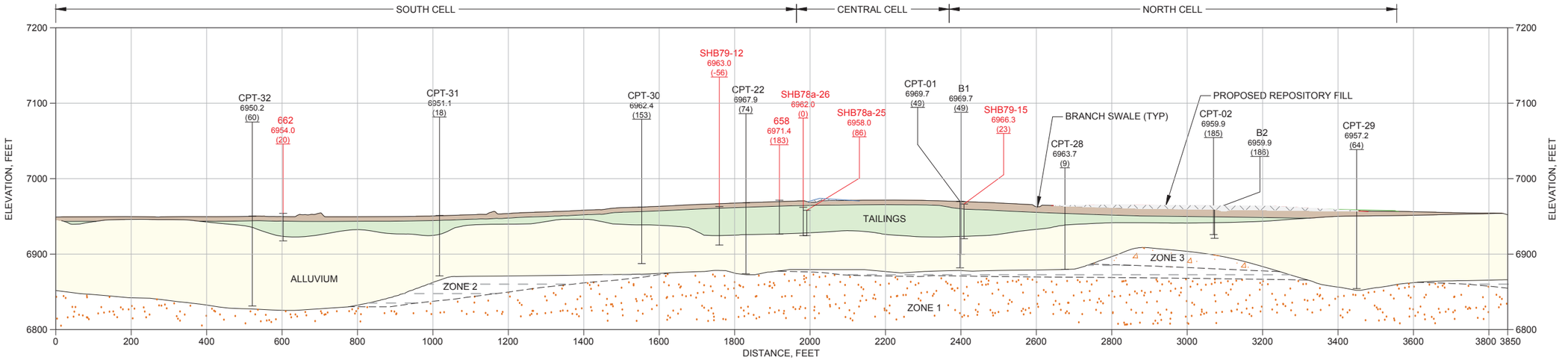
SOUTHWEST

NORTHEAST

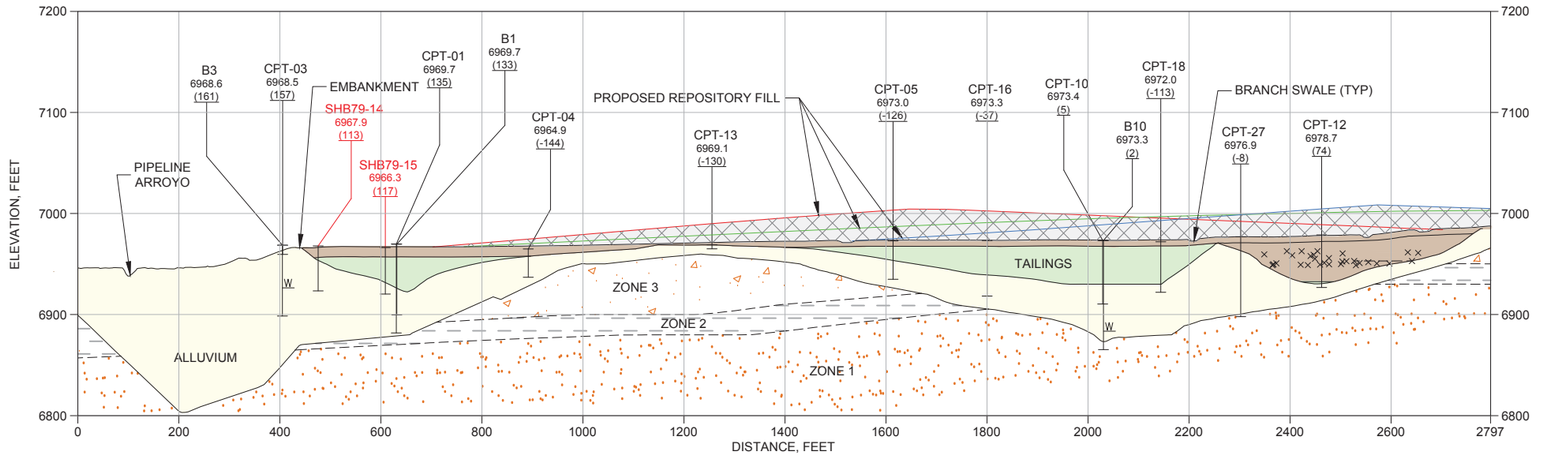


CROSS SECTION 3

VERTICAL SCALE 0 75' 150'
HORIZONTAL SCALE 0 150' 300'
VERTICAL EXAGGERATION = 2X

NORTHWEST

SOUTHEAST



CROSS SECTION 4

VERTICAL SCALE 0 75' 150'
HORIZONTAL SCALE 0 150' 300'
VERTICAL EXAGGERATION = 2X

LEGEND:

- PROPOSED REPOSITORY FILL
- EXISTING COVER/FILL
- TAILINGS (UNDIFFERENTIATED FINE AND COARSE)
- ALLUVIUM
- DILCO COAL
- ZONE 3 SANDSTONE
- ZONE 2 SHALE AND COAL
- ZONE 1 SANDSTONE
- REPOSITORY ALT 1 NORTH AND CENTRAL CELL
- REPOSITORY ALT 2 NORTH AND CENTRAL CELL
- REPOSITORY ALT 3 CENTRAL CELL
- × BURIED MILL DEMOLITION DEBRIS
- DEBRIS AREAS (CONCRETE, STEEL, EXCAVATED MILL MATERIAL)
- CONTACT, SOLID WHERE APPROXIMATE, DASHED WHERE UNCERTAIN
- W WATER ENCOUNTERED DURING DRILLING (MWH, 2013)

SHB79-14 — BOREHOLE DESIGNATION
6968 — ELEVATION
(467) — OFFSET
EXISTING GROUND SURFACE
BORING EXTENT

PDS 2013 BORING AND/OR CPT LOCATIONS (SHOWN IN BLACK)
HISTORIC BORINGS (SHOWN IN RED)
DIMENSIONS AND ELEVATIONS IN FEET

NOTES:

1. CROSS SECTION LOCATIONS SHOWN ON FIGURE 3-1.
2. CROSS SECTIONS WERE GENERATED FROM TOP-OF-UNIT SURFACES DEVELOPED FROM MWH BOREHOLE AND CPT INFORMATION AND SELECT HISTORIC BOREHOLES THAT PROVIDE INFORMATION ABOUT TAILINGS, THE EMBANKMENT, AND/OR ALLUVIUM. ADDITIONAL INFORMATION ON ZONE 1, ZONE 2, ZONE 3 AND DILCO COAL IS FROM TOP-OF-UNIT SURFACES DEVELOPED BY CHESTER ENGINEERS. LOCATIONS OF BOREHOLES PROJECTED ONTO CROSS-SECTIONS ARE FOR LOCATION REFERENCE ONLY.
3. LOCATIONS OF DEBRIS IN BORROW PIT 2 WERE SURVEYED DURING MILL DECOMMISSIONING.
4. HISTORIC BOREHOLE AND DEBRIS ELEVATIONS ARE BASED ON THE BEST AVAILABLE INFORMATION. DUE TO SURVEY ERROR AND DATUM CORRECTIONS, THE ELEVATIONS OF THE BOREHOLES, DEBRIS AND CONTACTS SHOWN ARE APPROXIMATE.
5. EXISTING COVER/FILL THICKNESS IS SHOWN AS AN ESTIMATED AVERAGE THICKNESS OF 10 FEET FOR THE NORTH CELL AND 6 FEET FOR THE CENTRAL CELL.
6. WATER ENCOUNTERED DURING DRILLING AND SHOWN HERE IS WITHIN ALLUVIUM.
7. TABLE 3-5 AND FIGURE 3-3 PROVIDE MORE DETAILED INFORMATION ON LOCATION OF FINE AND COARSE TAILINGS.

ISSUE / REV	DESCRIPTION	CF / TECH	ED / ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	D MIRANDA	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LESSON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: IMPOUNDMENT CROSS SECTION 3 AND 4
FIGURE: 3-5
REVISION: 0
FILE NAME: 10504918 PDS7

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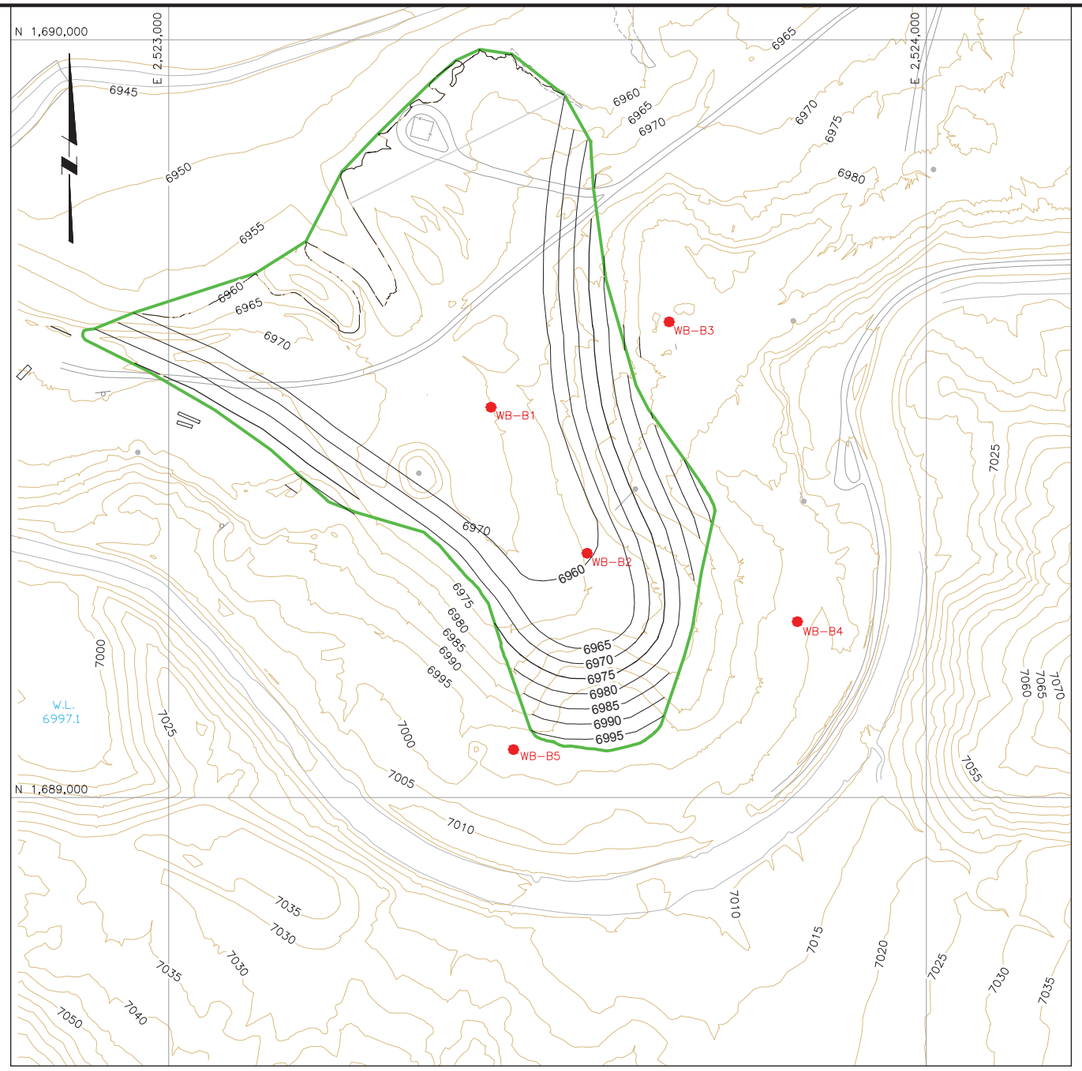
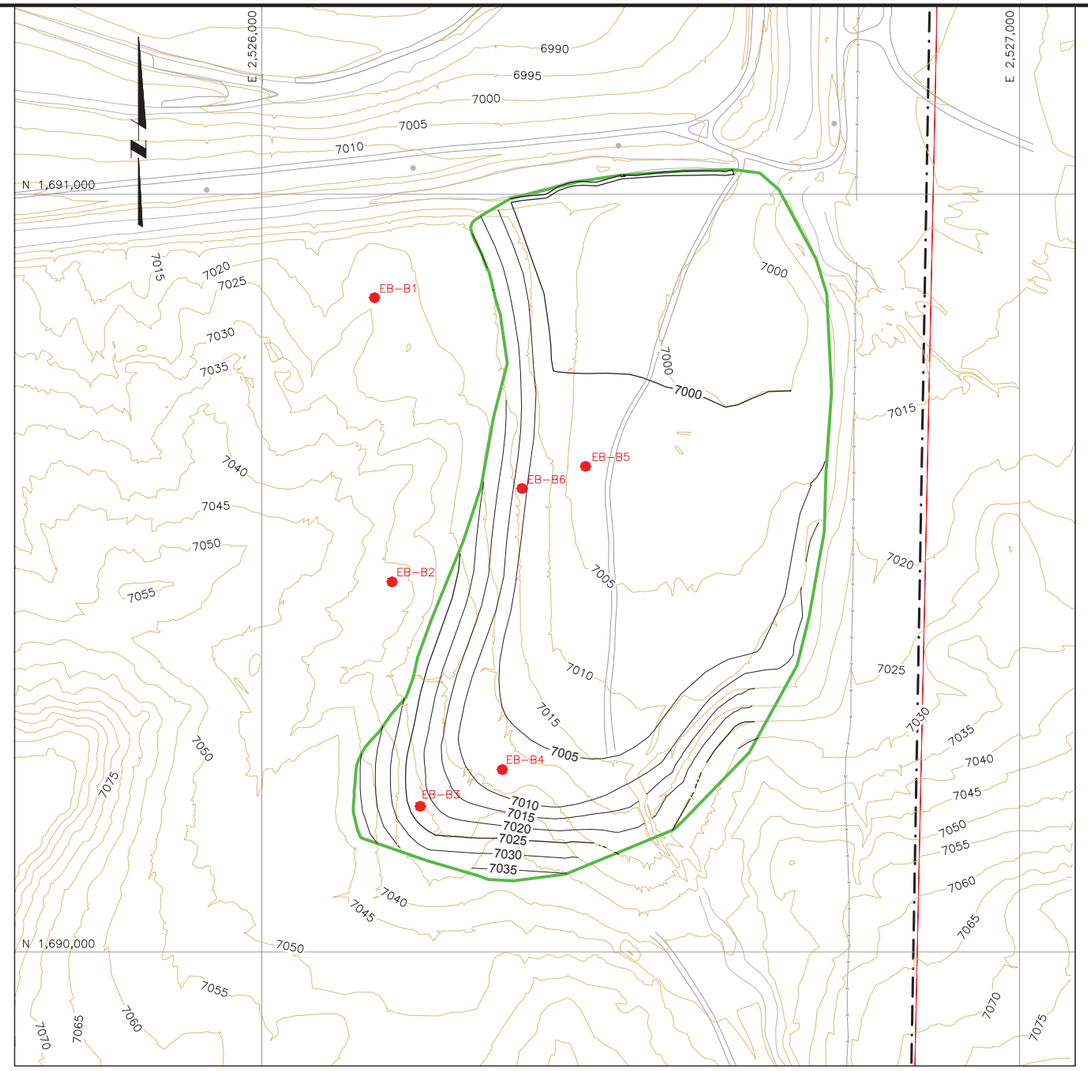


WEST BORROW AREA

0 100' 200'

CONTOUR INTERVAL = 5'



EAST BORROW AREA

0 100' 200'

CONTOUR INTERVAL = 5'

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- PRELIMINARY GRADING CONTOUR
- ROAD
- DRAINAGE
- APPROXIMATE LIMIT OF BORROW EXCAVATION
- SECTION BOUNDARY
- MILL SITE PROPERTY BOUNDARY
- WB-B5 — BORROW AREA DRILLING LOCATION

NOTE:

1. CULTURAL RESOURCE SITES (IF IDENTIFIED) HAVE BEEN ACCOUNTED FOR IN THE PRELIMINARY GRADING PLANS WITH A 100 FT BUFFER ZONE.
2. PROPOSED BORROW AREA BOUNDARIES REPRESENT EXTENTS OF GRADING TO EXTRACT USABLE MATERIAL AND MAINTAIN POSITIVE FINAL DRAINAGE. BOUNDARIES HAVE BEEN MODIFIED FROM WORK PLAN BASED ON GRADING TIE-INS.

ISSUE REV	DESCRIPTION	CF TECH	ED ENG	DATE
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DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

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ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

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PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: DRILLING LOCATIONS AND PRELIMINARY GRADING EAST AND WEST BORROW AREAS
FIGURE: 3-6
REVISION: 0
FILE NAME: 10504918 PDS9

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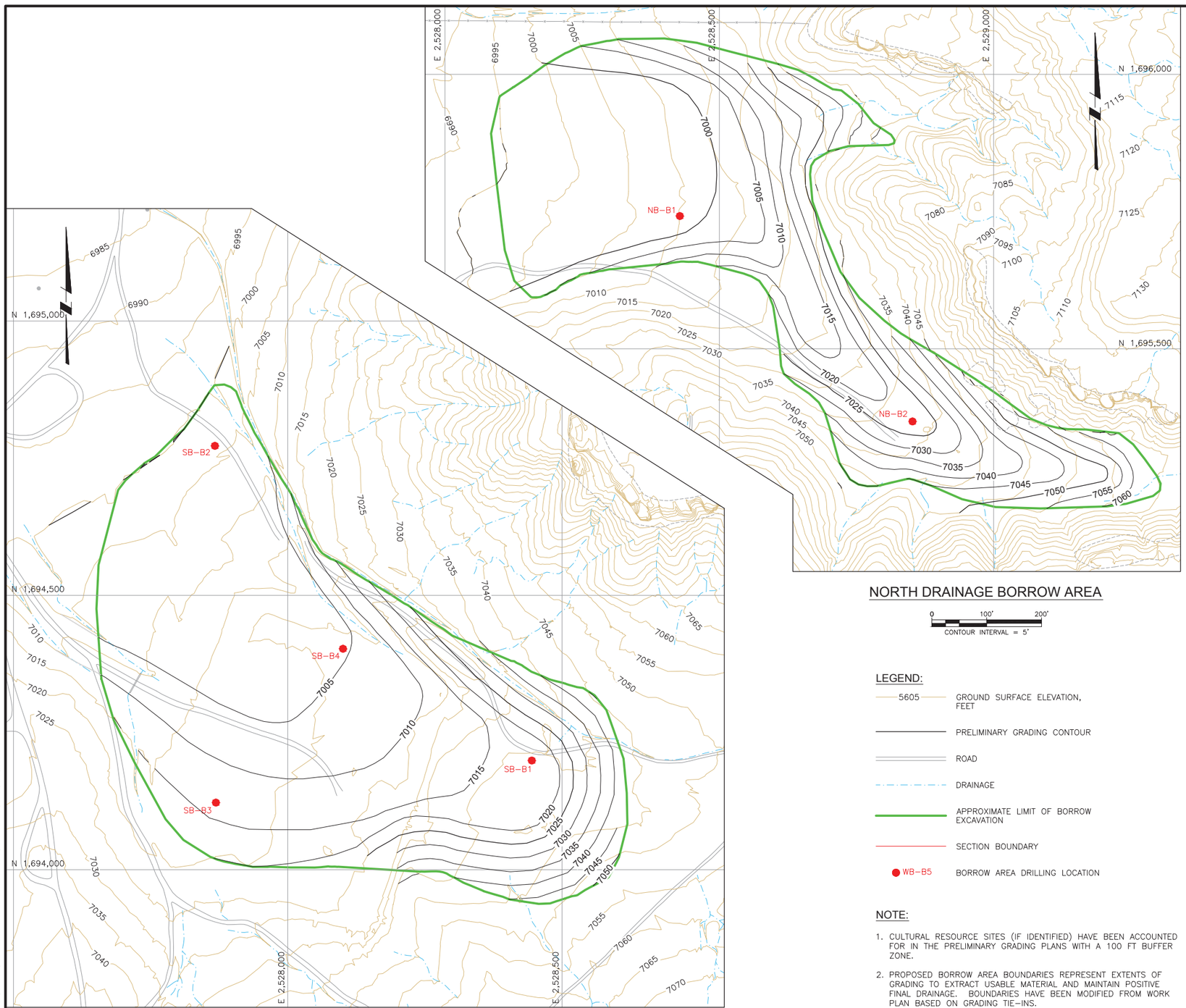


NORTH DRAINAGE BORROW AREA

0 100' 200'
CONTOUR INTERVAL = 5'

SOUTH DRAINAGE BORROW AREA

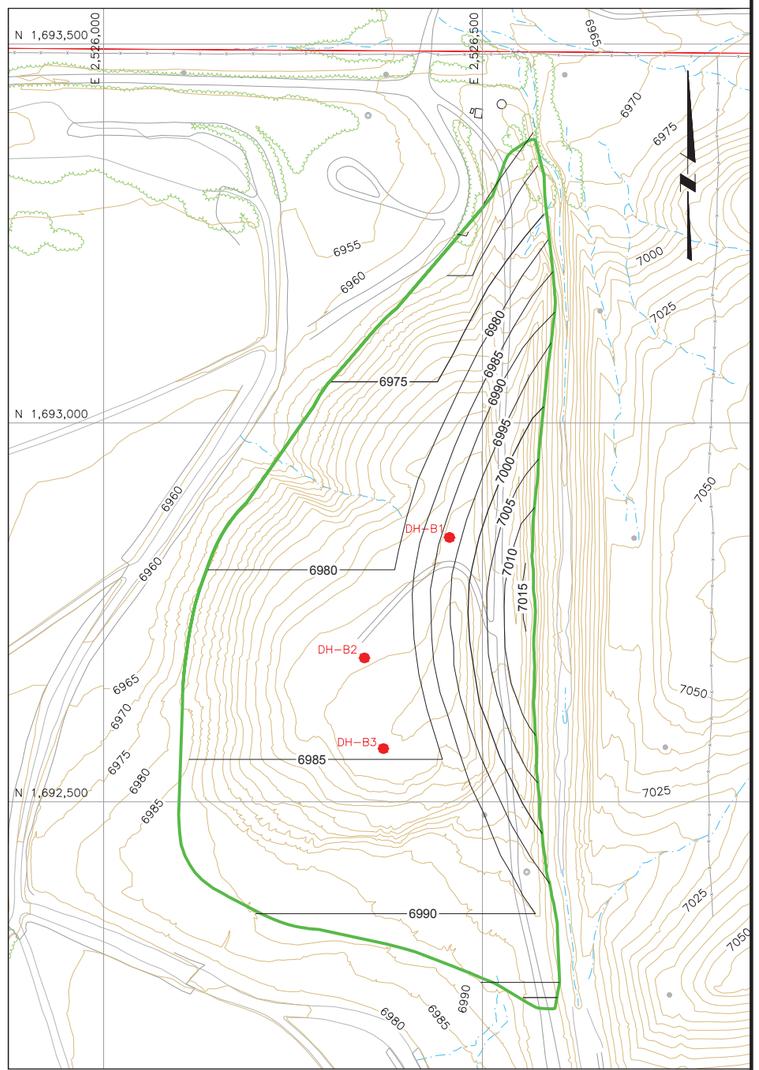
0 100' 200'
CONTOUR INTERVAL = 5'

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- PRELIMINARY GRADING CONTOUR
- ROAD
- DRAINAGE
- APPROXIMATE LIMIT OF BORROW EXCAVATION
- SECTION BOUNDARY
- WB–B5 — BORROW AREA DRILLING LOCATION

NOTE:

1. CULTURAL RESOURCE SITES (IF IDENTIFIED) HAVE BEEN ACCOUNTED FOR IN THE PRELIMINARY GRADING PLANS WITH A 100 FT BUFFER ZONE.
2. PROPOSED BORROW AREA BOUNDARIES REPRESENT EXTENTS OF GRADING TO EXTRACT USABLE MATERIAL AND MAINTAIN POSITIVE FINAL DRAINAGE. BOUNDARIES HAVE BEEN MODIFIED FROM WORK PLAN BASED ON GRADING TIE–INS.



DILCO HILL BORROW AREA

0 100' 200'
CONTOUR INTERVAL = 5'

ISSUE / REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10–14

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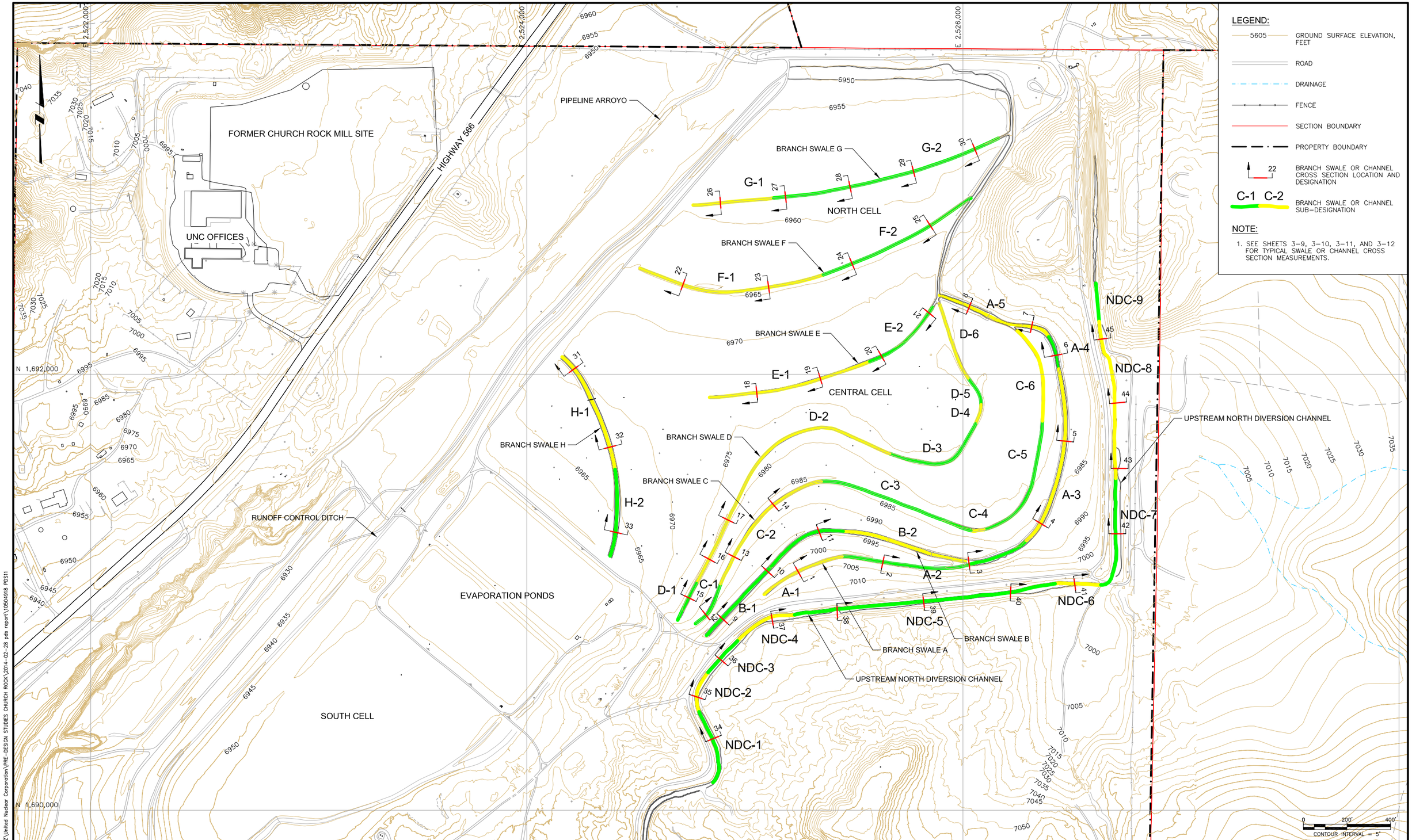
PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07–14
DRAWN BY	D MIRANDA	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: DRILLING LOCATIONS AND PRELIMINARY GRADING NORTH, SOUTH, AND DILCO HILL BORROW AREAS
FIGURE: 3-7
REVISION: 0
FILE NAME: 10504918 PDS10

N:\Design–Drafting\Clients_O–Z\United Nuclear Corporation\PRE–DESIGN STUDIES CHURCH ROCK\2014–02–28 pds report\10504918 PDS10



ISSUE REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
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ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

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APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: BRANCH SWALES AND NORTH UPSTREAM DIVERSION CHANNEL SECTION LOCATIONS
FIGURE: 3-8
REVISION: 0
FILE NAME: 10504918 PDS11

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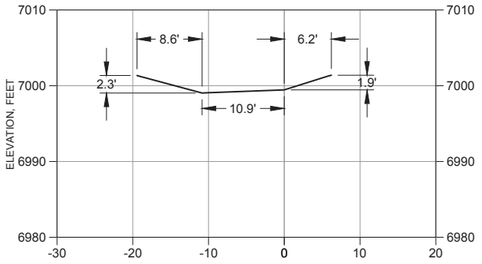
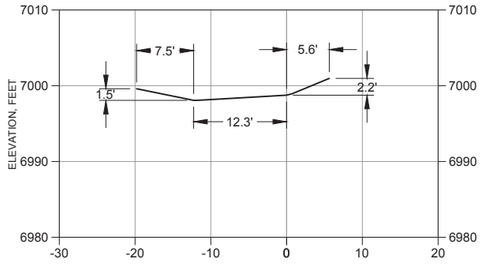
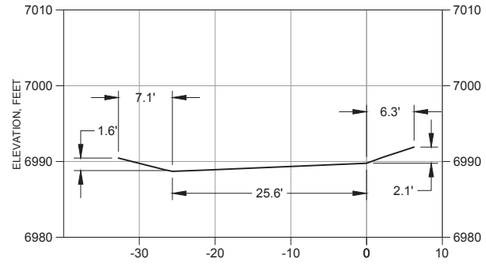
BRANCH SWALE A



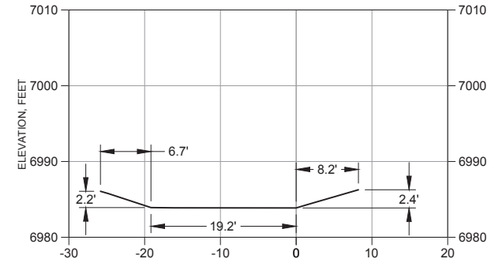
1 / 3-8 BRANCH SWALE A-1



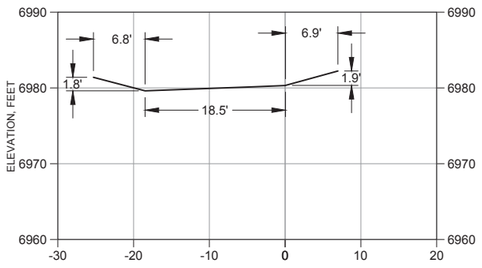
2 / 3-8 BRANCH SWALE A-2



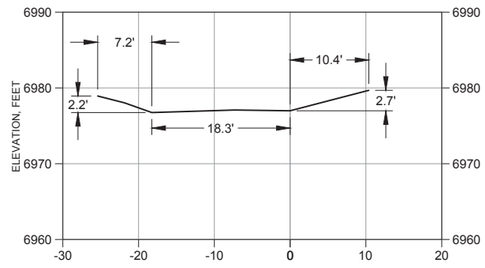
3 / 3-8 BRANCH SWALE A-2



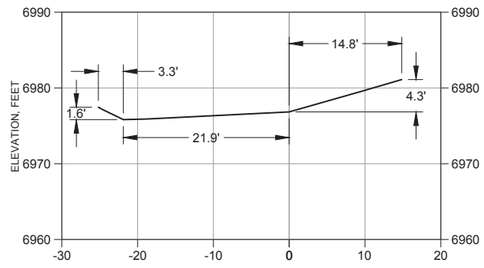
4 / 3-8 BRANCH SWALE A-3



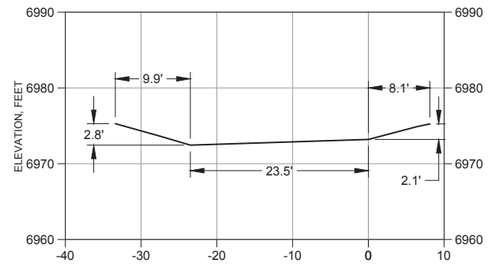
5 / 3-8 BRANCH SWALE A-3



6 / 3-8 BRANCH SWALE A-4

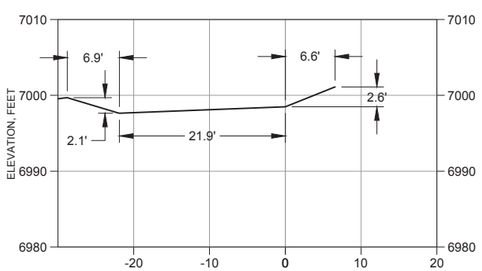


7 / 3-8 BRANCH SWALE A-5

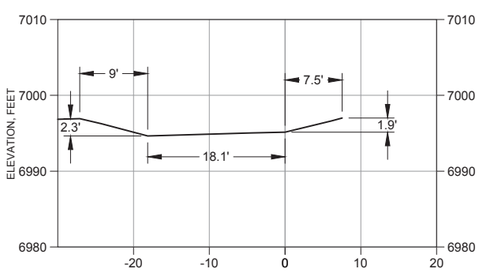


8 / 3-8 BRANCH SWALE A-5

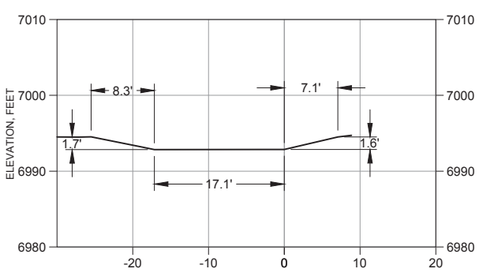
BRANCH SWALE B



9 / 3-8 BRANCH SWALE B-1



10 / 3-8 BRANCH SWALE B-1



11 / 3-8 BRANCH SWALE B-1

0 10' 20'

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DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	K TULLAR	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: BRANCH SWALE CROSS SECTIONS (1 OF 3)
FIGURE: 3-9
REVISION: 0
FILE NAME: 10504918 PDS12

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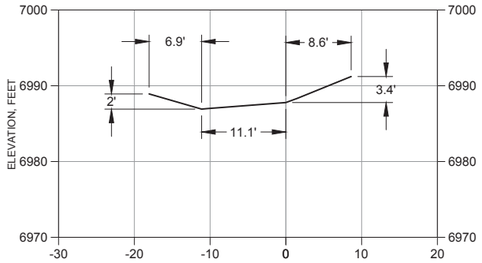
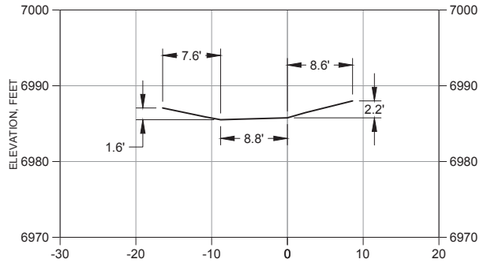
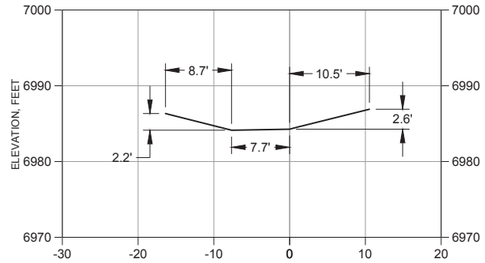
BRANCH SWALE C



12 / 3-8 BRANCH SWALE C-1

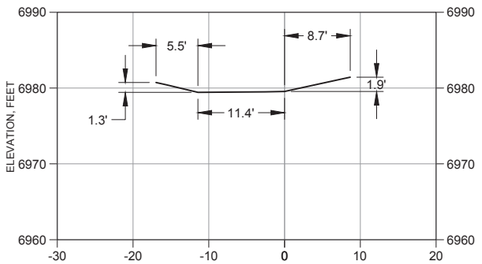


13 / 3-8 BRANCH SWALE C-2

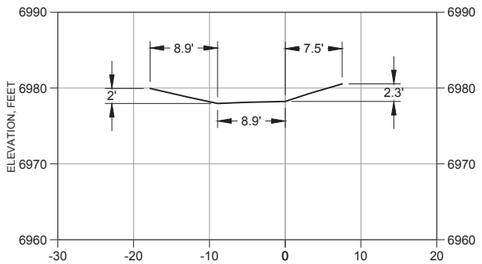


14 / 3-8 BRANCH SWALE C-2

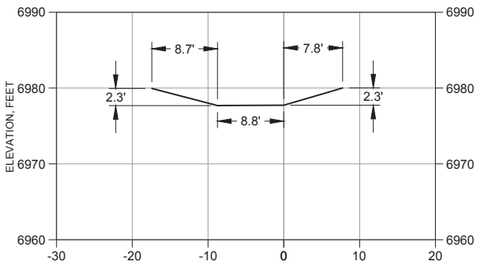
BRANCH SWALE D



15 / 3-8 BRANCH SWALE D-1

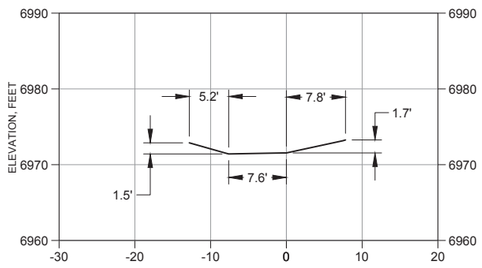


16 / 3-8 BRANCH SWALE D-2

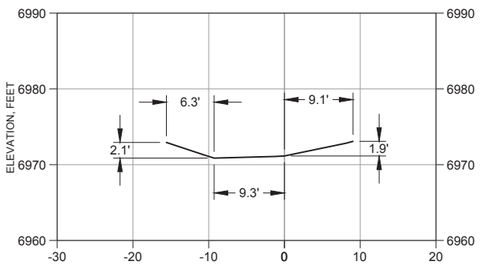


17 / 3-8 BRANCH SWALE D-2

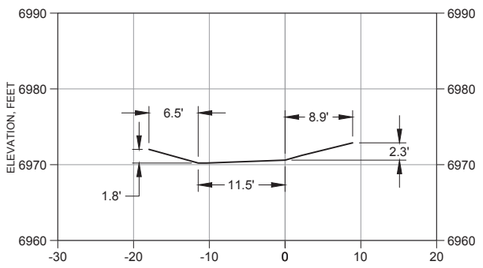
BRANCH SWALE E



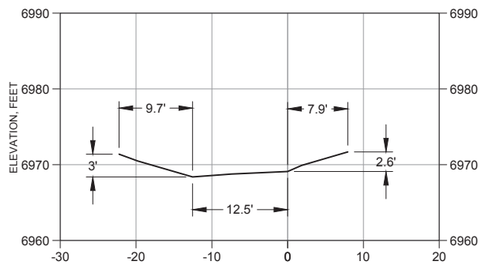
18 / 3-8 BRANCH SWALE E-1



19 / 3-8 BRANCH SWALE E-1



20 / 3-8 BRANCH SWALE E-2



21 / 3-8 BRANCH SWALE E-2

0 10' 20'

ISSUE / REV	DESCRIPTION	CF / TECH	ED / ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
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PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	K TULLAR	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: BRANCH SWALE CROSS SECTIONS (2 OF 3)
FIGURE: 3-10
REVISION: 0
FILE NAME: 10504918 PDS12

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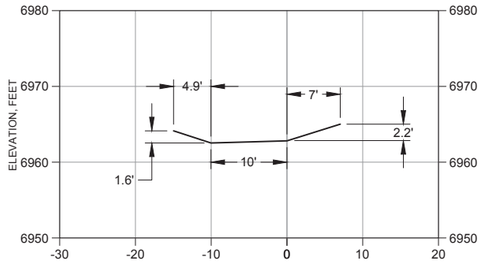
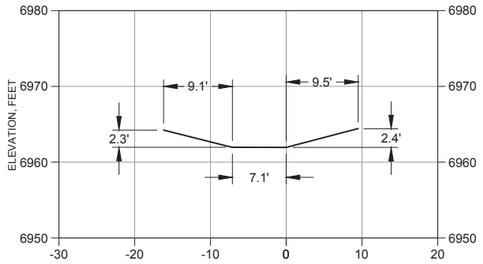
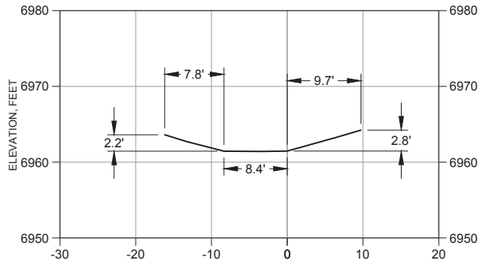
BRANCH SWALE F



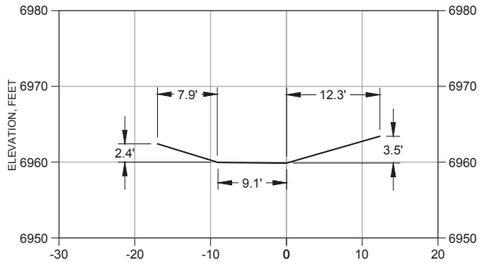
22 / 3-8 BRANCH SWALE F-1



23 / 3-8 BRANCH SWALE F-1

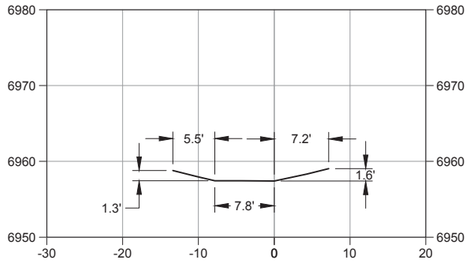


24 / 3-8 BRANCH SWALE F-2

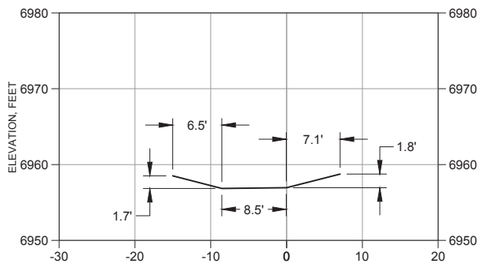


25 / 3-8 BRANCH SWALE F-2

BRANCH SWALE G



26 / 3-8 BRANCH SWALE G-1



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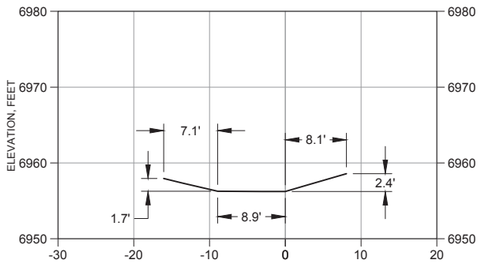

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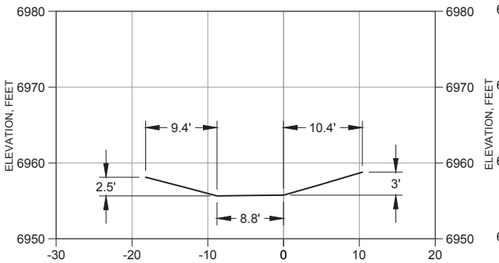

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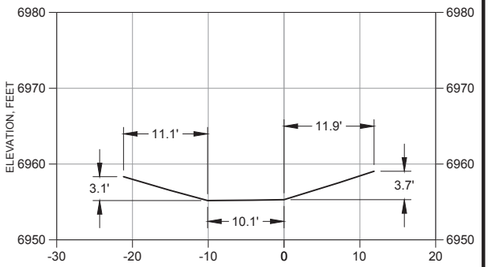
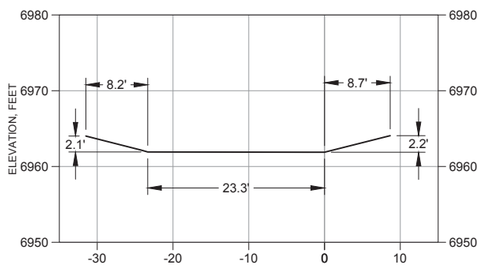
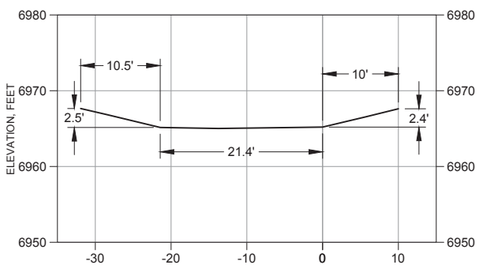


30 / 3-8 BRANCH SWALE G-2

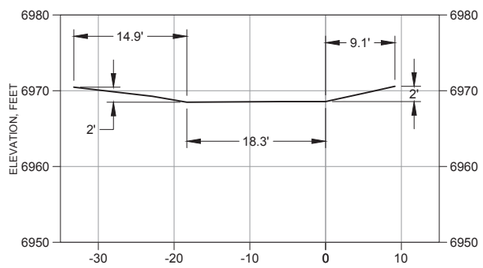
BRANCH SWALE H



31 / 3-8 BRANCH SWALE H-1



32 / 3-8 BRANCH SWALE H-1



33 / 3-8 BRANCH SWALE H-2

0 10' 20'

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
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UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	K TULLAR	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: BRANCH SWALE CROSS SECTIONS (3 OF 3)
FIGURE: 3-11
REVISION: 0
FILE NAME: 10504918 PDS12

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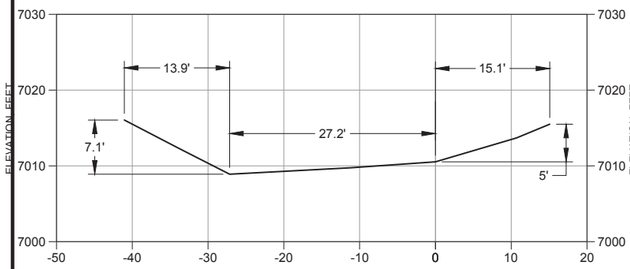
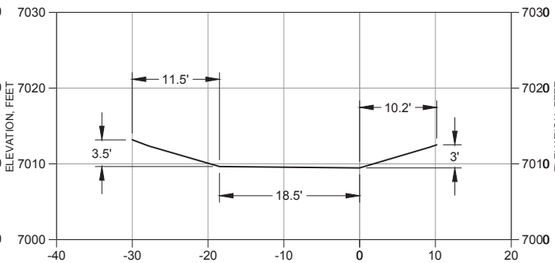
NORTH UPSTREAM DIVERSION CHANNEL



34 / 3-8 DIVERSION CHANNEL NDC-1



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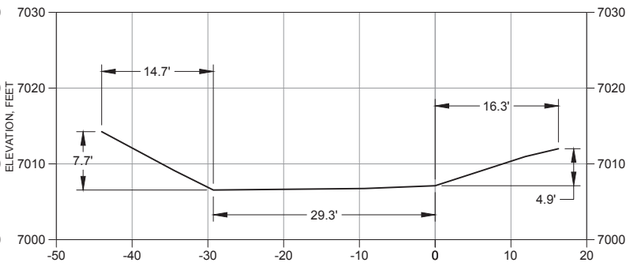

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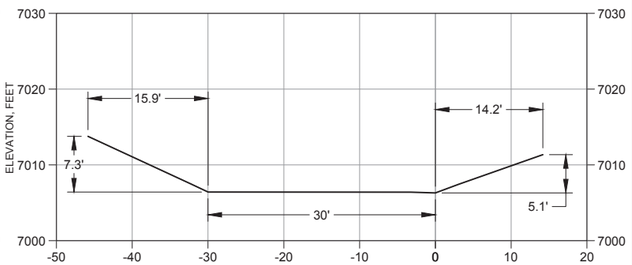

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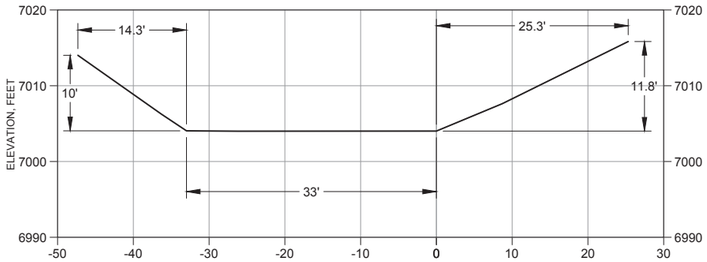
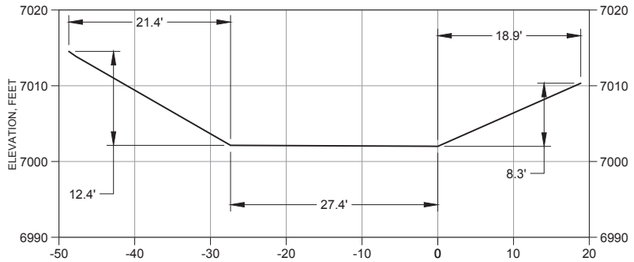


38 / 3-8 DIVERSION CHANNEL NDC-5



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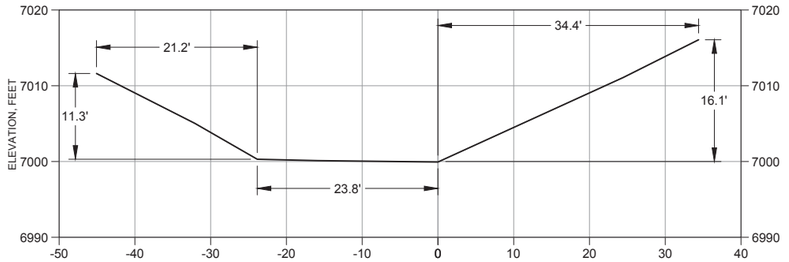

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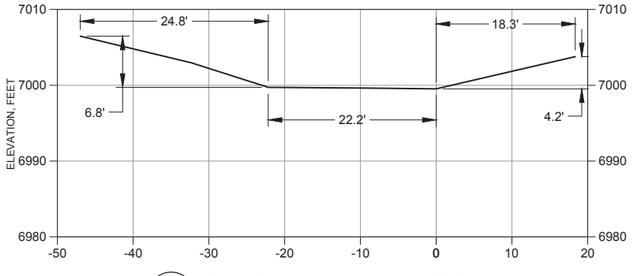

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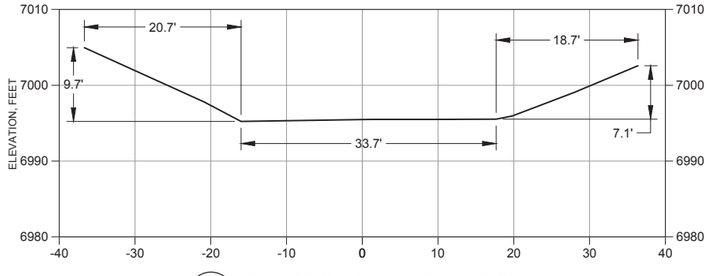

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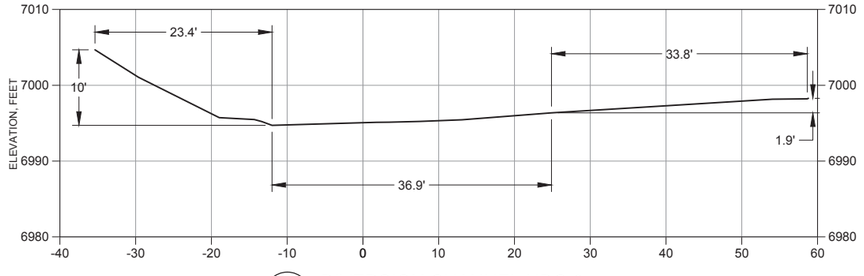
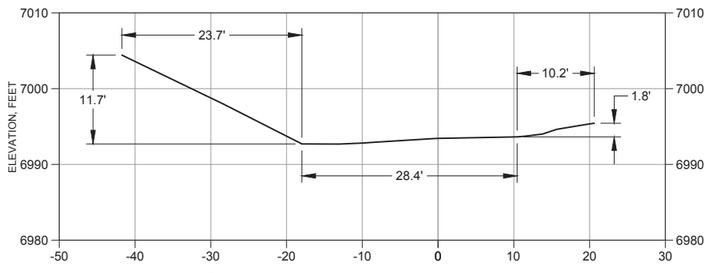
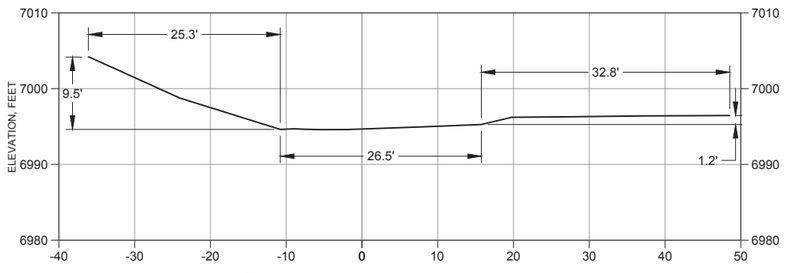


43 / 3-8 DIVERSION CHANNEL NDC-8



44 / 3-8 DIVERSION CHANNEL NDC-8



45 / 3-8 DIVERSION CHANNEL NDC-8

0 10' 20'

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		TECH	ENG	DATE

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PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	K TULLAR	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: NORTH UPSTREAM DIVERSION CHANNEL CROSS SECTIONS
FIGURE: 3-12
REVISION: 0
FILE NAME: 10504918 PDS12

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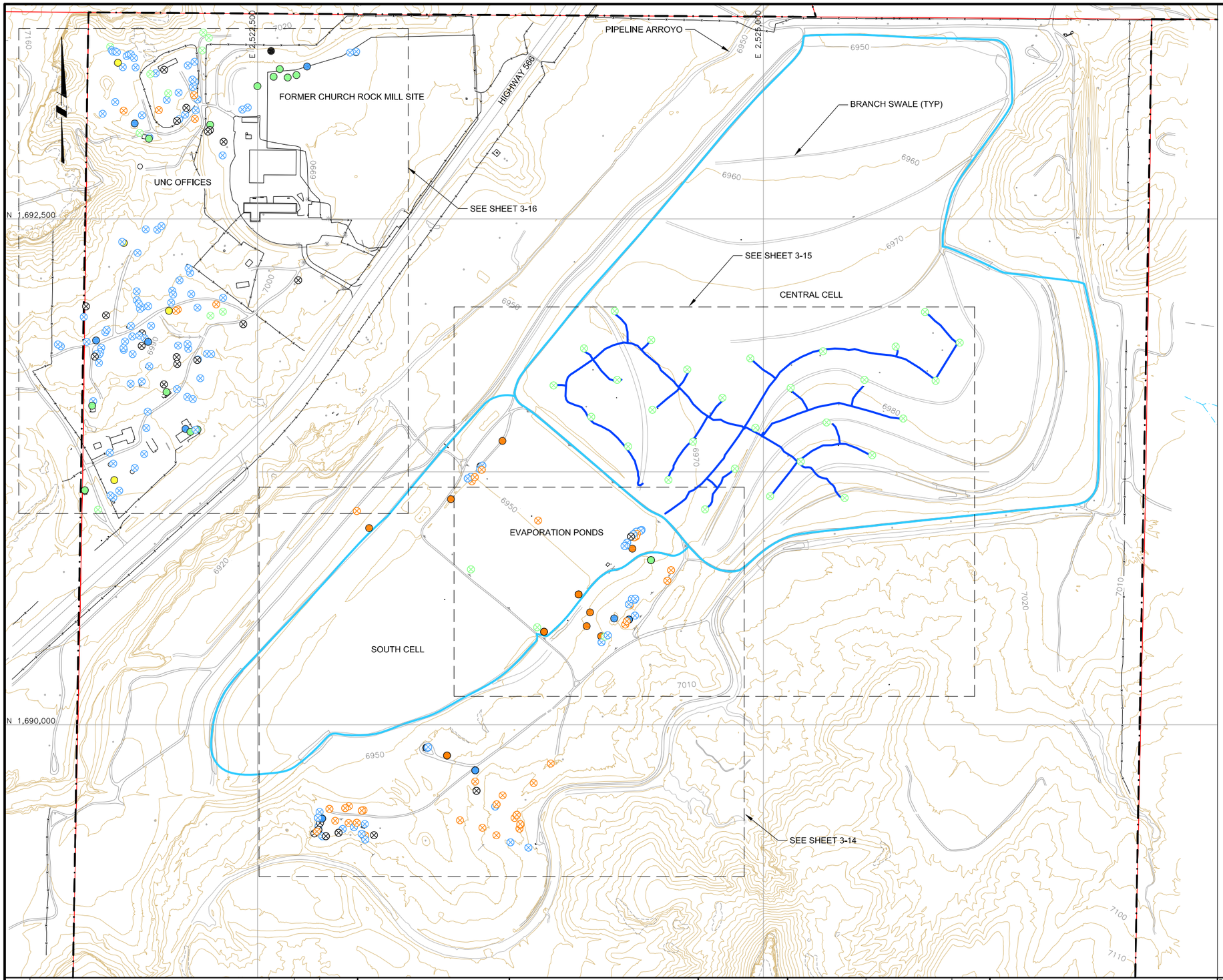

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- ROAD
- DRAINAGE
- FENCE
- TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)
- SECTION BOUNDARY
- MILL SITE PROPERTY BOUNDARY
- PHYSICAL STRUCTURE

EXISTING DEBRIS TYPE:

NON–FIXED	FIXED	
⊗	●	METAL
⊗	●	CONCRETE
⊗	●	PLASTIC
●	●	WOOD
⊗	●	OTHER
		DRISCO PIPE

NOTES:

1. FIXED DEBRIS IS PARTIALLY BURIED.
2. DESCRIPTION OF DEBRIS BY IDENTIFICATION NUMBER IS PROVIDED IN APPENDIX B.

0 250′ 500′
CONTOUR INTERVAL = 10′

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10–14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07–14
DRAWN BY	C FOWLER	07–14
CHECKED BY	E DORNFEST	07–14
APPROVED BY	T LEESON	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: MILL SITE DEBRIS OVERVIEW
FIGURE: 3-13
REVISION: 0
FILE NAME: 10504918 PDS16

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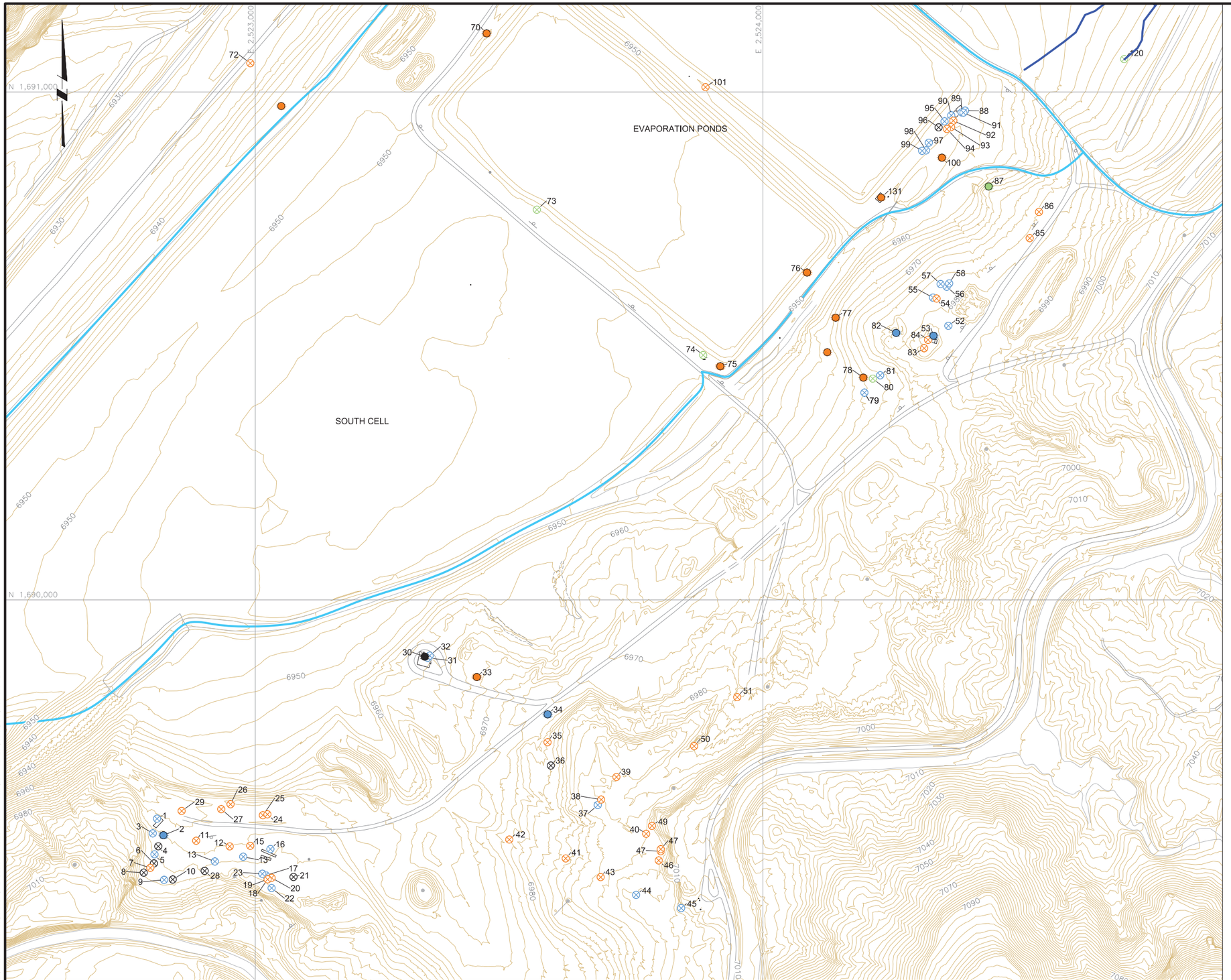

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- ROAD
- TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)

EXISTING DEBRIS TYPE:

NON–FIXED	FIXED	
⊗	●	METAL
⊗	●	CONCRETE
⊗	●	PLASTIC
●	●	WOOD
⊗	●	OTHER
		DRISCO PIPE

NOTES:

1. FIXED DEBRIS IS PARTIALLY BURIED.
2. DESCRIPTION OF DEBRIS BY IDENTIFICATION NUMBER IS PROVIDED IN APPENDIX B.

0 100' 200'
CONTOUR INTERVAL = 2'

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10–14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07–14
DRAWN BY	C FOWLER	07–14
CHECKED BY	E DORNFEST	07–14
APPROVED BY	T LEESON	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: MILL SITE DEBRIS INVENTORY (1 OF 3)
FIGURE: 3-14
REVISION: 0
FILE NAME: 10504918 PDS17

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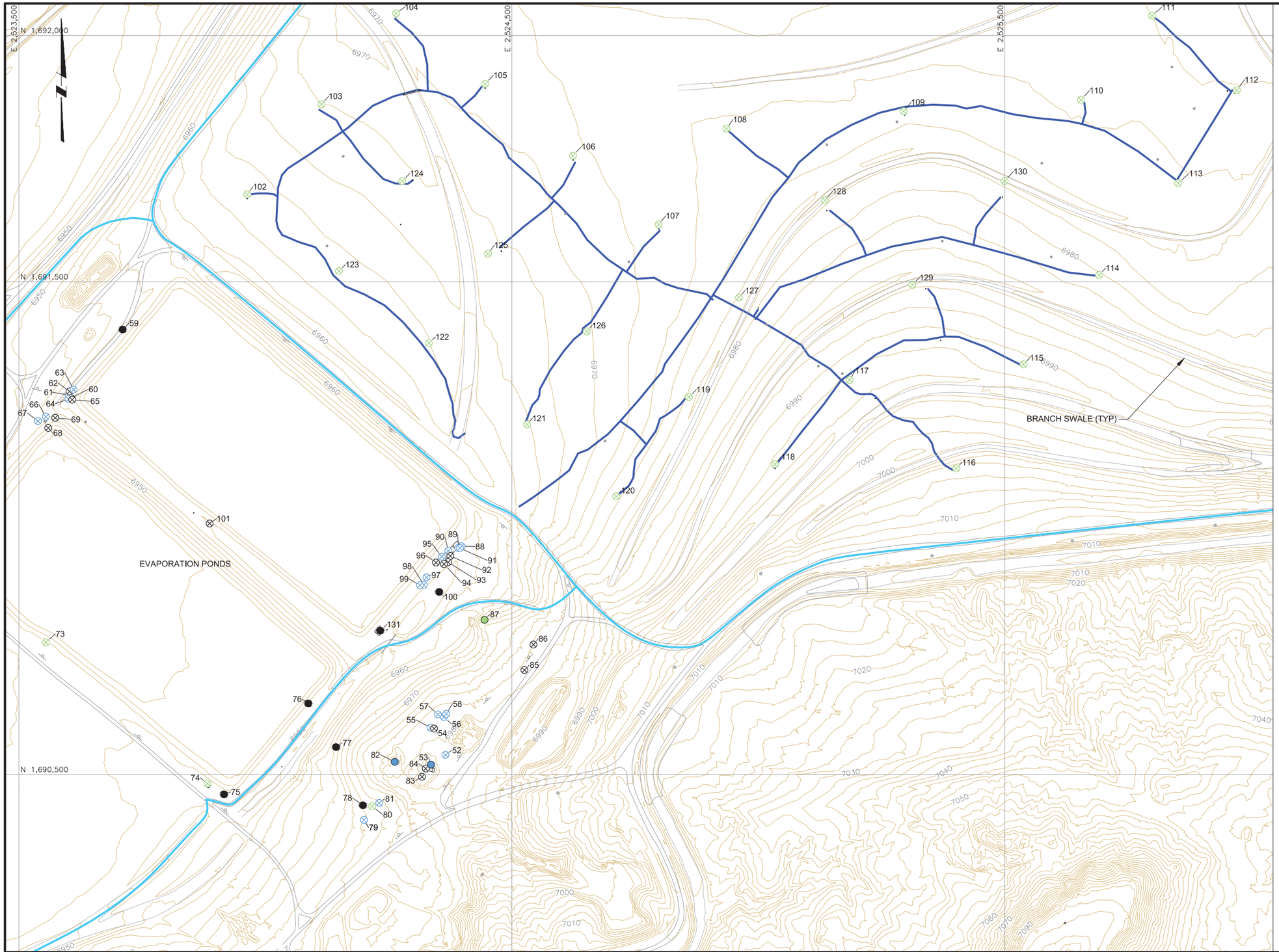

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- ROAD
- TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)

EXISTING DEBRIS TYPE:

NON-FIXED	FIXED	
⊗	●	METAL
⊗	●	CONCRETE
⊗	●	PLASTIC
●	●	WOOD
⊗	●	OTHER
—	—	DRISCO PIPE

NOTES:

1. FIXED DEBRIS IS PARTIALLY BURIED.
2. DESCRIPTION OF DEBRIS BY IDENTIFICATION NUMBER IS PROVIDED IN APPENDIX B.

0 100' 200'
CONTOUR INTERVAL = 2'

ISSUE / REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07-14
DRAWN BY	C FOWLER	07-14
CHECKED BY	E DORNFEST	07-14
APPROVED BY	T LEESON	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: MILL SITE DEBRIS INVENTORY (2 OF 3)
FIGURE: 3-15
REVISION: 0
FILE NAME: 10504918 PDS18

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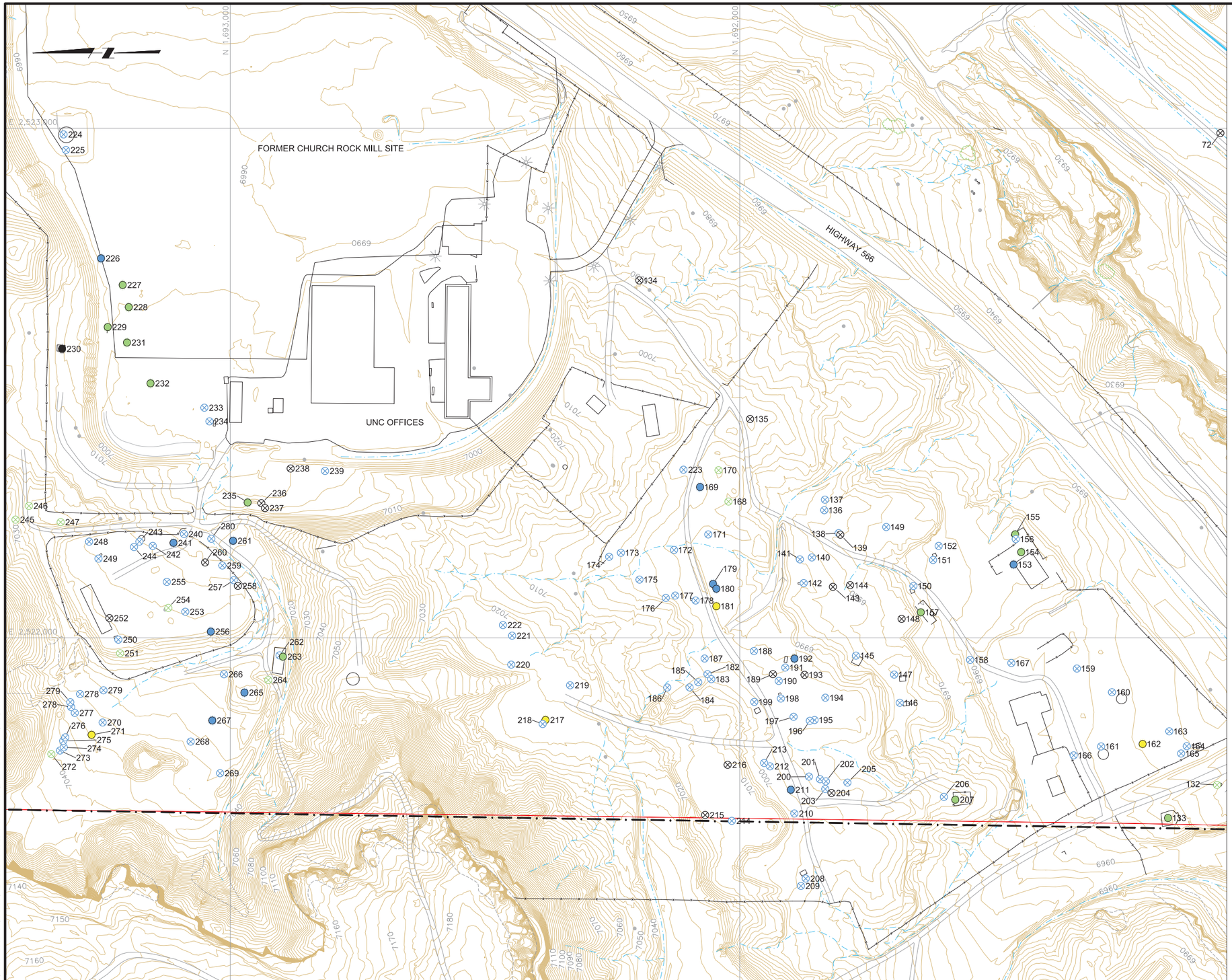

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- ROADS
- DRAINAGE
- FENCE
- TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)
- SECTION BOUNDARY
- MILL SITE PROPERTY BOUNDARY
- PHYSICAL STRUCTURE

EXISTING DEBRIS TYPE:

NON–FIXED	FIXED	
⊗	●	METAL
⊗	●	CONCRETE
⊗	●	PLASTIC
●	●	WOOD
⊗	●	OTHER
		DRISCO PIPE

NOTES:

1. FIXED DEBRIS IS PARTIALLY BURIED.
2. DESCRIPTION OF DEBRIS BY IDENTIFICATION NUMBER IS PROVIDED IN APPENDIX B.

0 100' 200'
CONTOUR INTERVAL = 2'

ISSUE REV	DESCRIPTION	CF TECH	ED ENG	10–14 DATE
0	FINAL	CF	ED	10–14

DRAWING REFERENCE(S):
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PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07–14
DRAWN BY	C FOWLER	07–14
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APPROVED BY	T LEESON	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: MILL SITE DEBRIS INVENTORY (3 OF 3)
FIGURE: 3-16
REVISION: 0
FILE NAME: 10504918 PDS19

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4.0 SUMMARY AND CONCLUSIONS

The PDS were conducted at the Mill Site in preparation for design of the repository, as a part of the NECR Mine Site RA. The goal of the PDS was to collect pre-design data and information necessary to design the RA in accordance with the proposed performance standards and United States Environmental Protection Agency's Region 9 (USEPA) *Action Memorandum: Request for Non-Time Critical Removal Action at the Northeast Church Rock Mine Site* (Action Memo) (USEPA, 2011a) and the USEPA Region 6's *Proposed Plan* (USEPA, 2012) and the *Record of Decision* (ROD) for the United Nuclear Corporation (Church Rock Mill Site) Surface Soil Operable Unit NPL Site (USEPA, 2013). The tasks that were conducted during the PDS consisted of the following:

- Topographic survey of the impoundment cells and surrounding areas
- Geotechnical evaluation of tailings impoundment and underlying units
- Borrow material investigation
- Volume and characteristics of on-site erosion protection materials
- Revegetation study
- Biointrusion evaluation
- Cultural resources survey
- Visual inspection and survey of branch swales and North Upstream Diversion Channel
- Debris inventory

Results of the individual investigations are described in Section 3.0 and the data are provided in Appendices. The significant results from the PDS at the Mill Site are summarized below, along with findings that potentially impact RA design.

The tailings encountered in the tailings impoundment are laterally and vertically heterogeneous, and contain varying amounts of fine-grained tailings. This variability is consistent with the operation of the mill and location of slurried tailings discharge and ponded water within the impoundment. As a result of this heterogeneity, the tailings water content varies throughout the impoundment and within individual tailings profiles. Based on the CPT work, observation of collected samples, and laboratory testing, the tailings profiles encountered in the PDS investigation are unsaturated.

While there is variability in the tailings particle-size distribution and water content, the tailings impoundment is a suitable repository site, with appropriate design considerations for tailings settlement. Potential performance issues related to tailings settlement will be accommodated during design with the total amount and rate of loading from mine spoils placement.

Results of the borrow investigations and preliminary grading layouts indicate that up to 400,000 cy of soil are available in the borrow areas, excluding the Dilco Hill Borrow Area which is mostly sedimentary rock. The preliminary grading and excavation plans exclude areas within 100 feet (buffer zone) of the identified cultural sites. Approximately 20,000 cy is available in the topsoil

stockpile. The soil in the borrow areas has an average fines content of 53 percent, indicating it is suitable for construction of an evapotranspirative (ET) cover. Based on preliminary designs and assuming a repository capacity of 900,000 cy with a three foot thick ET cover, up to 323,000 cy of cover and clean fill soil could be required for repository construction. This soil volume does not include fill required for regrading at the NECR Mine Site. If more than 420,000 cy of borrow is required for RA construction at both the Mine and Mill Sites, rock material could be excavated from the Dilco Hill and crushed in limited quantities.

The existing soil-gravel admixture in the cover on the impoundment can be stripped and reused during RA construction. Volume estimates indicate there is up to 80,000 cy of this material available, depending on the final repository design. Grading plans will dictate whether additional larger rock are needed to supplement the rock sizes presently in the admixture layer.

The existing erosion protection rock present at the Mill Site (in stockpiles) could be used as supplemental material for RA construction. The durability scoring of the existing stockpiled materials indicates some oversizing may be required for this material, depending on its intended future use. Riprap for channels would likely need to be imported, due to the limited volumes of material stockpiled on site.

The existing clay layer (radon barrier) beneath the cover admixture layer was tested for geotechnical properties, including remolded saturated hydraulic conductivity. The clay layer is suitable for a physical barrier between the mine spoils and underlying tailings. Testing of remolded samples of the clay layer material indicate that saturated conductivities on the order of 10^{-7} cm/sec would be achieved if the material was reworked and compacted at near optimum water content to between 95 and 100% of standard Proctor density.

The existing drainage swales and the north diversion can be incorporated into the RA design. Some localized areas may require maintenance or improvements during construction to remove vegetation or siltation. The sizes of the existing swales and diversion channel may require adjustments to accommodate design flows. This evaluation will be completed during RA design.

Animal biointrusion studies results indicate the presence of pocket gophers, prairie dogs, and badgers in the vicinity of the Mill Site. The vegetation and biointrusion studies also identified a calcium carbonate accumulation zone in the vegetation analog areas that could potentially restrict plant root and water infiltration depth. Further characterization of the borrow area soils is necessary to investigate the concentration of calcium carbonate throughout the depth of the excavations proposed in the borrow areas, in order to design the evapotranspirative cover and specify organic amendments necessary for vegetation establishment.

Results of the vegetation and wildlife surveys at the borrow areas indicate the following:

1. No rare, threatened or endangered species occur within any of the potential borrow sites.

2. If soils from the East Borrow Area are used to construct the repository cover, the noxious weeds in the area should be managed via chemical control prior to construction, in order to minimize the spread of noxious weeds as a result of construction.

3. The baseline and analog sites are comparable; therefore the analogs can be used as a reference for post-construction revegetation success criteria.

The data collected and summarized in this report as a portion of the PDS meet the objectives of the Work Plan and are sufficient for use in the RA design. The only identified data gap is potential further agronomic characterization of borrow area soils, which would be implemented during the design phase.

5.0 REFERENCES

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APPENDIX A

PREVIOUS WORK

APPENDIX A1

SUMMARY OF RELEVANT GEOTECHNICAL DATA

MWH

MWH

BUILDING A BETTER WORLD

TECHNICAL MEMORANDUM

TO: *Mr. Lance Hauer, GE*

DATE: *August 12, 2013*
(Revised September 26, 2013)

FROM: *Jason Cumbers, PE, MWH*

REFERENCE: *1012376*

CC: *Toby Leeson, MWH*

SUBJECT: *Church Rock Mill Site Repository - Summary of Relevant Geotechnical Data*

Background

NRC and DOE comments on the MWH Draft Data Gaps Report (MWH, 2012) recommended a site geotechnical investigation of the foundation materials for the new repository. MWH evaluated existing geotechnical, geological and hydraulic data for the tailings and underlying materials in the vicinity of the proposed repository. Specifically, this information was evaluated relevant to the placement of mine spoils on top of the reclaimed tailings impoundment, in order to develop a focused geotechnical investigation program to obtain information to supplement existing information on the tailings, the underlying alluvium, and the Zone 3 Sandstone.

This memorandum provides a summary of existing data from the materials described above. This summary of data is focused on the area around the conceptual repository layouts and the specific data for the tailings, in the North and Central Cells. Pertinent geotechnical, geological and hydraulic information is summarized herein, and references, where specific test results and borehole information can be found, are presented. Figure 1 shows the locations of pertinent historic borings, wells, and geologic cross sections in the vicinity of the North and Central Cells. Figure 2 shows the locations of the currently existing wells at the site, as well as the locations of aquifer tests performed within the sandstone and alluvium, and permeability tests conducted at soil boring locations. Information on the borehole permeability tests is included in this summary and the existing information from the aquifer tests is further discussed in the documents included in Appendix B.

Table 1 provides a description of the existing relevant geotechnical data by study date and material type. This data summary includes available geotechnical data pertinent to loading of the tailings with mine spoils, and generally does not include data collected in the South Cell. Information in Table 1 is compiled from reports listed in the References section of this memorandum. Table 1 is not a comprehensive summary of all available geotechnical data from the North and Central Cells.

Tailings

Geotechnical data on the tailings in the North and Central Cells are available from several sources. Additional tailings data also exist for the tailings in the South Cell. During the

preliminary geotechnical investigation for the impoundment in 1974 (SHB, 1974), a bulk sample of the cycloned tailings sands was tested for gradation, permeability, and shear strength. The 1978 geotechnical investigation (SHB, 1978a) included drilling borings through the impoundment and through the tailings within the impoundment. Tailings samples were tested for Atterberg Limits, gradations, shear strength, and relative density. In 1979, UNC conducted a stability and integrity assessment of the dam (SHB, 1979). This assessment included a series of seven borings on the interior dikes (Northern Cross Dike and Southern Cross Dike) which separate the three cells. These borings were drilled through the existing tailings and provide thickness information and standard penetration test (SPT) data on the tailings. This investigation also includes data collected in the south cell.

A series of borings (658, 659, 660, and 662) were drilled through the tailings impoundment in 1985. Borings 658, 659, and 660 were located, west to east, across the Central Cell with 660 located within Borrow Pit No. 1. Boring 662 was drilled in the South Cell. These boring logs are included as attachments to a UNC memo (UNC, 1986) and provide tailings thickness information, as well as depths and thickness of fine-grained material within the profile. Testing on the samples collected from these boreholes include specific gravity, water content, dry density, and consolidation. This data was partially summarized in the impoundment Reclamation Plan (Canonie, 1991).

In 1992, a series of shallow borings were drilled in the tailings of the Central Cell, to aid in evaluation of the radon modeling (UNC, 1993). Geotechnical samples collected from shallow depths (less than 8 feet deep) were tested for specific gravity, water content, dry density, and gradation. No boring logs for this program were available for review. Interim stabilization of the Central Cell was completed in 1991, and tailings samples were collected in November 1992. Ground surface elevations are not provided; however, the borings appear to have been drilled from the interim cover surface. This tailings data was included in Appendix B of the Central Cell Final Reclamation As-Built Report (Canonie, 1995).

Based on the data for the North and Central Cells, the average specific gravity of the tailings samples is 2.71 and in general the samples are non-plastic. Fine-grained tailings samples have about twice the percentages (average by weight) passing the No. 100 (46 percent) and No. 200 (31 percent) sieves, and 6 percent finer than 0.001 mm, as compared with the coarse-grained samples. With the exception of one sample, both the coarse and fine fractions of the tailings samples were finer than the No. 10 sieve.

The water contents of the samples tested range from 4 to 60 percent with dry densities ranging from 73 to 118 pounds per cubic foot (pcf). Average water content of the coarser samples tested is 15 percent with an average dry density of 101 pcf. The average water content of the finer samples tested is 21 percent with an average dry density of 96 pcf. The reported coefficient of consolidation (C_c) results range from 0.018 to 1.00 for the tailings samples and the friction angles (from direct shear testing) range from 30° to 39°, with some results showing cohesion.

Embankment (North and Central Cells)
A series of borings (78a-15, 17, 18, 19, 20, 21) were drilled through the tailings embankment (SHB, 1978a), presumably to provide information on the materials and construction of the embankment. Borings 15, 17 and 18 were drilled adjacent to the Central Cell. Borings 19, 20, and 21 were drilled through the embankment on the north side of the North Cell. Data from

these borings include SPT, torvane shear strength, Atterberg limits, gradations, water contents, dry density, triaxial and direct shear, and laboratory permeability.

The 33 samples from the embankment adjacent to the North and Central Cells are generally classified as low plasticity clay (CL). Atterberg limits for the embankment soils indicate the liquid limits range from 23 to 42 percent and the plasticity indices range from 8 to 22 percent. The average of the plastic Atterberg limits results is a liquid limit of 31 percent and a plasticity index of 13 percent. The percentage passing the No. 200 sieve (fines) ranges from 50 to 77 percent (by weight) and the percentage passing the No. 4 sieve (sand) ranges from 98 to 100 percent. The average of the embankment soils tested indicate 66 percent fines by weight and 100 percent sand size particles, or smaller, by weight. The water content for the embankment samples ranges from 5 to 24 percent with dry densities ranging from 107 to 126 pcf. The average water content is 13 percent and the average dry density is 114 pcf. Direct shear test results on the embankment materials include phi angles of 7°, 49°, and 38° with cohesions of 1.45 kips per square foot (ksf), 1.69 ksf and 0.31 ksf, respectively.

Alluvium
Many of the site drilling programs previously performed in the area of the North and Central Cells include information from both drilling and laboratory testing on the alluvium underlying the tailings, the embankment and the existing cover at the site. Extensive data was collected on the alluvium including field and laboratory permeabilities, Atterberg Limits, gradations, water contents, consolidation tests, Proctor compaction tests, and shear strength. The SHB investigations (SHB, 1974, 1976, 1978a, 1978b, 1979) include laboratory tests on more than 200 alluvium samples taken from the vicinity of the North and Central Cells. While portions of the alluvium were excavated for construction at the site, several of the borings appear to extend below the current depths of tailings in the area of interest and provide geotechnical data on materials still in-place below the impoundment. Borings with geotechnical data below the estimated tailings depths include SHB-74-04, SHB-76-08, 11, SHB-78a-76, 77, and SHB-78b-07.

The alluvium samples from the North and Central Cells are generally classified as low plasticity clay (CL), but also include plastic and non-plastic silts, as well as silty and clayey sands. Atterberg limits for the plastic alluvial soils indicate the liquid limits of the alluvium range from 20 to 67 percent. The plasticity indices range from 4 to 45 percent. The average of the plastic Atterberg limits results is a liquid limit of 36 percent and a plasticity index of 18 percent, which corresponds to a low plasticity clay. The percentage passing the No. 200 sieve (fines) ranges from 0 to 94 percent (by weight) and the percentage passing the No. 4 sieve (sand) ranges from 1 to 100 percent. The average of the alluvium results indicate 41 percent fines by weight and 80 percent sand size particles, or smaller, by weight. The water content for the alluvium samples ranges from 2 to 31 percent with dry densities ranging from 94 to 106 pcf.

Zone 3 Sandstone
More than 50 geotechnical borings were identified that extend into the Zone 3 Sandstone in the vicinity of the proposed repository (SHB, 1974, 1976, 1978a, 1978b, 1979 and CSI, 1980). The bulk of the sandstone data include SPT data, water contents, and the contact elevations. Geotechnical laboratory data includes gradations, water content and Atterberg limits. Field permeability tests were also performed in the sandstone. Laboratory data on samples from the Zone 3 Sandstone is limited; however, water content results range from 5 to 19 percent, and two Atterberg limits tests indicate the sandstone is non-plastic. Two gradation results indicate 27

percent and 25 percent (by weight) passing the no. 200 sieve and 68 percent and 54 percent passing the No. 4 sieve.

Proposed Borrow Areas
MWH identified nineteen borings previously drilled in/or near the proposed East and West Borrow Areas. These include ten borings (SHB78b-18,19,20,28,30,31,32,33,34 and DH-1,3) in the East Borrow (SHB, 1978b and CSI, 1980) and eight borings (SHB78a-52,53,54,55,56 and DH-6,7,8) in or near the West Borrow (SHB, 1978a and CSI, 1980). After reviewing surface elevations to account for previous borrow operations in these areas, the existing data on the remaining subsurface profile includes depth to rock, SPT, gradations, Atterberg limits, and water contents. Depth of alluvium above the sandstone or siltstone appears to vary between about 0 and 25 feet in the proposed West Borrow and between about 0 and 14 feet in the proposed East Borrow Area. The alluvium in the borrow areas is generally classified as silty clay, sandy clay, silty sand, clayey sand, or clayey silt.

Laboratory data on samples from the lower alluvium includes, water content results ranging from 4 to 9 percent, dry densities ranging from 82 to 103 pcf, and two Atterberg limits tests indicate CL or CL-ML classification (liquid limits of 29 and 25 percent, plasticity indices of 14 and 6 percent). Gradation results indicate between 37 percent and 61 percent (by weight) passing the no. 200 sieve. Strength and consolidation testing was conducted on alluvium samples from DH-1 and DH-3 (CSI, 1980), located in the proposed East Borrow. Visual classification of the alluvium and SPT data are included on the referenced boring logs.

Conclusions
Based on the available data, and the geologic mapping of impoundment Area (Appendix B), the sampling plan has been developed to collect additional stratigraphy data on the thickness of the tailings in areas, where data is limited, specifically Borrow Pit No. 1 and the center of the Central Cell. The laboratory data previously collected provides index properties for the tailings, the embankment, and the underlying alluvium. The objectives of the proposed investigation will be to confirm these index properties and collect additional data on the consolidation and strength properties of the tailings, the strength properties of the alluvium and the embankment, and hydraulic properties (conductivity and soil water characteristic curves (SWCC)) on the tailings, the alluvium, and the Zone 3 sandstone.

Attachments:
Figure 1 – Location of Historic Borings, Wells, and Geologic Cross Sections
Figure 2 – Location of Existing Wells, and Hydraulic Field Test Data
Table 1 – Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

References:

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Sergent, Hauskins & Beckwith (SHB). 1978b. *Engineering Analysis Report – Embankment Volumes-Borrow Quantities, Tailings Disposal Systems Analysis, UNC Church Rock Mill Site*. Church Rock, New Mexico. October.

Sergent, Hauskins & Beckwith (SHB). 1979. *Geotechnical Investigation Report, Stability and Integrity Assessment, Church Rock Uranium Mill, United Nuclear Corporation.* Church Rock, New Mexico. Volume 1. July.

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FORMER MILL SITE

UNC OFFICES

NORTH CELL

CENTRAL CELL

SOUTH CELL

PIPELINE ARROYO

HIGHWAY 566

BRANCH SWALE (TYP)

REPOSITORY FOOTPRINT ALTERNATIVE NO. 1

REPOSITORY FOOTPRINT ALTERNATIVE NO. 2

REPOSITORY FOOTPRINT ALTERNATIVE NO. 3

APPROX TOE OF EXISTING EMBANKMENT

RUNOFF CONTROL DITCH

BORROW PIT NO. 1

BORROW PIT NO. 2

BURIED DEBRIS AREAS (TYP)

NORTH DIVERSION DITCH

GEOLOGIC CROSS-SECTION LINE EE

LEGEND:

- 6980 EXISTING GROUND SURFACE CONTOUR ELEVATION, FT
- EXISTING DRAINAGE
- EXISTING ROADS
- PLSS SECTION LINE
- CROSS SECTION (D'APPOLONIA, 1981)
- CROSS SECTION (CANONIE, 1987)
- ZONE 3 MONITORING WELL
- ZONE 1 MONITORING WELL
- ALLUVIUM MONITORING WELL
- GEOTECHNICAL BORING
- GEOTECHNICAL BORING WITH TAILINGS INFORMATION

0 200' 400'

PROJECT LOCATION: McKINLEY COUNTY, NEW MEXICO

PROJECT: CHURCH ROCK MILL SITE PDS WORK PLAN

TITLE: LOCATION OF HISTORIC BORINGS, WELLS, AND GEOLOGIC CROSS SECTIONS

MWH

FIGURE 1 | REVISION A

FILE NAME 1012376 GEO ALL | DATE AUG 2013

L:\Design-Drafting\Clients-Q-Z\UNC\1012376 CHURCH ROCK\013-Sheet Set\2013-06-07 GEO SAMP PLAN\1012376 GEO ALL

PIPELINE ARROYO

FORMER MILL SITE

UNC OFFICES

HIGHWAY 566

REPOSITORY FOOTPRINT ALTERNATIVE NO. 2

REPOSITORY FOOTPRINT ALTERNATIVE NO. 1

REPOSITORY FOOTPRINT ALTERNATIVE NO. 3

APPROX TOE OF EXISTING EMBANKMENT

RUNOFF CONTROL DITCH

BRANCH SWALE (TYP)

NORTH CELL

CENTRAL CELL

SOUTH CELL

BORROW PIT NO. 1

BORROW PIT NO. 2

BURIED DEBRIS AREAS (TYP)

NORTH DIVERSION DITCH

EPA 21 EPA 22A EPA 23 EPA 02 EPA 03 EPA 04 EPA 05 EPA 07 EPA 08 EPA 09 EPA 13 EPA 18

SHB76-04 SHB76-05 SHB76-06 SHB76-07 SHB76-10 SHB76-11 SHB76-12 SHB76-13 SHB76-14 SHB76-15 SHB76-17 SHB74-04 SHB74-12 SHB76-03 SHB76-04

DH-3

Z3 M-01 Z3 M-02

0105 A 0106 D 0107 D 0109 A 0110 D 0120 0121 0123 0125 0126 0127 0448 0501 A 0501 B 0502 A 0502 B 0503 0504 0505 A 0505 B 0506 A 0507 0508 0509 D 0510 0511 0512 0513 0514 0515 A 0516 A 0517 0518 0519 0600 0601 0602 0603 0604 0605 0606 0607 0608 0609 0610 0611 0612 0613 0616 0617 0618 0619 0701 0702 0703 0705 0706 0708 0711 0714 0807 0803 0806 0805 0808 0009 D 0010 D 0011 D 0012 D 0322 0323 0324 615 614

LEGEND:

- 6980 — EXISTING GROUND SURFACE CONTOUR ELEVATION, FT
- EXISTING DRAINAGE
- EXISTING ROADS
- PLSS SECTION LINE
- EXISTING MONITORING WELL
- ZONE 3 AQUIFER TEST LOCATION
- ZONE 1 AQUIFER TEST LOCATION
- ALLUVIUM AQUIFER TEST LOCATION
- SOIL BORING ZONE 3 PERMEABILITY TEST LOCATION
- SOIL BORING ALLUVIUM PERMEABILITY TEST LOCATION

0 200' 400'

PROJECT LOCATION: McKINLEY COUNTY, NEW MEXICO

PROJECT: CHURCH ROCK MILL SITE PDS WORK PLAN

TITLE: LOCATION OF EXISTING WELLS, AND HYDRAULIC FIELD TEST DATA

FIGURE 2

REVISION: A

FILE NAME: 1012376 GEO INFO

DATE: AUG 2013

MWH

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Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
Hemphill 1969	6	6950	7.5-9	alluvium	Silt	SC					37	15		47				13								Central
	6	6950	40.5-41	sandstone	-	-																	UC = 296 ksf			Central
SHB 1974	SHB74-03	6954	5	alluvium	Sandy Clay	CH	18				62	45		70	87	99	100	6								Central
	SHB74-03	6954	10	alluvium	Sandy Clay	CL	46				44	27		77	93	99	100	10								Central
	SHB74-03	6954	15	alluvium	Sandy Silt	CL-ML	20				21	4		70	93			8								Central
	SHB74-03	6954	20	alluvium	Sandy Silt	CL-ML	16											4								Central
	SHB74-03	6954	25	alluvium	Sandy Silt	CL-ML	23											3								Central
	SHB74-04	6949	5	alluvium	Sandy Silt	ML	8				-	NP		55	82	99	99	5								Central
	SHB74-04	6949	10	alluvium	Clay	CL	56		4		46	29		98	99			12	104	X						Central
	SHB74-04	6949	15	alluvium	Clay	CL	45				23	4		53	82	97	100	14	104	X				42.5		Central
	SHB74-04	6949	20	alluvium	Clayey Sand	SC	11				29	11		39	79	99	100	5								Central
	SHB74-04	6949	25	alluvium	Clayey Sand	SC	15											5								Central
	SHB74-04	6949	30	alluvium	Clayey Sand	SC	15											4								Central
	SHB74-05	6946	5	alluvium	Silty Sand	SM	15				-	-		-				6	91	X				30.5		Central
	SHB74-05	6946	10	alluvium	Silty Sand	SM	24				-	-		-				10	105	X						Central
	SHB74-05	6946	15	alluvium	Sandy Silt	ML	34				23	4		53				8								Central
	SHB74-05	6946	20	sandstone	-	-	40											5								Central
	SHB74-05	6946	25	sandstone	-	-	24											10								Central
	SHB74-05	6946	30	sandstone	-	-	28											13								Central
	SHB74-06	6946	14	sandstone	-	-	-																			Central
	SHB74-39	6946	8.25	sandstone	End of Boring	SC	50/1																			North
		-	-	tailings	Cycloned Sands	-								4	9									38.5	2375	-
SHB 1976	SHB76-05		0	alluvium	Sandy Silt	ML	2											8								Central
	SHB76-05		5	alluvium	Sandy Silt	ML	3											20								Central
	SHB76-05		10	alluvium	Sandy Clay	CL	9				36	15		98	99			29								Central
	SHB76-05		9-18.5	alluvium	Clay	CH	13		0.0									22								Central
	SHB76-05		19-25	alluvium	Silty Sand	SM	9		1.7		-	NP		44	87			13								Central
	SHB76-05		25	alluvium	Silty Sand	SM	9											16								Central
	SHB76-05		30	alluvium	Silty Sand	SM	12											8								Central
	SHB76-06		0	alluvium	Silty Sand	SM	6											8								Central
	SHB76-06		5	alluvium	Sandy Clay	CL	12				32	13		81	96	100		9								Central
	SHB76-06		10	alluvium	Sandy Clay	CL	45											8								Central
	SHB76-06		9-16.5	alluvium	Sandy Silt	ML	33		5.5		39	9		87	98			11								Central
	SHB76-06		20	alluvium	Sandy SIlt	CL-ML	11											6								Central
	SHB76-06		25	alluvium	Sandy SIlt	CL-ML	6											8								Central
	SHB76-06		19-24.5	alluvium	Sandy SIlt	CL-ML	7		5.1									6								Central
	SHB76-06		35	alluvium	Sandy SIlt	CL-ML	10											8								Central
	SHB76-06		40	alluvium	Sandy SIlt	CL-ML	8											14								Central
	SHB76-06		45	alluvium	Sandy Silt	CL-ML	11											25								Central
	SHB76-06		50	alluvium	Sandy Silt	CL-ML	10											22								Central
	SHB76-06		55	alluvium	Sandy Silt	CL-ML	16											21								Central
	SHB76-06		60	alluvium	Sandy Silt	CL-ML	8											26								Central
	SHB76-06		70	alluvium	Sandy Silt	CL-ML	9											25								Central
	SHB76-07		0	alluvium	Sandy Silt	ML	2											18								North
	SHB76-07		5	alluvium	Sandy Clay	CL	4				31	12		79	95	100		25								North
	SHB76-07		10-20	alluvium	Sandy Silt	CL-ML	5		1.1		21	4		52	77			14			124.2@11				0.179	North
	SHB76-07		15	alluvium	Sandy Silt	ML	7				-	NP		57	88	100		15								North
	SHB76-07		18.5-27.5	alluvium	Sandy Silt	ML	3		1.0									26								North
	SHB76-07		25	alluvium	Sandy Silt	ML	6											20								North
	SHB76-07		30	sandstone	-	-	50/1																			North
	SHB76-07		35	sandstone	-	-	50																			North
	SHB76-08		0	alluvium	Silty Sand	SM	3											9								North

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB76-08		5	alluvium	Silty Sand	SM	2											22								North
	SHB76-08		10	alluvium	Silty Sand	SM	2											23								North
	SHB76-08		15	alluvium	Clay	CL	11											26								North
	SHB76-08		20	alluvium	Clay	CL	13				46	25		97	99			22								North
	SHB76-08		25	sandstone	-	-	23											17								North
	SHB76-08		30	shale	-	-	50/5											17								North
	SHB76-08		35	sandstone	-	-	50/0																			North
	SHB76-09		0	alluvium	Silty Sand	SM	2											12								North
	SHB76-09		5	alluvium	Silty Clay	CL	7											29								North
	SHB76-09		10	alluvium	Sandy Silt	ML	5											22								North
	SHB76-09		15-25	alluvium	Clay	CL	13				38	21		78	94	100		25								North
	SHB76-09		20	alluvium	Clay	CL	21				46	25		94	98	100		21								North
	SHB76-09		25	alluvium	Clay	CL	22											22								North
	SHB76-09		30	alluvium	Sandy Clay	CL	10											31								North
	SHB76-09		35	alluvium	Clay	CH	14											26								North
	SHB76-09		40	alluvium	Sandy Silt	ML	1																			North
	SHB76-09		45	alluvium	Clay	CH	11											30								North
	SHB76-09		50	alluvium	Clay	CH	5											31								North
	SHB76-09		55	alluvium	Silty Sand	SM	36											23								North
	SHB76-09		60	alluvium	Silty Sand	SM	13											24								North
	SHB76-09		65	alluvium	Silty Sand	SM	10											21								North
	SHB76-09		70	alluvium	Sandy Clay	SC	13											20								North
	SHB76-09		75	alluvium	Sandy Clay	SC	45											18								North
	SHB76-10		1.5-7.5	sandstone 3	-	-	50/3		15.3									9								North
	SHB76-10		5	sandstone 3	-	-	50/5											8								North
	SHB76-11	6957	0	alluvium	Sandy Silt	ML	6											9								Central
	SHB76-11	6957	5	alluvium	Sandy Silt	ML	10											6								Central
	SHB76-11	6957	10	alluvium	Sandy Clay	CL	26				27	10		67	90	100		10								Central
	SHB76-11	6957	9-18	alluvium	Sandy Clay	CL	25		1.1		26	10		78	94	100		16								Central
	SHB76-11	6957	18.5-27.5	alluvium	Sandy Silt	ML	12		1.0									5								Central
	SHB76-11	6957	25	alluvium	Sandy Clay	CL	14											22								Central
	SHB76-11	6957	30	alluvium	Sandy Silt	ML	11											10								Central
	SHB76-11	6957	35	alluvium	Sandy Silt	ML	9					NP		55	94	100		10								Central
	SHB76-11	6957	40	alluvium	Sandy Silt	ML	9											11								Central
	SHB76-11	6957	45	alluvium	Sandy Silt	CL-ML	12											18								Central
	SHB76-11	6957	50	alluvium	Sandy Silt	CL-ML	15											9								Central
	SHB76-11	6957	55	alluvium	Sandy Silt	CL-ML	21											10								Central
	SHB76-11	6957	60	alluvium	Sandy Silt	CL-ML	10											24								Central
	SHB76-11	6957	65	alluvium	Sandy Silt	CL-ML	7											21								Central
	SHB76-11	6957	70	alluvium	Sandy Silt	CL-ML	2											22								Central
	SHB76-11	6957	75	sandstone	-	-	38											13								Central
	SHB76-12		0	alluvium	Silty Sand	SM	16											12								Central
	SHB76-12		5	alluvium	Sandy Clay		21											6								Central
	SHB76-12		9-16	alluvium	Sandy Clay		27		12.0									10								Central
	SHB76-12		15	alluvium	Sandy Clay		6											6								Central
	SHB76-12		18.5-25	alluvium	Sandy Clay		16		14.5		-	NP		61	91	100		8								Central
	SHB76-12		25	alluvium	Sandy Clay		13											6								Central
	SHB76-12		30	alluvium	Sandy SIlt	ML	21											5								Central
	SHB76-12		35	alluvium	Sandy Clay	CL	54											12								Central
	SHB76-12		40	alluvium	Sandy SIlt	CL-ML	34											8								Central
	SHB76-12		45	alluvium	Sandy Silt	CL-ML	23											4								Central
	SHB76-12		50	alluvium	Sandy Silt	CL-ML	18											5								Central

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							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB76-12		55	alluvium	Sandy Silt	CL-ML	40											7								Central
	SHB76-12		60	sandstone	-	-	50/1											9								Central
	SHB76-13		0	alluvium	Sandy Clay	CL	13											9								Central
	SHB76-13		9-17.5	alluvium	Sandy Clay	CL	31		8.0		35	17		82	97			8								Central
	SHB76-13		10	alluvium	Sandy Silt	ML	40											4								Central
	SHB76-13		15	alluvium	Sandy Clay	CL	59											9								Central
	SHB76-13		18.5-25	alluvium	Sandy Silt	CL-ML	24		1.3									10								Central
	SHB76-13		25	alluvium	Sandy Silt	CL-ML	22											4								Central
	SHB76-13		30	alluvium	Sandy Silt	CL-ML	22											8								Central
	SHB76-13		35	alluvium	Sandy Silt	CL-ML	28											6								Central
	SHB76-13		40	alluvium	Sandy Silt	CL-ML	26											8								Central
	SHB76-13		45	alluvium	Sandy Silt	CL-ML	29											8								Central
	SHB76-13		50	alluvium	Sandy Silt	CL-ML	24											5								Central
	SHB76-13		55	alluvium	Sandy Silt	CL-ML	30											7								Central
	SHB76-13		60	sandstone	-	-	50/4											16								Central
SHB 1978a	SHB-78a-15	6964	0-2	dam	Sandy Clay	-	9											11								Central
	SHB-78a-15	6964	4.5-6	dam	Sandy Clay	-	21											16								Central
	SHB-78a-15	6964	9.5-10.5	dam	Sandy Clay	CL	35	0.89			32	10		75	93	100		14	114			1 pt (15 deg.), c=1600 psf				Central
	SHB-78a-15	6964	14.5-16	dam	Sandy Clay	CL	58	0.99										13								Central
	SHB-78a-15	6964	18.5-21	dam	Sandy Clay	CL	75											13								Central
	SHB-78a-15	6964	24.5-25	dam	Sandy Clay	CL	44	0.95			42	22		75	90	99	100	16	116							Central
	SHB-78a-15	6964	28.5-31	dam	Sandy Clay	CL	25	0.60										16								Central
	SHB-78a-15	6964	34.5-36	dam	Sandy Clay	CL	12											21								Central
	SHB-78a-15	6964	39.5-40.5	dam	Sandy Clay	CL	22	0.99										18	110					7, 1.45		Central
	SHB-78a-15	6964	44.5-45.5	dam	Sandy Clay	CL	26	0.67										23								Central
	SHB-78a-17	6962	0-1	dam	Sandy Clay	CL	14	0.42										10	110							North
	SHB-78a-17	6962	4.5-6	dam	Sandy Clay	CL	27											15								North
	SHB-78a-17	6962	9.5-11	dam	Sandy Clay	CL	38	0.79										12								North
	SHB-78a-17	6962	14.5-16	dam	Sandy Clay	CL	41											11								North
	SHB-78a-17	6962	19.5-20.5	dam	Sandy Clay	CL	85	0.92			30	12		63	88	99	100	11	124				1 pt			North
	SHB-78a-17	6962	24.5-26	dam	Sandy Clay	CL	20	0.6										12								North
	SHB-78a-17	6962	29.5-31	dam	Sandy Clay	CL	12											24								North
	SHB-78a-17	6962	34.5-36	dam	Sandy Clay	CL	18	0.52										20	107							North
	SHB-78a-17	6962	39.5-41	alluvium	Silty Sand	SM	19	0.2										19								North
	SHB-78a-17	6962	44.5-46	alluvium	Clay	CL	15											24								North
	SHB-78a-18	6959	0-1.5	dam	Clay	CL-SC	10											12								North
	SHB-78a-18	6959	4.5-6	dam	Clay	CL-SC	52											12								North
	SHB-78a-18	6959	9.5-11	dam	Clay	CL-SC	30											12	115							North
	SHB-78a-18	6959	14.5-16	alluvium	Sandy Clay	CL	4											30								North
	SHB-78a-18	6959	19.5-20.5	alluvium	Silty Sand	SM	3											27								North
	SHB-78a-19	6965	0-2	dam	Sandy Clay	CL												12								North
	SHB-78a-19	6965	2-3.5	dam	Sandy Clay	CL	125	0.99			29	13		61	86	100		10	126					49, 1.69		North
	SHB-78a-19	6965	3.5-4.5	dam	Sandy Clay	CL	50	0.83										10								North
	SHB-78a-19	6965	4.5-7	dam	Sandy Clay	CL	43											12								North
	SHB-78a-19	6965	7-9.5	dam	Sandy Clay	CL												10								North
	SHB-78a-19	6965	9.5-11	dam	Sandy Clay	CL	82	0.69			23	8		50	72	97	98	10	114					38, 0.31		North
	SHB-78a-19	6965	11-13.5	dam	Sandy Clay	CL	30											8								North
	SHB-78a-19	6965	13.5-16	alluvium	Silty Sand	CL	-											18								North
	SHB-78a-19	6965	17.5-21	alluvium	Silty Sand	SM	3											21								North
	SHB-78a-19	6965	20-21.5	alluvium	Silty Sand	SM	10											27	94	X						North
	SHB-78a-19	6965	24-25.5	alluvium	Silty Sand	CL	32											28								North
	SHB-78a-19	6965	25.5-28	alluvium	Clay	CL	22											26								North

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Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB-78a-19	6965	28-29.5	alluvium	Clay	CL	28																			North
	SHB-78a-19	6965	29.5-32	alluvium	Clay	CL	20											26								North
	SHB-78a-19	6965	32-33.5	alluvium	Silty Sand	SM	13	0.16				NP		46	88	100		20	111							North
	SHB-78a-19	6965	33.5-36	alluvium	Silty Sand	SM	16											25								North
	SHB-78a-19	6965	36-37.5	alluvium	Silty Sand	CL	51				41	22		74	94	100		23	100							North
	SHB-78a-19	6965	37.5-40	alluvium	Clay	CH	43											24								North
	SHB-78a-19	6965	40-41.5	alluvium	Clay	CH	34	0.83			61	38		73	80	100		25	99				1 pt			North
	SHB-78a-19	6965	41.5-44	alluvium	Clay	CH	22											28								North
	SHB-78a-19	6965	44-45	alluvium	Clay	CH	22	0.13			67	41		78	87	100		27	96							North
	SHB-78a-20	6964	0-1.5	dam	Clay	CL	7											15								North
	SHB-78a-20	6964	4.5-6	dam	Clay	CL	49	0.79										11								North
	SHB-78a-20	6964	9.5-10.5	dam	Clay	CL	40	0.67			28	13		63	86	99	100	10	111							North
	SHB-78a-20	6964	14.5-16	alluvium	Silty Sand	SM	19											10								North
	SHB-78a-20	6964	19.5-20.5	alluvium	Silty Sand	SM	5					NP		16	35			23	96						5.5	North
	SHB-78a-20	6964	24.5-25.5	alluvium	Silty Sand	CH	15	0.33										29	93							North
	SHB-78a-20	6964	29.5-31	alluvium	Clay	CH	12																			North
	SHB-78a-20	6964	34.5-35.5	alluvium	Clay	CH	12	0.84										26								North
	SHB-78a-20	6964	39.5-40.5	alluvium	Clay	CH	13	0.93			57	31		93	96	97	98	26	97				1 pt			North
	SHB-78a-20	6964	44.5-46	alluvium	Clay	CH	17											27								North
	SHB-78a-21	6964	0-1.5	dam	Sandy Clay	CL	16											14								North
	SHB-78a-21	6964	4.5-6	dam	Sandy Clay	CL	55				34	16		77	90			13								North
	SHB-78a-21	6964	9.5-10.5	dam	Sandy Clay	CL	51	0.55										5	107							North
	SHB-78a-21	6964	14.5-15.5	alluvium	Sandy Clay	CL	13	0.67										12								North
	SHB-78a-21	6964	19.5-21	alluvium	Sandy Clay	CL	4				39	21		72	88			29								North
	SHB-78a-21	6964	24.5-25.5	alluvium	Sandy Clay	CL	18	0.96										22	105					25.5, 0.05		North
	SHB-78a-21	6964	29.5-30.5	alluvium	Clay	CH	19	0.73										24								North
	SHB-78a-21	6964	34.5-36	alluvium	Clay	CH	17											23								North
	SHB-78a-21	6964	39.5-40.5	alluvium	Clay	CH	27	0.72			50	32		84	94			22	102				1 pt			North
	SHB-78a-21	6964	44.5-45.5	alluvium	Clay	CH	19	0.87										19								North
	SHB-78a-22	6956	0-1.0	alluvium	Silty Sand	SM	4											6	93							North
	SHB-78a-22	6956	1.0-3.0	alluvium	Silty Sand	SM	9											9								North
	SHB-78a-22	6956	3.0-5.0	alluvium	Silty Sand	SM	11											11	100							North
	SHB-78a-22	6956	5.0-7.0	alluvium	Sandy Clay	CL	3											12								North
	SHB-78a-22	6956	7.0-9.0	alluvium	Sandy Clay	CL	10				26	10		55	78	100		21	103				1 pt			North
	SHB-78a-22	6956	9.0-11.0	alluvium	Sandy Clay	CL	3				27	10		56	69			31								North
	SHB-78a-22	6956	11-13.0	alluvium	Sandy Clay	CL	10											34	105							North
	SHB-78a-22	6956	13-15.0	alluvium	Sandy Clay	CL	3																			North
	SHB-78a-24	6955	0-1.5	tailings	Silty Sand	SM												9	84							Central
	SHB-78a-24	6955	1.5-3.5	tailings	Silty Sand	SM	4																			Central
	SHB-78a-24	6955	3.5-5.5	tailings	Silty Sand	SM	2/30											23								Central
	SHB-78a-24	6955	5.5-8	tailings	Silty Sand	SM						NP		13	25	100		19								Central
	SHB-78a-24	6955	8-10.0	tailings	Silty Sand	SM	3/18											36								Central
	SHB-78a-24	6955	10.0-12	alluvium	Silty Sand	SM	7											27								Central
	SHB-78a-24	6955	12-14.5	alluvium	Sandy Clay	CL												24								Central
	SHB-78a-24	6955	14.5-16.5	alluvium	Sandy Clay	CL	14	0.43			42	23		83	93			24	99				1 pt			Central
	SHB-78a-24	6955	16.5-18.5	alluvium	Sandy Clay	CL	2											29								Central
	SHB-78a-24	6955	18.5-21	alluvium	Sandy Clay	CL												22	81							Central
	SHB-78a-24	6955	21-23.0	alluvium	Clay	CL	39	0.69			42	21		87	97	98	100	21	106				1 pt			Central
	SHB-78a-24	6955	23.0-25	alluvium	Clay	CL	15											19								Central
	SHB-78a-24	6955	25-27.5	alluvium	Clay	CL												23	83							Central
	SHB-78a-24	6955	27.5-30	alluvium	Silty Sand	SM	9											24								Central
	SHB-78a-25	6958	6-8.5	tailings	Silty Sand	SM	20	0.06				NP		14	25	98	100	9								Central

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	SHB-78a-25	6958	17-18.0	tailings	Silty Sand	SM	7					NP		14	25	99	100	20								Central
	SHB-78a-25	6958	19.5-22	alluvium	Sandy Clay-Clayey Sand	CL-SC	2											27								Central
	SHB-78a-25	6958	22.0-24	alluvium	Sandy Clay-Clayey Sand	CL-SC	5				35	17		59	81			27								Central
	SHB-78a-25	6958	24.0-26	alluvium	Sandy Clay-Clayey Sand	CL-SC	8	0.1										29	93							Central
	SHB-78a-25	6958	26-28.5	alluvium	Sandy Clay-Clayey Sand	CL-SC		0.32										21	64							Central
	SHB-78a-25	6958	28.5-30.5	alluvium	Sandy Clay-Clayey Sand	CL-SC	4				28	12		42	79			21								Central
	SHB-78a-25	6958	30.5-32.5	alluvium	Sandy Clay-Clayey Sand	CL-SC	16											21								Central
	SHB-78a-25	6958	32.5-33.5	alluvium	Sandy Clay-Clayey Sand	CL-SC		0.8										19	108					30, 0		Central
	SHB-78a-26	6962	6.5-9	tailings	Silty Sand	SM	8					NP		22	43			10	96					30, 0		Central
	SHB-78a-26	6962	8.0-10.5	tailings	Silty Sand	SM												19								Central
	SHB-78a-26	6962	10.5-12.5	tailings	Silty Sand	SM	2											21						33, 0		Central
	SHB-78a-26	6962	12.5-14.5	tailings	Silty Sand	SM	9											12	99							Central
	SHB-78a-26	6962	15.5-18	tailings	Silty Sand	SM	3					NP		14	23	100		17								Central
	SHB-78a-26	6962	19.5-22	tailings	Silty Sand	SM	2/18"					NP		20	33			18								Central
	SHB-78a-26	6962	21-23	tailings	Silty Sand	SM												24								Central
	SHB-78a-26	6962	23-25.5	alluvium	Sandy Clay	CL	10											27								Central
	SHB-78a-26	6962	25.5-27.5	alluvium	Sandy Clay	CL	10											27								Central
	SHB-78a-26	6962	27.5-30	alluvium	Sandy Clay	CL												23	83							Central
	SHB-78a-26	6962	31-32.5	alluvium	Sandy Clay	CL	7				39	22		78	91	100		26								Central
	SHB-78a-26	6962	32-34	alluvium	Sandy Clay	CL	7	0.55										22								Central
	SHB-78a-26	6962	34-36.5	alluvium	Sandy Clay	CL		0.92										20	110							Central
	SHB-78a-26	6962	36.5-37.5	alluvium	Sandy Clay	CL	14											22								Central
	SHB-78a-27	6957	3.5-5	alluvium	Silty Clay	CL	10											20								Central
	SHB-78a-27	6957	5-10.5	alluvium	Silty Clay	CL	13											17	95							Central
	SHB-78a-27	6957	9.5-11	alluvium	Silty Clay	CL	3				37	15		86	95			29								Central
	SHB-78a-27	6957	14.5-15.5	alluvium	Silty Clay	CL	16				42	21		66	78	92	94	24	94							Central
	SHB-78a-27	6957	19.5-21	alluvium	Silty Clay	CL	2				31	11		89	98			31								Central
	SHB-78a-27	6957	25-30.5	alluvium	Silty Clay	CL	7											27	94							Central
	SHB-78a-27	6957	30.5-35	alluvium	Silty Clay	CL	8											25								Central
	SHB-78a-27	6957	35-40.5	alluvium	Silty Clay	CL	20											22	100							Central
	SHB-78a-27	6957	40.5-45	alluvium	Silty Clay	CL	7											22								Central
	SHB-78a-27	6957	44.5-45.5	alluvium	Silty Clay	CL	9				40	20		80	93			21								Central
	SHB-78a-27	6957	50.5-51	alluvium	Silty Sand	SM	3											24								Central
	SHB-78a-28	6955	4.5-6	alluvium	Silty Clay	CL	15				41	21		92	98			21	101							Central
	SHB-78a-28	6955	5.5-10	alluvium	Silty Clay	CL	19											17								Central
	SHB-78a-28	6955	10-15.5	alluvium	Silty Clay	CL	7											18	102							Central
	SHB-78a-28	6955	15.5-20	alluvium	Silty Sand	SM	15											15								Central
	SHB-78a-28	6955	20-25.5	alluvium	Silty Sand	SM	4											31	85							Central
	SHB-78a-28	6955	25.5-30	alluvium	Silty Clay	CL	3											30								Central
	SHB-78a-28	6955	30-35.5	alluvium	Silty Clay	CL	10											26	97							Central
	SHB-78a-28	6955	34.5-36	alluvium	Silty Clay	CL	3				36	16		90	98			23								Central
	SHB-78a-28	6955	40.5-45.5	alluvium	Silty Clay	CL	8											24	95							Central
	SHB-78a-28	6955	45.5-49.5	alluvium	Silty Sand	SM	19											25								Central
	SHB-78a-28	6955	49.5-49.6	sandstone	-	-	50/1"																			Central
			bulk	tailings		SM-SP						NP		5	11			18	98			90.5 / 107.8		34.5, 0.13		Central
			bulk	tailings														18	100					37, 0.22		Central
			bulk	tailings														18	102					39, 0.15		Central
	SHB-78a-52	6988	5.0-10	alluvium	Clayey Sand	SC					27	11		43	73	95	98	7								W. Borrow
	SHB-78a-52	6988	20	alluvium	Silty Clay	CL																				W. Borrow
	SHB-78a-52	6988	25	alluvium	Silty Clay	CL																				W. Borrow
	SHB-78a-52	6988	30	alluvium	Silty Sand	SM																				W. Borrow
	SHB-78a-52	6988	35	alluvium	Silty Clay	CL																				W. Borrow

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB-78a-52	6988	39.5	total depth	Silty Clay	CL	-																			W. Borrow
	SHB-78a-53	6985	0	alluvium	Silty Clay	CL	5											8								
	SHB-78a-53	6985	5	alluvium	Silty Sand	SM	3											6								W. Borrow
	SHB-78a-53	6985	10	alluvium	Silty Sand	SM	7											7								W. Borrow
	SHB-78a-53	6985	15	alluvium	Silty Sand & Gravel	SM	14											6								W. Borrow
	SHB-78a-53	6985	20	alluvium	Silty Sand & Gravel	SM	14											4								W. Borrow
	SHB-78a-53	6985	25	alluvium	Silty Sand	SM	19											6								W. Borrow
	SHB-78a-53	6985	30	alluvium	Silty Sand	SM	22											9								W. Borrow
	SHB-78a-53	6985	35	alluvium	Silty Sand	SM	20											7								W. Borrow
	SHB-78a-53	6985	40	alluvium	Silty Sand & Gravel	SM	24											6								W. Borrow
	SHB-78a-53	6985	41	total depth	Silty Sand & Gravel	SM	-																			W. Borrow
	SHB-78a-54	6985	4.5-8.5	sandstone	-	-	-																			W. Borrow
	SHB-78a-55	6995	0	alluvium	Silty Sand	SM	5																			W. Borrow
	SHB-78a-55	6995	5	alluvium	Silty Sand	SM	9																			W. Borrow
	SHB-78a-55	6995	10	alluvium	Silty Sand	SM	17																			W. Borrow
	SHB-78a-55	6995	15	alluvium	Silty Sand	SM	25																			W. Borrow
	SHB-78a-55	6995	20	alluvium	Clayey Sand	SC	30																			W. Borrow
	SHB-78a-55	6995	24.5-26	alluvium	Clayey Sand	SC	41				29	14		49	72	95	98	8								W. Borrow
	SHB-78a-55	6995	30	alluvium	Silty Sand	SM	39																			W. Borrow
	SHB-78a-55	6995	35	alluvium	Silty Sand	SM	42																			W. Borrow
	SHB-78a-55	6995	40	alluvium	Silty Clay	CL	38																			W. Borrow
	SHB-78a-55	6995	45	alluvium	Silty Clay	CL	47																			W. Borrow
	SHB-78a-55	6995	50-51	alluvium	Silty Sand	SM	30																			W. Borrow
	SHB-78a-56	6993	0-4.5	sandstone	-	-																				W. Borrow
	SHB-78a-64	6973	.5-2	alluvium	Silty Sand & Gravel	SC-SM	81				23	7		46	64	87	94	7								North
	SHB-78a-64	6973	2-4.5	sandstone	-	SM						NP		27	54	64	68	7								North
	SHB-78a-64	6973	4.5-6	sandstone	-	GM	50/.5"				20	NP		25	28	46	54	5								North
	SHB-78a-68	6989	1-5.5	alluvium	Silty Sand	SM	20												5							Central
	SHB-78a-68	6989	4.5-6	alluvium	Silty Sand	SM	18				20	NP		31	48	67	74		4							Central
	SHB-78a-68	6989	9.5-11	alluvium	Silty Sand	SM	17				21	NP		40	60	70	80		6							Central
	SHB-78a-68	6989	14.5-16	alluvium	Clayey Silt	CL	88				32	12		93	95	100			9							Central
	SHB-78a-68	6989	19.5-22	Sandstone	-	-	50/3"												8							Central
	SHB-78a-68	6989	22.5-24.5	Sandstone	-	-	50/3"												9							Central
	SHB-78a-74	6963	0-10	alluvium	Silty Clay	CL					31	31		72	86	100		9								Central
	SHB-78a-76	6965	0-5	alluvium	Silty Clay	CL					33	16		71	77	100		7								Central
	SHB-78a-76	6965	5-10	alluvium	Silty Clay	CL					42	21		79	92			10								Central
	SHB-78a-76	6965	16-19.5	alluvium	Sandy Silt	ML					23	NP		52	84	100		6								Central
	SHB-78a-78	6980	6-10	alluvium	Silty Sand	SM					23	NP		48	81	98	100	7								Central
	SHB-78a-78	6980	17-20	alluvium	Clayey Sand	SC					26	9		49	67	83	87	10								Central
	SHB-78a-78	6980	22-25	alluvium	Clayey Silt	CL					33	15		75	90	99	100	15								Central
	SHB78a-81	6975	0.5-2	alluvium	Silty Clay	CL	15											7								Central
	SHB78a-81	6975	4.5-6	alluvium	Silty Clay	CL	30											9								Central
	SHB78a-81	6975	9.5-11	alluvium	Silty Sand	SM	21											4								Central
	SHB78a-81	6975	14.5-16	alluvium	Silty Sand	SM	9											7								Central
	SHB78a-81	6975	19.5-21	alluvium	Silty Clay	CL	28											10								Central
	SHB78a-81	6975	24.5-26	alluvium	Silty Sand	SM	23											5								Central
	SHB-78a-83	6985	0.5-2	alluvium	Silty Sand	SM	10											4								Central
	SHB-78a-83	6985	4.5-6	alluvium	Silty Sand	SM	20				-	NP		26	51	87	94	2								Central
	SHB-78a-83	6985	9.5-11	alluvium	Silty Sand	SM	14				-	NP		24	49	94	97	4								Central
	SHB-78a-83	6985	12-14.5	sandstone	-	-	50/1"																			Central
	SHB-78a-85	6983	0.5-2	alluvium	Silty Sand	SM	9											3								Central
	SHB-78a-85	6983	4.5-6	alluvium	Silty Clay	CL	17				33	15		60	77	100		6								Central

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB-78a-85	6983	9.5-11	alluvium	Silty Sand	SM	17					NP		34	62	94	97	3								Central
	SHB-78a-85	6983	14.5-16	alluvium	Silty Clay	CL	26				35	16		80	93	100		8								Central
	SHB-78a-85	6983	19.5-21	alluvium	Silty Clay	CL	16				34	15		74	87	98	99	8								Central
	SHB-78a-85	6983	24.5-26	alluvium	Silty Sand	SM	23											4								Central
	SHB-78a-85	6983	29.5-31	alluvium	Silty Clay	CL	21											7								Central
SHB, 1978b	SHB78b-1	6996	0	alluvium	Sandy Silt	ML	32																			Central
	SHB78b-1	6996	5	alluvium	Sandy Silt	ML	14				26	NP		54	85	98	100	6								Central
	SHB78b-1	6996	10	alluvium	Sandy Silt	ML	24																			Central
	SHB78b-1	6996	15	sandstone	-	-	50/0.5"																			Central
	SHB78b-1	6996	20	sandstone	-	-	50/1"																			Central
	SHB78b-1	6996	25	Shale	-	-	50/2"																			Central
	SHB78b-2	6990	0	alluvium	Sandy Clay	CL	7																			Central
	SHB78b-2	6990	5	alluvium	Sandy Clay	CL	36																			Central
	SHB78b-2	6990	10	alluvium	Sandy Clay	CL	37				25	10		53	72	90	95	7								Central
	SHB78b-2	6990	15	alluvium	Silty Sand	SM	17																			Central
	SHB78b-2	6990	20	alluvium	Silty Sand	SM-SC	15																			Central
	SHB78b-2	6990	25	alluvium	Clayey Sand	SC	10																			Central
	SHB78b-2	6990	30	alluvium	Clayey Sand	SC	18																			Central
	SHB78b-3	6991	0	alluvium	Sandy Clay	CL	8																			Central
	SHB78b-3	6991	5	alluvium	Sandy Clay	CL	32																			Central
	SHB78b-3	6991	10	alluvium	Sandy Clay	CL	24																			Central
	SHB78b-3	6991	15	alluvium	Silty Sand	SM	15				-	NP		48	91	100		5								Central
	SHB78b-3	6991	20	alluvium	Silty Sand	SM	18																			Central
	SHB78b-3	6991	25	alluvium	Sandy Clay	CL	20																			Central
	SHB78b-3	6991	30	alluvium	Silty Sand	SM	27																			Central
	SHB78b-4	6994	0	alluvium	Sandy Clay	CL	10																			Central
	SHB78b-4	6994	5	alluvium	Sandy Clay	CL	40				34	16		79	95	100		8								Central
	SHB78b-4	6994	10	alluvium	Silty Sand	SM	11																			Central
	SHB78b-4	6994	15	alluvium	Silty Sand	SM	12																			Central
	SHB78b-4	6994	25	alluvium	Silty Sand	SM-SC	21																			Central
	SHB78b-4	6994	30	alluvium	Clayey Sand	SC	33																			Central
	SHB78b-5	6998	0	alluvium	Clayey Sand	SC	7																			Central
	SHB78b-5	6998	5	alluvium	Sandy Clay	CL	39				32	15		76	91	100		7								Central
	SHB78b-5	6998	10	alluvium	Sandy Clay	CL	21																			Central
	SHB78b-5	6998	15	alluvium	Sandy Clay	CL	16				30	13		62	80	100		8								Central
	SHB78b-5	6998	20	alluvium	Sandy Clay	CL	19																			Central
	SHB78b-5	6998	25	alluvium	Sandy Clay	CL	29																			Central
	SHB78b-5	6998	30	alluvium	Silty Sand	SM-SC	24																			Central
	SHB78b-6	7002	0	alluvium	Sandy Clay	CL-ML	10																			Central
	SHB78b-6	7002	5	alluvium	Sandy Clay	CL-ML	12				24	5		61	84	98	100	5								Central
	SHB78b-6	7002	10	alluvium	Silty Sand	SM	38																			Central
	SHB78b-6	7002	15	alluvium	Clayey Sand	SC	15																			Central
	SHB78b-6	7002	20	alluvium	Clayey Sand	SC	55																			Central
	SHB78b-6	7002	25	alluvium	Silty Sand	SM-SC	31																			Central
	SHB78b-6	7002	30	alluvium	Silty Sand	SM-SC	19																			Central
	SHB78b-7	6987	0	alluvium	Sandy Clay	CL	23																			Central
	SHB78b-7	6987	5	alluvium	Sandy Clay	CL	44																			Central
	SHB78b-7	6987	10	alluvium	Silty Sand	SM	18				23	NP		44	85	99		5								Central
	SHB78b-7	6987	15	alluvium	Silty Sand	SM	26																			Central
	SHB78b-7	6987	20	alluvium	Sandy Clay	CL	56																			Central
	SHB78b-7	6987	25	alluvium	Silty Sand	SM	23																			Central
	SHB78b-7	6987	30	alluvium	Clayey Sand	SM	53																			Central

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	SHB78b-7	6987	35	alluvium	Silty Sand	SM-SC	35																			Central
	SHB78b-7	6987	40	alluvium	Silty Sand	SM-SC	72																			Central
	SHB78b-7	6987	45	alluvium	Silty Sand	SM-SC	26																			Central
	SHB78b-7	6987	50	alluvium	Silty Sand	SM-SC	40																			Central
	SHB78b-7	6987	55	alluvium	Silty Sand	SM-SC	21																			Central
	SHB78b-7	6987	60	alluvium	Silty Sand	SM-SC	37																			Central
	SHB78b-8	6985	0	alluvium	Sandy Clay	CL	10																			Central
	SHB78b-8	6985	5	alluvium	Silty Sand	SM	14																			Central
	SHB78b-8	6985	10	alluvium	Silty Sand	SM	16																			Central
	SHB78b-8	6985	15	alluvium	Silty Sand	SM	14																			Central
	SHB78b-8	6985	20	alluvium	Silty Clay	CL	18																			Central
	SHB78b-8	6985	25	alluvium	Silty Clay	CL	21				33	14		94	99			13								Central
	SHB78b-8	6985	30	alluvium	Silty Sand	SM	42																			Central
	SHB78b-9	7007	0	alluvium	Silty Sand	SM-SC	27																			Central
	SHB78b-9	7007	5	alluvium	Clay	CH	48																			Central
	SHB78b-9	7007	10	alluvium	Silty Sand	CL	50				42	18		93	94	98	100	11								Central
	SHB78b-9	7007	15	shale	Silty Sand	CL	27																			Central
	SHB78b-10	7000	0	alluvium	Silty Sand	SM	9																			Central
	SHB78b-10	7000	5	alluvium	Silty Sand	SM	2																			Central
	SHB78b-10	7000	10	alluvium	Silty Sand	SM	18				-	NP		22	43	69	87	4								Central
	SHB78b-10	7000	15	alluvium	Silty Sand	SM	12																			Central
	SHB78b-10	7000	20	sandstone	-	-	100/1"																			Central
	SHB78b-18	7018	0	alluvium	Silty Sand	SM	8																			E. Borrow
	SHB78b-18	7018	4.5	alluvium	Sandy Clay	CL	14				26	11		52	79	95	99	4								E. Borrow
	SHB78b-18	7018	12	alluvium	Clay	CH	41																			E. Borrow
	SHB78b-18	7018	14.5	shale	-	-	100/6				32	11		92	98	100		38								E. Borrow
	SHB78b-18	7018	20	shale	-	-	100/8"																			E. Borrow
	SHB78b-18	7018	25	shale	-	-	100/5"																			E. Borrow
	SHB78b-19	7032	0	alluvium	Silty Sand	SM	7																			E. Borrow
	SHB78b-19	7032	4.5	alluvium	Silty Sand	SM	24				22	NP		41	64	88	94	5								E. Borrow
	SHB78b-19	7032	9	sandstone	-	-	100/0"																			E. Borrow
	SHB78b-20	7053	3	sandstone	Silty Sand	SM-SC	9																			E. Borrow
	SHB78b-28	7052	0	alluvium	Silty Sand	SM	27																			E. Borrow
	SHB78b-28	7052	7	sandstone	-	-	100/8"																			E. Borrow
	SHB78b-30	7045	0	alluvium	Sandy Clay	CL	15																			E. Borrow
	SHB78b-30	7045	4.5	alluvium	Sandy Clay	CL	39				27	11		55	73	86	92	8								E. Borrow
	SHB78b-30	7045	7	sandstone	-	-	100/0"																			E. Borrow
	SHB78b-30	7045	15	sandstone	-	-	100/0"																			E. Borrow
	SHB78b-31	7016	0	alluvium	Silty Sand	SM-SC	6																			E. Borrow
	SHB78b-31	7016	5	alluvium	Silty Sand	SM	16																			E. Borrow
	SHB78b-31	7016	9.5	alluvium	Sandy Clay	CL	42				26	11		52	83	99	100	5								E. Borrow
	SHB78b-31	7016	15	alluvium	Sandy Clay	CL	26																			E. Borrow
	SHB78b-31	7016	20	alluvium	Silty Sand	SM	35																			E. Borrow
	SHB78b-31	7016	25	alluvium	Silty Sand	SM	35																			E. Borrow
	SHB78b-31	7016	30	alluvium	Silty Clay	CL	43																			E. Borrow
	SHB78b-32	7023	0	alluvium	Silty Sand	SM-SC	7																			E. Borrow
	SHB78b-32	7023	4.5	alluvium	Silty Sand	SM	13				-	NP		29	70	100										E. Borrow
	SHB78b-32	7023	10	alluvium	Sandy Clay	CL-ML	23																			E. Borrow
	SHB78b-32	7023	15	alluvium	Sandy Clay	CL-ML	26																			E. Borrow
	SHB78b-32	7023	20	alluvium	Sandy Clay	CL-ML	26																			E. Borrow
	SHB78b-32	7023	24.5	alluvium	Sandy Clay	CL-ML	50				25	6		61	92	100		6								E. Borrow

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	SHB78b-32	7023	30	alluvium	Sandy Clay	CL-ML	50																			E. Borrow
	SHB78b-33	7025	0	alluvium	Silty Sand	SM-SC	7																			E. Borrow
	SHB78b-33	7025	4.5	alluvium	Sandy Clay	CL	19				27	9		51	77	100		7								E. Borrow
	SHB78b-33	7025	10	alluvium	Silty Sand	SM	19																			E. Borrow
	SHB78b-33	7025	14.5	alluvium	Silty Sand	SM	32				21	NP		47	86	100		5								E. Borrow
	SHB78b-33	7025	20	alluvium	Clayey Silt	ML	16																			E. Borrow
	SHB78b-33	7025	25	alluvium	Clayey Silt	ML	50																			E. Borrow
	SHB78b-34	7037	0	alluvium	Silty Sand	SM	10																			E. Borrow
	SHB78b-34	7037	5	alluvium	Clayey Silt	ML	15																			E. Borrow
	SHB78b-34	7037	10	alluvium	Silty Sand	SM-SC	39																			E. Borrow
	SHB78b-34	7037	14.5	alluvium	Silty Sand	SM-SC	12				18	NP		40	69	98	98	5								E. Borrow
	SHB78b-34	7037	20	alluvium	Silty Sand	SM-SC	40																			E. Borrow
	SHB78b-34	7037	25	alluvium	Silty Sand	SM	23																			E. Borrow
	SHB78b-34	7037	30	alluvium	Clayey Silt	ML-CL	20																			E. Borrow
SHB, 1979	SHB-79-9	6967	0	alluvium	Sandy Clay	CL	11											19								North
	SHB-79-9	6967	5	alluvium	Clayey Sand	SC	59											12								North
	SHB-79-9	6967	10	alluvium	Clayey Sand	SC	85																			North
	SHB-79-9	6967	15	alluvium	Silty Sand	SM	27											11								North
	SHB-79-9	6967	20	alluvium	Silty Sand	SM	11											5								North
	SHB-79-9	6967	25	alluvium	Clay	CH	11											21								North
	SHB-79-9	6967	30	alluvium	Clay	CH	31																			North
	SHB-79-9	6967	35	alluvium	Clay	CH	13											26								North
	SHB-79-9	6967	40	alluvium	Clay	CH	6											31								North
	SHB-79-9	6967	45	alluvium	Clayey Sand	SC	12											21								North
	SHB-79-9	6967	50	sandstone	-	-	17											19								North
	SHB-79-9	6967	55	sandstone	-	-	50/0"																			North
	SHB-79-10	6967	0	alluvium	Sandy Clay	CL	33											12								North
	SHB-79-10	6967	5	alluvium	Silty Sand	SC-SM	42											14								North
	SHB-79-10	6967	10	alluvium	Silty Sand	SC	54																			North
	SHB-79-10	6967	15	alluvium	Clayey Sand	SC	29											14								North
	SHB-79-10	6967	20	alluvium	Clayey Sand	SC	26																			North
	SHB-79-10	6967	25	sandstone	-	-	50/0"																			North
	SHB-79-11	6967	30	sandstone	-	-																				North
	SHB-79-12	6968	0	alluvium	Clayey Sand	SC	46																			Central
	SHB-79-12	6968	5	tailings	Sand	SP	11																			Central
	SHB-79-12	6968	10	tailings	Sand	SP	5																			Central
	SHB-79-12	6968	15	tailings	Sand	SP	2																			Central
	SHB-79-12	6968	20	tailings	Sand	SP	1																			Central
	SHB-79-12	6968	25	tailings	Sand	SP	12																			Central
	SHB-79-12	6968	30	tailings	Sand	SP	9																			Central
	SHB-79-12	6968	35	tailings	Sand	SP	13																			Central
	SHB-79-12	6968	40	alluvium	Clay	CH	16																			Central
	SHB-79-12	6968	45	alluvium	Sand	SP	5																			Central
	SHB-79-12	6968	50	alluvium	Silty Sand	SM-SC	8																			Central
	SHB-79-12	6968	55	alluvium	Sandy Clay	CL	6																			Central
	SHB-79-13	6968	0	alluvium	Clayey Sand	SC	35																			Central
	SHB-79-13	6968	5	alluvium	Clayey Sand	SC	7																			Central
	SHB-79-13	6968	10	Tailings	Sand	SP-SC	4																			Central
	SHB-79-13	6968	15	Tailings	Sand	SP-SC	1																			Central
	SHB-79-13	6968	20	Tailings	Sand	SP-SC	1																			Central
	SHB-79-13	6968	25	Tailings	Sand	SP-SC	1																			Central
	SHB-79-13	6968	30	Tailings	Sand	SP-SC	10																			Central

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB-79-13	6968	35	Tailings	Sand	SP-SC	19																			Central
	SHB-79-13	6968	40	alluvium	Clay	CH	8																			Central
	SHB-79-13	6968	45	alluvium	Silty Sand	SM	9																			Central
	SHB-79-14	6968	0	alluvium	Clay	CH	15											17								North
	SHB-79-14	6968	5	tailings	Sand	SP-SC	4											15								North
	SHB-79-14	6968	10	tailings	Sand	SP-SC	2											22								North
	SHB-79-14	6968	15	tailings	Sand	SP-SC	8											41								North
	SHB-79-14	6968	20	tailings	Sand	SP-SC	10											34								North
	SHB-79-14	6968	25	alluvium	Sandy Clay	CL	5											36								North
	SHB-79-14	6968	30	alluvium	Clayey Sand	SC	5											24								North
	SHB-79-14	6968	35	alluvium	Clayey Sand	SC	7											26								North
	SHB-79-14	6968	40	alluvium	Clay	CH	8											9								North
	SHB-79-14	6968	45	alluvium	Clay	CH	23											32								North
	SHB-79-15	6966	0	alluvium	Clayey Sand	SC	26											12								North
	SHB-79-15	6966	5	tailings	Sand	SP-SC	6											12								North
	SHB-79-15	6966	10	tailings	Sand	SP-SC	1																			North
	SHB-79-15	6966	15	tailings	Sand	SP-SC	2											45								North
	SHB-79-15	6966	20	alluvium	Sand	SP-SC	6											36								North
	SHB-79-15	6966	25	alluvium	Sand	SP-SC	6											28								North
	SHB-79-15	6966	30	alluvium	Sand	SP-SC	2											21								North
	SHB-79-15	6966	35	alluvium	Sand	SP-SC	4											22								North
	SHB-79-15	6966	40	alluvium	Sand	SP-SC	8											23								North
	SHB-79-15	6966	45	alluvium	Clay	CH	11											29								North
	SHB-79-16	6968	0	alluvium	Clayey Sand	SC	50/.5"											8								North
	SHB-79-16	6968	5	sandstone	-	-	50/2"											6								North
	SHB-79-17	6967	0	alluvium	Silty Sand	SM-SC	24																			Central
	SHB-79-17	6967	5	alluvium	Silty Sand	SM-SC	17																			Central
	SHB-79-17	6967	10	tailings	Sand	SP-SC	50/5"																			Central
	SHB-79-18	6967	0	alluvium	Silty Sand	SM-SC	57																			Central
	SHB-79-18	6967	5	alluvium	Silty Sand	SM-SC	8																			Central
	SHB-79-18	6967	10	tailings	Sand	SP-SC	4																			Central
	SHB-79-18	6967	15	tailings	Sand	SP-SC	19																			Central
	SHB-79-18	6967	20	tailings	Sand	SP-SC	11																			Central
	SHB-79-18	6967	25	tailings	Sand	SP-SC	27																			Central
	SHB-79-18	6967	30	tailings	Sand	SP-SC	9																			Central
	SHB-79-18	6967	35	tailings	Sand	SP-SC	10																			Central
	SHB-79-18	6967	40	tailings	Sand	SP-SC	19																			Central
	SHB-79-18	6967	45	tailings	Sand	CH	75																			Central
CSI, 1980	DH-1	7016	4	alluvium	Sandy Clayey Silt to Clayey Silty Sand	SM-SL	14																			E. Borrow
	DH-1	7016	6	alluvium		SM-SL	18																			E. Borrow
	DH-1	7016	8	alluvium		SM-SL	13																			E. Borrow
	DH-1	7016	12	alluvium	Sandy Clayey Silt	ML	13											6.1	91	X						E. Borrow
	DH-1	7016	15	alluvium	Sandy Clayey Silt	ML	18											5.2	82							E. Borrow
	DH-1	7016	19	alluvium	Sandy Clayey Silt	ML				2.65								5.5	88	C						E. Borrow
	DH-1	7016	20	alluvium	Sandy Clayey Silt	ML	18											5.5	85				CU			E. Borrow
	DH-1	7016	21	alluvium	Sandy Clayey Silt	ML												5.2	84							E. Borrow
	DH-1	7016	24	alluvium	Sandy Clayey Silt	ML	17																			E. Borrow
	DH-1	7016	29	alluvium	Sandy Clayey Silt	ML	19																			E. Borrow
	DH-1	7016	34	alluvium	Sandy Clayey Silt	ML																				E. Borrow
	DH-1	7016	39	alluvium	Sandy Clayey Silt	ML	22																			E. Borrow
	DH-1	7016	70	alluvium	Sandy Clayey Silt	ML	27																			E. Borrow
	DH-2	7082	2	alluvium	Sandy Silt	ML												18.4	101							S. Central

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	DH-2	7082	5	alluvium	Sandy Silt	ML	6											5.3	78							S. Central
	DH-2	7082	6	alluvium	Sandy Silt	ML												4.5	93				UU			S. Central
	DH-2	7082	8	alluvium	Sandy Silt	ML	8											4.6	88							S. Central
	DH-2	7082	11	alluvium	Sandy Silt	ML	17											4.9	105							S. Central
	DH-2	7082	15	alluvium	Sandy Silt	ML	17											7.8	88							S. Central
	DH-2	7082	22	sandstone	Silty Sand	-	50/1"																			S. Central
	DH-2	7082	25	sandstone	-	-	50/1"																			S. Central
	DH-2	7082	30	sandstone	-	-	50/1"																			S. Central
	DH-3	7043	2	alluvium	Sandy Clayey Silt to Clayey Silty Sand	SM-ML								37	76		100	11.7	105	C						E. Borrow
	DH-3	7043	5	alluvium		SM-ML	12			2.66								6.5	97	S						E. Borrow
	DH-3	7043	6	alluvium		SM-ML	12																			E. Borrow
	DH-3	7043	8	alluvium		SM-ML	13																			E. Borrow
	DH-3	7043	12	alluvium	Sandy Clayey Silt	ML	9						24	87	96		99	9.4	90							E. Borrow
	DH-3	7043	13	alluvium	Sandy Clayey Silt	ML												7.1	83	C						E. Borrow
	DH-3	7043	16	alluvium	Sandy Clayey Silt	ML	10											5.8	94							E. Borrow
	DH-3	7043	20	alluvium	Sandy Clayey Silt	ML	11							37	66		90	5.5	103				CU		416	E. Borrow
	DH-3	7043	25	alluvium	Sandy Clayey Silt	ML	14											6.1	87							E. Borrow
	DH-3	7043	26	alluvium	Sandy Clayey Silt	ML												5.4	88				UU			E. Borrow
	DH-3	7043	29	alluvium	Sandy Clayey Silt	ML							14	55	91		100									E. Borrow
	DH-3	7043	31	alluvium	Sandy Clayey Silt	ML	12											6.5	90							E. Borrow
	DH-3	7043	35	alluvium	Sandy Clayey Silt	ML	16																			E. Borrow
	DH-3	7043	46	total depth	Sandy Silt to Silty Sand	SM-ML	46																			E. Borrow
	DH-4	7019	4	alluvium	Silty Sand to Sandy Silt	SM-ML	50																			S. Central
	DH-4	7019	6	siltstone	-	-	50																			S. Central
	DH-4	7019	8	siltstone	-	-	50																			S. Central
	DH-4	7019	10	siltstone	-	-	100																			S. Central
	DH-4	7019	15	siltstone	-	-	50																			S. Central
	DH-4	7019	20	siltstone	-	-	50																			S. Central
	DH-4	7019	25	siltstone	-	-	50																			S. Central
	DH-4	7019	29	sandstone	-	-	100																			S. Central
	DH-4	7019	40	total depth	-	-	100																			S. Central
	DH-6	7012	4	alluvium	Sandy Clayey Silt	ML	17																			W. Borrow
	DH-6	7012	6	alluvium	Sandy Clayey Silt	ML	50																			W. Borrow
	DH-6	7012	8	alluvium	Sandy Clayey Silt	ML	50																			W. Borrow
	DH-6	7012	10	alluvium	Sandy Clayey Silt	ML	50																			W. Borrow
	DH-6	7012	15	siltstone	-	-	50																			W. Borrow
	DH-6	7012	20	siltstone	-	-	50																			W. Borrow
	DH-6	7012	25	siltstone	-	-	100																			W. Borrow
	DH-6	7012	30	siltstone	-	-	100																			W. Borrow
	DH-6	7012	40	total depth	-	-	100																			W. Borrow
	DH-7	7022	4	alluvium	Clayey Silt to Sandy Clayey Silt	ML	50																			W. Borrow
	DH-7	7022	6	siltstone	-	-	50																			W. Borrow
	DH-7	7022	9	siltstone	-	-	50																			W. Borrow
	DH-7	7022	11	siltstone	-	-	50																			W. Borrow
	DH-7	7022	15	siltstone	-	-	50																			W. Borrow
	DH-7	7022	20	sandstone	-	-	50																			W. Borrow
	DH-7	7022	25	siltstone	-	-	50																			W. Borrow
	DH-7	7022	30	siltstone	-	-	50																			W. Borrow
	DH-7	7022	40	siltstone	-	-	50																			W. Borrow
	DH-7	7022	50	total depth	-	-	50																			W. Borrow
	DH-8	6998	4	alluvium	Clayey Silt	ML-CL	50																			W. Borrow

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							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	DH-8	6998	6	alluvium	Clayey Silt	ML-CL	50																			W. Borrow
	DH-8	6998	8	siltstone	-		50																			W. Borrow
	DH-8	6998	11	siltstone	-		50																			W. Borrow
	DH-8	6998	15	siltstone	-		50																			W. Borrow
	DH-8	6998	20	shale	-		X																			W. Borrow
	DH-8	6998	25	siltstone	-		100																			W. Borrow
	DH-8	6998	30	siltstone	-		50																			W. Borrow
	DH-8	6998	40	siltstone	-		50																			W. Borrow
	DH-8	6998	50	total depth	-		50																			W. Borrow
Canonie, 1986	658	6976	7.5-10	tailings	Fine					2.81								17.4	88							Central
&1991	658		12.5-15	tailings														21.5	105	0.018						Central
	658		17.5-20	tailings	Fine/Coarse mixed					2.83								23.5	104							Central
	658		27.5-30	tailings	Coarse					2.81								23.4	98							Central
	658		30-32.5	tailings	Coarse					-								43.6	97	0.055						Central
	658		37.5-40	tailings	Coarse					2.89								31.2	92							Central
	659	6990	7.5-10	tailings	Coarse					2.84								6.1	95							Central
	659		17.5-20	tailings	Coarse					2.83								10.5	94							Central
	659		27.5-30	tailings	Coarse					2.74								13.1	97							Central
	659		30-32.5	tailings	Coarse					-								32	106	0.022						Central
	659		35-37.5	tailings	Fine/Coarse mixed					2.72								29.6	78							Central
	660	6975	8	tailings	Fine					2.81								44.2	74							Central
	660		12.5-15	tailings	Fine					2.84								60	94							Central
	660		25-27.5	tailings	Fine					2.75								32.2	89	sample disturbed						Central
	660		35-37.5	tailings	Fine					2.84								41.4	79							Central
	660		38	tailings	Fine													44.5	73	Cc=1.0						Central
	662	6957	17.5-20	tailings	Sandy, coarse													34.1	97	Cc=0.043						South
	662		25	tailings	Coarse					2.78								25.1	96							South
	662		30	tailings	Coarse					2.79								29.6	94							South
	662		32.5	tailings	Coarse					-								34.1	97							South
	662		37.5-40	tailings	Fine					2.72								36.4	84	0.068						South
	662		40-42.5	tailings	Fine/Coarse mixed					-								43.8	89	0.082						South
Canonie, 1993	5M		5-5.8	tailings	Coarse					2.63			5	20	28	100		8.5	90							Central
	5M		6.8-7.5	tailings	Coarse					2.65			2	11	22	100		6.4	103							Central
	9M		3.3-4	tailings	Coarse					2.68			3	9	15	100		6.9	105							Central
	9M		5-5.5	tailings	Coarse					2.68			4	15	17	100		7.1	-							Central
	9M		6.2-7	tailings	Coarse					2.65			2	10	17	100		7.1	112							Central
	9G		3.3-4	tailings	Coarse					2.68			4	18	29	100		9.8	113							Central
	9G		4-5	tailings	Coarse					2.64			2	10	20	100		7.5	-							Central
	9G		5.8-6.5	tailings	Coarse with slime					2.65			6	22	32	100		27.3	78							Central
	11M		2.5-5	tailings	Coarse					2.68			3	16	22	100		4.9	101							Central
	11M		4-5	tailings	Coarse					2.64			2	9	15	100		5	-							Central
	11M		6.4-7.5	tailings	Coarse					2.69			3	11	17	100		4.7	102							Central
	13K		3.3-4	tailings	Sand					2.67			2	8	16	100		5.2	109							Central
	13K		4-5	tailings	Sand					2.65			2	10	17	100		7.2	-							Central
	13K		5.8-6.5	tailings	Sand Trace Slime					2.64			3	10	14	100		7.8	102							Central
	17A		1.8-2.4	tailings	Coarse with clay					2.69			6	26	38	100		11.1	117							Central
	17A		3.2-4	tailings	Coarse with clay					2.63			3	21	29	100		13.4	113							Central
	17A		4-5	tailings	Coarse with slime					2.69			5	25	37	100		14.1	-							Central
	17A		5.8-6.5	tailings	Coarse with slime					2.66			6	25	36	100		13.7	115							Central
	11K		3.3-4	tailings	Coarse					2.68			3	12	18	100		10.7	101							Central
	11K		4-4.7	tailings	Fine with clay					2.66			2	12	15	100		7.0	96							Central
	11K		6.3-7	tailings	Fine with clay					2.67			5	22	29	100		9.3	95							Central

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	13G		1-1.5	tailings	Fine with slime					2.69			26	76	92	100		12.0	117							Central
	13G		3.3-4	tailings	Fine with slime					2.66			4	17	25	100		12.8	100							Central
	13G		4-4.9	tailings	Fine					2.67			3	12	41	100		8.0	101							Central
	13G		5.8-6.5	tailings	Fine					2.65			6	17	52	100		5.9	95							Central
	15C		2.9-3.6	tailings	Fine with slime					2.67			3	24	34	100		14.4	110							Central
	15C		4.1-4.8	tailings	Fine with slime					2.68			4	23	38	100		14.0	112							Central
	15C		6.3-7.0	tailings	Fine with slime					2.67			4	23	38	100		19.0	98							Central
	17I		3.0-4.1	tailings	Fine with slime					2.67			3	45	59	100		11.5	112							Central
	17I		4.1-4.8	tailings	Fine with slime					2.67			4	31	47	100		17.1	110							Central
	17I		6.1-6.8	tailings	Fine with slime					2.69			3	39	52	100		13.3	94							Central
																					Notes: (1) remolded to 95% of ASTM D698,				
																					c=cohesion, UC=unconfined compression, CU=consolidated undrained				
																					UU=unconsolidated undrained, C=collapse, S=swell, NP=non-plastic				

APPENDIX A2

POTENTIAL BORROW AREAS AND BORROW CHARACTERIZATION PLAN, CHURCH ROCK MILL SITE

MWH

MWH

BUILDING A BETTER WORLD

TECHNICAL MEMORANDUM

TO: *Mr. Lance Hauer, GE* DATE: *February 17, 2012*

FROM: *Eileen Dornfest, Clint Strachan, MWH, Inc.*
Stephen Dwyer, Dwyer Engineering, LLC REFERENCE: *1012151*

SUBJECT: *Potential Borrow Areas and Borrow Characterization Plan, Northeast Church Rock Millsite*

Cover Construction Materials

As requested by GE, available cover materials from select potential borrow areas on the NECR site were evaluated for geotechnical characteristics and estimated volume. Five potential areas containing borrow source material have been identified within the United Nuclear Corporation property at the Northeast Church Rock Millsite. These potential borrow sources are Borrow Areas 1, 2, D-N, D-S, and Dilco Hill. Limited investigations have been conducted within Borrow Areas 1 and 2. The remaining borrow areas have not yet been sampled or characterized. The potential borrow areas are shown on Figure BA-1. A stockpile of topsoil material available for cover construction is also shown on Figure BA-1.

Estimated quantities of soil material required for cover construction range from approximately 160,000 cubic yards (cy) to over 350,000 cy, depending on the capacity and configuration of the mine waste repository. In addition, the Engineering Evaluation/Cost Analysis (EPA, 2009) indicates that approximately 200,000 cy of borrow material may be required to restore the mine site.

Borrow Areas 1 and 2

Borrow Areas 1 and 2 were sampled in 2008 with an excavator. Thirteen test pits were excavated within Borrow Area 1, with depths ranging from 8.0 feet to greater than 12.0 feet. The depths of the test pits excavated in Borrow Area 1 were generally limited by the reach of the excavator. Twelve test pits were excavated within Borrow Area 2, with depths ranging from 3.9 to 12.0 feet. The test pit identification numbers, GPS coordinates, and depths are provided in Tables 1 and 2 for Borrow Areas 1 and 2, respectively. The approximate locations of the test pits in Borrow Areas 1 and 2 are shown in Figure BA-2.

Table 1. Borrow Area 1 Test Pit Depths and Locations

Test Pit ID	GPS Location (latitude/longitude)	Depth
NTP-01	N 35º 38.734´/ W 108º 29.668´	9.5 ft Rock[1]
NTP-02	N 35º 38.733´/ W 108º 29.692´	>12.0 ft
NTP-03	N 35º 38.734´/ W 108º 29.720´	>12.0 ft
NTP-04	N 35º 38.709´/ W 108º 29.662´	>12.0 ft
NTP-05	N 35º 38.702´/ W 108º 29.692´	>12.0 ft
NTP-06	N 35º 38.700´/ W 108º 29.726´	8.0 ft Rock[1]
NTP-07	N 35º 38.673´/ W 108º 29.662´	>12.0 ft
NTP-08	N 35º 38.674´/ W 108º 29.692´	>12.0 ft
NTP-09	N 35º 38.678´/ W 108º 29.725´	8.5ft Shale[1]
NTP-10	N 35º 38.643´/ W 108º 29.664´	>12.0 ft
NTP-11	N 35º 38.644´/ W 108º 29.693´	>12.0 ft
NTP-12	N 35º 38.647´/ W 108º 29.732´	>12.0 ft
NTP-13	N 35º 38.?´/ W 108º 29.?´	>12.0 ft

Notes: 1. The test pits were terminated shallower than 12 ft due to refusal as a result of rock or shale.

Table 2. Borrow Area 2 Test Pit Depths and Locations

Test Pit ID	GPS Location (latitude/longitude)	Depth
STP-01	N 35º 38.439´/ W 108º 30.262´	3.9 ft
STP-02	N 35º 38.460´/ W 108º 30.264´	4.0 ft
STP-03	N 35º 38.456´/ W 108º 30.267´	9.9 ft
STP-04	N 35º 38.444´/ W 108º 30.279´	9.5 ft
STP-05	N 35º 38.434´/ W 108º 30.286´	3.1 ft
STP-06	N 35º 38.478´/ W 108º 30.300´	8.6 ft
STP-07	N 35º 38.471´/ W 108º 30.311´	8.5 ft
STP-08	N 35º 38.458´/ W 108º 30.329´	11.8 ft
STP-09	N 35º 38.456´/ W 108º 30.333´	4.9 ft
STP-10	N 35º 38.505´/ W 108º 30.336´	10.3 ft
STP-11	N 35º 38.498´/ W 108º 30.345´	12.0 ft
STP-12	N 35º 38.487´/ W 108º 30.360´	11.1 ft

Estimates of available borrow material volume from Borrow Areas 1 and 2 are provided below. Estimates are based on the depth of borrow material encountered in test pits, as well as assumptions about geometry of the borrow pit excavations.

- Borrow Area 1 – 204,000 cy (assumes an average excavation depth of 12 ft, and 5:1 (horizontal:vertical) slopes along the excavation perimeter).
- Borrow Area 2 – 143,000 cy (assumes an average excavation depth of 8 ft, with 5:1 slopes along the excavation perimeter).

AMEC collected samples from both Borrow Areas 1 and 2 and tested them for limited geotechnical properties in 2008. The results of the laboratory testing and the material types are provided in Table 3 below (Dwyer, 2012).

Table 3. Laboratory Test Results for Borrow Areas 1 and 2

Sample	Ksat (cm/sec)	% Sand	% Silt	% Clay	USDA Classification
Borrow Area 1	1.41E-04	35.8	31.9	33.6	Clay Loam
Borrow Area 2	4.19E-04	46.2	24.1	29.6	Sandy Clay Loam

Dilco Hill Borrow Area

The area designated as Dilco Hill is shown on Figure BA-1. No exploration or characterization of this potential borrow source has been conducted, but the material is assumed to be composed predominately of shale with siltstone and sandstone. Estimates of the volume of material available from the Dilco Hill Borrow Area are based on an assumed depth and lateral extent of excavation, as shown on Figure BA-3. The estimated volume of material available from Dilco Hill is approximately 337,000 CY.

Borrow Areas D-N and D-S

The areas designated as potential Borrow Areas D-N and D-S are located in drainages north of the Church Rock tailings facility, as shown in Figure BA-1. No exploration or characterization of these potential borrow sources has been conducted, and no estimates of available borrow material have been developed. If these borrow sources are determined to be necessary for cover construction, these borrow areas will be sampled and characterized as a portion of the pre-design data collection activities.

Topsoil Stockpile

A topsoil stockpile containing approximately 34,000 CY of material exists on UNC property north of Highway 566 and west of the UNC offices. The location of the topsoil stockpile is shown on Figure BA-1. AMEC tested one sample from the topsoil stockpile for limited geotechnical properties in 2008. The results of the laboratory testing are provided in Table 4 below (Dwyer, 2012).

Table 4. Laboratory Test Results for Topsoil Stockpile Material

Sample	Ksat (cm/sec)	% Sand	% Silt	% Clay	USDA Classification
Topsoil Stockpile	1.27E-04	34.5	31.9	33.6	Clay Loam

Further characterization of these borrow materials will be necessary to determine suitability of the proposed material for soil cover construction, as well as to develop geotechnical parameters for final design. The proposed borrow soil investigation is discussed below.

Erosion Protection Materials

Erosion protection materials (basalt rock) are also currently stockpiled on site (personal communication with UNC personnel). These rock sizes and stockpile volumes are provided in Table 5 below. These erosion protection materials are surplus materials from previous construction at the site and have already been tested and characterized. Therefore, they should not require any additional geotechnical sampling or testing.

Table 5. Volume of Materials Stockpiled on Site

D_{50} Diameter (in)	Volume Stockpiled on Site (cubic yards)
0.02 (crusher fines)	822
0.35 (base coarse)	325
1.5	4,469
3.0	600
6.0	143
10.0	314

Future Borrow Soil investigation

The borrow sources described above will require sampling and laboratory testing to measure applicable geotechnical and hydraulic properties. The sample frequency and laboratory testing program will be specified as part of the pre-design data collection task. The laboratory test results will be used to help determine the applicability of the different soils for use in a final cover system. An adequate number of trenches and/or borings will need to be excavated and sampled to adequately characterize the full extent of the borrow sources. If the borrow soil investigation results indicate the material volumes or properties are inadequate for cover construction, investigation of additional borrow sources may be warranted.

A preliminary summary of the laboratory testing to be performed on samples from the borrow areas is provided in Table 6. The tests will be performed as specified during the pre-design data collection task.

Table 6. Soil Tests and Methods for Additional Borrow Material Characterization

Test	Test Method
Saturated hydraulic conductivity	(Rigid Wall - ASTM D2434M) or flexible wall depending on soil texture flexible wall
Dry bulk density	ASTM D7263
Moisture Content	ASTM D7263
Calculated total porosity	ASTM D7263
Moisture Characteristics (5-7pts. min): other test methods such as centrifuge is to be approved prior to their use	
Hanging Column Method	ASTM D6836
Pressure Plate Method	ASTM D6836
Water Potential (Dewpoint Potentiometer)	ASTM D6836
Relative Humidity (Box)	Karathanasis & Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil Clays. SSA Journal 46:1321-1325; Campbell, G. and G. Gee. 1986. Water Potential: Miscellaneous Methods. Chp. 25, pp. 631-632, in A. Klute (ed.), Methods of Soil Analysis, American Society of Agronomy, Madison, WI
Moisture Retention Characteristics & Calculated Unsaturated Hydraulic Conductivity:	ASTM D6836; van Genuchten, M.T. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. SSSAJ 44:892-898; van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991
Specific Gravity Fine	ASTM D854
Specific Gravity Coarse	ASTM C127
Particle size analysis (Wet) Standard Sieves with Wash & Hydrometer	ASTM D422
USDA Classification	ASTM D422, USDA Soil Textural Triangle
Atterberg Limits:	ASTM D4318
Standard Proctor Compaction	ASTM D698

References

US Environmental Protection Agency Region 9. 2009. *Engineering Evaluation /Cost Analysis Northeast Church Rock (NECR) Mine Site, Gallup New Mexico.* May 30.

Dwyer, Steve. 2012. *Memo: Summary of NECR Geotechnical Data Available to Date.* January 3.

cc: Randall McAlister, GE
Toby Leeson, MWH

Attachments:

Figure BA-1: Potential Borrow Area Locations
Figure BA-2: Test Pit Locations in Borrow Area 1
Figure BA-3: Dilco Hill Borrow Area

FIGURES

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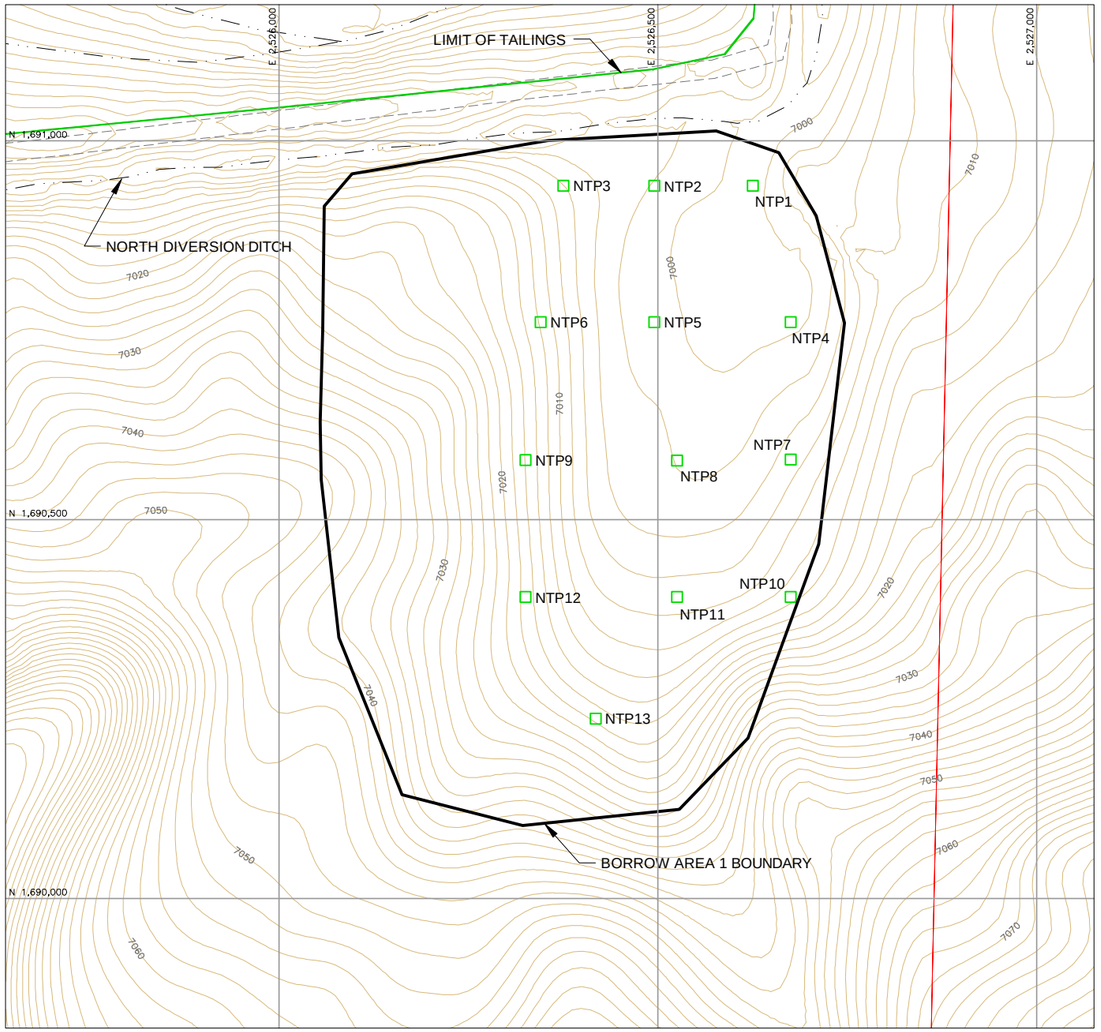
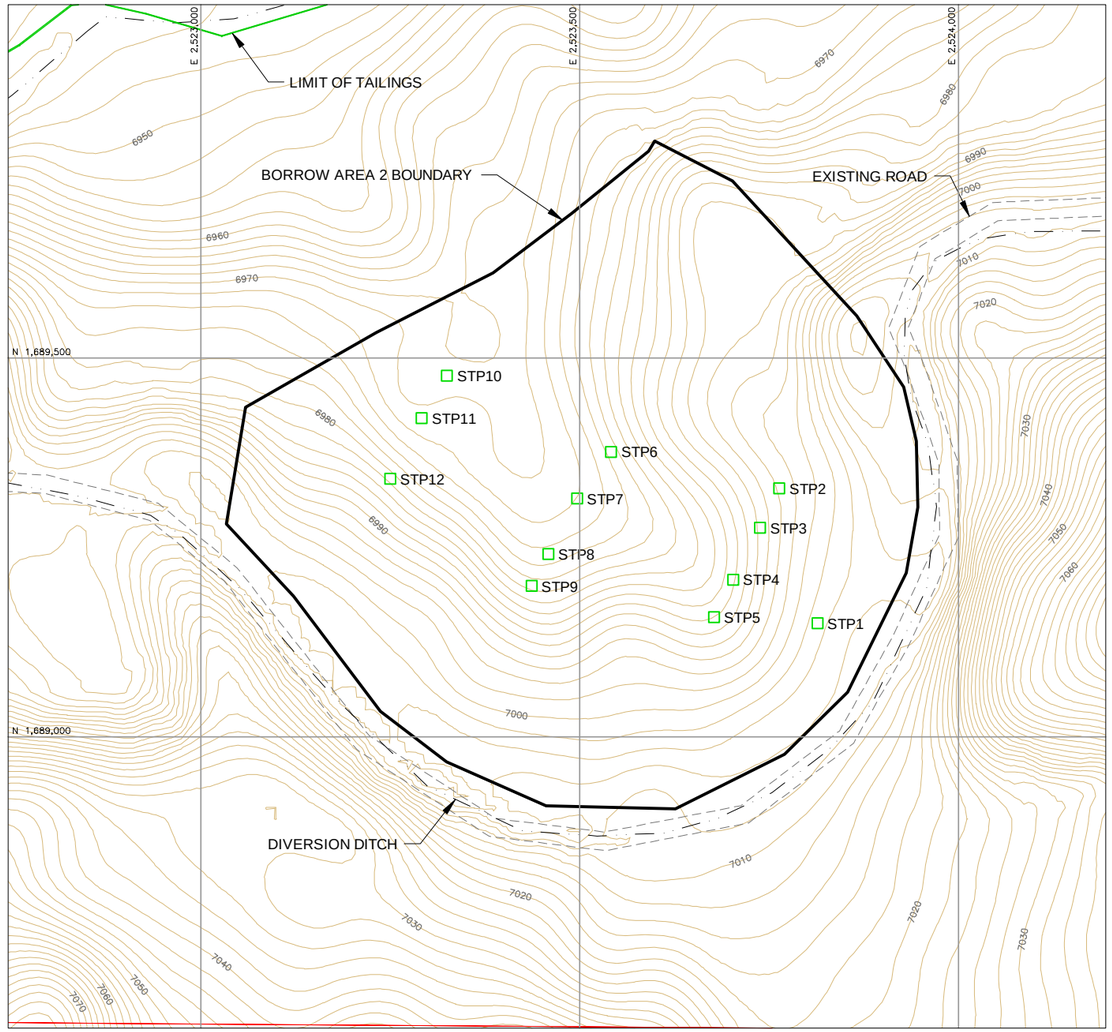
P.O. BOX 3077
Gallup, New Mexico 87305-3077

PROJECT LOCATION: McKINLEY COUNTY, NEW MEXICO
PROJECT: NECR REMOVAL ACTION
TITLE: POTENTIAL BORROW AREA LOCATIONS
FIGURE: BA-1
DATE: FEB 2012
FILE NAME: 1012217D008

MWH



BORROW AREA 1 TEST PIT LOCATIONS



BORROW AREA 2 TEST PIT LOCATIONS

LEGEND:

- NECR CELL BOUNDARY
- PLSS SECTION LINE
- NTP13 APPROXIMATE BORROW TEST PIT LOCATION

SCALE
100' 0 100' 200'

P.O. BOX 3077
Gallup, New Mexico 87305-3077

PROJECT LOCATION: McKINLEY COUNTY, NEW MEXICO
PROJECT: NECR REMOVAL ACTION
TITLE: BORROW AREA TEST PIT LOCATION MAP
FIGURE: BA-2
DATE: JAN 2012
FILE NAME: 1012217D010

MWH

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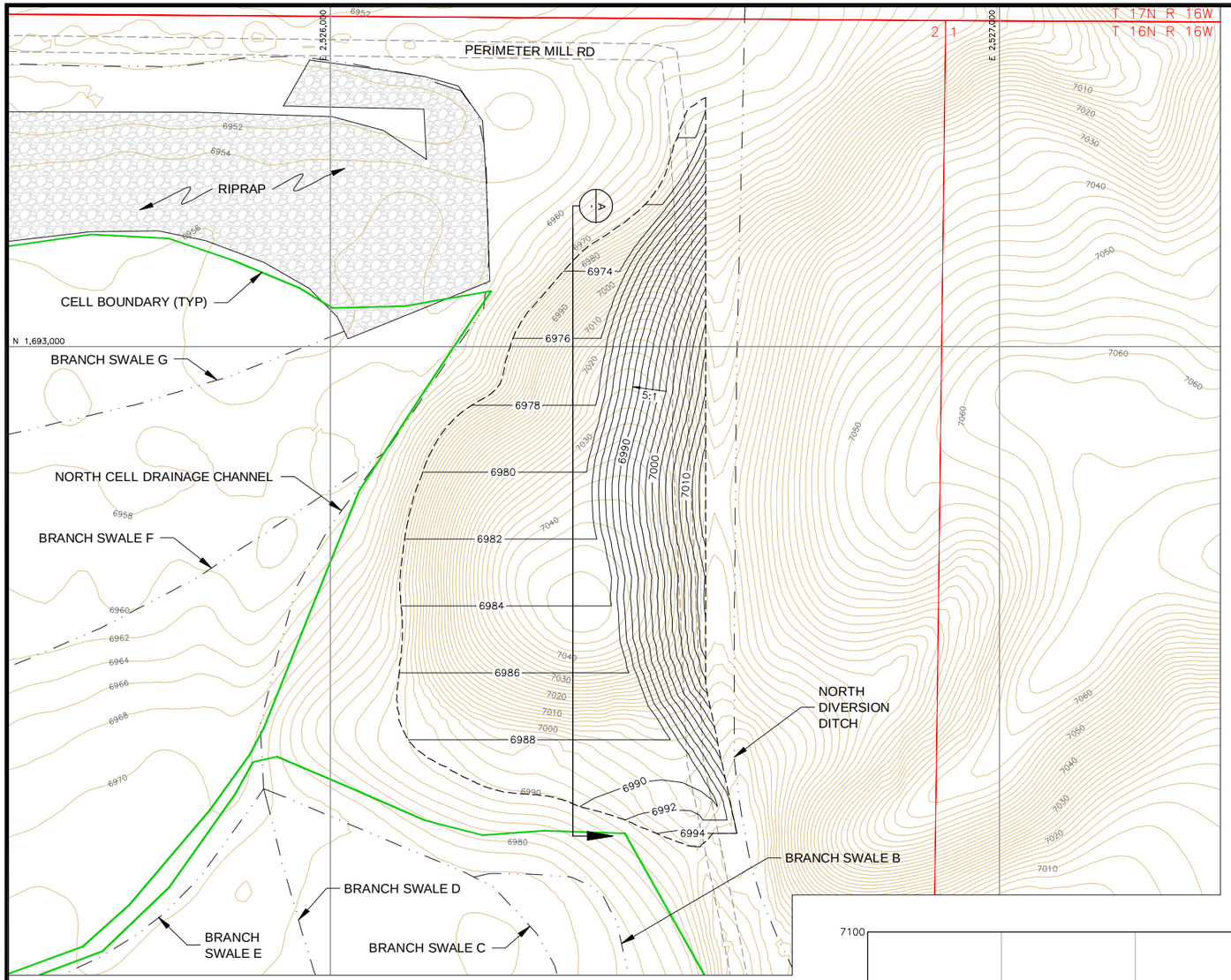
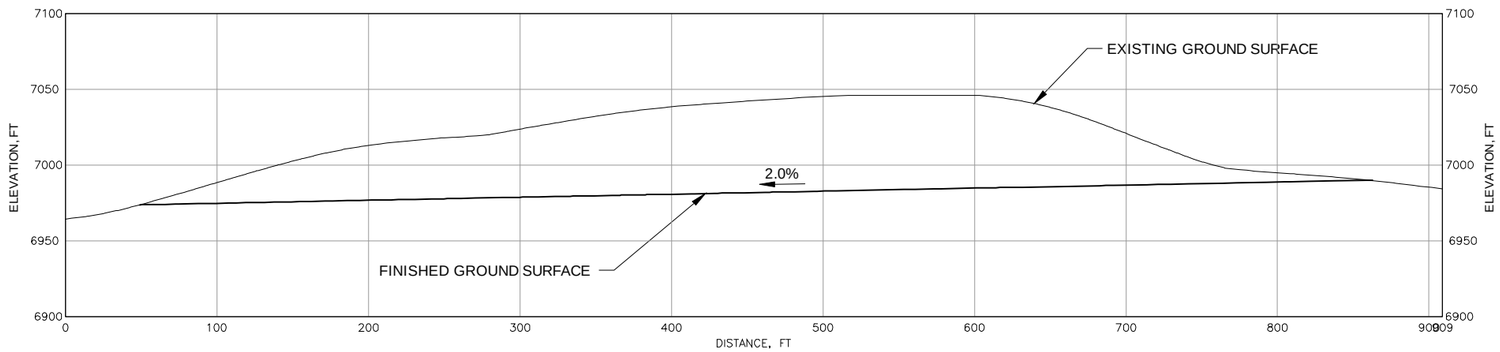


PLAN

SCALE
100' 0 100' 200'
CONTOUR INTERVAL = 2 FEET

LEGEND:

- 6980 — EXISTING GROUND SURFACE CONTOUR ELEVATION, FT
- 6980 — FINISHED GROUND SURFACE CONTOUR, FT
- EXISTING ROADS
- PLSS SECTION LINE



SECTION A

SCALE
50' 0 50' 100'

P.O. BOX 3077
Gallup, New Mexico 87305-3077

PROJECT LOCATION: McKINLEY COUNTY, NEW MEXICO
PROJECT: NECR REMOVAL ACTION
TITLE: DILCO HILL BORROW AREA
FIGURE: BA-3
DATE: JAN 2012
FILE NAME: 1012217D009

MWH

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APPENDIX A3

SUMMARY OF GEOTECHNICAL DATA

DWYER ENGINEERING, LLC

MEMO

To: Lance Hauer

From: Steve Dwyer

Date: 01/03/2012

Re: Summary of NECR Geotechnical Data available to date

Message:

The following tables summarize the available geotechnical data collected to date from the NECR site. The data includes samples tested by AMEC in 2008 as well as samples collected from the Interim Removal Area in 2011.

AMEC Samples

The AMEC samples were taken from Borrow Pit 1, Borrow Pit 2, and a Topsoil Stockpile. The date of the AMEC results is December 2, 2008.

Table 1. AMEC Results

Sample	Ksat (cm/sec)	% Sand	% Silt	% Clay	USDA Classification
Borrow Pit 1	1.41E-04	35.8	31.9	33.6	Clay Loam
Borrow Pit 2	4.19E-04	46.2	24.1	29.6	Sandy Clay Loam
Topsoil Stockpile	1.27E-04	34.5	31.9	33.6	Clay Loam

Figure 1. AMEC Sample Locations

Interim Removal Area Samples

The soil samples taken from the Interim Removal Area were tested at a local geotechnical laboratory and are summarized as follows:

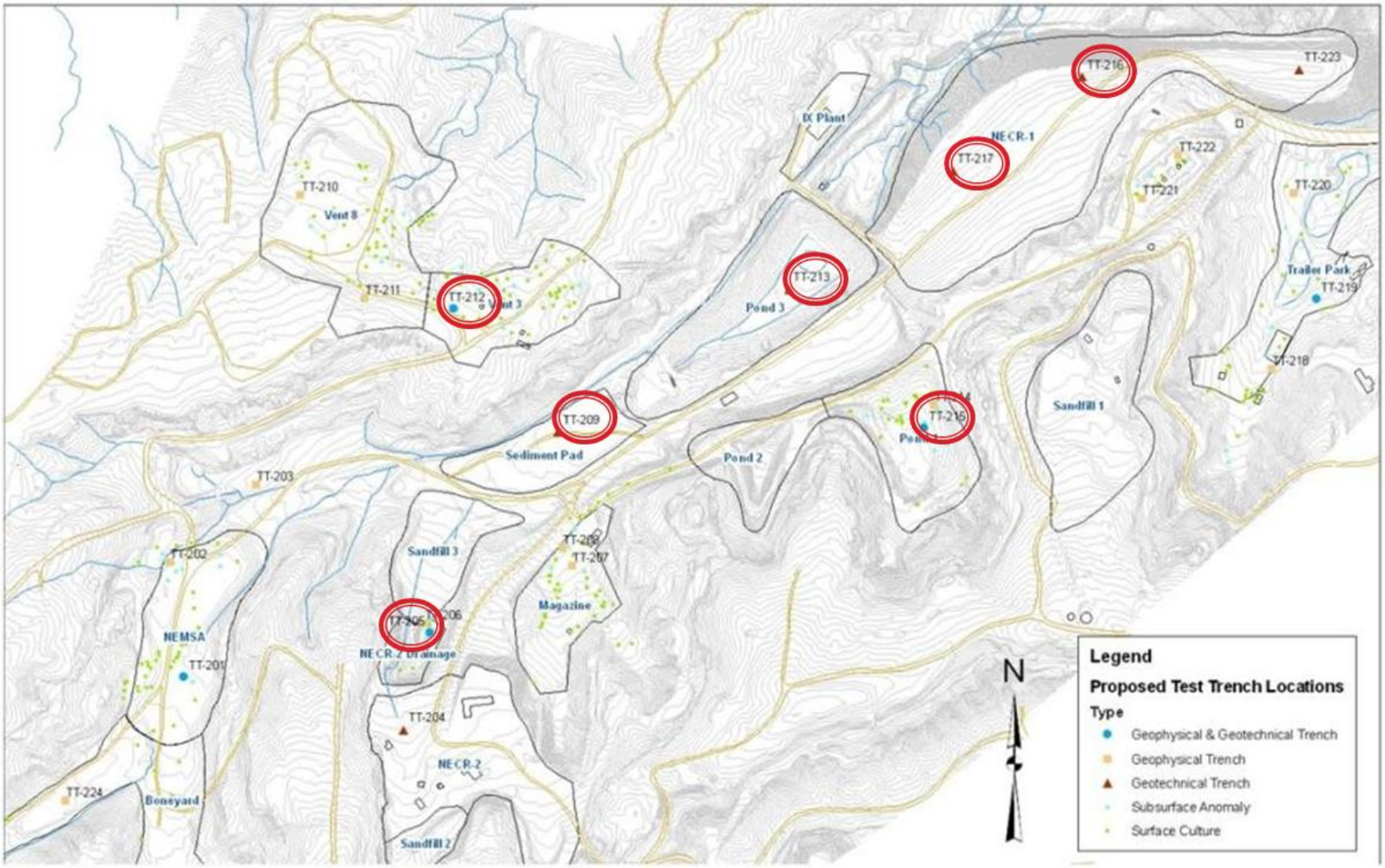

Figure 2. Interim Action Soil Sample Locations

Table 2. Summary of Interim Action Sample Preparations

Summary of Sample Preparation/Volume Changes														
Sample Number	**Proctor Data**		**Target Remold Parameters[1]**			**Actual Remold Data**			**Volume Change Post Saturation[2]**			**Volume Change Post Drying Curve[3]**		
	Opt. Moist. Cont.	Max. Dry Density	Moist. Cont.	Dry Bulk Density	% of Max. Density	Moist. Cont.	Dry Bulk Density	% of Max. Density	Dry Bulk Density	% Volume Change	% of Max. Density	Dry Bulk Density	% Volume Change	% of Max. Density
	(%, g/g)	(g/cm^3)	(%, g/g)	(g/cm^3)	(%)	(%, g/g)	(g/cm^3)	(%)	(g/cm^3)	(%)	(%)	(g/cm^3)	(%)	(%)
TT-205-GT1	13.9	1.78	13.9	1.60	90%	13.9	1.60	89.9%	1.60	---	89.9%	1.60	---	89.9%
TT-209-GT1	11.6	1.88	11.6	1.69	90%	11.4	1.69	90.3%	1.69	---	90.3%	1.72	-1.5%	91.7%
TT-212-GT1	---	---	13.9	1.60	90%	14.4	1.59	89.6%	1.64	-2.6%	92.1%	1.67	-4.6%	94.0%
TT-213-GT1	13.5	1.85	13.5	1.66	90%	13.5	1.66	90.0%	1.66	---	90.0%	1.66	---	90.0%
TT-215-GT1	---	---	13.9	1.60	90%	14.6	1.59	89.5%	1.59	---	89.5%	1.59	---	89.5%
TT-216-GT2	---	---	13.9	1.60	90%	14.1	1.59	89.6%	1.59	---	89.6%	1.59	---	89.6%
TT-217-GT1	11.4	1.84	11.4	1.65	90%	11.4	1.66	90.2%	1.66	---	90.2%	1.69	-2.1%	92.1%

Table 3. Summary of Interim Action Grain Size Distribution

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)	% Fines Clay + Silt	USDA Classification
TT-205-GT1	5.4	67.5	16.3	10.8	27.1	Sandy Loam
TT-209-GT1	3.1	81.8	7.4	7.6	15.0	Loamy Sand
TT-212-GT1	1.2	80.3	8.4	10.1	18.5	Loamy Sand
TT-213-GT1	1.0	65.2	20.9	13.0	33.9	Sandy Loam
TT-215-GT1	25.5	41.8	21.1	11.7	32.8	Sandy Loam
TT-216-GT2	1.7	56.4	25.9	16.1	42.0	Sandy Loam
TT-217-GT1	0.0	87.9	6.9	5.1	12.1	Sand

Table 4. Summary of Interim Action Hydraulic Properties

Summary of Hydraulic Properties					
Sample Number	α (cm^{-1})	**N** (dimensionless)	θ_r (% vol)	θ_s (% vol)	**K_{sat} (cm/sec)**
TT-205-GT1	0.0525	1.2338	0.00	37.74	2.2E-04
TT-209-GT1	0.0378	1.3596	1.25	35.64	1.8E-03
TT-212-GT1	0.0363	1.4247	2.01	40.83	3.1E-03
TT-213-GT1	0.0184	1.2306	0.00	35.58	1.1E-04
TT-215-GT1	0.0056	1.2674	0.00	36.52	9.7E-06
TT-216-GT2	0.0192	1.2335	0.00	35.95	5.4E-05
TT-217-GT1	0.0381	1.4302	1.33	33.77	2.6E-03

APPENDIX B

PRE-DESIGN STUDIES

APPENDIX B1

LABORATORY TEST REPORTS

APPENDIX B1.1

ANALYTICAL TEST RESULTS

ENERGY LABORATORIES

ENERGY LABORATORIES
www.energylab.com
Analytical Excellence Since 1952
Helena, MT 877-472-0711 • Billings, MT 800-735-4489 • Casper, WY 888-235-0515
Gillette, WY 866-686-7175 • Rapid City, SD 888-672-1225 • College Station, TX 888-690-2218

ANALYTICAL SUMMARY REPORT

January 31, 2014

Montgomery Watson Harza
1475 Pine Grove Rd Ste 109
Steamboat Springs, CO 80477

Workorder No.: C13120735

Project Name: Church Rock Pre-Design Study

Energy Laboratories, Inc. Casper WY received the following 9 samples for Montgomery Watson Harza on 12/20/2013 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
C13120735-001	TI-CS02-01 [0-7]inches	11/12/13 0:00	12/20/13	Soil	Cation Exchange Capacity Metals, NH4OAc Extractable Metals, Saturated Paste Conductivity Exchangeable Sodium Percentage Lime as CaCO3 Total Kjeldahl Nitrogen Organic Carbon/Matter Walkely-Black Soluble Metals from Paste pH, Saturated Paste Phosphorus-Olsen CEC NH4AC Soil Extraction Gamma Sample Preparation Lime Percentage NH4AC Soil Extraction Saturated Paste Total Organic Matter Prep Gross Gamma Sodium Adsorption Ratio Saturation Percentage
C13120735-002	TI-CS07-01 [0-6]inches	11/13/13 10:55	12/20/13	Soil	Same As Above
C13120735-003	TI-CS11-01 [0-6]inches	11/13/13 14:35	12/20/13	Soil	Same As Above
C13120735-004	WB-B2-04 [0-10]inches	11/14/13 16:00	12/20/13	Soil	Same As Above
C13120735-005	EB-B4-03 [0-10]inches	12/10/13 11:40	12/20/13	Soil	Same As Above
C13120735-006	SB-B4-01 [0-15]inches	12/12/13 16:45	12/20/13	Soil	Same As Above
C13120735-007	NB-B1-04 [0-15]inches	12/12/13 14:25	12/20/13	Soil	Same As Above
C13120735-008	DH-B3-02 [0-10]inches	12/11/13 14:40	12/20/13	Soil	Same As Above
C13120735-009	Topsoil Stockpile	11/21/13 15:35	12/20/13	Soil	Same As Above

The results as reported relate only to the item(s) submitted for testing. The analyses presented in this report were performed at Energy Laboratories, Inc., 2393 Salt Creek Hwy., Casper, WY 82601, unless otherwise noted. Radiochemistry analyses were performed at Energy Laboratories, Inc., 2325 Kerzell Lane, Casper, WY 82601, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

If you have any questions regarding these test results, please call.

Report Approved By:

Stephanie D Waldrop
Reporting Supervisor

Digitally signed by
Stephanie Waldrop
Date: 2014.01.31 12:03:16 -07:00

CLIENT: Montgomery Watson Harza
Project: Church Rock Pre-Design Study
Sample Delivery Group: C13120735

Report Date: 01/31/14

CASE NARRATIVE

LEVEL III COMMENTS
Included with the analysis reports are instrument data reports for all analysis associated with the instrument calibration, QC sample analysis, and sample analysis for Gamma results. All analytical data is within method QA/QC specifications except as noted on analyses and/or QC summary reports, or in this narrative. The analytical report identifies which QC batch ID and sequence QC is associated with each analysis result for a sample. The results of this Analytical Report relate only to the items submitted for analysis. Only the raw data associated with parameters listed on this report should be validated.

BRANCH LABORATORY SUBCONTRACT ANALYSIS
Tests associated with analyst identified as ELI-B were subcontracted to Energy Laboratories, 1120 S. 27th St., Billings, MT, EPA Number MT00005.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID TI-CS02-01 [0-7]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-001
Collection Date: 11/12/13
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	43.9	%		0.1		USDA27a	01/07/14 09:35 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	2	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.95	mmhos/cm		0.01		ASAM10-3	01/07/14 10:55 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	3	40253
pH, sat. paste	7.7	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	1	40253
Calcium, sat. paste	30.4	meq/L		0.05		SW6010B	01/14/14 17:49 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	97	40253
Magnesium, sat. paste	8.36	meq/L		0.08		SW6010B	01/14/14 17:49 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	97	40253
Potassium, sat. paste	0.87	meq/L		0.03		SW6010B	01/14/14 17:49 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	97	40253
Sodium, sat. paste	1.04	meq/L		0.04		SW6010B	01/14/14 17:49 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	97	40253
Sodium Adsorption Ratio (SAR)	0.2	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	1	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	2.5	%		0.1		USDA23c	01/07/14 11:21 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	3	40270
Organic Matter	1.5	%		0.2		ASA29-3	12/30/13 10:12 / dm	12/30/13 08:37	ASA29-3	OC_131230A	3	40199
Total Kjeldahl Nitrogen	448	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	1	B_R217865
Cation Exchange Capacity	30.5	meq/100g		0.6		SW6010B	12/31/13 18:06 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	64	40195
Potassium	309	mg/kg-dry		10		SW6010B	12/27/13 17:09 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	80	40182
Sodium	40	mg/kg-dry	D	2		SW6010B	12/27/13 17:09 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	80	40182
Sodium, soluble	10.5	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	1	140130ALTU
Exchangeable Sodium Percentage	0.4	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	1	R182830
Phosphorus, Olsen	7	mg/kg		1		ASA24-5	01/03/14 15:55 / eli-			SUB-B217349	4	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	3	40160
Radium 226 precision (±)	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	3	40160
Radium 226 MDC	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	3	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID TI-CS07-01 [0-6]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-002
Collection Date: 11/13/13 10:55
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	38.4	%		0.1		USDA27a	01/07/14 09:36 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	3	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	0.81	mmhos/cm		0.01		ASAM10-3	01/07/14 10:56 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	4	40253
pH, sat. paste	7.8	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	2	40253
Calcium, sat. paste	6.27	meq/L		0.05		SW6010B	01/14/14 18:33 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	109	40253
Magnesium, sat. paste	1.94	meq/L		0.08		SW6010B	01/14/14 18:33 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	109	40253
Potassium, sat. paste	0.40	meq/L		0.03		SW6010B	01/14/14 18:33 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	109	40253
Sodium, sat. paste	0.29	meq/L		0.04		SW6010B	01/14/14 18:33 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	109	40253
Sodium Adsorption Ratio (SAR)	0.1	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	2	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	2.1	%		0.1		USDA23c	01/07/14 11:27 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	4	40270
Organic Matter	1.5	%		0.2		ASA29-3	12/30/13 10:15 / dm	12/30/13 08:37	ASA29-3	OC_131230A	4	40199
Total Kjeldahl Nitrogen	392	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	3	B_R217865
Cation Exchange Capacity	24.8	meq/100g		0.6		SW6010B	12/31/13 18:10 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	65	40195
Potassium	251	mg/kg-dry		10		SW6010B	12/27/13 17:13 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	81	40182
Sodium	10	mg/kg-dry	D	2		SW6010B	12/27/13 17:13 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	81	40182
Sodium, soluble	2.6	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	2	140130ALTU
Exchangeable Sodium Percentage	0.1	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	2	R182830
Phosphorus, Olsen	8	mg/kg		1		ASA24-5	01/03/14 15:56 / eli-			SUB-B217349	5	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.7	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	4	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	4	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	4	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID TI-CS11-01 [0-6]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-003
Collection Date: 11/13/13 14:35
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	37.5	%		0.1		USDA27a	01/07/14 09:36 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	4	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.81	mmhos/cm		0.01		ASAM10-3	01/07/14 10:56 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	5	40253
pH, sat. paste	7.7	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	3	40253
Calcium, sat. paste	23.9	meq/L		0.05		SW6010B	01/14/14 18:36 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	110	40253
Magnesium, sat. paste	8.23	meq/L		0.08		SW6010B	01/14/14 18:36 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	110	40253
Potassium, sat. paste	0.95	meq/L		0.03		SW6010B	01/14/14 18:36 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	110	40253
Sodium, sat. paste	4.19	meq/L		0.04		SW6010B	01/14/14 18:36 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	110	40253
Sodium Adsorption Ratio (SAR)	1.0	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	3	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	3.4	%		0.1		USDA23c	01/07/14 11:33 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	5	40270
Organic Matter	1.3	%		0.2		ASA29-3	12/30/13 10:17 / dm	12/30/13 08:37	ASA29-3	OC_131230A	5	40199
Total Kjeldahl Nitrogen	336	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	4	B_R217865
Cation Exchange Capacity	22.0	meq/100g		0.6		SW6010B	12/31/13 18:14 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	66	40195
Potassium	268	mg/kg-dry		10		SW6010B	12/27/13 17:16 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	82	40182
Sodium	80	mg/kg-dry	D	2		SW6010B	12/27/13 17:16 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	82	40182
Sodium, soluble	36.2	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	3	140130ALTU
Exchangeable Sodium Percentage	0.9	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	3	R182830
Phosphorus, Olsen	7	mg/kg		1		ASA24-5	01/03/14 15:58 / eli-			SUB-B217349	6	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.0	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	5	40160
Radium 226 precision (±)	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	5	40160
Radium 226 MDC	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	5	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID WB-B2-04 [0-10]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-004
Collection Date: 11/14/13 16:00
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	36.5	%		0.1		USDA27a	01/07/14 09:37 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	5	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.63	mmhos/cm		0.01		ASAM10-3	01/07/14 10:57 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	6	40253
pH, sat. paste	7.4	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	4	40253
Calcium, sat. paste	27.3	meq/L		0.05		SW6010B	01/14/14 18:40 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	111	40253
Magnesium, sat. paste	9.50	meq/L		0.08		SW6010B	01/14/14 18:40 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	111	40253
Potassium, sat. paste	0.26	meq/L		0.03		SW6010B	01/14/14 18:40 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	111	40253
Sodium, sat. paste	0.87	meq/L		0.04		SW6010B	01/14/14 18:40 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	111	40253
Sodium Adsorption Ratio (SAR)	0.2	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	4	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	2.8	%		0.1		USDA23c	01/07/14 11:39 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	6	40270
Organic Matter	1.5	%		0.2		ASA29-3	12/30/13 10:19 / dm	12/30/13 08:37	ASA29-3	OC_131230A	6	40199
Total Kjeldahl Nitrogen	280	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	5	B_R217865
Cation Exchange Capacity	25.2	meq/100g		0.6		SW6010B	12/31/13 18:17 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	67	40195
Potassium	94	mg/kg-dry		10		SW6010B	12/27/13 17:20 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	83	40182
Sodium	23	mg/kg-dry	D	2		SW6010B	12/27/13 17:20 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	83	40182
Sodium, soluble	7.3	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	4	140130ALTU
Exchangeable Sodium Percentage	0.3	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	4	R182830
Phosphorus, Olsen	6	mg/kg		1		ASA24-5	01/03/14 16:02 / eli-			SUB-B217349	7	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.0	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	6	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	6	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	6	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID EB-B4-03 [0-10]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-005
Collection Date: 12/10/13 11:40
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	43.0	%		0.1		USDA27a	01/07/14 09:37 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	6	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	3.30	mmhos/cm		0.01		ASAM10-3	01/07/14 10:57 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	7	40253
pH, sat. paste	7.7	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	5	40253
Calcium, sat. paste	27.9	meq/L		0.05		SW6010B	01/14/14 18:43 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	112	40253
Magnesium, sat. paste	13.1	meq/L		0.08		SW6010B	01/14/14 18:43 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	112	40253
Potassium, sat. paste	0.46	meq/L		0.03		SW6010B	01/14/14 18:43 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	112	40253
Sodium, sat. paste	3.35	meq/L		0.04		SW6010B	01/14/14 18:43 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	112	40253
Sodium Adsorption Ratio (SAR)	0.7	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	5	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	2.3	%		0.1		USDA23c	01/07/14 11:44 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	7	40270
Organic Matter	0.9	%		0.2		ASA29-3	12/30/13 10:22 / dm	12/30/13 08:37	ASA29-3	OC_131230A	7	40199
Total Kjeldahl Nitrogen	280	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	6	B_R217865
Cation Exchange Capacity	25.5	meq/100g		0.6		SW6010B	12/31/13 18:21 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	68	40195
Potassium	178	mg/kg-dry		10		SW6010B	12/27/13 17:24 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	84	40182
Sodium	83	mg/kg-dry	D	2		SW6010B	12/27/13 17:24 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	84	40182
Sodium, soluble	33.1	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	5	140130ALTU
Exchangeable Sodium Percentage	0.8	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	5	R182830
Phosphorus, Olsen	6	mg/kg		1		ASA24-5	01/03/14 16:04 / eli-			SUB-B217349	8	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.1	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	7	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	7	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	7	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID SB-B4-01 [0-15]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-006
Collection Date: 12/12/13 16:45
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	47.9	%		0.1		USDA27a	01/07/14 09:38 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	7	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.66	mmhos/cm		0.01		ASAM10-3	01/07/14 10:58 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	8	40253
pH, sat. paste	7.8	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	6	40253
Calcium, sat. paste	26.1	meq/L		0.05		SW6010B	01/14/14 18:51 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	114	40253
Magnesium, sat. paste	10.3	meq/L		0.08		SW6010B	01/14/14 18:51 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	114	40253
Potassium, sat. paste	0.72	meq/L		0.03		SW6010B	01/14/14 18:51 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	114	40253
Sodium, sat. paste	1.20	meq/L		0.04		SW6010B	01/14/14 18:51 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	114	40253
Sodium Adsorption Ratio (SAR)	0.3	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	6	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	6.1	%		0.1		USDA23c	01/07/14 11:50 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	8	40270
Organic Matter	0.8	%		0.2		ASA29-3	12/30/13 10:25 / dm	12/30/13 08:37	ASA29-3	OC_131230A	8	40199
Total Kjeldahl Nitrogen	336	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	7	B_R217865
Cation Exchange Capacity	24.5	meq/100g		0.6		SW6010B	12/31/13 18:25 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	69	40195
Potassium	292	mg/kg-dry		10		SW6010B	12/27/13 17:42 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	89	40182
Sodium	49	mg/kg-dry	D	2		SW6010B	12/27/13 17:42 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	89	40182
Sodium, soluble	13.2	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	6	140130ALTU
Exchangeable Sodium Percentage	0.6	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	6	R182830
Phosphorus, Olsen	7	mg/kg		1		ASA24-5	01/03/14 16:05 / eli-			SUB-B217349	9	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.0	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	8	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	8	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	8	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID NB-B1-04 [0-15]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-007
Collection Date: 12/12/13 14:25
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	38.3	%		0.1		USDA27a	01/07/14 09:38 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	8	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	1.01	mmhos/cm		0.01		ASAM10-3	01/07/14 10:58 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	9	40253
pH, sat. paste	8.0	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	7	40253
Calcium, sat. paste	5.34	meq/L		0.05		SW6010B	01/14/14 18:54 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	115	40253
Magnesium, sat. paste	3.18	meq/L		0.08		SW6010B	01/14/14 18:54 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	115	40253
Potassium, sat. paste	0.16	meq/L		0.03		SW6010B	01/14/14 18:54 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	115	40253
Sodium, sat. paste	2.37	meq/L		0.04		SW6010B	01/14/14 18:54 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	115	40253
Sodium Adsorption Ratio (SAR)	1.1	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	7	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	6.6	%		0.1		USDA23c	01/07/14 11:54 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	9	40270
Organic Matter	0.4	%		0.2		ASA29-3	12/30/13 10:26 / dm	12/30/13 08:37	ASA29-3	OC_131230A	9	40199
Total Kjeldahl Nitrogen	280	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	8	B_R217865
Cation Exchange Capacity	20.4	meq/100g		0.6		SW6010B	12/31/13 18:28 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	70	40195
Potassium	136	mg/kg-dry		10		SW6010B	12/27/13 17:45 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	90	40182
Sodium	69	mg/kg-dry	D	2		SW6010B	12/27/13 17:45 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	90	40182
Sodium, soluble	20.9	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	7	140130ALTU
Exchangeable Sodium Percentage	1.0	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	7	R182830
Phosphorus, Olsen	7	mg/kg		1		ASA24-5	01/03/14 16:06 / eli-			SUB-B217349	10	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	0.8	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	9	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	9	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	9	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID DH-B3-02 [0-10]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-008
Collection Date: 12/11/13 14:40
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	34.2	%		0.1		USDA27a	01/07/14 09:38 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	9	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	1.84	mmhos/cm		0.01		ASAM10-3	01/07/14 10:59 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	10	40253
pH, sat. paste	7.8	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	8	40253
Calcium, sat. paste	7.07	meq/L		0.05		SW6010B	01/14/14 18:58 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	116	40253
Magnesium, sat. paste	4.26	meq/L		0.08		SW6010B	01/14/14 18:58 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	116	40253
Potassium, sat. paste	0.05	meq/L		0.03		SW6010B	01/14/14 18:58 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	116	40253
Sodium, sat. paste	9.61	meq/L		0.04		SW6010B	01/14/14 18:58 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	116	40253
Sodium Adsorption Ratio (SAR)	4.0	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	8	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	0.4	%	B	0.1		USDA23c	01/07/14 12:00 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	10	40270
Organic Matter	0.2	%		0.2		ASA29-3	12/30/13 10:29 / dm	12/30/13 08:37	ASA29-3	OC_131230A	10	40199
Total Kjeldahl Nitrogen	168	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	9	B_R217865
Cation Exchange Capacity	10.3	meq/100g		0.6		SW6010B	12/31/13 18:32 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	71	40195
Potassium	42	mg/kg-dry		10		SW6010B	12/27/13 17:49 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	91	40182
Sodium	155	mg/kg-dry	D	2		SW6010B	12/27/13 17:49 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	91	40182
Sodium, soluble	75.6	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	8	140130ALTU
Exchangeable Sodium Percentage	3.3	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	8	R182830
Phosphorus, Olsen	6	mg/kg		1		ASA24-5	01/03/14 16:08 / eli-			SUB-B217349	11	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.3	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	10	40160
Radium 226 precision (±)	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	10	40160
Radium 226 MDC	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	10	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
B - The analyte was detected in the method blank.
ND - Not detected at the reporting limit.
D - RL increased due to sample matrix.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID Topsoil Stockpile
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-009
Collection Date: 11/21/13 15:35
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	51.1	%		0.1		USDA27a	01/07/14 09:39 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	10	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.30	mmhos/cm		0.01		ASAM10-3	01/07/14 10:59 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	11	40253
pH, sat. paste	7.9	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	9	40253
Calcium, sat. paste	11.1	meq/L		0.05		SW6010B	01/14/14 19:02 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	117	40253
Magnesium, sat. paste	7.99	meq/L		0.08		SW6010B	01/14/14 19:02 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	117	40253
Potassium, sat. paste	0.20	meq/L		0.03		SW6010B	01/14/14 19:02 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	117	40253
Sodium, sat. paste	7.16	meq/L		0.04		SW6010B	01/14/14 19:02 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	117	40253
Sodium Adsorption Ratio (SAR)	2.3	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	9	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	5.4	%		0.1		USDA23c	01/07/14 12:05 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	11	40270
Organic Matter	0.4	%		0.2		ASA29-3	12/30/13 10:30 / dm	12/30/13 08:37	ASA29-3	OC_131230A	11	40199
Total Kjeldahl Nitrogen	224	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	10	B_R217865
Cation Exchange Capacity	33.5	meq/100g		0.6		SW6010B	12/31/13 18:50 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	76	40195
Potassium	196	mg/kg-dry		10		SW6010B	12/27/13 17:52 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	92	40182
Sodium	228	mg/kg-dry	D	2		SW6010B	12/27/13 17:52 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	92	40182
Sodium, soluble	84.1	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	9	140130ALTU
Exchangeable Sodium Percentage	1.9	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	9	R182830
Phosphorus, Olsen	4	mg/kg		1		ASA24-5	01/03/14 16:12 / eli-			SUB-B217349	14	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.0	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	11	40160
Radium 226 precision (±)	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	11	40160
Radium 226 MDC	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	11	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA24-5									Batch: B_14010301-PS3	
Sample ID: LCS	Laboratory Control Sample					Run: SUB-B217349			01/03/14 15:42	
Phosphorus, Olsen		12	mg/kg	1.0	93	50	150			
Sample ID: B13121331-001ADUP	Sample Duplicate					Run: SUB-B217349			01/03/14 15:49	
Phosphorus, Olsen		6.9	mg/kg-dry	1.0				8.3	30	
Sample ID: B13121331-001AMS	Sample Matrix Spike					Run: SUB-B217349			01/03/14 15:51	
Phosphorus, Olsen		18	mg/kg-dry	1.0	96	50	150			
Sample ID: C13120735-008A	Sample Duplicate					Run: SUB-B217349			01/03/14 16:09	
Phosphorus, Olsen		5.2	mg/kg	1.0				12	30	
Sample ID: C13120735-008A	Sample Matrix Spike					Run: SUB-B217349			01/03/14 16:11	
Phosphorus, Olsen		18	mg/kg	1.0	117	50	150			

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA29-3										Batch: 40199
Sample ID: MB-40199		Method Blank				Run: OC_131230A				12/30/13 10:06
Organic Matter		ND	%	0.2						
Sample ID: LCS1-40199		Laboratory Control Sample				Run: OC_131230A				12/30/13 10:08
Organic Matter		1.45482	%		1.01	80	120			
Sample ID: C13120735-009ADUP		Sample Duplicate				Run: OC_131230A				12/30/13 10:32
Organic Matter		0.395121	%					0.107997	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA31-3										Batch: B_R217865
Sample ID: C13120735-001A	Sample Duplicate					Run: SUB-B217865				01/15/14 11:20
Total Kjeldahl Nitrogen		448	mg/kg	10				0.0	30	
Sample ID: LCS-1401151120	Laboratory Control Sample					Run: SUB-B217865				01/15/14 11:20
Total Kjeldahl Nitrogen		616	mg/kg	10	94	50	150			
Sample ID: C13120735-001A	Sample Matrix Spike					Run: SUB-B217865				01/15/14 11:22
Total Kjeldahl Nitrogen		3360	mg/kg	10	73	50	150			

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASAM10-3									Analytical Run: COND1-C_140107A	
Sample ID: CCV1_140107A	Continuing Calibration Verification Standard								01/07/14 10:54	
Conductivity, sat. paste		5.00	mmhos/cm	0.010	100	90	110			
Method: ASAM10-3									Batch: 40253	
Sample ID: LCS1-40253	Laboratory Control Sample					Run: COND1-C_140107A			01/07/14 10:55	
Conductivity, sat. paste		3.31	mmhos/cm	0.010	97	80	120			
Sample ID: C13120735-009ADUP	Sample Duplicate					Run: COND1-C_140107A			01/07/14 10:59	
Conductivity, sat. paste		2.24	mmhos/cm	0.010				2.6	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASAM10-3.2										Batch: 40253
Sample ID: C13120735-009ADUP	Sample Duplicate					Run: ORION 3 STAR PH_140107A				01/07/14 09:10
pH, sat. paste		7.91	s.u.	0.10				0.3	20	
Sample ID: LCS1-40253	Laboratory Control Sample					Run: ORION 3 STAR PH_140107A				01/07/14 09:10
pH, sat. paste		7.07	s.u.	0.10	100	90	110			

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E901.1										Batch: 40160
Sample ID: LCS-R182728		Laboratory Control Sample				Run: GAM-HPGE_140115A				01/15/14 08:20
Bismuth 214		7.8	pCi/g-dry		90	70	130			
- The LCS sample uses Bi214 for Ra226.										
Sample ID: MB-R182728	2	Method Blank				Run: GAM-HPGE_140115A				01/15/14 08:20
Radium 226		ND	pCi/g-dry							U
Radium 226 precision (±)		ND	pCi/g-dry							
Sample ID: C13120735-009ADUP	3	Sample Duplicate				Run: GAM-HPGE_140115A				01/15/14 08:20
Radium 226		0.7	pCi/g-dry					35	20	R
Radium 226 precision (±)		0.4	pCi/g-dry							
Radium 226 MDC		0.5	pCi/g-dry							
- Duplicate RPD is outside of the acceptance range for this analysis; however, the RER of 0.9 is less than the limit of 2.0. This batch is approved.										

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
U - Not detected at minimum detectable concentration
ND - Not detected at the reporting limit.
R - RPD exceeds advisory limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Analytical Run: ICP4-C_131227A	
Sample ID: ICV	2	Initial Calibration Verification Standard							12/27/13 12:43	
Potassium		49.6	mg/L	0.50	99	90	110			
Sodium		50.083	mg/L		1	90	110			
Sample ID: ICSA	2	Interference Check Sample A							12/27/13 12:57	
Potassium		0.00360	mg/L	0.50						
Sodium		-0.29403	mg/L		0					
Sample ID: ICSAB	2	Interference Check Sample AB							12/27/13 13:01	
Potassium		-0.00757	mg/L	0.50						
Sodium		-0.39872	mg/L		0					
Method: SW6010B									Batch: 40182	
Sample ID: MB-40182	2	Method Blank				Run: ICP4-C_131227A			12/27/13 16:54	
Potassium		ND	mg/kg-dry	40						
Sodium		ND	mg/kg-dry	100						
Sample ID: LCS1-40182	2	Laboratory Control Sample				Run: ICP4-C_131227A			12/27/13 16:58	
Potassium		341	mg/kg-dry	42	131	63	136			
Sodium		182.542	mg/kg-dry		1.09	25	100			S
Sample ID: C13120735-009ADIL	2	Serial Dilution				Run: ICP4-C_131227A			12/27/13 17:56	
Potassium		168	mg/kg-dry	10		0	0			
Sodium		202.063	mg/kg-dry		0	0	0			
Sample ID: C13120735-009ADUP	2	Sample Duplicate				Run: ICP4-C_131227A			12/27/13 18:00	
Potassium		197	mg/kg-dry	10				0.8	20	
Sodium		251.97	mg/kg-dry					0.0977984	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.
S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Analytical Run: ICP4-C_131231A	
Sample ID: ICV		Initial Calibration Verification Standard							12/31/13 14:39	
Sodium		50.7	mg/L	0.50	101	90	110			
Sample ID: ICSA		Interference Check Sample A							12/31/13 14:54	
Sodium		0.0306	mg/L	0.50						
Sample ID: ICSAB		Interference Check Sample AB							12/31/13 14:58	
Sodium		0.0603	mg/L	0.50						
Method: SW6010B									Batch: 40195	
Sample ID: MB-40195		Method Blank				Run: ICP4-C_131231A			12/31/13 17:15	
Sodium		ND	mg/L	100						
Sample ID: LCS1-40195		Laboratory Control Sample				Run: ICP4-C_131231A			12/31/13 17:19	
Sodium		7240	mg/L	150	140	75	138			S
Sample ID: C13120735-009ADIL		Serial Dilution				Run: ICP4-C_131231A			12/31/13 18:53	
Sodium		6900	mg/L	740		0	0		20	N
Sample ID: C13120735-009ADUP		Sample Duplicate				Run: ICP4-C_131231A			12/31/13 18:57	
Sodium		7190	mg/L	150				7.0	20	

Qualifiers:

RL - Analyte reporting limit.

MDC - Minimum detectable concentration

S - Spike recovery outside of advisory limits.

ND - Not detected at the reporting limit.

N - The analyte concentration was not sufficiently high to calculate a RPD for the serial dilution test.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Analytical Run: ICP4-C_140114A	
Sample ID: ICV	4	Initial Calibration Verification Standard							01/14/14 12:22	
Calcium		49.6	mg/L	0.50	99	90	110			
Magnesium		49.3	mg/L	0.50	99	90	110			
Potassium		48.2	mg/L	0.50	96	90	110			
Sodium		49.1	mg/L	0.50	98	90	110			
Sample ID: ICSA	4	Interference Check Sample A							01/14/14 12:36	
Calcium		465	mg/L	0.50	93	80	120			
Magnesium		498	mg/L	0.50	100	80	120			
Potassium		0.0214	mg/L	0.50						
Sodium		-0.00758	mg/L	0.50						
Sample ID: ICSAB	4	Interference Check Sample AB							01/14/14 12:40	
Calcium		462	mg/L	0.50	92	80	120			
Magnesium		496	mg/L	0.50	99	80	120			
Potassium		0.0212	mg/L	0.50						
Sodium		-0.180	mg/L	0.50						
Method: SW6010B									Batch: 40253	
Sample ID: MB-40253	4	Method Blank				Run: ICP4-C_140114A			01/14/14 17:41	
Calcium		ND	mg/L	10						
Magnesium		ND	mg/L	4						
Potassium		ND	mg/L	8						
Sodium		ND	mg/L	8						
Sample ID: LCS1-40253	4	Laboratory Control Sample				Run: ICP4-C_140114A			01/14/14 17:45	
Calcium		610	mg/L	55	100	70	130			
Magnesium		158	mg/L	8.2	106	70	130			
Potassium		ND	mg/L	42		70	130			S
Sodium		166	mg/L	150	104	70	130			
Sample ID: C13120735-009ADUP	4	Sample Duplicate				Run: ICP4-C_140114A			01/14/14 19:23	
Calcium		216	mg/L	1.0				3.3	30	
Magnesium		93.6	mg/L	1.0				3.6	30	
Potassium		7.40	mg/L	1.0				3.8	30	
Sodium		160	mg/L	1.0				3.1	30	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.
S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: USDA23c										Batch: 40270
Sample ID: MB-40270		Method Blank				Run: ORION 3 STAR PH_140107B				01/07/14 11:08
Lime as CaCO3		0.1	%	0.1						
Sample ID: LCS1-40270		Laboratory Control Sample				Run: ORION 3 STAR PH_140107B				01/07/14 11:15
Lime as CaCO3		4.03	%	0.10	104	80	120			
Sample ID: C13120735-009ADUP		Sample Duplicate				Run: ORION 3 STAR PH_140107B				01/07/14 12:10
Lime as CaCO3		5.30	%	0.10				1.9	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: USDA27a										Batch: 40253
Sample ID: LCS1-40253	Laboratory Control Sample					Run: SARTORIUS_140107B				01/07/14 09:35
Saturation		45.6	%	0.10	107	80	120			
Sample ID: C13120735-009ADUP	Sample Duplicate					Run: SARTORIUS_140107B				01/07/14 09:39
Saturation		51.0	%	0.10				0.2	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

Workorder Receipt Checklist

Montgomery Watson Harza

C13120735

Login completed by: Tessa Parke
Date Received: 12/20/2013

Reviewed by: BL2000\swaldrop
Received by: dcq

Reviewed Date: 1/10/2014
Carrier name: Ground

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Applicable ☑
Container/Temp Blank temperature:	N/A°C		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Contact and Corrective Action Comments:

None

2 Buckets

Chain of Custody and Analytical Request Record

Page 1 of 1

PLEASE PRINT- Provide as much information as possible.

Company Name:	Project Name, PWS, Permit, Etc.	Sample Origin	EPA/State Compliance:
MWH Global	Church Rock Pre-Design Study	State: NM	Yes ☐ No ☑
Report Mail Address: 3665 JFK Parkway, Bldg. 1, Suite 206, Fort Collins, CO 80525	**Contact Name:** Jason Cumbers	**Phone/Fax:** (970) 377-9410	**Email:**
			Sampler: (Please Print) Robert Schaut
Invoice Address: Same	**Invoice Contact & Phone:** Jason Cumbers (970) 377-9410	**Purchase Order:**	**Quote/Bottle Order:**

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

☐ DW ☐ A2LA
☐ GSA ☐ EDD/EDT (Electronic Data)
☐ POTW/WWTP Format:_____
☐ State: _____ ☐ LEVEL IV
☐ Other: _____ ☐ NELAC

Number of Containers
Sample Type: Air Water Soils/Solids Vegetation Bioassay Other

ANALYSIS REQUESTED

SEE ATTACHED

Normal Turnaround (TAT)

RUSH

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by: UPS Ground
Cooler ID(s): 2 Buckets
Receipt Temp N/A °C
On Ice: Yes No N/A
Custody Seal (Y) N
Intact (Y) N
Signature Match (Y) N

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	SEE ATTACHED	Normal TAT	RUSH
1	TI - CS02 - 01 (0 - 7")	11/12/13	—	Soil	X		
2	TI - CS07 - 01 (0 - 6")	11/13/13	10:55	Soil	X		
3	TI - CS11 - 01 (0 - 6")	11/13/13	14:35	Soil	X		
4	WB - B2 - 04 (0 - 10')	11/14/13	16:00	Soil	X		
5	EB - B4 - 03 (0 - 10')	12/10/13	11:40	Soil	X		
6	SB - B4 - 01 (0 - 15')	12/12/13	16:45	Soil	X		
7	NB - B1 - 04 (0 - 15')	12/12/13	14:25	Soil	X		
8	DH - B3 - 02 (0' - 10')	12/11/13	14:40	Soil	X		
9	Topsoil Stockpile	11/21/13	15:35	Soil			
10							

LABORATORY USE ONLY

Custody Record MUST be Signed

	Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
1	Robert Schaut	12/14/13 8 AM				
2						
3				**Received by Laboratory:**	Date/Time: 12/20/13 945	Signature:

Sample Disposal: Return to Client: _____ Lab Disposal: X

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested.
This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Energy Labs - Agronomic Testing
Church Rock Pre-Design Study

Sample ID	Date	Type	Ra-226 activity --- EPA Method 901.1	pH --- Saturated Paste pH (USDA Staff, 1954)	Electrical conductivity --- Solution conductivity (USDA Staff, 1954)	Exchangeable sodium percentage - SAR Estimation (USDA Staff,1954)	Calcium carbonate equivalent - Rapid titration (Agronomy Society of America,1965)	Cation exchange capacity - Na saturated then NH4OAc extracted (Agronomy Society of America, 1965)	Percent organic matter Walkley – Black (Agronomy Society of America, 1982)	Nitrogen Kjeldahl (Agronomy Society of America, 1965)	Phosphorous Olsen (Ludwick and Reuss, 1974; Olsen, et al., 1954)	Potassium (K) 1:5 NH4OAc Extract (Ludwick and Reuss, 1974)
TI - CS02 - 01 (0 - 7")	11/12/2013	Bag	1	1	1	1	1	1	1	1	1	1
TI - CS07 - 01 (0 - 6")	11/13/2013	Bag	1	1	1	1	1	1	1	1	1	1
TI - CS11 - 01 (0 - 6")	11/13/2013	Bag	1	1	1	1	1	1	1	1	1	1
WB - B2 - 04 (0 - 10')	11/14/2013	Bag	1	1	1	1	1	1	1	1	1	1
EB - B4 - 03 (0 - 10')	12/10/2013	Bag	1	1	1	1	1	1	1	1	1	1
SB - B4 - 01 (0 - 15')	12/12/2013	Bag	1	1	1	1	1	1	1	1	1	1
NB - B1 - 04 (0 - 15')	12/12/2013	Bag	1	1	1	1	1	1	1	1	1	1
DH - B3 - 02 (0 - 10')	12/11/2013	Bag	1	1	1	1	1	1	1	1	1	1
Topsoil Stockpile	11/21/2013	Bag	1	1	1	1	1	1	1	1	1	1

C13120735, 1-9

Radiochemistry
Level 4 Reporting Checklist Gamma

Method #: EPA 901.1 ***Analyte:*** Ra-226

✓ Energy Labs Batch ID: GEGG 140115A @ 8:20

✓ Omega Data Entry Batch ID: 182728

✓ Instrument ID: DETECTOR 1 (DET 1)

✓ Instrument background check

✓ Instrument efficiency/calibration check

✓ Bench-sheets (Sample run order should include MD 10 samples)

✓ Photocopy of instrument run log

✓ Photocopy of standard source calibration certificate noting manufacturer, stock and/or lot number

____ Photocopy of method control charts for the following:
(provided by QA Dept.)

____ Matrix Duplicates (MD)

✓ Analyst Case Narrative consisting of the following:

✓ A statement documenting the analytes and the method used

✓ Date of analysis

✓ Any instrument adjustment or anomalies encountered during analysis

✓ Printed name and signature of analyst

Analyst Case Narrative

Method #: EPA 901.1 Analyte Ra226 Date/time of analysis: 1-15-14 8:20

Any problems or anomalies encountered during analysis?

No ✓ Yes_____ (please explain below)

Analyst case narrative: ANALYZED SAMPLES ACCORDING TO EPA 901.1 METHOD UTILIZING ORTEC GAMMAVISION SOFTWARE.

Any instrument adjustments or anomalies encountered during analysis?

No ✓ Yes_____ (please explain below)

Analyst case narrative: NO ADJUSTMENTS OR ANOMALIES.

Analyst DAVID BLANDA
Please print

Signature David Blanda

PREP BATCH REPORT

Technician: David Mikesell
Prep Start Date: 12/24/2013 09:10:40
Prep End Date: 12/24/2013 09:16:00

Prep Batch 40160 Prep Code: PRP-GAMMA Batch Units: G

Sample ID	Matrix	pH	Initial Samp Amt	Sol Added	Sol Recov	Fin Vol (mL)	Factor	Balance	PrepStart	PrepEnd
C13120735-001A - D & G	Soil	all DET /	179.68	0	0	179.68	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-002A	Soil		182.65	0	0	182.65	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-003A	Soil		184.85	0	0	184.85	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-004A	Soil		193.65	0	0	193.65	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-005A	Soil		190.61	0	0	190.61	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-006A	Soil		181.78	0	0	181.78	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-007A	Soil		193.81	0	0	193.81	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-008A	Soil		199.87	0	0	199.87	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-009A	Soil	[redacted]	189.68	0	0	189.68	1	Sartorius CP3202	12/24/2013	12/24/2013

Started 1-15-14 @ 8:20 DB
GEGE
140115A
8:20

LCS [redacted]

(12)
1-17-14
DB
calc'd

1-15-14

Energy Laboratories, Inc.
Alpha Spectroscopy / Gamma Spectroscopy
Instrument / Maintenance Run Log

Instruments: EGG Ortec Octete PC Alpha Spectroscopy System and EGG Ortec High Purity Germanium Detector

Date	Det. No.	Count Time Min.	Isotope	Batch ID	Associated Samples	Data File Number	Instrument ID Alpha Spec	Instrument ID Gamma Spec	Int	Comments Maintenance Log
1-14-14	3-6,8,11-19	240	Po210	539		Po-539	✓		DJ	
1-14-14	3-6,8,11-18	240	Th	1984		Th-1984	✓		DJ	
1-14-14	11-18	720	↓	↓	Added time for MDC	↓	✓		DJ	
1-15-14	1, 2	10, 30	960	RAD96 Det 2, 4	C13120735 1-8	→		✓	DJ	
1-15-14	3-5,8,11-18	120	Po210	540	↓	Po-540	✓		DJ	
1-15-14	4, 14	300	Th	1978	added count time-MDC	Th-1978	✓		DJ	
1-16-14	1	10, 30, 60	DCK, BKG	C13120735, 1-9		→		✓	DJ	
1-16-14	3-5,8,11-19, 22-24	360	Th	1986		Th-1986	✓		DJ	
1-16-14	↓	240	Th	1988		Th-1988	✓		DJ	

ACTIVITY DECAY CORRECTIONS
LCS CANS 6 - 10, gbkg

Input Analyte	LCS #	Input Half life Years	Calc Half life Days	Calc Half life Hours	Input Original pCi	Calc Original uCi	Calc Corrected pCi	Calc Corrected nCi	Calc Corrected uCi	Calc Corrected Bq	Input Reference Date	Input Current Date	Calc DPM	Input Measured pCi	Calc Percent Recovery	LCS #	
IPL-6	6	1600	5.84E+05	14025600	47.4	4.74E-05	46.85	0.05	4.69E-05	1.734	4/1/1987	12/26/2013	104.02	43.10	0.92	6	DET1
IPL-6	6	1600	5.84E+05	14025600	47.4	4.74E-05	46.85	0.05	4.69E-05	1.734	4/1/1987	12/26/2013	104.02	41.40	0.88	6	DET2
IPL-7	**7**	**1600**	**5.84E+05**	**14025600**	**8.72**	**8.72E-06**	**8.66**	**0.01**	**8.66E-06**	**0.320**	**2/1/1997**	**1/17/2014**	**19.22**	**7.77**	**0.90**	**7**	**DET1**
IPL-7	7	1600	5.84E+05	14025600	8.72	8.72E-06	8.66	0.01	8.66E-06	0.320	2/1/1997	12/26/2013	19.22	8.23	0.95	7	DET2
IPL-7	7	1600	5.84E+05	14025600	8.72	8.72E-06	8.66	0.01	8.66E-06	0.320	2/1/1997	12/26/2013	19.22	8.84	1.02	7	DET2
IPL-8	8	1600	5.84E+05	14025600	23.93	2.39E-05	23.77	0.02	2.38E-05	0.879	2/1/1997	1/2/2013	52.76	22.60	0.95	8	DET1

Eckert & Ziegler
Isotope Products

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661·309·1010
Fax 661·257·8303

CERTIFICATE OF CALIBRATION
MULTINUCLIDE STANDARD SOURCE

Customer: ENERGY LABORATORIES
P.O. No.: 89552
Catalog No.: EG-ML

Source No.: 1692-18
Reference Date: 1-Jul-13 12:00 PST
Contained Radioactivity: 0.9146 µCi 33.84 kBq

Physical Description:

A. Capsule type: Customer supplied 3" can
B. Nature of active deposit: Multinuclide distributed in 1.5g/cc epoxy matrix
C. Active diameter/volume: Approximately 124.1 mL (186.1 grams)
D. Backing: Plastic
E. Cover: Plastic

Gamma-Ray Energy (keV)	Nuclide	Half-life	Branching Ratio (%)	Activity (µCi)	Gammas per second	Total Uncert.
60	Am-241	432.17 ± 0.66 years	36.0	0.02632	350.6	3.0 %
88	Cd-109	462.6 ± 0.7 days	3.63	0.2603	349.6	3.2 %
122	Co-57	271.79 ± 0.09 days	85.6	0.01012	320.5	3.1 %
159	Te-123m	119.7 ± 0.1 days	84.0	0.01317	409.3	3.1 %
320	Cr-51	27.706 ± 0.007 days	9.86	0.3094	1129	3.0 %
392	Sn-113	115.09 ± 0.04 days	64.9	0.04999	1200	3.0 %
514	Sr-85	64.849 ± 0.004 days	98.4	0.05939	2162	3.0 %
662	Cs-137	30.17 ± 0.16 years	85.1	0.04230	1332	3.1 %
898	Y-88	106.630 ± 0.025 days	94.0	0.09347	3251	3.0 %
1173	Co-60	5.272 ± 0.001 years	99.86	0.05012	1852	3.1 %
1333	Co-60	5.272 ± 0.001 years	99.98	0.05012	1854	3.1 %
1836	Y-88	106.630 ± 0.025 days	99.4	0.09347	3438	3.0 %

Method of Calibration:

This source was prepared from weighed aliquots of solutions whose concentrations in µCi/g were determined by gamma spectrometry.

Notes:

- See reverse side for leak test(s) performed on this source.
- EZIP participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- Overall uncertainty is calculated at the 99% confidence level.
- This source has a working life of 1 year.

Quality Control

16-Jul-13
Date

EZIP Ref. No.: 1692-18

Calibration Data from file: julycc_5th_det1_169218.Clb
Energy Calibration Date: 12/10/2013 Time: 10:50:03
Efficiency Calibration Date: 7/26/2013 Time: 07:55:14

Calibration Description:
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration Fit
Energy = -0.4469 +0.243196*Channel +1.47595e-009*Channel**2
FWHM (keV) = 2.7806 +0.001109*Channel -4.93042e-008*Channel**2

Energy/FWHM Table

Channel	Energy(keV)	Fit(keV)	Delta	FWHM	Fit	Delta
246.10	59.54	59.40	0.23%	0.71	0.74	-4.73%
363.33	88.00	87.91	0.10%	0.76	0.77	-1.72%
503.25	122.00	121.94	0.05%	0.78	0.81	-4.09%
655.18	159.00	158.89	0.07%	0.86	0.85	0.90%
1318.39	320.00	320.18	-0.06%	1.14	1.01	11.50%
1612.23	391.00	391.64	-0.16%	1.06	1.08	-1.87%
2114.99	514.00	513.92	0.02%	1.17	1.19	-1.58%
2722.39	662.00	661.64	0.05%	1.33	1.32	1.00%
3694.44	898.00	898.05	-0.01%	1.48	1.51	-1.84%
4826.12	1173.00	1173.28	-0.02%	1.71	1.70	0.71%
5480.96	1333.00	1332.55	0.03%	1.75	1.79	-2.26%
7551.50	1836.00	1836.13	-0.01%	2.05	2.03	0.94%

Efficiency Calibration Fit
Polynomial Uncertainty = 1.3912 %
Coefficients:
-0.329484 -5.959887 0.633715 -0.076489 0.004220 -0.000092

Efficiency Table

Energy	Efficiency	Fit	Delta
59.54	1.4792E-002	1.4791E-002	0.00%
88.00	1.8292E-002	1.8301E-002	-0.05%
122.05	1.8426E-002	1.7693E-002	3.98%
159.03	1.5851E-002	1.5830E-002	0.13%
320.06	8.9257E-003	8.9862E-003	-0.68%
391.58	7.4870E-003	7.4242E-003	0.84%
513.94	5.6263E-003	5.7648E-003	-2.46%
661.60	4.7749E-003	4.6047E-003	3.56%
898.05	3.5676E-003	3.5554E-003	0.34%
1173.18	2.8125E-003	2.8533E-003	-1.45%
1332.77	2.5347E-003	2.5675E-003	-1.29%
1836.10	1.9651E-003	1.9465E-003	0.95%

Calibration Certificate Table

Isotope	Energy	Pct	Halflife	Activity	GPS	Error	Date &
Cd-109	88.03	3.63	4.63E+002	9630.85	349.60	3.20%	7/1/2013 12:00:00
Co-57	122.07	85.60	2.72E+002	374.42	320.50	31.00%	7/1/2013 12:00:00
Te-123m	159.07	84.00	1.20E+002	487.26	409.30	3.10%	7/1/2013 12:00:00
Sn-113	391.69	64.90	1.15E+002	1849.00	1200.00	3.00%	7/1/2013 12:00:00
Y-88	898.02	94.00	1.07E+002	3458.51	3251.00	3.00%	7/1/2013 12:00:00
Co-60	1173.24	99.86	1.93E+003	1854.60	1852.00	3.10%	7/1/2013 12:00:00
Co-60	1333.00	99.98	1.93E+003	1854.37	1854.00	3.10%	7/1/2013 12:00:00
Y-88	1836.01	99.40	1.07E+002	3458.75	3438.00	3.00%	7/1/2013 12:00:00
Cr-51	320.00	9.86	2.77E+001	11450.30	1129.00	3.00%	7/1/2013 12:00:00
Sr-85	514.00	98.40	6.48E+001	2197.15	2162.00	3.00%	7/1/2013 12:00:00
Cs-137	661.66	85.10	1.10E+004	1565.22	1332.00	3.10%	7/1/2013 12:00:00
Cd-109	1836.27	3.63	4.63E+002	9220.39	334.70	3.10%	6/1/2009 12:00:00
Am-241	59.72	36.30	1.58E+005	965.84	350.60	3.00%	7/13/2013 12:00:00
	392.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
	514.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
	662.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
Y-88	898.00	94.00	1.07E+002	3458.51	3251.00	3.00%	7/13/2013 12:00:00
	1173.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
	1333.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
Am-241	1836.00	36.30	1.58E+005	965.84	350.60	3.00%	7/1/2013 12:00:00

RS-17

CERTIFICATE OF CALIBRATION IPL 7
GAMMA STANDARD SOURCE CAN

Radionuclide:	Ra-226	Customer.:	ENERGY LABORATORIES
Half Life:	1600 ± 7 years	P.O. No:	C40177
Catalog No.:	EG-0242	Reference Date:	1 February 1997 12:00 PST
Source No.:	548-133-2	Contained Radioactivity:	(Ra-226) 1.423 nCi (52.64 Bq)

Description of Source

a. Capsule type:	Customer supplied can
b. Nature of active deposit:	Metallic salts in epoxy matrix
c. Active diameter/volume:	Approx. 125 ml (mass of epoxy = 163.16 g)
d. Backing:	Steel
e. Cover:	Steel

Radioimpurities:

None detected (other than daughters)

Method of Calibration

The source was prepared from a weighed aliquot of a solution whose concentration in μCi/gram was determined by gamma spectrometry:

Energy peak(s) integrated under:	186	keV.
Branching ratio(s) used:	0.0351	gamma rays per decay.

Uncertainty of Measurement

a. Systematic uncertainty in instrument calibration:	± 3.0%
b. Random uncertainty in assay:	± 3.0%
c. Random uncertainty in weighing(s):	± 0.6%
d. Total uncertainty at the 99% confidence level:	± 4.3%

NIST Traceability

This calibration is traceable to the National Institute of Standards and Technology.

Leak Test(s)

See reverse side for Leak Test(s) applied to this source.

Notes

1. IPL participates in an NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).

2. This source has a Ra-226 concentration of 8.722 pCi/g

ID #: 3132
Opened:_____
Gamma-Standard Source-548-133-2
Expires: 2/1/1999
Rec'd: 2/1/1997
Energy Laboratories, Inc 2393 Salt Creek Hwy
Casper WY 82602

Chris U. Ha
QUALITY CONTROL

24 Jan 97
Date Signed

ISOTOPE PRODUCTS LABORATORIES
1800 N. KEYSTONE STREET
BURBANK, CALIFORNIA 91504
818·843·7000 FAX 818·843·6168

IPL Ref. No.: 548-133-2

ORTEC g v - i (15) wan32 G53W2.06 15-JAN-2014 08:22:58 Page 1
Energy Laboratory Spectrum name: QA000714.Spc

Sample description
011514pckdet1

Spectrum Filename: C:\User\QA000714.Spc

Acquisition information

Start time:	15-Jan-2014 08:12:50
Live time:	600
Real time:	606
Dead time:	1.02 %
Detector ID:	2

Detector system
Det 1

Calibration

Filename:	apr13mb_16th_det1_1671271.Clb

10/9/13 mb calibration polynomial energy re-cal
IPL #1671271

Energy Calibration

Created:	09-Oct-2013 13:50:38
Zero offset:	-0.317 keV
Gain:	0.243 keV/channel
Quadratic:	2.269E-09 keV/channel^2

Efficiency Calibration

Created:	25-Apr-2013 08:44:34
Type:	Polynomial
Uncertainty:	1.119 %
Coefficients:	-0.379781 -4.955815 0.632347
	-0.076310 0.004092 -0.000084

Library Files

Main analysis library:	qaeff.Lib
Library Match Width:	0.500

Analysis parameters

Analysis engine:	wan32 G53W2.06
Start channel:	200 (48.31keV)
Stop channel:	8144 (1980.10keV)
Peak rejection level:	20.000%
Peak search sensitivity:	3
Sample Size:	1.0000E+00
Activity scaling factor:	2.7000E+01/(1.0000E+00* 1.0000E+00) = 2.7000E+01
Detection limit method:	LLD - ORTEC method (US-NRC)
Random error:	1.0000000E+00
Systematic error:	1.0000000E+00
Fraction Limit:	0.000%
Background width:	best method (based on spectrum).
Half lives decay limit:	12.000

ORTEC g v - i (15) wan32 G53W2.06 15-JAN-2014 08:22:58 Page 2
Energy Laboratory Spectrum name: QA000714.Spc

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	15-Feb-2004 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	NO	
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00
		Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.0991

- -

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide	Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA
CO-60	1.5060E+04	5.5468E+04	2.3966E+03	2.8104E+03	1.516E+03
CS-137	3.8293E+04	4.8090E+04	1.0655E+03	1.6985E+03	1.977E+03
AM-241	2.8802E+04	2.9263E+04	7.3673E+02	1.3089E+03	1.689E+03

< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (48.3 to 1980.1 keV) 8.2154781E+04 pCi/g
Total Decayed Activity (48.3 to 1980.1 keV) 1.3282133E+05 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1332.50 - CO-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.

ORTEC g v - i (15) wan32 G53W2.06 15-JAN-2014 08:22:58 Page 3
Energy Laboratory Spectrum name: QA000714.Spc

& - Calculated peak centroid is not close enough to the
library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: ______________________________
Dave Blaida

Reviewed by: ______________________________
Supervisor

Laboratory: Energy Laboratory

QA_HHQPHFD1033701_00670.Rpt

GammaVision V6.01 QA Background Report 1/15/2014 08:54:33

Detector:	2 Det 1
Measurement Number:	670
Data Acquired On:	1/15/2014 08:24:34
Real Time:	1800.00 Sec.
Live Time:	1799.14 Sec.
Status:	OK

	Minimum	Low	Actual	High	Maximum
Background (CPS):	1.96	2.21	2.39	2.70	2.95

```
 ORTEC     g v - i (  15) wan32  G53W2.06  16-JAN-2014 09:10:40 Page    1
Energy Laboratory               Spectrum name: QA000715.Spc


Sample description
     011614pckdet1


Spectrum Filename: C:\User\QA000715.Spc

Acquisition information
       Start time:                16-Jan-2014 09:00:33
       Live time:                600
       Real time:                606
       Dead time:                  1.02 %
       Detector ID:                   2

Detector system
     Det 1


Calibration
       Filename:                  apr13mb_16th_det1_1671271.Clb
     10/9/13 mb calibration polynomial energy re-cal
     IPL #1671271

       Energy Calibration
            Created:              09-Oct-2013 13:50:38
            Zero offset:         -0.317 keV
            Gain:                 0.243 keV/channel
            Quadratic:            2.269E-09 keV/channel^2

       Efficiency Calibration
            Created:              25-Apr-2013 08:44:34
            Type:                 Polynomial
            Uncertainty:          1.119 %
            Coefficients:        -0.379781  -4.955815   0.632347
                                 -0.076310   0.004092  -0.000084

Library Files
       Main analysis library:     qaeff.Lib
       Library Match Width:       0.500

Analysis parameters
       Analysis engine:           wan32   G53W2.06
       Start channel:            200 (    48.31keV )
       Stop channel:            8144 (  1980.10keV )
       Peak rejection level:     20.000%
       Peak search sensitivity:  3
       Sample Size:              1.0000E+00
       Activity scaling factor:  2.7000E+01/(  1.0000E+00*  1.0000E+00) =
                                 2.7000E+01
       Detection limit method:   LLD - ORTEC method (US-NRC)

       Random error:             1.0000000E+00
       Systematic error:         1.0000000E+00
       Fraction Limit:           0.000%
       Background width:         best method (based on spectrum).

       Half lives decay limit:   12.000
```

ORTEC g v - i (15) wan32 G53W2.06 16-JAN-2014 09:10:40 Page 2
Energy Laboratory Spectrum name: QA000715.Spc

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	15-Feb-2004 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	NO	
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00
		Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.0781

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide	Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA
CO-60	1.5190E+04	5.5968E+04	1.7207E+03	2.2703E+03	1.524E+03
CS-137	3.8354E+04	4.8169E+04	1.0660E+03	1.7005E+03	1.978E+03
AM-241	2.9247E+04	2.9716E+04	6.8716E+02	1.2958E+03	1.576E+03

< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

S U M M A R Y

Total Activity (48.3 to 1980.1 keV) 8.2790836E+04 pCi/g
Total Decayed Activity (48.3 to 1980.1 keV) 1.3385288E+05 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.

ORTEC g v - i (15) wan32 G53W2.06 16-JAN-2014 09:10:40 Page 3
Energy Laboratory Spectrum name: QA000715.Spc

& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

QA_HHQPHFD1033701_00671.Rpt

GammaVision V6.01 QA Background Report 1/16/2014 09:42:21

Detector:	2 Det 1
Measurement Number:	671
Data Acquired On:	1/16/2014 09:12:22
Real Time:	1800.00 Sec.
Live Time:	1799.14 Sec.
Status:	OK

	Minimum	Low	Actual	High	Maximum
Background (CPS):	1.96	2.21	2.42	2.70	2.95

ORTEC g v - i (143) wan32 G53W2.06 17-JAN-2014 09:18:10 Page 1
Energy Laboratory Spectrum name: 011614ipl7lcsdet1.An1

Sample description
011614ipl7lcsdet1

Spectrum Filename: C:\User\011614ipl7lcsdet1.An1

Acquisition information
Start time: 16-Jan-2014 15:49:27
Live time: 3600
Real time: 3602
Dead time: 0.06 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 200 (48.19keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.6316E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.6316E+02) =
1.6548E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (143) wan32 G53W2.06 17-JAN-2014 09:18:10 Page 2
Energy Laboratory Spectrum name: 011614ipl7lcsdet1.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	01-Feb-1997 16:00:00
Decay during acquisition:	NO	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.0981

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide	Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty (1 Sigma) Counting pCi/g	Total pCi/g	MDA
Ra-228 B<	1.4440E+00	1.1150E+01			
Ra-226 <	6.1892E+00	6.2348E+00			
Bi-214	7.7677E+00	7.8250E+00	4.8240E-01	4.9479E-01	7.156E-01
Pb-214	8.0222E+00	8.0814E+00	3.7933E-01	3.9600E-01	5.576E-01
Ir-192 B<	8.33E-02	>12 Halflives			
Sb-124 B<	1.27E-01	>12 Halflives			
Sc-46	1.0871E+00	>12 Halflives	1.6414E-01	1.6485E-01	3.728E-01
Pb-210	No in-range peaks				
Th-228 <	8.7290E+00	4.1053E+03			
Th-230 <	3.0449E+01	3.0454E+01			
Cs-137 <	2.2641E-01	3.3456E-01			
Co-60 B<	1.7837E-01	1.6584E+00			
Am-241 <	4.1258E-01	4.2395E-01			
K-40 <	2.4792E+00	2.4792E+00			
U-235 <	3.7080E-01	3.7080E-01			
Th-234 B<	2.44E+01	>12 Halflives			
Cs-134 <	2.2992E-01	6.8701E+01			
Pb-212 <	3.9927E-01	3.9927E-01			
Ra-224 <	6.97E+00	>12 Halflives			
I-131 B<	1.30E-01	>12 Halflives			
Mn-54 <	1.64E-01	>12 Halflives			
Tl-208 <	2.13E-01	>12 Halflives			
Bi-212 <	9.44E-01	>12 Halflives			
Ra-223 <	8.72E-01	>12 Halflives			
Pa-234 <	5.56E-01	>12 Halflives			
Eu-154 <	6.3805E-01	2.4260E+00			

ORTEC g v - i (143) wan32 G53W2.06 17-JAN-2014 09:18:10 Page 3

```
Eu-152  <    7.2676E-01    1.7551E+00
Na-22   <    1.7855E-01    1.6403E+01
Zn-65   <      6.40E-01 >12 Halflives
Ba-133  <    2.5399E-01    7.7793E-01
Ru-103 B<      8.33E-02 >12 Halflives
Be-7   B<      1.15E+00 >12 Halflives
I-125    No in-range peaks
Tl-201 B<      1.23E+00 >12 Halflives
Pa-234 B<      3.25E-01 >12 Halflives
Np-237 B<    1.2986E+00    1.2986E+00
Ce-144 B<      9.57E-01 >12 Halflives
Eu-155  <    5.4772E-01    5.8565E+00
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------   S U M M A R Y   ----------------------------
Total Activity (   48.2 to  1980.2 keV) 1.5789982E+01  pCi/g
Total Decayed Activity (   48.2 to  1980.2 keV) 1.5906395E+01  pCi/g

*********  S U M M A R Y   O F   D I S C AR D E D   P E A K S  *********
  911.07 % Ra-228     969.10 % Ra-228    1001.00 % Th-234    1115.52 % Zn-65
 1173.00 % Co-60     1274.50 & Na-22     1274.54   Eu-154    1333.00 % Co-60
 1408.00 % Eu-152    1460.80 & K-40

  ! - Peak is part of a multiplet and this area went
      negative during deconvolution.
  ? - Peak is too narrow.
  @ - Peak is too wide at FW25M, but ok at FWHM.
  % - Peak fails sensitivity test.
  $ - Peak identified, but first peak of this nuclide
      failed one or more qualification tests.
  + - Peak activity higher than counting uncertainty range.
  - - Peak activity lower than counting uncertainty range.
  = - Peak outside analysis energy range.
  & - Calculated peak centroid is not close enough to the
      library energy centroid for positive identification.
  P - Peakbackground subtraction
```

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

```
 ORTEC     g v - i ( 143) wan32  G53W2.06  16-JAN-2014 15:48:12 Page    1
Energy Laboratory               Spectrum name: 011614blankdet1.An1


Sample description
     011614blankdet1


Spectrum Filename: C:\User\011614blankdet1.An1

Acquisition information
       Start time:                16-Jan-2014 14:31:23
       Live time:               3598
       Real time:               3600
       Dead time:                 0.05 %
       Detector ID:                  2

Detector system
     Det 1


Calibration
       Filename:                  julycc_5th_det1_169218.Clb
     12/10/13 calibration energy/efficiency
     IPL #1692-18  recal energy calibration perched

       Energy Calibration
            Created:              10-Dec-2013 10:50:03
            Zero offset:         -0.447 keV
            Gain:                 0.243 keV/channel
            Quadratic:            1.476E-09 keV/channel^2

       Efficiency Calibration
            Created:              26-Jul-2013 07:55:14
            Type:                 Polynomial
            Uncertainty:          1.391 %
            Coefficients:        -0.329484  -5.959887   0.633715
                                 -0.076489   0.004220  -0.000092

Library Files
       Main analysis library:     Norman.lib
       Library Match Width:       0.500

Analysis parameters
       Analysis engine:            wan32   G53W2.06
       Start channel:            200 (    48.19keV )
       Stop channel:            8144 (  1980.24keV )
       Peak rejection level:      20.000%
       Peak search sensitivity:   5
       Sample Size:               1.0000E+00
       Activity scaling factor:   2.7000E+01/(  1.0000E+00*  1.0000E+00) =
                                  2.7000E+01
       Detection limit method:    Nureg 4.16

       Random error:              1.0000000E+00
       Systematic error:          1.0000000E+00
       Fraction Limit:            0.000%
       Background width:          best method (based on spectrum).

       Half lives decay limit:   12.000
```

ORTEC g v - i (143) wan32 G53W2.06 16-JAN-2014 15:48:12 Page 2
Energy Laboratory Spectrum name: 011614blankdet1.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	30-Apr-1999 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 1.0000

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/l	Time Corrected Activity pCi/l	Uncertainty Counting pCi/l	2 Sigma Total pCi/l	MDA
Ra-228	B<	1.9071E+02	1.1242E+03			
Ra-226	<	6.4834E+02	6.5249E+02			
Bi-214	B<	8.8903E+01	8.9472E+01			
Pb-214	<	7.4387E+01	7.4862E+01			
Ir-192	B<	7.35E+00	>12 Halflives			
Sb-124	B<	3.19E+01	>12 Halflives			
Sc-46	<	3.01E+01	>12 Halflives			
Pb-210	No in-range peaks					
Th-228	<	1.2075E+03	2.5197E+05			
Th-230	<	2.2300E+03	2.2303E+03			
Cs-137	<	2.2302E+01	3.1299E+01			
Co-60	B<	2.6796E+01	1.8559E+02			
Am-241	<	4.6072E+01	4.7172E+01			
K-40	<	4.0462E+02	4.0462E+02			
U-235	<	3.8968E+01	3.8968E+01			
Th-234	B<	2.62E+03	>12 Halflives			
Cs-134	<	2.8073E+01	3.9514E+03			
Pb-212	<	4.4432E+01	4.4432E+01			
Ra-224	<	4.82E+02	>12 Halflives			
I-131	B<	2.01E+01	>12 Halflives			
Mn-54	<	2.87E+01	>12 Halflives			
Tl-208	<	3.88E+01	>12 Halflives			
Bi-212	<	2.13E+02	>12 Halflives			
Ra-223	<	1.38E+02	>12 Halflives			
Pa-234	<	5.28E+01	>12 Halflives			
Eu-154	<	5.8463E+01	1.8634E+02			

ORTEC g v - i (143) wan32 G53W2.06 16-JAN-2014 15:48:12 Page 3

Eu-152	<	1.1862E+02	2.5497E+02
Na-22	<	2.6211E+01	1.3255E+03
Zn-65	<	6.29E+01	>12 Halflives
Ba-133	<	2.3187E+01	6.1259E+01
Ru-103	B<	2.32E+01	>12 Halflives
Be-7	B<	1.03E+02	>12 Halflives
I-125	No in-range peaks		
Tl-201	B<	1.16E+02	>12 Halflives
Pa-234	B<	4.14E+01	>12 Halflives
Np-237	B<	8.3617E+01	8.3618E+01
Ce-144	B<	1.06E+02	>12 Halflives
Eu-155	<	5.7604E+01	4.5043E+02

< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

S U M M A R Y

Total Activity (48.2 to 1980.2 keV) 0.0000000E+00 pCi/l
Total Decayed Activity (48.2 to 1980.2 keV) 0.0000000E+00 pCi/l

********* S U M M A R Y O F D I S C AR D E D P E A K S *********

911.07	?	Ra-228	969.10	%	Ra-228	1001.00 ? Th-234	1115.52 % Zn-65
1120.51	%	Sc-46	1173.00	&	Co-60	1274.50 % Na-22	1274.54 ? Eu-154
1333.00	&	Co-60	1408.00	?	Eu-152	1460.80 % K-40	

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 11:01:56 Page 1
Energy Laboratory Spectrum name: C13120735.1.An1

Sample description
C13120735.1

Spectrum Filename: C:\User\C13120735.1.An1

Acquisition information
Start time: 15-Jan-2014 09:25:39
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.7968E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.7968E+02) =
1.5027E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 11:01:56 Page 2
Energy Laboratory Spectrum name: C13120735.1.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1945

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA
Ra-228	B<	1.8482E+00	1.8616E+00			
Ra-226	<	4.6075E+00	4.6076E+00			
Bi-214	#	1.4502E+00	1.4502E+00	5.7086E-01	5.7232E-01	5.900E-01
Pb-214	<	4.3494E-01	4.3495E-01			
Ir-192	B<	1.3999E-01	1.7184E-01			
Sb-124	B<	1.1214E-01	1.4428E-01			
Sc-46		4.4662E-01	5.3525E-01	1.9018E-01	1.9077E-01	1.039E-01
Pb-210	<	3.2127E+00	3.2187E+00			
Th-228	<	9.1301E+00	9.3309E+00			
Th-230	<	2.2478E+01	2.2478E+01			
Cs-137	<	1.2413E-01	1.2430E-01			
Co-60	B<	1.6203E-01	1.6331E-01			
Am-241	<	2.1997E-01	2.1999E-01			
K-40		1.3698E+01	1.3698E+01	3.0981E+00	3.1220E+00	2.252E+00
U-235	<	2.7634E-01	2.7634E-01			
Th-234	B<	1.4566E+01	2.7341E+01			
Cs-134	<	1.4424E-01	1.4717E-01			
Pb-212		1.2170E+00	1.2170E+00	2.4375E-01	2.4624E-01	2.769E-01
Ra-224	<	3.7563E+00	2.4849E+02			
I-131	B<	1.5263E-01	1.0077E+00			
Mn-54	<	1.4900E-01	1.5641E-01			
Tl-208	<	2.50E-01	>12 Halflives			
Bi-212	<	1.47E+00	>12 Halflives			
Ra-223	<	7.8605E-01	2.9651E+00			
Pa-234	<	3.76E-01	>12 Halflives			
Eu-154	<	3.2539E-01	3.2693E-01			

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 11:01:56 Page 3

```
Eu-152  <    8.0301E-01    8.0552E-01
Na-22   <    1.9556E-01    1.9871E-01
Zn-65   <    3.5671E-01    3.7957E-01
Ba-133  <    1.0334E-01    1.0375E-01
Ru-103 B<    1.8432E-01    2.7105E-01
Be-7   B<    7.3764E-01    9.8007E-01
I-125  B<    1.6428E+00    2.1143E+00
Tl-201 B<    9.3292E-01    1.3639E+02
Pa-234 B<      3.51E-01 >12 Halflives
Np-237 B<    1.0382E+00    1.0382E+00
Ce-144 B<    7.4386E-01    7.8464E-01
Eu-155  <    2.0129E-01    2.0298E-01

  # - All peaks for activity calculation had bad shape.
  * - Activity omitted from total
  & - Activity omitted from total and all peaks had bad shape.
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
-----------------------------  S U M M A R Y  ----------------------------
Total Activity (   19.0 to  1980.2 keV) 1.6811813E+01  pCi/g
Total Decayed Activity (   19.0 to  1980.2 keV) 1.6900480E+01  pCi/g

*********  S U M M A R Y   O F   D I S C AR D E D   P E A K S  *********
  911.07 % Ra-228     969.10 % Ra-228     1001.00 % Th-234     1115.52 % Zn-65
 1173.00 ? Co-60     1274.50   Na-22      1274.54 % Eu-154     1333.00 % Co-60
 1408.00 ? Eu-152

  ! - Peak is part of a multiplet and this area went
      negative during deconvolution.
  ? - Peak is too narrow.
  @ - Peak is too wide at FW25M, but ok at FWHM.
  % - Peak fails sensitivity test.
  $ - Peak identified, but first peak of this nuclide
      failed one or more qualification tests.
  + - Peak activity higher than counting uncertainty range.
  - - Peak activity lower than counting uncertainty range.
  = - Peak outside analysis energy range.
  & - Calculated peak centroid is not close enough to the
      library energy centroid for positive identification.
  P - Peakbackground subtraction
```

- -

▯

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 11:01:56 Page 4
Energy Laboratory Spectrum name: C13120735.1.An1

Analyzed by: ______________________________
Dave Blaida

Reviewed by: ______________________________

Page 3

Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 12:08:56 Page 1
Energy Laboratory Spectrum name: C13120735.2.An1

Sample description
C13120735.2

Spectrum Filename: C:\User\C13120735.2.An1

Acquisition information
Start time: 15-Jan-2014 11:02:59
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.8265E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.8265E+02) =
1.4782E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 12:08:56 Page 2
Energy Laboratory Spectrum name: C13120735.2.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1679

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA
Ra-228	B<	1.6083E+00	1.6200E+00			
Ra-226	<	4.3884E+00	4.3885E+00			
Bi-214		1.7316E+00	1.7316E+00	4.3648E-01	4.3919E-01	4.621E-01
Pb-214		1.5309E+00	1.5310E+00	3.7515E-01	3.7761E-01	5.171E-01
Ir-192	B<	1.1764E-01	1.4450E-01			
Sb-124	B<	1.5064E-01	1.9397E-01			
Sc-46	<	2.1036E-01	2.5224E-01			
Pb-210	<	3.2392E+00	3.2453E+00			
Th-228	<	8.8435E+00	9.0386E+00			
Th-230	<	2.7891E+01	2.7891E+01			
Cs-137	<	1.4136E-01	1.4155E-01			
Co-60	B<	1.4671E-01	1.4788E-01			
Am-241	<	3.1939E-01	3.1942E-01			
K-40		1.6544E+01	1.6544E+01	3.3574E+00	3.3895E+00	2.215E+00
U-235	<	2.5688E-01	2.5688E-01			
Th-234	B<	1.4330E+01	2.6949E+01			
Cs-134	<	1.5593E-01	1.5911E-01			
Pb-212		1.2510E+00	1.2510E+00	2.4742E-01	2.5002E-01	2.832E-01
Ra-224	<	4.1197E+00	2.7608E+02			
I-131	B<	2.0739E-01	1.3773E+00			
Mn-54	<	2.1459E-01	2.2529E-01			
Tl-208	#H	4.2052E-01	>12 Halflives	1.6758E-01	1.6799E-01	1.890E-01
Bi-212	<	1.24E+00	>12 Halflives			
Ra-223	<	9.1294E-01	3.4579E+00			
Pa-234	<	4.03E-01	>12 Halflives			
Eu-154	<	3.2010E-01	3.2162E-01			

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 12:08:56 Page 3

Eu-152	<	6.4945E-01	6.5148E-01
Na-22	<	1.2437E-01	1.2638E-01
Zn-65	<	5.1347E-01	5.4647E-01
Ba-133	<	1.3412E-01	1.3465E-01
Ru-103	B<	7.4410E-02	1.0955E-01
Be-7	B<	8.2648E-01	1.0991E+00
I-125	B<	1.7443E+00	2.2466E+00
Tl-201	B<	7.9603E-01	1.1818E+02
Pa-234	B<	3.88E-01	>12 Halflives
Np-237	B<	9.9616E-01	9.9616E-01
Ce-144	B<	6.2688E-01	6.6136E-01
Eu-155	<	3.9468E-01	3.9801E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

----------------------------- S U M M A R Y ----------------------------

Total Activity (19.0 to 1980.2 keV) 2.1058031E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 2.1058117E+01 pCi/g

********* S U M M A R Y O F D I S C AR D E D P E A K S *********

911.07 % Ra-228	969.10 % Ra-228	1001.00 % Th-234	1115.52 % Zn-65
1120.51 % Sc-46	1173.00 ? Co-60	1274.50 ? Na-22	1274.54 ? Eu-154
1333.00 % Co-60	1408.00 ? Eu-152		

! - Peak is part of a multiplet and this area went
negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide
failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the
library energy centroid for positive identification.
P - Peakbackground subtraction

- -

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 12:08:56 Page 4
Energy Laboratory Spectrum name: C13120735.2.An1

Analyzed by: ______________________________
Dave Blaida

Reviewed by: ______________________________

Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 13:22:47 Page 1
Energy Laboratory Spectrum name: C13120735.3.An1

Sample description
C13120735.3

Spectrum Filename: C:\User\C13120735.3.An1

Acquisition information
Start time: 15-Jan-2014 12:09:51
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.8485E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.8485E+02) =
1.4606E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 13:22:47 Page 2
Energy Laboratory Spectrum name: C13120735.3.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1628

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	B	1.0175E+00	1.0249E+00	4.2980E-01	4.3076E-01	1.596E+00
Ra-226	A	1.0753E+00	1.0753E+00	2.5841E+00	2.5843E+00	4.374E+00
Bi-214	F	1.0138E+00	1.0138E+00	5.2236E-01	5.2314E-01	6.251E-01
Pb-214		1.3547E+00	1.3548E+00	3.5972E-01	3.6174E-01	3.989E-01
Ir-192	#B	2.9675E-02	3.6467E-02	8.3077E-02	8.3084E-02	1.070E-01
Sb-124	F	2.3244E-01	2.9947E-01	2.1391E-01	2.1408E-01	1.866E-01
Sc-46	A	1.2014E-01	1.4412E-01	1.2256E-01	1.2263E-01	2.564E-01
Pb-210	#	4.8133E+00	4.8224E+00	2.4816E+00	2.4841E+00	2.964E+00
Th-228	#A	-1.7011E+00	-1.7387E+00	-3.5183E+01	-3.5183E+01	7.146E+00
Th-230	#A	3.8395E+00	3.8395E+00	1.3300E+01	1.3301E+01	2.303E+01
Cs-137	#A	-1.7392E-02	-1.7417E-02	1.7535E+02	1.7535E+02	1.207E-01
Co-60	#B	-3.0352E-02	-3.0593E-02	1.9464E+02	1.9464E+02	1.450E-01
Am-241	#A	-6.6988E-03	-6.6995E-03	-2.3306E-01	-2.3306E-01	2.394E-01
K-40		1.4911E+01	1.4911E+01	3.1761E+00	3.2037E+00	2.189E+00
U-235	A	6.6520E-02	6.6520E-02	1.4739E-01	1.4740E-01	2.685E-01
Th-234	F	4.8029E+01	9.0446E+01	3.6178E+01	3.6361E+01	1.416E+01
Cs-134	#A	6.0777E-02	6.2020E-02	8.7992E-02	8.8009E-02	1.584E-01
Pb-212		1.1764E+00	1.1764E+00	2.2946E-01	2.3194E-01	2.505E-01
Ra-224	A	1.1179E+00	7.5586E+01	1.3076E+02	1.3078E+02	3.283E+00
I-131	B	1.0074E-01	6.7169E-01	6.1699E-01	6.1728E-01	1.146E-01
Mn-54	#A	1.3251E-01	1.3914E-01	1.3770E-01	1.3775E-01	1.927E-01
Tl-208	H	4.4050E-01	>12 Halflives	1.6345E-01	1.6392E-01	1.828E-01
Bi-212	#	2.3745E+00	>12 Halflives	1.2697E+00	1.2715E+00	1.322E+00
Ra-223	A	8.1633E-01	3.1007E+00	3.1306E+00	3.1319E+00	9.920E-01
Pa-234	A	3.9910E-02	>12 Halflives	2.0733E-01	2.0733E-01	3.700E-01
Eu-154	A	0.0000E+00	0.0000E+00	1.3165E+03	1.3165E+03	7.163E-01

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 13:22:47 Page 3

Eu-152	#A	5.0665E-02	5.0823E-02	7.1392E-02	7.1406E-02	8.198E-01
Na-22	#A	1.1877E-01	1.2069E-01	9.3826E-02	9.3887E-02	1.229E-01
Zn-65	A	1.9570E-02	2.0830E-02	1.8112E-01	1.8112E-01	3.609E-01
Ba-133	A	1.1495E-01	1.1541E-01	1.3362E-01	1.3366E-01	1.835E-01
Ru-103	#B	3.1622E-02	4.6596E-02	8.5072E-02	8.5093E-02	9.510E-02
Be-7	#B	0.0000E+00	0.0000E+00	1.0601E+03	1.0601E+03	5.944E-01
I-125	F	1.8410E+00	2.3726E+00	1.7508E+00	1.7530E+00	1.723E+00
Tl-201	#B	3.8069E-01	5.7117E+01	8.9264E+01	8.9294E+01	8.709E-01
Pa-234	#B	8.3680E-02	>12 Halflives	1.6104E-01	1.6107E-01	2.741E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.2810E+03	1.2810E+03	8.773E-01
Ce-144	F	1.3371E+00	1.4108E+00	1.0913E+00	1.0920E+00	8.481E-01
Eu-155	A	0.0000E+00	0.0000E+00	3.3163E+02	3.3163E+02	2.031E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.7442120E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.7442156E+01 pCi/g

********* S U M M A R Y O F D I S C AR D E D P E A K S *********
1173.00 - Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

```
 ORTEC     g v - i (2191) wan32  G53W2.06  15-JAN-2014 14:32:39 Page    1
Energy Laboratory               Spectrum name: C13120735.4.An1


Sample description
     C13120735.4


Spectrum Filename: C:\User\C13120735.4.An1

Acquisition information
       Start time:                 15-Jan-2014 13:25:02
       Live time:                3598
       Real time:                3600
       Dead time:                  0.05 %
       Detector ID:                   2

Detector system
     Det 1


Calibration
       Filename:                   julycc_5th_det1_169218.Clb
     12/10/13 calibration energy/efficiency
     IPL #1692-18  recal energy calibration perched

       Energy Calibration
            Created:               10-Dec-2013 10:50:03
            Zero offset:          -0.447 keV
            Gain:                  0.243 keV/channel
            Quadratic:             1.476E-09 keV/channel^2

       Efficiency Calibration
            Created:               26-Jul-2013 07:55:14
            Type:                  Polynomial
            Uncertainty:           1.391 %
            Coefficients:         -0.329484  -5.959887   0.633715
                                  -0.076489   0.004220  -0.000092

Library Files
       Main analysis library:      Norman.lib
       Library Match Width:        0.500

Analysis parameters
       Analysis engine:            wan32   G53W2.06
       Start channel:               80 (    19.01keV )
       Stop channel:              8144 (  1980.24keV )
       Peak rejection level:       20.000%
       Peak search sensitivity:    3
       Sample Size:                1.9365E+02
       Activity scaling factor:    2.7000E+01/(  1.0000E+00*  1.9365E+02) =
                                   1.3943E-01
       Detection limit method:     Nureg 4.16

       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).

       Half lives decay limit:    12.000
```

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 14:32:39 Page 2
Energy Laboratory Spectrum name: C13120735.4.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1902

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting 2 Sigma pCi/g	Total pCi/g	MDA pCi/g
Ra-228	F	1.5019E+00	1.5129E+00	5.0740E-01	5.0918E-01	1.391E+00
Ra-226	#A	0.0000E+00	0.0000E+00	1.0201E+04	1.0201E+04	4.407E+00
Bi-214	#F	1.0410E+00	1.0411E+00	4.3292E-01	4.3391E-01	5.154E-01
Pb-214		9.1519E-01	9.1522E-01	3.9976E-01	4.0059E-01	5.229E-01
Ir-192	#F	1.9056E-01	2.3429E-01	1.6366E-01	1.6379E-01	1.454E-01
Sb-124	#B	7.7922E-02	1.0045E-01	1.5541E-01	1.5544E-01	1.653E-01
Sc-46	A	2.0485E-01	2.4584E-01	1.7851E-01	1.7865E-01	2.114E-01
Pb-210	#A	4.7155E-01	4.7244E-01	1.9244E+00	1.9244E+00	2.974E+00
Th-228	A	1.2386E+00	1.2660E+00	4.2403E+00	4.2404E+00	7.418E+00
Th-230	A	1.9954E+01	1.9954E+01	2.0134E+01	2.0139E+01	2.780E+01
Cs-137	#A	-1.2298E-04	-1.2315E-04	-5.4012E-02	-5.4012E-02	1.300E-01
Co-60	#B	3.1419E-02	3.1670E-02	6.0874E-02	6.0880E-02	1.384E-01
Am-241	#A	-6.3944E-03	-6.3950E-03	-1.4728E-01	-1.4728E-01	1.747E-01
K-40		1.4081E+01	1.4081E+01	3.0164E+00	3.0423E+00	2.090E+00
U-235		2.7985E-01	2.7985E-01	1.5949E-01	1.5969E-01	2.183E-01
Th-234	B	2.0172E+01	3.8045E+01	3.6928E+01	3.6960E+01	2.408E+01
Cs-134	#A	2.7246E-02	2.7805E-02	8.3260E-02	8.3264E-02	1.589E-01
Pb-212		9.9776E-01	9.9776E-01	2.2606E-01	2.2787E-01	2.780E-01
Ra-224	A	1.9878E+00	1.3575E+02	1.4981E+02	1.4985E+02	3.606E+00
I-131	#B	3.7509E-02	2.5122E-01	6.7715E-01	6.7718E-01	1.093E-01
Mn-54	#A	1.3640E-02	1.4323E-02	6.7375E-02	6.7376E-02	1.513E-01
Tl-208	H	4.9055E-01	>12 Halflives	2.0251E-01	2.0298E-01	2.248E-01
Bi-212	#A	4.1287E-01	>12 Halflives	7.5621E-01	7.5629E-01	1.304E+00
Ra-223	A	4.1450E-01	1.5794E+00	2.2687E+00	2.2692E+00	8.250E-01
Pa-234	A	1.2502E-01	>12 Halflives	2.2146E-01	2.2149E-01	3.771E-01
Eu-154	#A	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.019E-01

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 14:32:39 Page 3

Eu-152	#A	1.2769E-01	1.2809E-01	2.6402E-01	2.6404E-01	6.126E-01
Na-22	#A	-1.8829E-02	-1.9135E-02	1.4895E+02	1.4895E+02	1.173E-01
Zn-65	#A	-1.0082E-02	-1.0733E-02	-5.3676E-01	-5.3676E-01	5.235E-01
Ba-133	#A	2.7590E-02	2.7700E-02	9.9994E-02	9.9997E-02	1.675E-01
Ru-103	#B	1.5093E-02	2.2260E-02	6.2960E-02	6.2966E-02	8.136E-02
Be-7	#B	1.1999E+00	1.5977E+00	1.6667E+00	1.6679E+00	1.383E+00
I-125	#B	9.5856E-01	1.2361E+00	1.8354E+00	1.8360E+00	1.958E+00
Tl-201	#B	5.0705E-02	7.6987E+00	5.3059E+01	5.3060E+01	6.101E-01
Pa-234	#B	2.0857E-01	>12 Halflives	2.9556E-01	2.9566E-01	3.762E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.2814E+03	1.2814E+03	8.754E-01
Ce-144	F	2.2833E+00	2.4094E+00	1.5329E+00	1.5344E+00	6.075E-01
Eu-155	A	9.7986E-02	9.8817E-02	1.1998E-01	1.2000E-01	2.634E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.5078738E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.5078738E+01 pCi/g

********* S U M M A R Y O F D I S C AR D E D P E A K S *********
1173.00 + Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 15:43:24 Page 1
Energy Laboratory Spectrum name: C13120735.5.An1

Sample description
C13120735.5

Spectrum Filename: C:\User\C13120735.5.An1

Acquisition information
Start time: 15-Jan-2014 14:33:15
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.9061E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.9061E+02) =
1.4165E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 15:43:24 Page 2
Energy Laboratory Spectrum name: C13120735.5.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1184

- -

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.2438E+00	1.2529E+00	4.3050E-01	4.3194E-01	1.106E+00
Ra-226	A	1.2185E+00	1.2185E+00	2.4344E+00	2.4347E+00	4.099E+00
Bi-214		1.0577E+00	1.0577E+00	4.0241E-01	4.0351E-01	4.888E-01
Pb-214		1.0505E+00	1.0505E+00	3.8949E-01	3.9061E-01	4.581E-01
Ir-192	F	1.7006E-01	2.0917E-01	1.5831E-01	1.5842E-01	1.444E-01
Sb-124	#B	1.4491E-01	1.8692E-01	2.0472E-01	2.0479E-01	1.853E-01
Sc-46		3.1358E-01	3.7647E-01	2.2197E-01	2.2222E-01	2.541E-01
Pb-210	#	4.2871E+00	4.2952E+00	2.1865E+00	2.1888E+00	2.789E+00
Th-228	A	3.4030E+00	3.4786E+00	5.2287E+00	5.2293E+00	8.753E+00
Th-230	#A	2.5858E+00	2.5858E+00	9.6696E+00	9.6698E+00	1.774E+01
Cs-137	#A	-1.0170E-02	-1.0184E-02	-1.3507E-01	-1.3507E-01	1.320E-01
Co-60	#B	-2.9435E-02	-2.9670E-02	1.8877E+02	1.8877E+02	1.406E-01
Am-241	#A	4.5271E-02	4.5275E-02	1.5724E-01	1.5725E-01	2.753E-01
K-40	#	1.4925E+01	1.4925E+01	3.1265E+00	3.1546E+00	2.123E+00
U-235	A	1.1379E-01	1.1379E-01	1.3715E-01	1.3718E-01	2.455E-01
Th-234	B	4.3751E+00	8.2625E+00	3.9049E+00	3.9191E+00	1.733E+01
Cs-134	#	2.1524E-01	2.1966E-01	1.6050E-01	1.6062E-01	1.923E-01
Pb-212		1.3257E+00	1.3257E+00	2.5651E-01	2.5932E-01	3.008E-01
Ra-224	A	1.7243E+00	1.1883E+02	1.5960E+02	1.5963E+02	3.855E+00
I-131	#B	4.6719E-02	3.1419E-01	6.8476E-01	6.8481E-01	1.589E-01
Mn-54	#A	1.3858E-02	1.4554E-02	9.8855E-02	9.8856E-02	1.793E-01
Tl-208	H	5.2716E-01	>12 Halflives	1.8575E-01	1.8634E-01	2.043E-01
Bi-212	#	2.1217E+00	>12 Halflives	1.3782E+00	1.3794E+00	1.583E+00
Ra-223	#A	7.2763E-01	2.7805E+00	2.3522E+00	2.3535E+00	8.146E-01
Pa-234	A	1.1863E-01	>12 Halflives	2.2587E-01	2.2590E-01	3.861E-01
Eu-154	#A	2.4971E-01	2.5091E-01	2.8972E-01	2.8981E-01	3.871E-01

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 15:43:24 Page 3

Eu-152	#A	-1.0183E-01	-1.0215E-01	7.8384E+02	7.8384E+02	6.223E-01
Na-22	#A	-1.9129E-02	-1.9440E-02	7.9817E+02	7.9817E+02	3.123E-01
Zn-65	A	7.5285E-02	8.0157E-02	2.0659E-01	2.0660E-01	3.712E-01
Ba-133	A	7.6923E-03	7.7231E-03	2.6268E-02	2.6269E-02	1.104E-01
Ru-103	#B	9.2002E-02	1.3580E-01	1.5681E-01	1.5691E-01	1.280E-01
Be-7	#B	3.7191E-01	4.9552E-01	7.5992E-01	7.6018E-01	9.322E-01
I-125	#	4.3055E+00	5.5549E+00	2.2112E+00	2.2207E+00	1.845E+00
Tl-201	#B	1.5025E-01	2.3060E+01	5.8025E+01	5.8033E+01	6.349E-01
Pa-234	#B	8.1153E-02	>12 Halflives	1.9057E-01	1.9059E-01	3.032E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.2783E+03	1.2783E+03	8.742E-01
Ce-144	F	1.9611E+00	2.0697E+00	1.6391E+00	1.6402E+00	7.315E-01
Eu-155	#A	6.7897E-02	6.8474E-02	1.8216E-01	1.8216E-01	3.015E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 2.2664307E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 2.3913780E+01 pCi/g

********* S U M M A R Y O F D I S C AR D E D P E A K S *********
1173.00 & Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
\+ - Peak activity higher than counting uncertainty range.
\- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 08:59:33 Page 1
Energy Laboratory Spectrum name: C13120735.6.An1

Sample description
C13120735.6

Spectrum Filename: C:\User\C13120735.6.An1

Acquisition information
Start time: 15-Jan-2014 15:44:05
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.8178E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.8178E+02) =
1.4853E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 08:59:33 Page 2
Energy Laboratory Spectrum name: C13120735.6.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1477

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.3845E+00	1.3947E+00	5.4563E-01	5.4703E-01	1.201E+00
Ra-226	A	9.1778E-01	9.1781E-01	2.3961E+00	2.3963E+00	4.076E+00
Bi-214	F	9.6484E-01	9.6486E-01	4.3882E-01	4.3966E-01	5.420E-01
Pb-214		1.0190E+00	1.0191E+00	3.7961E-01	3.8069E-01	4.415E-01
Ir-192	#B	9.1446E-02	1.1253E-01	1.1423E-01	1.1427E-01	1.213E-01
Sb-124	#B	2.5325E-02	3.2685E-02	9.4980E-02	9.4984E-02	1.341E-01
Sc-46		2.9521E-01	3.5457E-01	1.7965E-01	1.7993E-01	1.645E-01
Pb-210	A	1.8806E+00	1.8841E+00	2.4627E+00	2.4631E+00	3.444E+00
Th-228	A	1.3884E+00	1.4193E+00	4.8251E+00	4.8252E+00	8.381E+00
Th-230	A	7.8088E+00	7.8088E+00	1.6565E+01	1.6566E+01	2.525E+01
Cs-137	#A	9.9936E-02	1.0008E-01	8.5331E-02	8.5378E-02	1.205E-01
Co-60	#B	6.5640E-02	6.6166E-02	7.9427E-02	7.9449E-02	1.474E-01
Am-241	#A	9.3997E-02	9.4006E-02	2.3684E-01	2.3685E-01	3.440E-01
K-40		1.4514E+01	1.4514E+01	3.1639E+00	3.1901E+00	2.226E+00
U-235	A	6.8922E-02	6.8922E-02	1.2496E-01	1.2498E-01	2.340E-01
Th-234	F	2.3444E+01	4.4337E+01	2.5598E+01	2.5660E+01	1.440E+01
Cs-134	#A	-2.0141E-02	-2.0556E-02	-2.2339E-01	-2.2339E-01	1.567E-01
Pb-212		1.2543E+00	1.2543E+00	2.4898E-01	2.5157E-01	2.859E-01
Ra-224	A	1.3913E+00	9.6791E+01	1.5569E+02	1.5572E+02	3.769E+00
I-131	#B	9.6040E-02	6.4863E-01	7.4025E-01	7.4047E-01	1.520E-01
Mn-54	#A	-3.6472E-02	-3.8308E-02	-1.9915E-01	-1.9915E-01	1.578E-01
Tl-208	H	4.3524E-01	>12 Halflives	2.4419E-01	2.4450E-01	2.704E-01
Bi-212	#	2.5285E+00	>12 Halflives	1.7707E+00	1.7721E+00	1.884E+00
Ra-223	#A	-9.0902E-02	-3.4840E-01	2.9423E+03	2.9423E+03	4.839E-01
Pa-234	A	1.6786E-01	>12 Halflives	2.0745E-01	2.0750E-01	3.444E-01
Eu-154	#A	3.9041E-02	3.9228E-02	8.3950E-02	8.3958E-02	3.531E-01

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 08:59:33 Page 3

Eu-152	#A	4.5979E-01	4.6124E-01	4.2964E-01	4.2983E-01	6.526E-01
Na-22	#A	-9.6261E-03	-9.7831E-03	-1.0255E-01	-1.0255E-01	1.603E-01
Zn-65	A	2.9329E-01	3.1231E-01	2.9700E-01	2.9713E-01	4.408E-01
Ba-133	A	6.3264E-02	6.3518E-02	1.2113E-01	1.2114E-01	1.928E-01
Ru-103	#B	6.0294E-02	8.9077E-02	9.2254E-02	9.2324E-02	9.187E-02
Be-7	#B	3.0332E-01	4.0438E-01	8.6461E-01	8.6476E-01	1.101E+00
I-125	#F	2.6515E+00	3.4228E+00	2.2655E+00	2.2691E+00	2.031E+00
Tl-201	#B	1.6205E-01	2.5152E+01	5.3024E+01	5.3034E+01	5.921E-01
Pa-234	#B	8.9823E-02	>12 Halflives	1.6674E-01	1.6677E-01	2.729E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.4070E+03	1.4070E+03	9.597E-01
Ce-144	F	1.0543E+00	1.1128E+00	1.3440E+00	1.3444E+00	6.630E-01
Eu-155	A	2.0200E-01	2.0372E-01	1.6659E-01	1.6665E-01	3.752E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.7152647E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.7162807E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1173.00 - Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
\+ - Peak activity higher than counting uncertainty range.
\- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 08:59:33 Page 4
Energy Laboratory Spectrum name: C13120735.6.An1

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 11:08:00 Page 1
Energy Laboratory Spectrum name: C13120735.7.An1

Sample description
C13120735.7

Spectrum Filename: C:\User\C13120735.7.An1

Acquisition information
Start time: 16-Jan-2014 10:05:30
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.9381E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.9381E+02) =
1.3931E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 11:08:00 Page 2
Energy Laboratory Spectrum name: C13120735.7.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1685

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.5367E+00	1.5484E+00	7.4407E-01	7.4534E-01	9.840E-01
Ra-226	A	1.1691E+00	1.1691E+00	2.4081E+00	2.4084E+00	4.059E+00
Bi-214	#F	8.0351E-01	8.0353E-01	4.2435E-01	4.2495E-01	5.216E-01
Pb-214		8.6459E-01	8.6462E-01	3.3321E-01	3.3410E-01	3.805E-01
Ir-192	#F	1.5953E-01	1.9772E-01	1.7514E-01	1.7523E-01	1.558E-01
Sb-124	#B	0.0000E+00	0.0000E+00	1.5737E+02	1.5737E+02	8.536E-02
Sc-46	#	2.6137E-01	3.1591E-01	1.4128E-01	1.4156E-01	9.631E-02
Pb-210	A	1.6672E+00	1.6705E+00	1.7820E+00	1.7824E+00	2.609E+00
Th-228	A	4.2631E+00	4.3613E+00	4.7121E+00	4.7132E+00	7.776E+00
Th-230	#A	8.7483E+00	8.7483E+00	1.7762E+01	1.7763E+01	2.539E+01
Cs-137	#	2.9626E-01	2.9669E-01	1.6062E-01	1.6084E-01	1.650E-01
Co-60	#B	1.0682E-01	1.0771E-01	9.1265E-02	9.1315E-02	1.383E-01
Am-241	#A	1.6643E-02	1.6645E-02	1.4078E-01	1.4078E-01	2.438E-01
K-40		1.3765E+01	1.3765E+01	2.9831E+00	3.0081E+00	2.088E+00
U-235	A	7.7811E-02	7.7811E-02	1.4027E-01	1.4029E-01	2.540E-01
Th-234	B	3.2890E+00	6.3585E+00	3.4226E+00	3.4322E+00	1.350E+01
Cs-134	#A	-1.1205E-02	-1.1444E-02	-2.4168E-01	-2.4168E-01	2.009E-01
Pb-212		1.0570E+00	1.0570E+00	2.3059E-01	2.3258E-01	2.797E-01
Ra-224	A	3.8228E-01	3.0789E+01	1.6626E+02	1.6626E+02	3.603E+00
I-131	#F	2.1195E-01	1.5290E+00	1.0325E+00	1.0334E+00	1.236E-01
Mn-54	#A	3.7548E-02	3.9505E-02	1.3727E-01	1.3728E-01	1.956E-01
Tl-208	#H	4.7973E-01	>12 Halflives	1.5273E-01	1.5332E-01	1.581E-01
Bi-212	#A	-1.2175E-01	>12 Halflives	2.3335E+03	2.3335E+03	1.523E+00
Ra-223	#A	5.8718E-02	2.3573E-01	1.6540E+00	1.6540E+00	7.125E-01
Pa-234	A	3.1316E-02	>12 Halflives	2.3992E-01	2.3992E-01	4.242E-01
Eu-154	#A	0.0000E+00	0.0000E+00	1.0254E+03	1.0254E+03	5.781E-01

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 11:08:00 Page 3

Eu-152	#A	-1.0015E-01	-1.0048E-01	7.7099E+02	7.7099E+02	6.121E-01
Na-22	#A	6.9250E-02	7.0418E-02	7.3117E-02	7.3143E-02	1.172E-01
Zn-65	#A	-3.2818E-02	-3.5022E-02	1.0152E+03	1.0152E+03	5.051E-01
Ba-133	A	1.0831E-01	1.0876E-01	1.1416E-01	1.1420E-01	1.666E-01
Ru-103	#B	2.7647E-02	4.1400E-02	9.0640E-02	9.0655E-02	1.016E-01
Be-7	#B	2.0321E-01	2.7362E-01	7.1351E-01	7.1360E-01	8.987E-01
I-125	#B	7.5615E-01	9.8477E-01	1.4483E+00	1.4488E+00	1.622E+00
Tl-201	#B	0.0000E+00	0.0000E+00	1.5060E+05	1.5060E+05	4.776E-01
Pa-234	#B	2.1579E-01	>12 Halflives	1.9599E-01	1.9615E-01	2.743E-01
Np-237	B	3.9321E-01	3.9321E-01	4.7385E-01	4.7408E-01	7.789E-01
Ce-144	B	2.0059E-01	2.1211E-01	7.1226E-01	7.1228E-01	7.642E-01
Eu-155	A	1.7122E-01	1.7273E-01	2.2600E-01	2.2604E-01	3.242E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.5686782E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.5686806E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
911.07 - Ra-228 1173.00 - Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 12:12:38 Page 1
Energy Laboratory Spectrum name: C13120735.8.An1

Sample description
C13120735.8

Spectrum Filename: C:\User\C13120735.8.An1

Acquisition information
Start time: 16-Jan-2014 11:09:00
Live time: 3598
Real time: 3600
Dead time: 0.06 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.9987E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.9987E+02) =
1.3509E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 12:12:38 Page 2
Energy Laboratory Spectrum name: C13120735.8.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1524

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.6424E+00	1.6549E+00	5.7696E-01	5.7883E-01	1.444E+00
Ra-226	A	1.6020E+00	1.6021E+00	2.5966E+00	2.5970E+00	4.330E+00
Bi-214	F	1.3365E+00	1.3366E+00	5.4570E-01	5.4700E-01	5.925E-01
Pb-214		1.3671E+00	1.3671E+00	3.9162E-01	3.9351E-01	4.396E-01
Ir-192	#B	1.4971E-02	1.8562E-02	6.6641E-02	6.6643E-02	9.737E-02
Sb-124	#B	0.0000E+00	0.0000E+00	1.9710E+02	1.9710E+02	1.008E-01
Sc-46		4.3804E-01	5.2964E-01	2.0656E-01	2.0709E-01	1.720E-01
Pb-210		3.9480E+00	3.9557E+00	2.5876E+00	2.5892E+00	3.278E+00
Th-228	A	5.0740E+00	5.1911E+00	5.4020E+00	5.4033E+00	8.822E+00
Th-230	#A	0.0000E+00	0.0000E+00	2.7103E+04	2.7103E+04	1.593E+01
Cs-137	#A	2.0638E-02	2.0668E-02	4.8394E-02	4.8398E-02	1.013E-01
Co-60	#B	-2.3195E-02	-2.3387E-02	-1.2425E-01	-1.2425E-01	1.493E-01
Am-241	#A	3.6122E-02	3.6126E-02	2.0987E-01	2.0988E-01	3.183E-01
K-40	#	1.4947E+01	1.4947E+01	3.3449E+00	3.3712E+00	2.547E+00
U-235	A	1.2906E-01	1.2906E-01	1.4888E-01	1.4892E-01	2.611E-01
Th-234	B	4.7263E+00	9.1489E+00	4.0672E+00	4.0839E+00	1.700E+01
Cs-134	#A	-2.9497E-02	-3.0127E-02	1.6346E+02	1.6346E+02	1.149E-01
Pb-212		1.2827E+00	1.2827E+00	2.4633E-01	2.4907E-01	2.885E-01
Ra-224	A	1.4160E+00	1.1501E+02	1.7377E+02	1.7380E+02	3.587E+00
I-131	#B	9.5815E-02	6.9385E-01	1.2031E+00	1.2033E+00	1.619E-01
Mn-54	#A	-4.3111E-02	-4.5362E-02	-4.0473E-01	-4.0474E-01	1.524E-01
Tl-208	H	6.5586E-01	>12 Halflives	1.7874E-01	1.7969E-01	1.764E-01
Bi-212	#	2.3343E+00	>12 Halflives	1.3625E+00	1.3640E+00	1.509E+00
Ra-223	#A	7.0029E-02	2.8190E-01	1.7510E+00	1.7510E+00	7.645E-01
Pa-234	A	1.0280E-01	>12 Halflives	2.2333E-01	2.2335E-01	3.837E-01
Eu-154	#A	0.0000E+00	0.0000E+00	1.6152E+03	1.6152E+03	6.925E-01

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 12:12:38 Page 3

Eu-152	#A	2.7095E-01	2.7184E-01	3.3029E-01	3.3038E-01	5.935E-01
Na-22	#	1.2408E-01	1.2618E-01	9.1536E-02	9.1604E-02	1.137E-01
Zn-65	A	8.7015E-02	9.2871E-02	1.9309E-01	1.9310E-01	3.393E-01
Ba-133	#A	8.0644E-02	8.0979E-02	9.6282E-02	9.6309E-02	1.479E-01
Ru-103	#F	2.5347E-01	3.7985E-01	2.1070E-01	2.1126E-01	1.442E-01
Be-7	#B	3.5469E-01	4.7786E-01	8.5036E-01	8.5058E-01	9.866E-01
I-125	#B	1.2221E+00	1.5924E+00	1.4691E+00	1.4703E+00	1.499E+00
Tl-201	#B	4.6672E-01	8.7090E+01	1.2769E+02	1.2774E+02	8.760E-01
Pa-234	#B	3.0958E-01	>12 Halflives	2.5998E-01	2.6023E-01	3.205E-01
Np-237	B	1.7991E-01	1.7991E-01	5.2468E-01	5.2473E-01	8.900E-01
Ce-144	B	6.9190E-01	7.3174E-01	8.4669E-01	8.4694E-01	8.176E-01
Eu-155	#A	8.6337E-02	8.7099E-02	2.1502E-01	2.1503E-01	3.396E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.8035023E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.8126657E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1173.00 & Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
\+ - Peak activity higher than counting uncertainty range.
\- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 13:26:58 Page 1
Energy Laboratory Spectrum name: C13120735.9.An1

Sample description
C13120735.9

Spectrum Filename: C:\User\C13120735.9.An1

Acquisition information
Start time: 16-Jan-2014 12:13:27
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.8968E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.8968E+02) =
1.4235E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 13:26:58 Page 2
Energy Laboratory Spectrum name: C13120735.9.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1650

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.8758E+00	1.8901E+00	5.4029E-01	5.4290E-01	1.243E+00
Ra-226	A	9.2842E-01	9.2845E-01	2.3690E+00	2.3692E+00	4.024E+00
Bi-214	F	9.5056E-01	9.5059E-01	5.3939E-01	5.4006E-01	5.985E-01
Pb-214		7.0721E-01	7.0723E-01	3.3155E-01	3.3215E-01	5.025E-01
Ir-192	F	1.6476E-01	2.0437E-01	1.6036E-01	1.6046E-01	1.384E-01
Sb-124	#B	9.4386E-02	1.2302E-01	1.2277E-01	1.2281E-01	1.308E-01
Sc-46		2.8391E-01	3.4341E-01	1.6066E-01	1.6095E-01	1.182E-01
Pb-210	#	4.3205E+00	4.3290E+00	2.6015E+00	2.6034E+00	3.183E+00
Th-228	A	3.3877E+00	3.4660E+00	5.3375E+00	5.3381E+00	8.929E+00
Th-230	#A	4.1576E+00	4.1576E+00	1.2641E+01	1.2642E+01	2.104E+01
Cs-137	#A	8.9044E-02	8.9173E-02	1.2257E-01	1.2259E-01	1.699E-01
Co-60	#B	1.3998E-01	1.4114E-01	1.0310E-01	1.0317E-01	1.413E-01
Am-241	#A	-2.1391E-02	-2.1393E-02	2.9205E+02	2.9205E+02	1.745E-01
K-40	#	1.2820E+01	1.2820E+01	2.9183E+00	2.9405E+00	2.133E+00
U-235	A	3.0649E-02	3.0649E-02	1.3177E-01	1.3177E-01	2.472E-01
Th-234	B	6.4712E+00	1.2543E+01	5.7304E+00	5.7527E+00	1.450E+01
Cs-134	#A	-1.9302E-02	-1.9715E-02	-2.1425E-01	-2.1425E-01	1.502E-01
Pb-212		1.1659E+00	1.1659E+00	2.3103E-01	2.3345E-01	2.604E-01
Ra-224	A	8.4565E-01	6.9277E+01	1.7206E+02	1.7207E+02	3.604E+00
I-131	#B	8.3802E-02	6.0920E-01	6.4471E-01	6.4494E-01	1.026E-01
Mn-54	#A	-3.4953E-02	-3.6782E-02	-2.7042E-01	-2.7042E-01	1.693E-01
Tl-208	#H	7.2457E-01	>12 Halflives	2.0082E-01	2.0185E-01	1.877E-01
Bi-212	#	3.8608E+00	>12 Halflives	2.2981E+00	2.3006E+00	2.243E+00
Ra-223	A	5.6110E-01	2.2648E+00	2.5037E+00	2.5045E+00	8.423E-01
Pa-234	#A	-1.6987E-02	>12 Halflives	6.5885E+02	6.5885E+02	3.625E-01
Eu-154	A	0.0000E+00	0.0000E+00	6.7632E+02	6.7632E+02	4.509E-01

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 13:26:58 Page 3

Eu-152	#A	-1.0233E-01	-1.0267E-01	7.8778E+02	7.8778E+02	6.254E-01
Na-22	#A	2.5767E-02	2.6204E-02	5.2830E-02	5.2836E-02	1.198E-01
Zn-65	#A	-2.8380E-02	-3.0294E-02	-9.0306E-01	-9.0306E-01	2.473E-01
Ba-133	A	1.6776E-01	1.6846E-01	1.2729E-01	1.2738E-01	2.093E-01
Ru-103	#B	4.6226E-02	6.9329E-02	1.3208E-01	1.3211E-01	1.344E-01
Be-7	#F	1.1524E+00	1.5534E+00	1.1234E+00	1.1252E+00	9.637E-01
I-125	#B	1.7513E+00	2.2831E+00	2.2897E+00	2.2912E+00	2.246E+00
Tl-201	#B	3.4511E-02	6.5058E+00	4.6517E+01	4.6518E+01	4.821E-01
Pa-234	#B	1.3894E-01	>12 Halflives	1.9425E-01	1.9432E-01	3.004E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.2965E+03	1.2965E+03	8.861E-01
Ce-144	B	3.8382E-01	4.0597E-01	5.3835E-01	5.3847E-01	5.797E-01
Eu-155	A	2.3968E-01	2.4180E-01	3.2504E-01	3.2509E-01	4.293E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.5862253E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.5876553E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1173.00 - Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 14:29:48 Page 1
Energy Laboratory Spectrum name: C13120735.9dup.An1

Sample description
C13120735.9dup

Spectrum Filename: C:\User\C13120735.9dup.An1

Acquisition information
Start time: 16-Jan-2014 13:27:17
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.8968E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.8968E+02) =
1.4235E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 14:29:48 Page 2
Energy Laboratory Spectrum name: C13120735.9dup.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1245

***** SUMMARY OF NUCLIDES IN SAMPLE *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	B	1.3621E+00	1.3725E+00	7.8030E-01	7.8126E-01	1.420E+00
Ra-226	A	3.3126E-01	3.3127E-01	2.5553E+00	2.5553E+00	4.406E+00
Bi-214	F	7.3463E-01	7.3465E-01	3.7317E-01	3.7374E-01	4.984E-01
Pb-214		7.7265E-01	7.7267E-01	3.7593E-01	3.7656E-01	4.695E-01
Ir-192	B	1.1568E-01	1.4356E-01	1.1818E-01	1.1825E-01	1.238E-01
Sb-124	#B	7.5508E-02	9.8471E-02	1.5053E-01	1.5055E-01	1.663E-01
Sc-46		3.3743E-01	4.0831E-01	1.7681E-01	1.7719E-01	1.312E-01
Pb-210		3.1848E+00	3.1911E+00	1.9802E+00	1.9816E+00	2.737E+00
Th-228	A	4.4409E+00	4.5439E+00	5.0809E+00	5.0820E+00	8.378E+00
Th-230	#A	3.3260E+00	3.3260E+00	1.0624E+01	1.0624E+01	1.929E+01
Cs-137	A	1.6475E-01	1.6499E-01	1.4719E-01	1.4726E-01	1.881E-01
Co-60	#B	5.5171E-02	5.5631E-02	5.1020E-02	5.1044E-02	1.413E-01
Am-241	A	1.4458E-01	1.4459E-01	1.8809E-01	1.8812E-01	2.759E-01
K-40		1.2976E+01	1.2976E+01	2.9348E+00	2.9574E+00	2.133E+00
U-235	A	7.1959E-02	7.1959E-02	1.3793E-01	1.3794E-01	2.519E-01
Th-234	B	3.6693E+00	7.1225E+00	3.9954E+00	4.0057E+00	1.932E+01
Cs-134	A	1.4169E-01	1.4473E-01	1.2822E-01	1.2828E-01	1.769E-01
Pb-212		1.2796E+00	1.2796E+00	2.3733E-01	2.4015E-01	2.577E-01
Ra-224	A	2.0968E+00	1.7347E+02	1.6503E+02	1.6510E+02	3.235E+00
I-131	#B	7.3286E-02	5.3511E-01	8.9285E-01	8.9298E-01	1.172E-01
Mn-54	#A	-4.8918E-02	-5.1484E-02	-5.7440E-01	-5.7440E-01	1.721E-01
Tl-208	#H	5.7540E-01	>12 Halflives	1.9719E-01	1.9785E-01	1.949E-01
Bi-212		3.1875E+00	>12 Halflives	1.6805E+00	1.6828E+00	1.717E+00
Ra-223	#A	8.4612E-01	3.4259E+00	3.2010E+00	3.2024E+00	9.305E-01
Pa-234	A	9.8533E-02	>12 Halflives	2.4327E-01	2.4329E-01	4.195E-01
Eu-154	#A	7.6675E-02	7.7057E-02	1.7555E-01	1.7556E-01	3.238E-01

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 14:29:48 Page 3

Eu-152	#A	2.8550E-01	2.8644E-01	3.4803E-01	3.4812E-01	6.254E-01
Na-22	#A	-1.9223E-02	-1.9549E-02	3.3428E+02	3.3428E+02	1.852E-01
Zn-65	A	1.4325E-01	1.5293E-01	2.0066E-01	2.0071E-01	3.253E-01
Ba-133	#A	-2.9396E-03	-2.9519E-03	-1.5173E-01	-1.5173E-01	1.884E-01
Ru-103	#B	5.0078E-02	7.5173E-02	1.1623E-01	1.1627E-01	1.192E-01
Be-7	B	6.0212E-01	8.1224E-01	9.2724E-01	9.2782E-01	9.548E-01
I-125	#B	2.5753E-02	3.3594E-02	3.4750E-01	3.4750E-01	1.144E+00
Tl-201	#B	4.4002E-01	8.3922E+01	1.3645E+02	1.3649E+02	9.887E-01
Pa-234	#B	2.7183E-01	>12 Halflives	2.6675E-01	2.6694E-01	3.405E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.3653E+03	1.3653E+03	9.307E-01
Ce-144	F	1.7841E+00	1.8873E+00	1.5232E+00	1.5241E+00	7.421E-01
Eu-155	A	3.9363E-01	3.9712E-01	3.2726E-01	3.2739E-01	3.994E-01

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---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.4255527E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.4255527E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
911.07 - Ra-228

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
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- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 14:29:48 Page 4
Energy Laboratory Spectrum name: C13120735.9dup.An1

Laboratory: Energy Laboratory