# ST. ANTHONY MINE CLOSEOUT PLAN

Appendix C Geotechnical Investigation Memo

# Appendix C GEOTECHNICAL INVESTIGATION MEMO







To: Roy Blickwedel From: Cameron Fritz, EIT

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General Electric Stantec, Fort Collins, Colorado

File: St. Anthony Mine 233001076 Date: August 9, 2018

Reference: St. Anthony Mine Geotechnical Investigation 2018

## Introduction and Background

This memo presents information collected during the geotechnical drilling and field sampling specific to the waste rock piles and proposed borrow areas at the St. Anthony Mine Site ("Site"). Field notes, boring logs, and laboratory testing results are included in the attachments. Information presented will be used to supplement a previous field investigation conducted by MWH, described in the *Materials Characterization Report, Saint Anthony Mine Site* (MWH, 2007), and to advance the design of the closeout plan.

The St. Anthony Mine was an open pit and underground shaft uranium mine located on the Cebolleta Land Grant in Cibola County, New Mexico, approximately 40 miles west of Albuquerque and 4.6 miles southeast of Seboyeta. The Site is in a remote, sparsely populated area with difficult access. United Nuclear Corporation (UNC) operated the St. Anthony Mine from 1975 to 1981, pursuant to a mineral lease with the Cebolleta Land Grant, the current surface and mineral rights owner. The original lease covered approximately 2,560 acres. This lease was obtained on February 10, 1964 and was surrendered by a Release of Mineral Lease dated October 24, 1988. UNC has access to the Site through access agreements with the Cebolleta Land Grant and an adjacent landowner.

The Site includes underground workings comprising one mine shaft and several vent shafts that are now sealed at the surface, two open pits (one containing groundwater), seven piles of non-economic mine materials (now revegetated), numerous smaller piles of non-economical mine materials, and three topsoil and/or overburden piles. No perennial streams occur within the Site, but an arroyo (Meyer Gulch) passes through the Site. The two open pits at the Site are located in Sections 19 and 30, Township 11 North, Range 4 West, and the entrance to the underground mine is located in Section 24, Township 11 North, Range 5 West. Area disturbed during mining encompasses approximately 430 acres and includes roads, building and shaft pads, and former settling ponds along with the open pits and non-economic mine material piles.

# **Site Geology**

As described in the *St. Anthony Mine Site Closeout Plan* (MWH, 2010), the Site is located on the Colorado Plateau physiographic province, broadly characterized by plateaus of stratified sedimentary rock overlying tectonically stable Precambrian basement. The relatively high relief and dramatic topography of the Colorado Plateau formed as canyons were incised within thick sedimentary sequences. Within the southeastern portion of the Colorado Plateau lies the San Juan Basin, a structural depression encompassing most of northwestern New Mexico and adjoining parts of Colorado and Utah. The strata of the San Juan Basin dip gently to the north (approximately 2 degrees), although small faults and folds alter the dip of the strata locally. The San Juan Basin is truncated on its southeastern margin by the Jemez lineament, a northeasterly trending structural boundary between the Colorado Plateau to the northwest and the Rio Grande Rift to the south and east. The Site is within the Grants uranium district that lies on this transitional margin amidst many prominent Late Cenozoic volcanic fields that demarcate the Jemez lineament and the southeast margin of the San Juan Basin.



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Sediments in the Grants area were deposited in various continental environments. During late Permian time, the area now defined by the San Juan basin was an active seaway connecting the central New Mexico Sea with the Paradox basin in Utah. During this time, the Glorieta sandstone and San Andreas limestone were deposited. The region was subsequently uplifted in Laramide time and fluvial, lacustrine, and aolian sediments of the respective Chinle Formation, San Rafael Group, and Morrison Formation were deposited. Upper Cretaceous strata consist of marine shorezone sandstones, marine shales, and various continental deposits. In ascending order, these are represented by the Dakota Sandstone, Mancos Shale, and the Mesaverde Group.

Stratigraphy of interest at the Site includes the Mancos Formation (Late Cretaceous), the Dakota Formation (Early and Late Cretaceous) and the Morrison Formation (Late Jurassic). The surficial geologic unit at the Site is the Mancos Formation consisting of three sandstone units and interbedded shale units with a maximum thickness of 465 feet. The upper sandstone caps Gavilan Mesa to the south of the pits. The Dakota Formation sandstone is 6 to 20 feet thick in the Site area. The Morrison Formation is approximately 600 feet thick and is comprised of the Jackpile Member (sandstone), the Brushy Basin Member (interlayered mudstone and sandstone), the Westwater Canyon Member (sandstone), and the Recapture member (interbedded claystone and sandstone).

Uranium production at the Site was from the Jackpile Member with each pit penetrating approximately 75 feet into this unit. The Jackpile sandstone varies in thickness in the Site area from 80 to 120 feet and is representative of deposition in a braided stream environment.

#### **Geotechnical Investigation**

Field work for the current St. Anthony geotechnical investigation took place during March and April 2018 following client approval of the *St. Anthony Supplemental Investigations Work Plan* (Stantec, 2018). Field activities included drilling and soil sampling of select non-economic waste rock piles and potential borrow areas around the Site. The objective of the field investigation was to collect subsurface information to characterize soil and rock in the piles and evaluate the suitability of potential borrow sources as cover materials. This information was necessary to develop a material balance, grading plan, and cover design for reclamation of the Site.

Activities were conducted in accordance with the work plan and applicable SOPs. Some minor changes to drilling locations were implemented due to field conditions. Additionally, some proposed boreholes were not drilled due to safety, access, or other concerns as determined by the Field Engineer. Details of activities conducted and any variations from the Work Plan are described in the following sections.

Fifty-one boreholes were completed using the hollow-stem auger drilling technique (see Table 1 and Figure A1 for a complete list and plan view, respectively, of the borings): 12 in the Lobo Tract borrow area, 5 in the Borrow South area, 4 in the Borrow West area, 2 in the Topsoil North pile, 6 in the Topsoil/Overburden (T/O) pile, 4 in the Topsoil South pile, 6 in Shale Piles 1 and 2, 6 in Pile 3, and 6 in Pile 4. Drilling was performed by Cascade Drilling, LP ("Cascade") using a CME LAR 75 track-mounted drill rig and a CME 85 truck-mounted drill rig. The track-mounted rig was used during initial drilling. Due to mechanical failure of the track-mounted rig, the truck-mounted rig was used to complete the work. Boreholes completed by the track-mounted rig included the L1 boreholes in the Lobo Tract borrow area, four of the T/O pile boreholes (T/O-2, T/O-4 through 6), and a portion of one additional borehole (T/O-3) where the mechanical failure occurred.

Soil borings in the borrow areas (Lobo Tract, Borrow South, and Borrow West) were advanced either to anticipated excavation depths (generally 20-40 feet below ground surface (bgs)) or until encountering bedrock.



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Borings in the topsoil piles (T/O, Topsoil North, and Topsoil South) were advanced to native, undisturbed alluvial soils or bedrock to evaluate depths to the base of each pile. Drilling in Piles 1, 2, and 3 was also intended to locate the base of the piles; however, safety concerns related to the unexpected detection of hydrogen sulfide (H<sub>2</sub>S) and methane within the boreholes resulted in final drilled depths less than those originally proposed for most boreholes. Pile 4 drilling depths originally were proposed to coincide with the anticipated excavation depths (approximately 70 feet bgs) based on a preliminary material balance, but due to the continued detection of subsurface gases the boreholes were advanced to depths of only 10 to 40 feet bgs. Drilling was stopped at these locations on Piles 1 through 4 upon measuring gas concentrations at, or greater than, the permissible exposure limits (PEL) (e.g., 1.0 ppm H<sub>2</sub>S and 5.0% by volume of the lower explosive limit (LEL) of methane) as outlined in Stantec's Site-Specific Health and Safety Plan (HASP). Following drilling at each boring, the drilling crew backfilled the hole with drill cuttings to the original ground surface. Stantec then placed a wooden stake and surveyed the borehole location with a handheld GPS unit.

Five of the originally proposed borehole locations outlined in the Work Plan were not drilled. Borehole location BS-4 in the Borrow South area contained exposed bedrock at the ground surface, with no suitable borrow material (i.e., alluvial soils) apparent in the immediate area, and therefore was abandoned. Borehole location TN-3 in the Topsoil North area was located in close proximity to unstable slopes and the highwall of the main pit (Pit 1), and was not drilled due to drill rig access and safety concerns. Work on Pile 4 was stopped prior to drilling boreholes P4-1, P4-2, and P4-4 due to safety concerns regarding gas emissions at nearby boreholes (described above).

The Borrow West area (just south of Pit 1) was not originally included as a potential borrow source and no boreholes were proposed in this area prior to drilling operations at the Site. However, on-site observations of this area supported its potential as a source of additional borrow material, with the close proximity to Site facilities also indicative of potential cost savings in material transport during construction. As a result, four boreholes were proposed and completed in the Borrow West area during the final days of field work at the Site.

The total depth drilled during the investigation was 1,374 feet, including 429 feet of continuous core sampling using a five-foot-long, 4.25-inch inner diameter (I.D.) core barrel. Standard penetration test (SPT) sampling was performed at each five-foot interval (unless otherwise directed by the Field Engineer) using a 24-inch-long, 2.0-inch outer diameter (O.D.) Modified California (MC) sampler containing three 6-inch brass liners. Samplers were driven 18 inches by an automatic, 140-pound hammer falling 30 inches, with blow counts recorded for each successive 6-inch increment. Brass liner samples were logged, capped with plastic end caps, and stored at the staging area before being transported to Daniel B. Stephens & Associates, Inc. (DB Stephens), a geotechnical testing laboratory in Albuquerque. The recovered soil cores were logged, placed in labeled core boxes and photographed. Core boxes were temporarily stored at the staging area near the Site entrance and later transported to the UNC Mill Site office area at the Northeast Church Rock Site (near Gallup, NM). Borehole logs and core photographs are provided in Attachments B and C. Daily reports detailing the drilling activities are included in Attachment D.

Additional samples were collected from boreholes in Piles 1, 2, 4, and the Borrow West area for analytical testing of Radium-226, Uranium, Thorium-230, and Gross-Alpha concentrations. Prior to sampling, the MC sampler and liners were decontaminated using a cleaning solution (mixed on-site) to remove any remaining material from previous sampling drives. Samples were collected as bulk bag samples of material extracted from the MC brass liner samples, with sampling depths chosen to supplement results from the 2007 characterization and provide a more complete assessment of the general radiological contamination profile in each area. Samples from Piles 1, 2, and 4 were selected for analytical testing because these piles are expected to be used



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as backfill sources for Pit 1. Borrow West area samples were also tested to confirm this potential cover material did not contain elevated levels of radiological contamination. ALS Environmental laboratory in Fort Collins, CO performed the analytical testing of the samples.

**Table 1. Summary of Proposed and Completed Boreholes** 

	Area	Borehole ID	Proposed Depth (ft bgs)	Actual Depth (ft bgs)	Continuous Core
1	Lobo Tract (W of arroyo)	L1-1	20	20	Х
2	Lobo Tract (W of arroyo)	L1-2	20	20	
3	Lobo Tract (W of arroyo)	L1-3	20	20	
4	Lobo Tract (W of arroyo)	L1-4	20	20	
5	Lobo Tract (W of arroyo)	L1-5	20	20	Х
6	Lobo Tract (E of arroyo)	L2-1	20	20	
7	Lobo Tract (E of arroyo)	L2-2	20	15	
8	Lobo Tract (E of arroyo)	L2-3	20	15	
9	Lobo Tract (E of arroyo)	L2-4	20	20	Х
10	Lobo Tract (E of arroyo)	L2-5	20	20	
11	Lobo Tract (E of arroyo)	L2-6	20	20	Х
12	Lobo Tract (E of arroyo)	L2-7	20	20	
13	Borrow Area South	BS-1	20	15	
14	Borrow Area South	BS-2	20	20	
15	Borrow Area South	BS-3	20	15	Х
16	Borrow Area South	BS-4*	20	N/A	
17	Borrow Area South	BS-5	20	5	Х
18	Borrow Area South	BS-6	20	20	Χ
19	Topsoil North	TN-1	15	15	
20	Topsoil North	TN-2	25	30	
21	Topsoil North	TN-3 <sup>*</sup>	15	N/A	
22	Topsoil/Overburden	T/O-1	75	70	
23	Topsoil/Overburden	T/O-2	25	25	
24	Topsoil/Overburden	T/O-3	75	80	Х
25	Topsoil/Overburden	T/O-4	45	35	
26	Topsoil/Overburden	T/O-5	30	29	Х
27	Topsoil/Overburden	T/O-6	20	15	
28	Topsoil South	TS-1	60	35	
29	Topsoil South	TS-2	60	35	Х
30	Topsoil South	TS-3	60	30	
31	Topsoil South	TS-4	25	25	



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	Area	Borehole ID	Proposed Depth (ft bgs)	Actual Depth (ft bgs)	Continuous Core
32	Pile 1	P1-1	60	20	Х
33	Pile 1	P1-1A	60	35	Х
34	Pile 1	P1-2	120	65	
35	Pile 1	P1-3	40	40	
36	Pile 2	P2-1	120	30	
37	Pile 2	P2-2	60	20	
38	Pile 3	P3-1	25	15	
39	Pile 3	P3-2	50	45	Х
40	Pile 3	P3-3	100	40	
41	Pile 3	P3-4	100	40	
42	Pile 3	P3-5	75	15	
43	Pile 3	P3-6	75	55	
44	Pile 4	P4-1*	70	N/A	
45	Pile 4	P4-2*	70	N/A	
46	Pile 4	P4-3	70	15	
47	Pile 4	P4-4*	70	N/A	
48	Pile 4	P4-5	70	20	
49	Pile 4	P4-6	70	10	
50	Pile 4	P4-7	70	30	Х
51	Pile 4	P4-8	70	20	
52	Pile 4	P4-9	70	40	
53	Borrow Area West	BW-1 <sup>†</sup>	40	35	Х
54	Borrow Area West	BW-2 <sup>†</sup>	20	20	
55	Borrow Area West	BW-3 <sup>†</sup>	20	15	
56	Borrow Area West	BW-4 <sup>†</sup>	20	20	

bgs = below ground surface, ft = feet

#### **Laboratory Testing**

DB Stephens in Albuquerque, NM performed geotechnical laboratory testing of the soil samples. Laboratory testing of the brass liner samples included sieve analysis with hydrometer, Atterberg limits, moisture and density, and triaxial shear (consolidated undrained) of select samples. Laboratory testing of the bulk auger cutting samples included standard Proctor compaction. Analytical testing performed by ALS Environmental included testing for Radium-226 (Ra-226), Uranium, Thorium-230, and Gross-Alpha concentrations of select samples. Geotechnical and analytical test results are summarized in Tables E-1 through E-6 in Attachment E. Laboratory testing reports are included in Attachment F (DB Stephens) and Attachment G (ALS).

 $<sup>^{\</sup>star}$  Indicates borehole was not drilled due to safety, access, or other concerns.

<sup>†</sup> Indicates borehole was not included in original proposed (work plan) drilling locations.



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#### **Soil Classification and Material Descriptions**

Material encountered at the Site generally can be classified into two broad categories: (1) native alluvial soils, and (2) disturbed waste materials placed in piles following excavation from the two pits. The latter comprised mixtures of soil and rock with substantial variation between piles and, in some cases, considerable disparity within a given pile. The alluvial soils were generally more consistent both spatially and with depth throughout the borrow areas. Detailed descriptions of the materials found in each specific area are provided in the following sections.

#### **Borrow Sources**

The Lobo Tract borrow area contained alluvial deposits of silt, sand and clay. Most of the material encountered contained greater than 50 percent fine-grained soils and was dominated by silt-sized particles with varying levels of clay and sand. Sandy silt (ML) and silty sand (SM) were the most common classifications given for these materials, although several deposits of lean clay (CL) were also encountered. Silt-sized particles generally encompassed more than one-third of the particle size distributions for materials encountered in the Lobo Tract, including those classified as sand or clay. The material was slightly moist with moisture contents ranging from about 4 percent to 8 percent by weight, except for some areas with greater clay content containing moisture contents between approximately 10 and 15 percent. Silts and sands were medium dense to dense, except for some small pockets of loose and poorly-graded sand, and clayey materials ranged from very stiff to very hard. Clay was mostly encountered in lower elevation areas near the arroyo in the center of the alluvial "valley" and was often found in the upper 10 to 15 feet of the alluvium with silt and sand-dominated materials below. In areas near the edge of the borrow area, and closer to the sandstone mesas that surround the area, materials were sandy with less clay and lower moisture contents. Along the easternmost extents of the borrow area, bedrock was encountered at a depth of approximately 10 feet owing to the closer proximity of these boreholes (e.g., L2-2, L2-3, and L2-4) to the sandstone outcroppings.

The Topsoil North pile was relatively homogenous throughout its area and profile compared to the Lobo Tract, though the pile did contain similar alluvial soils. Material in this pile was classified as a slightly moist silty sand (SM) with few to little clay, and was loose to medium dense with similar blow counts recorded for most of the sampling intervals.

Located just off the southern edge of Pit 1, the Borrow West area contained similar soils (SM) as the Topsoil North pile but with slightly increased variability. Two main types of SM topsoil were identified, one being nearly the same as the Topsoil North pile material and the other having a slightly higher clay content with a coarse fraction less than 50 percent. The latter was identifiable based on darker brown coloring and slightly increased moisture compared to the former, and was found at depths greater than approximately 10 to 15 feet. This stratification was consistent with an observable color change with depth in the exposed topsoil along the western Pit 1 highwall.

Material in the Borrow South area was more comparable to the Lobo Tract soils than to the Topsoil North and Borrow West soils, with greater silt content relative to sand content and classified as ML. Soil encountered in this borrow area was slightly moist and loose to medium dense. Due to the area's proximity to a rock outcropping, weathered sandstone bedrock was encountered in each Borrow South borehole except BS-6. Depth to bedrock ranged from 5 to 20 feet, with the exception of the BS-4 location which, as previously discussed, was not drilled due to exposed bedrock at the ground surface.



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The T/O and Topsoil South piles contained similar mixtures of topsoil and waste rock from the pit excavations. The piles were highly heterogeneous with no explicit stratigraphy of soil and/or rock. Although the piles were covered in a thin layer of alluvium characteristic of the topsoil throughout the Site, the interior of each pile comprised a highly variable mixture of weathered bedrock (gray/brown sandstone and black/gray shale) and sandy silt. Most material was dominated by fine-grained silt and clay particles, except for some portions of the Topsoil South pile in which a silty sand was encountered. Fines were classified as either CL or ML. Soils were slightly moist with occasional moist areas and were generally medium dense to dense.

#### **Waste Piles**

Shale Piles 1 and 2 contained mixtures of weathered sandstone and shale. All material encountered was colored gray to black, though scattered iron and sulfur staining (red, orange, and yellow) also was observed. Samples were slightly moist to moist, with the wettest areas comprising mostly shale and black, possibly organic material. Most material contained a coarse fraction greater than 50 percent, including up to 20 percent gravel in samples from Pile 1. Some cobbles or boulders were encountered while drilling in Pile 1, resulting in damage to several augers. Samples from Pile 2 contained trace amounts of gravel, with higher sand, silt, and clay contents relative to Pile 1. Pile 2 samples also exhibited higher densities and moisture contents, possibly due to greater clay and/or organics content. Fines in Pile 1 were classified as ML, whereas fines in select Pile 2 samples were classified as CL. The northwestern portion of Pile 1 (near borehole location P1-3) contained numerous large, sandstone boulders, as indicated by frequent grinding on rock by the augers followed by sudden drops through large void spaces. Brass liner samples also contained mostly broken rock pieces.

Pile 3 material was largely composed of poorly-graded and fine- to medium-grained sand with trace amounts of gravel and sandstone pieces scattered throughout the profile. The majority of samples contained greater than 60 percent sand-sized particles, including amounts greater than 90 percent at depths of 30 to 40 feet in borehole P3-4. Some sand was characteristic of the Jackpile sandstone formation due to primarily gray and white coloring with areas of green and purple. Other areas contained brown or gray weathered sandstone and shale, frequently with traces of orange or yellow oxidation. Poorly-graded sands were generally moist and loose, whereas materials with improved gradation were medium-dense and slightly moist. Overall, moisture content appeared to increase with depth towards the center of the pile. Fine-grained soils usually comprised less than 30 to 40 percent of the material and were classified as ML. Minimal clay content or evidence of plasticity was observed.

Although borehole depths in Pile 4 were relatively shallow compared to the total depth of the pile, considerable variability was observed in the sampled material. Some variability was evident based on visual assessment of the surface of the pile, as material ranged from brown topsoil in the northern and southern extents of the pile, to gray and white sand and gravel (i.e., weathered and broken sandstone) in the central areas. Dark gray/black, weathered shale also was evident in the numerous drainage rivulets cutting across the pile surface. In the northern area of the pile at higher elevations, topsoil extended no more than approximately 5 to 10 feet bgs before grading into sand and broken rock mixtures. Lower elevations toward the central portion of the pile contained mixtures of sand, gravel, and highly weathered shale, ranging from light gray to black in color. Some areas contained almost exclusively broken sandstone pieces, whereas others contained poorly-graded sand similar to that encountered in Pile 3, but with higher gravel content. The latter presented traces of green and purple coloration characteristic of the Jackpile sandstone formation and was especially prevalent near borehole P4-5. Higher moisture content was noted in these sands compared to other sand and rock mixtures in the pile, which was consistent with the conditions observed in Pile 3 material. Sandy silt topsoil was the driest material observed in the pile, with moisture contents similar to those observed in the native borrow areas. Several of the



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boreholes (P4-3, P4-5, P4-6, and P4-8) appeared to extend into zones of higher shale content prior to being stopped due to elevated gas concentration levels.

## **Analytical Testing Results**

Seventeen soil samples were subjected to analytical testing for metals concentrations, including six from Shale Piles 1 and 2, five from Pile 4, and six from the Borrow West area. Overall, soil concentrations of Ra-226 in samples collected during the 2018 investigation ranged from 0.73 to 29.5 pCi/g. The lowest values were reported for the Borrow West area in which all samples contained concentrations below 1.15 pCi/g, similar to background and borrow area readings reported by MWH (2007). Values in Piles 1 and 2 generally were near background levels (0.91 to 3.85 pCi/g), except for one isolated sample (from borehole P1-2, 20 feet bgs) with a concentration of 16.1 pCi/g. In Pile 4, the highest soil concentrations were measured in borehole P4-5 and ranged from 18.6 to 29.5 pCi/g. All other samples from Pile 4 contained concentrations below 3.14 pCi/g. The results listed in Table E-6 were used in conjunction with analytical testing results from MWH (2007) to evaluate radon activity levels throughout the Site, including areas that were not sampled for analytical testing during the 2018 investigation.

#### Groundwater

Groundwater was not encountered in any boreholes during drilling operations, mainly because the drilling was performed either in waste piles located above the native ground surface or in native borrow areas with relatively deep groundwater levels compared to the shallow (generally 15 to 20 feet) borehole depths. According to the Stage I Abatement Plan Investigation Report (INTERA, 2006), the minimum depth to groundwater was more than 50 feet (in the vicinity of the arroyo) based on data collected during August, September, and December of 2004 from six monitoring wells located throughout the Site.

#### **Summary and Conclusions**

A total of 51 boreholes were drilled in waste piles and native borrow areas in and near the Site for this investigation. Several borings in the piles were not completed and many others only partially completed due to the presence of potentially harmful gases. However, Stantec expects the information to be sufficient for the intended purposes of the investigation, including the use of data for the reclamation design and closeout plan. Soil samples were collected using Modified California sampling methods as part of standard penetration tests and were delivered to testing laboratories for geotechnical and analytical testing. Results included index properties, gradations, compaction properties, and strength parameters from geotechnical testing, as well as metals concentrations from analytical testing.

Each borrow area was found to contain similar alluvial materials with varying combinations of silt, sand, and clay. Based on results for particle-size gradations and Ra-226 soil concentrations, these soils appear acceptable for use as cover material during Site reclamation. However, careful consideration of slopes will be necessary due to the material's susceptibility to erosion, as indicated by its relatively high fines content and by the numerous drainage gullies and rivulets observed on pile surfaces and in other areas with relatively high slope angles. The proximity of the Borrow West area to Pit 1 will be beneficial as material from this area will be easily accessible for potential use as cover material following the anticipated backfilling of Pit 1. The Borrow South area, although significantly smaller in area than Borrow West, is in relatively close proximity to Site facilities and will provide convenient access to cover materials. The Lobo Tract borrow area is located farther from Site facilities but is expected to provide a considerable contingency volume of cover material as needed during closeout. Portions of the borrow areas nearest to rock outcroppings and cliff bands generally exhibited



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shallower deposits of alluvium above the bedrock, with deeper deposits and greater potential borrow volumes in areas further from the cliffs (e.g., closer to the arroyo in the Lobo Tract and the center of the valley in which the Borrow West area is located).

Variable mixtures of topsoil and weathered rock overburden were encountered in the piles throughout the Site. The T/O and Topsoil South piles contained significantly less topsoil and more rock than was anticipated, suggesting that these piles may be more suitable as fill material for backfilling the pits than for use as cover material. Piles 1 through 4 also will likely be used as pit backfill material. Based on analytical testing results from this investigation and MWH (2007), Stantec anticipates materials from Piles 1 through 4 and T/O (i.e., materials with relatively low Ra-226 activities) will be deposited at upper elevations (near the cover) or lower elevations in the pit, below the expected groundwater rebound elevation (5966 feet above sea level (fasl)). For materials containing more elevated Ra-226 activities (e.g., west disturbance area, crusher/stockpile, and piles 5-7; see MWH, 2007), efforts will be made to place these materials near, or above elevation, 5966 fasl to reduce the future potential for contact with the groundwater. Relatively low-activity material (e.g., T/O pile) could be used as subsoil for cover material to enhance plant growth and provide additional buffer against the surface release of radon. Any residual pile material not used as backfill is expected to require additional cover material from borrow areas to facilitate revegetation, while also being regraded to reduce erosion of the topsoil.

Due to the presence of potentially harmful gases encountered during drilling, Stantec recommends additional safety precautions be taken during future earthwork at the Site. Special considerations during construction may include the use of personal H<sub>2</sub>S detectors by personnel near the earthwork, as well as the use of a 4-gas meter to routinely monitor the work area for elevated gas concentrations. Additional personal protective equipment (PPE) and/or engineering controls may be required under certain circumstances and conditions should be reevaluated prior to the start of earthwork.

Attachments: Attachment A – Figure A1. 2018 Geotechnical Investigation Borehole Locations

Attachment B – Borehole Logs

Attachment C - Photos

Attachment D - Daily Field Reports

Attachment E - Table E-1. Laboratory Results - Initial Properties

Table E-2. Laboratory Results – Particle-size Analyses Table E-3. Laboratory Results – Atterberg Limits Table E-4. Laboratory Results – Proctor Compaction

Table E-5. Laboratory Results – Triaxial Shear Table E-6. Laboratory Results – Analytical Testing

Attachment F – Geotechnical Laboratory Testing Report Attachment G – Analytical Laboratory Testing Reports



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Reference: St. Anthony Mine Geotechnical Investigation 2018

## References

INTERA, 2006. Stage I Abatement Plan Investigation Report. INTERA. October 26.

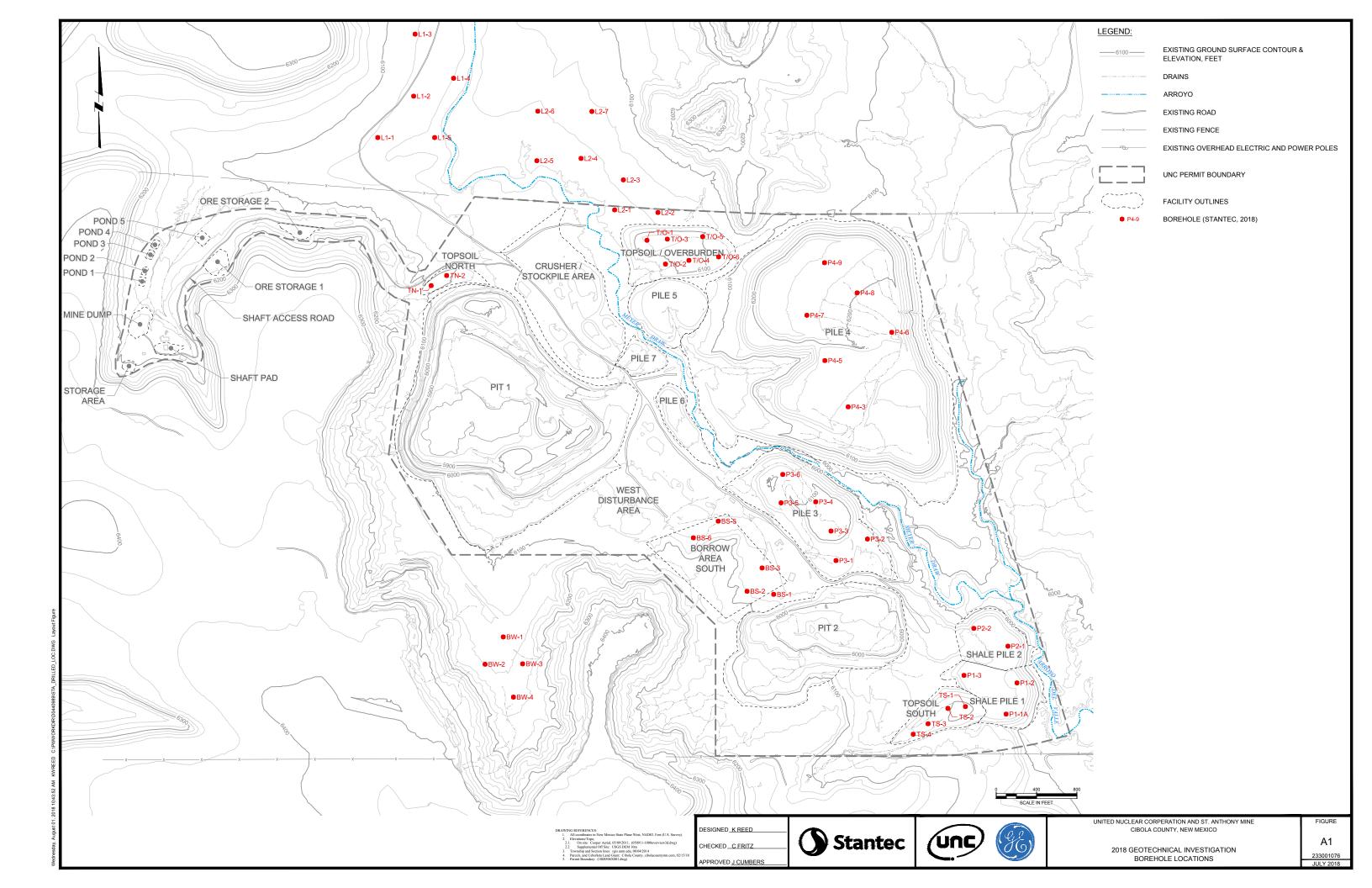
MWH, 2007. Materials Characterization Report: Saint Anthony Mine Site. MWH. October 26.

MWH, 2010. St. Anthony Mine Site Closeout Plan. MWH. July 2010.

Stantec, 2018. St. Anthony Supplemental Investigations Work Plan. Stantec. February 23.



# **Attachment A. 2018 Geotechnical Investigation Borehole Locations**





# **Attachment B. Borehole Logs**

	0	Star	nte	عر -		0	lient: GE - United Nuclear Corporation		BORING	BOREHOLE No.:	
	Drilling Com	pany: Cascade D				F	roject Number: 233001076    Drilling Rig: CNE & Bit Type: 4.25" I.D., 8" O.D		G FORM	Sheet of Start Date:	4/1/18
1	Drillers/(day	night): S. Lom, sentitive (day / nic	A. Ro	drigu	ez, J	Vigu	eria Drilling Method: Hollow Stern Auger Logged by: C. Fritz  Core Diameter: 1 A	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		Finish Date: Total Depth:	9/1/18
	Depth	Sample Number	Blow Count	Recovery (in,)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description	Graphic		Remarks	Well Details
0 +						ЗM	Silty sand with little clay (SM),				=
							medium dense weakly comented, light prountstightly moist				=
							HOLLY DIDONIZIONALLA WOIST	75			3
2 +								雪岩			=
	_							30			=
								1			=
4	_										=
	=										3
	=	TIA	13		10	SM	same as above	13			=
(o -	_	5'A 5'B	10					43			3
		(2) (3)	11								3
	=										
0								, , ,			
8 -	=							7			
- 4								1.7			
					) 						3
10-			9		8		increased carbonate content,	1::			
		10, Y	12		1	SM	Same material, slightly darker				
× 1		10,B	10				DWWN.				=
12 -								40.			4
											=
14								34			3
' \							Sandstone bedrack (SS), highly to	13,			=
		51000	21			25	Completely weathered, Orange 4 yellow chemical		1		
	<u> </u>	15' Bag	50	2"	_	22		1			
10 -	Ē,						EOB@ 15.67'	1			$\exists$
	2 2						2000				=
								7		4	3
18 -								7			
											=
								1			=
20-	GRAVEL 50% coar		il-grader	gravel ed ora	s. grave	I sand n	intuins, lette or no force GW (SPT) Blows/It* (mode/AU) Term (SPT) Blows/It* (	10		ize (mm) Size (inches)	Percentages of gravel, as sand, and fines may be started in terms
	## SANDS	SANDS W	y gravel yny grav fi-gradel	els poorly sands	graded rly-grad graves	gravel- od grav y sands		nds au	Cobbles 75 Coarse gravel 15	300 >12 5 to 300 3 to 12 9 to 75 3/4 to 3	o percentages as below
	#50% coar haction pass #4 seve	SANDS SIN	y sands	poorty o	raded v-trade	sand-gro d sand	1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2670   2570   2570   1.410   2570   2570   2570   1.410   257	83	Coarse sand 2 Medium sand 0	75 to 19 3/16 to 3/4 0 to 4 75 1/16 to 3/16 425 to 2 0 1/64 to 1/16 075 to 0 425 0 0003 to 1/64	Term % Trace <5 Few 5-10 Little 15-25 Some 30-45
	COMMON III	Oig	n clays panic silt rganic si	s and clo	ys of he	w plaste diatam	very nare >60 >78 >65 ** 1=0 pound namemer arciposo 30 arches	Tecm	Sitt / clay (fines) <	0 075 < 0.003	Mostly 50-100
		dd limit >50	tganic cl	ays of h	gh plas	ocity, fat	lays CH Wei-graded = poorly sorted Medium Moist Damp, does not wel palm		Crumbles or breaks with co	nsiderable finger pressure	(time and date)  Coptin to water after driving  (time and date)

	0	Star	ato	20		C	lient: GE - United Nuclear Corporation			BORING	BOREHOLE No.	BS-2	7
	<u></u>	<i>P</i>				P	roject Number. 233001076	Tupe: 4.25"   D. 9" O		FORM	Sheet c	4/1/18	4
	Drillers (day	pany: Cascade [ y night): S. Lom,	A. Ro	drigue	ez, J.	Vigue	eria Drilling Method: Hollow Stern Auger Log	Type: 4.25" I.D., 8" O gged by: C. Fritz	,D. Auger		Finish Date Total Depth	411118	
6	Pield Repres	Semble Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Core Diameter: V / A  Description		Graphic		Remarks	Well Details	3
0 =					4.4	N	Silty sand (SM), fairly well- light brown, slightly ma inedium dense, trace or	-graded, sist,	2,500				
2 -							(roots)	games					
4-													
6 -		5'A 5'B	987	_		М	Servie as above.						
8 =													
10 -		10'A 10'B	949		***	ŝΝ	same as above,		1. 2. 2. 2. 2. 2. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3.				
12 -									19. 19. 19. 19. 18. 18. 18. 18. 18. 18. 18. 18. 18. 18				
(-1)		15-1 A	6			34	Silty sand (SM), coarser & r graded than above, sligh	poorly				Junaman	
16 -		15'A	1186	£X.			graded than above, slight darker light brown.	1+14	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			A Translation	
18 -												na lama lam	
20 -	GRAVEL GRAVEL SANDS Faction pos- faction pos	GRAVELS SET SANDS SET SAND	only grade by graveh syon graded sandy grade by sands. sayon sand brigane si- organe site	ed grav  s. poorly  eds. poorly  ed sands  ed sand  poorly  ds. poorl  es very  ays of lo	ofs, grave graded by gravely s, grave raded s y-graded me sand w to med	gravel- di gravel- di gravel- sands, ty sand- and gra- sand- s, sity e burn pla-	Annotes in minutes  Obt. 1.4**(D. 20**(D. 25**)00  Vary soft 0.2** 0.2** 0.2** 0.2  Vary soft 0.2	Term (SPT) 1.4*1D 2.0*1D 2.2*  pry loose 0.4 0.5 0.  loose 4.10 5.12 7.  edulum dense 10-30 37-80 5.1*  pry fanse 30-50 37-80 5.1*  ri40 pound hammer dropped 30 in Field Test	CRAIN SIZ	Boulders > Cobbles 7: Coarse gravel 1: Fine gravel 4: Coarse sand 2: Medium sand 0: Fine sand 0	Size (nom)   Size (nohe	Term % Timce <5 Few 5-10	5
	No.	AND CLAYS	organic si organic ci ganic side	its, micas trys of his s and cia	ph plass ys of me	diatom city, fat dum to	Clays GH Weignation and profit Model Low Modium	Absence of moisture, dry to touch Damp does not wet palm	Moderate C	rumbles of brazils with ha Dumbles of breaks with co Vill not crumble or break wi	or sight to get pressure socrable toper pressure th finger pressure	(trne and date)  Depth to water after drill: (frne and date)	ng

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING BOREHOLE No.: 65 - 2 LOG FORM Sheet 2 of 2
Drilling Company: Cascade Drilling Dnillers (day / night): S. Lorn, A. Rodriguez, J. Vis Field Representitive (day / night):		be: 4.25" I.D., 8" O.D. Auger  d by: C. Fritz  Start Date: Sec Since 4  Finish Date:  Total Depth:
epth ample Number low Count ecovery (in.) (itst)		Graphic Bemarks Remarks
20' A 50/3' \$	TYPUS IND WIND HOM LOCAL - 102 CV LI	towns or a second
2 GRAVELS GRAVELS (WW-gadded graves, grave)-sond	Intercept state, dark wood  Working the organic type was a second of the control	Cioratiun
CON course or ten Poorly-graded graves, gravely grave at the course or ten Poorly-graded graves, graves grave at the course or ten Poorly-graded graves grav	Section   Sect	14'0   20'0   25'0   5   5   5   5   5   5   5   5   5
SILTS AND CLAYS  Siguid limit >50  Organic silts and clays of liew plan  Independ silts. Proceedings of date  Independ silts. Proceedings of date  Independ silts and clays of inection  HIGHET ORGANIC SOILS  Fig. 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	ocky MH Note  MN Note  E Nonplacto D Nonpl	et of moduler dy to butch of water field feet      Find feet

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	0	Stai	nte	ec.			E - United N		orporation						L BORING G FORM	BOREH Sheet_	<b>©</b>	BS-1	3
	Drilling Compar Drillers (day) n Field Represen	ight): S. Lom,	A. Ro		z, J. V	igueria	Drilling Rig: Drilling Methol Core Diamet	od: Hollow	Stem Auge	5 r		Bit Type: 4 Logged by	.25" I.D., 8" : C. Fritz	O.D. Auge		Fi	art Date: nish Date: ital Depth:	3/1/	18
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Littledagy / Symbol	Core Diamet			cription				Graphic		Rem		Nger	Well Details
2 -				1 41	5)	(ACX	ie sili le con ots), l oston	Nel1-	ina ( natis grac	SM) few led,	, tro oro tra i	ice ( Janic e	Jay, US						
4 -																			
6-	72-	万'A 万'B	からろく	不	5	M SCLV	ne as	5 CN	WÛVK										
8 -				30			inna	e cci t	e ce	ME	nta i	ien.		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				1	
10 -		v6	9.00	少不	S	Med Med	Mode Faw disce ce so	C) (C) (C) (C) (C) (C) (C) (C) (C) (C) (	ay. use	SILH	j 50 e CC	ind;	trac ncite!	٠					
17 -			IO.	- 30		30(	١.												
14 -		9	50/1	5.4/	5		begir nolsta Chner					DIT	01						
10-				11					@					1.1.1.1.1.1					
18 -																			
20=	fraction passes #4 sleve SANDS	GRAVELS GRAVELS SANDS SANDS SANDS GRAVES SANDS GRAVES SANDS GRAVES GRAVE	only-grade y gravers, y gravers, yyey grave if graded y sands, j yey sands, i yey sands, i yey sands, i yey sands, i yey sands i ganic sits i ganic	d graves poorly gr. its. poorly gr. its. poorly grav. poorly grav. poorly grav. poorly graves of tow to and clays s. micocco. ys of high and clays and clays.	gravel- dee graded graded avely so gravely so gravely sed san raded a sends, to module of low plants or du plants or du plants of du	isticity Tomacoous fine sa	or no fines te shines b les te tunes	2.55	Vary soft soft were shift very shift hard very hard	0-2 0-2 2-4 2-4 stiff 4-8 4-6 8-15 9-1 15-30 17-3 30-60 39-7 1 >60 >7/1	(modCAL) 10 2510 2 0-2 4 2-4 8 4-8 7 9-18 99 18-42 78 42-85 8 >85	very loose loose medium dense dense very dense	4-10 5-12 7- 10-30 12-37 18 30-50 37-60 51 >50 >60 > unmer dropped 30 n esture, dry to touch six wet palm	1-18 3-51 1-96 86 1-20 1-20 1-20 1-20 1-20 1-20 1-20 1-20	Boulders >: Cobbles 7: Coarse gravel 1! Fine gravel 4 Coarse sand 2 Medium sand 0 Fine sand 0	075 Iding or sight fing siderable finger p	5tz (inches) >12 3/4 to 3 3/16 to 3/4 1/16 to 3/4 1/16 to 3/15 1/64 to 1/16 0 003 to 1/64 <0.003	Percentages sand, and fine stated in structure of the stated of the stat	% <5 5-10 15-25 30-45 50-100

	0	Star	nte	ec			lient: GE - United Nuclear Corporation roject Number: 233001076	LO	BORING G FORM	BOREHOLE No.: Sheetof_	1
	Drilling Comp Drillers (day) Field Repres	pany: Cascade D / night): S. Lom, entitive (day / nig	Orilling A. Ro ght):	g odrigu	ez, J.		Drilling Rig: CME 85 Bit Type: 4.25" I.D., 8" of Drilling Method: Hollow Stern Auger Logged by: C. Fritz  Core Diameter: 4, 25"	O.D. Auger		Start Date: Finish Date: Total Depth:	
0	Depth	Sample Number	Blow Count	Recovery (in.)	qu (tsf)	Lithology / Symbol	Description	Graphic		Remarks	Well Details
2		0 = 10		144	3	M	Silty sand , slightly moist, light brown, trace carbonates, weak to moderate cementation (SM				una nal ma munan
4		2.5' Bag	23	<b>\</b>				次			majorana
6		5/13	10			35	Moderately weathered sandston	e			
8							EOB @ 65'	The same of the same			na mana mana
10 -								la man la managana			
14 -								The form that I was a			
14								er weed			de la constant
R -								errore commenters			alamana.
20-	SILTS /	with infine or no free, Plant State of the Country	orly gravel y gravel yey gravel eyey gravel y sands y sands yey san yegane s regane con grave bit yegane s regane s	ded gra- s, poorly vest, poorly o sanda ded san poorly ds, poorl ds, poorly ds, poorly ds	veis, gra- graded vity-grade , graveth ds. grave graded ty-graded ty-grade wito me ays of to coours o up, plast ays of me	el-sand gravel- id grave y sands. By sand- and-gra i sand- ss. sity of dum pla sery datom only fat sodum to	Little or no fines	0-7 7-18 opensity 1-86 opensity	Boulders Cobbles 7 Cobbles 7 Coarse gravel 1 Fine gravel 2 Medium send 0 Fine sand 0 Sitt ( tay ( next) <	Size (mm)   Size (inches)	Percentages of grant and, and fines may be stated in terms and country as stated in terms and country as may be stated in terms and country as may be stated in terms before and country as the fire with the country and the before and country Country to water other during These and country Country to water other during

	Q	Star	nte	ec			lient: GE - United Nuclear Corporation roject Number: 233001076		OIL BORING OG FORM	BOREHOLE No.: Sheet of	3S-6 2
f	Drillers (day	pany: Cascade I / night): S. Lom, entitive (day / hi	A. Ro	i drigu	ez, J. \	/iguer	Drilling Rig. CME X 5. Bit Type: 4.25" LD., 8"  Drilling Method: Hollow Stern Auger Logged by: C. Fritz  Core Diameter. 4, 25"	O.D. AL	ger	Start Date: 4 Finish Date: 4 Total Depth:	
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic	Remarks	Well Details
0 +				1	5	MI	LOOSE sirty sand, slightly moist light brown, organics in top 2	-, =			111111
2 =				301				Townson floor			umulu
4-	-			-		-	-> trace coarse frags	and the same			milin
6		5'A 5'B	12	1	5	M	same as above	and trees			milian
8=				71				and tone	16 16 16 16 16 16 16 16 16 16 16 16 16 1		
ΙÕ-		10'A 10'B	399	<b>↓</b>	. 5	М	same as above	ta manda a manda a			en en fra tra
12 -				41 				go ligo ama m			
14-				1					*** *** *** *** ***		adaa
10-		15'A 15'B	キらす	1	\$	М	Loose to medium dense (some) increasing carbonate content- areas of wear cementation	>			
18 -				47	-		\(\lambda_{\text{\tin}\text{\tint{\text{\tinit}\\ \text{\tinit}\\ \text{\text{\text{\text{\text{\text{\text{\text{\text{\texi}\text{\text{\text{\text{\text{\text{\text{\text{\text{\texi}}\\ \tittt{\text{\text{\text{\texi}\text{\texititt{\text{\text{\text{\texi}\text{\text{\text{\texi}\text{\texit{\text{\texi}\tex{\text{\text{\texi{\text{\texi}\texit{\texi{\texi{\texi{\t	ene livir ene			marlina
20-	GRAVELS 450% coan taction puss 44 spec	GRAVELS CI	orly grad Ty gravel Tyey grav	ed grav poorly ets. poo	els, grave graded g dy-graded	ravel-sa gravel	######################################	nodCAL 2.51D	₩ Boulders	Gize (num) Size (inches) 300 >12 7510 300 3 to 12	Percentages of gravel, or sand, and fines may be stated in terms in indication in mage of percentages as below
	SANDS -50% coars fraction pess fraction fract	AND CLAYS and India 150 On Indi	only grade by sands ayey san organic si organic sit organic sit organic sit organic sit organic sit organic sit	od sands podriy- dis poorlits/very- lays of lo s and cla ts, ruca ays of h s and cla	gravely is gravely raded sa y-graded one sands w to med oys of low cecus or o gh plastic sys of med	y sands y sands nd-grave sand-gr suity or um plast plasticity tutornac ty, fat clium to h	Little or no fines	7-18 18-51 51-86 >86 0 inches	Coarse gravel Fine gravel Coarse sand Medium sand Fine sand Str/day(1005)	19 to 75 3/4 to 3 475 to 19 3/16 to 3/4 20 to 475 1/16 to 3/16 0 425 to 2 0 1/64 to 1/16 0 075 to 0 425 0 003 to 1/64 <0 075 0 0 003	Term

THE CONTROL CANAGE DETAILS AND	Stantec	Client: GE - United Nuclear Corporation	SOIL BOR	1 1 .
Description	Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: SEE SINEE
SOUTH BANKS TO THE STATE OF THE	Drillers (day / night): S. Lom, A. Rodriguez, J. Vig Field Representitive (day / night):	ueria Drilling Method: Hollow Stem Auger Core Diameter: 4. 2.5"	Logged by: C. Fritz	
TOUR COLD STANDARD ST	Depth Sample Number Blow Count Recovery (in.) q <sub>u</sub> (tsf) Lithology / Symbol	Description		Remarks
	20'A 7 20'B 9	, Same as above		
SANDS   SAND		EOB @ 21.5		durana
SANDS   SAND				Junitum
SANDS   SAND				
SANDS   SAND				
SANDS   SAND				
SANDS   SAND			And the second s	
SANDS   SAND			desired Between	
SANDS   SAND			The second of the second of	
SANDS   Sand				
	50% coarse   The rest   Poorty-graded graves, graves   GRAVELS   Sky graves, poorty-graded graves   GRAVELS   Sky graves, poorty-graded graves   Graves graves, poorty-graded graves   Graves   Graves graves   Graves		Term 1.410 2010 2510 Boulders	Size (mm)   Size (inches)   Percentages of g   sind, and fines in stated in turns;   75 to 300   3 to 12   stated in turns;   sind a many inches to make the many inches the
Find I want to good and course a replicability of good and course a replicability of good and course a replicability of good and course and the replicability of	SANDS SANDS Well-peaded sands, growthy sands  SON corners on mine or net feet Poorly-peaded sands, growthy sands  SANDS Siny sands, poorly-peaded sands, see Clays yeards, poorly-peaded sands, see Clays yeards, poorly-peaded sands, see Clays yeards, poorly-peaded sands, see Clays and poorly-peade	h, little or no fines	medium dense 10-30   12-37   18-51   d.	el 4.75 to 19 3/16 to 3/4 Term 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

	C	Star	nte	ec			:: GE - United Nuclear Corporation t Number: 233001076			BORING FORM	BOREHOLE No.	1860-1
	Drillers (day	pany: Cascade [ / night): S. Lom, sentitive (day / nig	A. Ro	j odrigu	2z, J.	Vigueria	Drilling Rig: CM C 85 Drilling Method: Hollow Stem Auger Core Diameter: 4, 15	Bit Type: 4.25" I.D., 8" C Logged by: C, Fritz	D.D. Auger		Start Date: Finish Date: Total Depth	35 ft
5	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic		Remarks	Well Details
2=				4	$\rightarrow$	2 M 3	ity sand (SIM) little l ignitly worst, light	Glay, 1005 brown	e, 100			a carractara
4 -			<u>5</u>	<del>}</del> <del>/</del>								or tree from
(b - 8 -		GA GB	1094 1094	1		Siv S	ance as about					an en en en en
10 -			150	<b>→</b>		iM				Avail	yh Cal	
12-		10' Bag	ريا	46		q	>Few ciany below the ense of wearing come	12', medio		200	mpie	um dhum
14-		15' A	7			(	ace carbonales, color nan about , trace shi olacies	cin piece	2) <del>- 1</del>			
19=		151B	85	1								alman.
18 -				\ \ \								
ω-	SILTS	man with the bridge of the control o	eorly grave by grave by grave by grade cony gra ity sandi by sandi by sandi borganic san clays was seed a conganic	ded gra- is poorly niets poor of sands ded sands L poorly- nds poor sats-very clays of it	eth gravely graded dry-graded gravely the gravely the graded ty-graded ty-graded the same with me to me to to me to me to me to me to me to me to me to me to to me to me to to me to me to me to me to me to to me to to me to to me to to me to to me to to to me to to to to to to to to to to	es sand mixts gravel-sand- di gravel-sands, little ly sands, little ly sands, little ly sands, little and-gravel-si s sand-gravel- s, sitty or clas sium plasticity r plasticity	Section   Sect	very loose 0-4 0-5 loose 4-10 5-12 7 medium dense 10-30 12-37 1 dense 30-50 37-60 5 very dense >50 >60 :: *= 140 pound hammer dropped 30	0-7 oct sand Grave(s) oct sand	Cobbles Coarse gravel Fine gravel Coarse sand Medium sand Fine sand Sall / clay (fines) Courbles or breaks with in	Size (mm)   Size (inche)	minded in farms industrial of infarms industrial of a range of percentages an below 7 erm % Trace <5 Few 5-10 Industrial 15-25

	0	Stai	nte	eC.		Client: GE - United Nuclear Corporation roject Number: 233001076			BORING G FORM	BOREHOLE No.: (3) Sheet 2 of	2
	Drillers (day	oany: Cascade I / night): S. Lom, entitive (day / ni	A. Ro		, J. Vigue	Drilling Rig: Drilling Method: Hollow Stem Auger Core Diameter: 4, 25	Bit Type: 4.25" I.D., 8" O. Logged by: C. Fritz	D. Auger		Start Date: Start Date: Total Depth:	Sneet
20 _	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Description		Graphic		Remarks	Well Details
		20' A 20' B	2779	1	SM	Same as above					
11 -				18							g.
24 -				\ \ \ \					5" rec	overy bo	m+c
26-		25' A 25' B	6651		514	same as above			liners	overy loc (no clensi)	1
28 -			2	10							
30 -		30' A 30' B	1544	1	514	same as above					
32 -				1 04					(0 > 5	00 pipm	g .
34 -				\ \ \ \		(Additional moisture water down how to	From pouring Suppressigni		LEL= 2 (4' don	oppinion hole	
36 -						EOB @ 3	55' —	and and			a gran
38 -											er ith on En et
40-	SILTS	SANDS WAS SANDS	only grade by gravets. Ayely grave eth-graded overly grade dy sanes, by sanes, by sanes derganic site organic cus an clays organic site organic site organic site organic site organic site	o gravelli poorly gravel, sands, go of sands, poorly gravel, specify gravel, swelly fine ys of tow? and clays s, microse ys of high and clays and clays	gravel-sand stood gravel- graded gravel- gravelly sands, gravelly sand- graded sand-gra- graded sand-gra- graded sand- sands, sifty of o medium pla- of low plastic plasticity, fet of medium to of medium to	inician cicley matures  OC State of the circle of the circ	Term   43°77   Control   Control	Tem Moderate	Fine gravel 4.75 Coarse sand 2.0 kg Medium sand 0.425	300 3 to 12 75 3/4 to 3 to 19 3/16 to 3/4 4/4 75 1/16 to 3/16 to 0.425 0.003 to 1/64 to 0.425 0.003 to 1/64 or 0.003 to 1/64 or 0.003 to 1/64 or 0.003 to 1/64	retentages of gravel, and, and fines may be addeding a range of exceedings as before 7 to 2.5 few 5-10. Little 15-25 Some 30-45 Mostly 50-100 and a first water and dample and d

	C	Star	nte	эc			Client: GE - United Nuclear Corporation			BORING FORM		1: BW-Z of Z	
	Drillers (day	pany: Cascade [ // night): S. Lom, sentitive (day / ni	A. Ro	drigu	ez, J.	Vigue	Drilling Rig: Drilling Method: Hollow Stem Auger Core Diameter: V / A	Bit Type: 4.25" I.D., 8" C Logged by: C, Fritz	D.D. Auger		Start Date: Finish Date Total Depti	4/18/18	
	Depth	Sample Number	Blow Count	Recovery (in.)	qu (tsf)	Lithology / Symbol	Description		Graphic		Remarks	Well Details	Well Details
2 -						SM	Silty sand willittle claufew corporates (espin cemented clods), trace or croots, grasses), light by slightly moist, medium	nown,	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			สโภเพโบกเป็นเป็นก	
8		5'Bag	191013		<	5M	Same as above		سيسياسسياليسسينيين پوهندو دريود دريون	Anally Court lives	tical So From A )	mple	
10 -		10'A 10'B	900		4	5M	Same as above, trace	e Clay	سيساليسالاسالاسالاسالاسالاسالاسالاسالاسا				
14-		15' A	9+1		v.	5H	Same as above		مىلىمىمىلىمىمىئىيىسىك ئىيدۇرىي چاقەتلاپ ئازىمەكى				
18 -		(5'B	17						مين ملاميسيل ميسيلاميس جرد بار جوجي دي ومخرج ويعدع				
20 -	SILTS	SAND CLAYS and SAND C	orly-grad by gravels sylvy gravels orly-graded orly-graded by sands. sylvy sands sylvy sands organic silve ganic silve ganic silve ganic silve ganic silve ganic silve ganic silve ganic silve	ed gra- s, poorly- mis, poo- d sands ed san- soorly- ds, poo- ds,	ens, grave graded dy grace) ds, gravely ds, gravely graded is by-graded fine sand oer to mex deposit of the coous or gh grass grass of me	gravel- gravel- drawel- sands, dy sand sand- san	sceous fine sand or saft MH Note	very loose 0-4 0-5 0-1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	nds and Gravels) DENSITY Weak Moderale	Boulders >3 Cobbles 75 Coarse gravel 15 Fine gravel 4 Coarse sand 20 Medium sand 00 Fine sand 00 Silt / clay (fines) <0		stated in terms indicating a range of percentages in being trace 5 Few 5-1 indicating a few 5-1 indicating a range of percentages in being trace 5 Few 5-1 indicating trace 5 Few 5-1 i	5 10 25 45

20'80924 Shorown + white w/ trace plack (bulk from A.B. c.) Shale pieces, stigntly moist liners)		C	Star	nte	ЭC			GE - United		Corporat	ion							BORING	BORE		BW-	. 2
Description  Remarks  Description  Description  Remarks  Description  Description  Remarks  Analytical Sample  Share preces, Silty Sand (SH), few carrange, Analytical Sample  Share preces, Silgnity moist  Share preces, Silgnity moist		Drillers (day	/ night): S. Lom,	A. Ro	drigue	z, J.	/igueria	Drilling M	ethod: Hollo		Auger		L	Bit Type: .ogged b	4,25" I.D y: C. Frit	., 8" O.D. z	Auger		F	inish Date:	ee sne	e+ 1
Dense silty sand (SH), few carronard, Analytical sample subscient from A.B. c Shale pieces, slightly moist iners)	<b>1</b> 10				Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol			I							Graphic					Well Details
22 E Préces, Stignitiq moist	LO =	-	10, 8evd	11 24 32			M De	nse s wn .	ilty + wv	San ine	vol (5	trou H),	fec e v	ט/מכ מי פנ	K-	KIK)	が高端	Anana Cours	tical from	San A.K	npie 3, c	
E013 @ 20+ 21.5'	22 =						SNO	ue t	NAC67	137	10/14	ud	WD	15t	/			111001	2)	-		
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		<u>-</u>														3						
		ega figa																				
GRAVELS ORAVELS Web-graded gravits, gravels and mintures. Iddit or no fines OW 14-00 2010 25:00 14-00 2010 2		₩ <50% coar	se with little or no fines. Pe	iorly-grad	ed-gravi	ets, grav	i-sand mixtures.	ittle or no fines.		OW GP OM > ~		90 200		Term	15F1) 1.410 2	ws/ft* (mosCAL 01D 251D		Developer	>300	>12	M. stated in terr	
44 sleeve with 195 rise City of graveth, pooling-graded gravel and-city mixtures OC 9 with 95 rise City of graveth, pooling-graded gravel and-city mixtures OC 9 with 95 rise City of graveth, pooling-graded gravel and-city mixtures OC 9 with 95 rise City of graveth, pooling-graded gravel and-city mixtures OC 9 with 95 rise City of graveth, pooling-graded gravel and-city mixtures OC 9 with 95 rise City of graveth, pooling-graded gravel and-city mixtures OC 9 with 95 rise City of graveth, pooling-graded gravel and-city mixtures OC 9 with 95 rise City of graveth, pooling-graded gravel and-city mixtures OC 9 with 95 rise City of graveth, pooling-graded gravel and-city mixtures OC 9 with 95 rise City of graveth, pooling-graded gravel graveth, pooling-graded gravel graveth, pooling-graded grave		SANDS <50% coan	sands W	syey grav eli-grader	sands.	fy-grade gravelly	ands, little or no	tioes		S SE S	oft nedium stiff tiff ary stiff	2-4 2-4 4-8 4-8 8-15 9-17 5-30 17-39	2-4 4-8 9-18 18-42	nedium der dense	4-10 5 10-30 13 30-50 37	-12 7-18 3-37 18-51 7-60 51-86	DENSITY ds and Gravel	Fine gravel Coarse sand Medium sand	19 to 75 4 75 to 19 2 0 to 4 75 0 425 to 2 0	3/4 to 3 3/16 to 3/4 1/16 to 3/16 1/64 to 1/16	percentages  Term Trace Few	% <5 5-10 15-25
liquid limit <50   learn clays   way yeard   >60   >78   >60   ** Nonpilestic   **   **   **   **   **   **   **		SILTS	AND CLAYS	pri clays ganic sitt organic si organic cl	s and cla its. micas ays of he	ys of line your or yh plaste	plasticity digitomaceous fin ity, fat clays	sand or sid		OL MH Note CH Wel-grades	ard :	>60 >78	>85	* = 140 pound	moisture dry I	oped 30 inches	Term Vveak	Fine sand Silt / clay (fines) Field Test Crumples or bleaks with	<0.075 h handing or slight	<0.003	Mostly	30-45 50-100 vater

ĺ	(	Star	nte	ec			Client: GE - United Nuclear Corporation			BORING G FORM	BOREHOLE No.:	BW-3
	Drilling Com	pany: Cascade [	Onilling	3		- 1		Bit Type: 4.25" I.D., 8" C		G I OKWI	Start Date:	
	Drillers (day Field Repres	/ night): S. Lom, entitive (day / ni	A. Ro ght):	odrigu	ez, J.	Vigue	Prilling Method: Hollow Stem Auger Core Diameter: N / A	Logged by: C. Fritz			Finish Date: Total Depth:	
$\cap$	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic		Remarks	Well Details
					1		Silty Sand (SM) w/ few Slightly moist, brown, t	trace				THILL
2							organics, medium dense	J				mulus
4												drama
		5'A	8		V	M	Same as above					
6-		5'B	97									Lance and the
8 -												
10 -		1000	7	-			same as above, withan	. bnoken		Analo	inical sa From A	mpie
12 -		10' Bag	789			) 0	sandstore, tew carbon	ars		Cours		1B,C =
. 2	e de la constante de la consta											e de
i4 -			30				Highly weathered shak t some chunks solid t le	Sandston 188-Weath		1		The state of
10=		15'A	59	「ら"			scindstone EDB@15.9'					
18 -							2012 6 113, 1		line in			
20-	GRAVELS 450% coan maction pasts 450% coan selection pasts 450% coan maction pasts 450% coan maction pasts maction	GRAVELS CU	y gravet y gravet yey grav	ed grav L poorly wis, poo	graded cry-grade cry-grade	gravel-s d-gravel-s	where little or no from	Term (SPT) 1/411D 2011D 20 10	Sands and Gran	Boulders > Cobbles 75 Coarse gravel 15 Fine gravel 4 Coarse sand 2	Size (inches   Size	stated in terms maked in terms midcating a range of percentages as below  Term % Trace < 5 Few 5-10
	SILTS SILTS	AND CLAYS Inc. Inc. Inc. Inc. Inc. Inc. Inc. Inc.	n cuys panic sit rganic si rganic ci panic sit	s and cit its, mica lays of h s and cit	ays of low ceours or ign plants ays of me	plastic diatom ity, fat o dium to	very hard >60 >78 >85  OL  Nonplastic W Terr	very dense >50 >60 > *= 140 pound hammer dropped 30 a	86 (els) (f)	Fine sand 0 Sit / clay (fines) <	425 to 2 0 1/64 to 1/16 075 to 0 425 0 003 to 1/64 0 075 <0 003	of Lattle 15,25

	C	Star	nte	ec			Client: GE - United Nuclear Corporation Project Number: 233001076	1	OG FORM Sheet 1 of 2
- 1	Drillers (day	ppany: Cascade E / / night): S. Lom, sentitive (day / nig	A. Ro	drigu	ez, J.	Vigu	Drilling Rig: ( ) 2 3 5 Bit Type: 4.25" l.D., 8" ( Pria Drilling Method: Hollow Stem Auger Logged by: C. Fritz  Core Diameter:	O.D. Auger	Start Date: 4 18/19 Finish Date: 4/18/13 Total Depth: 21.5 FT
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description	Graphic	Graphic Sylvell Details
2 -						SM	Lipose silty scind, light brown, slightly moist, some weekly cementa closs	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	2.00
4 -			7						The contract of the contract o
9-	-	5609	500			SM	Same as above	***************************************	Ananytical Sample = (A,B,C livers-thuik)
8 -									
10 -		10'A	440		ć	M	same as above, trace fine graves		
12 -									HIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
16 -	-	15 Bag	ルルイ		4	5121	Stiffy Sand with trace clay, Slightly danger brown than abo medium olense & weak cementation	200	Analytical sample (Bulk from A.B.C. Ilmers)
18 -									회 회 [
20 -	SILTS	SAND CLAYS uid limit >50  SAND CLAYS uid limit >50  SAND CLAYS uid limit >50	y graveh y graveh yey grade il gradeo y sanda, yey san granic si n clays granic sin granic sin granic sin granic sin	L poorly- vers poorly- vers poorly- december of sands and sands poorly- december of the ma-very-flays of the sand classes and	els, gra graded ny grade gravel s, grave yaded y grade me san w to ny cedus e gh plas ys of ny	gravel gravel ed gravel y sands y sand-gravel dram pl dram pl w plast- or diatom ticity, fal- edium ti	Immunities   1	0-7 7-18 8-51 61-86 >86 Weak Moderate	00   Medium sand   0.425 to 2.0   1/64 to 1/16   Fine sand   0.075 to 0.425   0.030 to 1/64   Store   1/64 to 1/

Sta	ntec		E - United Nuclea umber: 233001076	ar Corporation		SOIL BORIN LOG FORM	Sheet of
Orilling Company: Cascad Orillers (day / night): S. Lo Field Representitive (day /	m, A. Rodriguez,	J. Vigueria	Drilling Rig: Drilling Method: He Core Diameter:	ollow Stem Auger	Bit Type: 4.25" I.D., Logged by: C. Fritz	8" O.D. Auger	Start Date: Size Size Finish Date: Total Depth:
Depth Sample Number	Blow Count Recovery (in.)	Lithology / Symbol	Core Diameter. 1	Description	1	Graphic	Remarks   signal   si
20'A		SU 50	ime cis	above			111111111111111111111111111111111111111
			<u>2</u>	1015@21.	5'		
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						T.	
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						Tenentalia	
GRAVELS GRAVELS GRAVELS GRAVELS GRAVELS GRAVELS GRAVELS GRAVELS GRAVELS	Well-graded gravet, gra Poorly-graded gravets, gra Sity gravets, poorly-grad Cayey gravets, poorly-grad	ravel-sand mixtures, in od-gravel-sand-sit mix	tures	GP Term (SP7)	ows/it*   Term (3F7)   Blows   2010 2510   1410 2010   0-2 0-2   very loose   0-4 0-5	D 251D S Boulders	Size (mm)   Size (inches)   Percentages of yr   sand, and fines in   sand, and fines in   sand and fines
SANDS SANDS SON coarse fraction passes Plasers Sulfan AND CLAYS liquid limit <50	Web-graded sands, grav- Feorly-graded sands, grav- Sity sands, poorly-graded Clayey sands, poorly-graded loopsand sattlesy fine is helpanic clays of law to lean clays.	elly sames, little or no is samp-gravel-sit misto ded samp-gravel-clay r ande, city or clayey fine medium plashicity, grave law plashicity.	nes ines ontures o sands, sits with sight playsed My clays, sandy clays, sity clay	SM   SM   SM   SM   SM   SM   SM   SM	2-4 2-4 loose 4-10 5-12 medium derse 10-30 12-3 dense 30-50 37-8 38-5 37-8 8-85	7 18-51 0 51-86 0 286 2 286 28	475 to 19 3/16 to 3/4 1 Trace 2 1 Trace 2 1 Trace 3 1 Tr
SILTS AND CLAYS Iquid Ilmit >50 HIGHLY ORGANIC SOILS	Inorganic sits, micaceour inorganic citys of high of Cirganic sits and clays of Peat, humus, swamp son	medium to high plastic	dy.	Ot. Wiff-graded = poorly sorted OH Poorly-graded = well sorted H	w 2 Dry Absence of moisture dry to to addum Moist Damp does not well palm Wet Visible Free Water	ouch Week Crumbles or creaks Maderate Crumbles or breaks	with considerable frame and date.  With considerable frame and sales after a free and sales.

	0	Star	nte			Clien	: GE - United Nucle	ear Corporatio	on				L BORING		OLE No.:		
	Drilling Com	pany: Cascade D	Veli coo	_		Proje	Number: 233001076	ME L	ALT	5 Bit	Type: 4,25" I,D.,		G FORM		of art Date: 😤	_	ΙX
	Drillers (day)	/ night): S. Lom, entitive (day / nig	A. Roc	Iriguez	z, J. V	igueria	Drilling Method I Core Diameter.		iger this		ged by: C. Fritz			Fi	nish Date: 3 stal Depth: )		13
<b>()</b> =	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)				escription			Graphic		Rem	arks		Well Details
2			3	1 B	\$	CV (v	ense sir Y, ligh oots),we .vvev.ta	ar to	con, i	Talle	. Grocky	105	8				
4-			The 1	<u></u>									Doub	N.C.	10/0C		
() =		5'A	25			را ن اخ	languty s	MICINA (	SC);āl	ard ard	Proces	)		137	Vicin 5		
8 -			9		51	J 10	ense sil ignaly ace to eace to	ty Si mick	ry (S)	ht lan	iry 10 two	18.15					
10-			10 25	1	S		ione as			it c	Evrital	Citron.					
12 -				5)													
14-				1													
10-		15'A 15'B	14 19 20		5	N .	CIVNL (	as cu	SUDO								
18 -				40													
20 -	SILTS	BANDS WE SANDS SAN	orly gradery gravets, yey gravets, yey grader organics, yey sands, yey sands, yey sands, ganic sitts ganic sitts reganic sitts reganic sitts reganic sitts panic s	d graval poorly gr is, poorly sands, g 5 sands, confy-gra poorly swery-fin- ps of low and cray- sy of high and cray- sy of high and cray- sy of high and cray-	s gravely aded graded graded ravely s gravely ded san graded is sands. to media a of low pours or d plastics of media	sand mixtur avel sand signivel sand ands, little or sands, little of gravel-sit and gravel- sity or clay in plestory, insticity	clay mintures to fines instrumes are fines instrumes are more fines as well as the fines as well as well as got plant reveally clays, sandy clays, safty clays, sand or sit instruments.	SONS SONS SONS SONS SONS SONS SONS SONS	y soft 0-2 0-2 1 2-4 2-4	(modCAL) T 2.5 ID ver 2.4 loo 4.8 me 7 9-18 der 9 18-42 ver 8 42-85 8 >85 *=1	y loose 0-4 0-5 se 4-10 5-12 dium dense 10-30 12-3 nse 30-50 37-6	int (modCAL) (Sand Service) (ModCAL) (ModC	Boulders Cobbles Coarse gravel Fine gravel Coarse sand Medlum sand Fine sand Coarse sand	reiderable finger	preseure w		% <5 5-10 15-25 30-45 50-100

	Sta					Client: GE - United	01076	oration				L	OIL BOR	1140	et <u>2</u> of _	
Drillers (day	npany: Cascade / / night): S. Lom :sentitive (day / n	A. R	g odrigu	ez, J	, Vigue	Drilling Rig eria Drilling Me Core Diam	: thod: Hollow Ste leter: 🛶 . Z	em Auger		Bit Type Logged	: 4.25" I.D., 8 by: C. Fritz	8" O.D. AL	ger		Start Date: Se Finish Date: Total Depth:	S SM
Depth	Sample Number	Blow Count		q <sub>u</sub> (tsf)	Lithology / Symbol		•	Desc	ription				Graphic	Re	emarks	
	20'A 20'B	多万多		2	51~	Sawu	US (	(00	re							
							EOB	<u>,</u> @	21.5	`		neransea Bres				
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GRAVEI 450% coo	GRAVELS SH Ses GRAVELS SH SESTIMATE CL	orly-grad ty gravel tyny gra	led grav s, poorly reis, poo	eis, gra graded rly-grad	vel-sand gravel-s ed-grave	indures, little or no fines mutures, little or no fines and salt minimus insand-clay minimus, little or no fines s. little or no fines	WE DO WE	Term	2-4 2-4 2	vary loose foose	4-10 5-12	0-7 7-18	Term Boulders Cobbles Coarse gr		Dize (inches) >12 3 to 12 3/4 to 3 3/16 to 3/4	Percentages sand, and fe stated in ten indicating a percentages
5 fraction par 84 sevi	SANDS SANDS SAND CLAYS	ty sands zyny san irganic s irganic c	poorly-g ds. poorl ds. very f ays of io	y-grade y-grade ine san- w to me	sand-gra d sand-g ds. sity o deam pla	s. little or no fines vel-sit minitures pravel-clay modures r clayey fine sands, sits with sli socity, gravelly clays, sandy clay	SM SG NO OPERATE STATE OF THE S	medium st stiff vary stiff hard		dense dense very dense	30-50 37-60 a >50 >60 a harmon drapped	>86	Fine grave Coarse se Medium s Fine sand	nd 20 to 475 and 0425 to 20 0075 to 042	1/16 to 3/16 1/64 to 1/16	Traca Few Little

	0	Stan	ite	C		Client: GE - United Nuclear Corporation		BORING	BOREHOLE No.: (	1-2
	Drilling Compar Drillers (day / ni	ny: Cascade D	rilling	ton in		Drilling Rig: C. LA LAK- 75 His Torigot Bit Type: 4,25" I.D., 8" O.I			Start Date: 3	
	Field Represent			ingue.		Core Diameter: V / A	- I		Total Depth:	1.4.17
•	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Description	Graphic		Remarks	Well Details
U				个		Lean clay i meatium dense, dry,	35			=
						light brown, trace calcium	HAR			=
				i		Carbonate				7
) -				0		car beginne	1			
_							=			1
							3-2-			3
1 -										
4				1			1-			7
		- 1 A	IΔ	A			1-			=
,		5' A	14		CI	Same as about				
6 -		518	20	П			]			
							3-1			=
				19						=
8 -										=
							-			∄
	3						-3-			7
10 -	=    -		0	4		Silter Fine Sand traditions bours	-			7
		0, Y	9		72	Large are a same of the start of	<b>7</b> 制			
	= 1	0'B	19	П		Silty fine sand, tan light bown trace cay + gravel, slightly moist, medium dense				
12 =	=			П		MIST ST I WIRCHIOM ELECTIFE				=
12				10						3
	}			1			-100 200			3
I/A	5						38			Ξ
14 -	E						16.			=
		- 1 1	cà(	<u>v</u>		C	1			1
		5'A	9		Sh	Silty sound, trace to ten grand	<b>"</b> 题			4
10			17 22			tanlight brown, slightly moist				Ξ
						Silty Sand, trace to few graves tanlinght brown, slightly moist weakly cemented, medium to				=
.0-				16		dense				Ŧ
18 -	-			1			-1,1			
										3
	Ε						訓			3
20-	E. GRAVELS	GRAVELS We	Fgraded	W. Gravers	gravel-sand	makurs, into or no fines GW Blows/h*	111	Term Si	te (mm) Size (inches)	Percentages of gravel.
	S SANDS	GRAVELS Diffy	riy-grade y gravels yey grave	poorly-g is, poorl	s gravel-sa raded grave v-graded gr	d mathems, little or no fines.   GP   Term (SPT)   ImpeCAL)   Term (SPT)   ImpeCAL)	SIZ	Boulders >3 Cobbles 75		Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below
	SANUS 450% coarse fraction posses #4 serve	SANOS SIE	vily-grade v sands, s	d sands cody gr	gravely se seed sand-; graded san	was late or no fines 5P medium still 4-8 4-8 4-8 medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-17 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (2014) medium still 8-15 9-18 dance 30-50 37-80 51-8 (	ALISP RAIN	Fine gravel 4.7 Coarse sand 2.0 Medium sand 0.4	5 to 19 3/16 to 3/4 16 4 75 1/16 to 3/16	Term % Trace <5 Few 5-10
	SILTS ANI Ikquid lin	D CLAYS inor	rganic sitt rganic cta n clays sanic sitts	ys of low and clay	to medium; s of low plan	very right 200 210 200 1 = implementation dropped at the	es E		075 to 0 425 0 003 to 1/64 075 <0.003	Mostry 50-100
	SILTS ANI liquid lin	D CLAYS Inci	rganic sit	s, micac	nous or diate	nacoous fine sand or sill MH Plaste S Toy Assessed most or to lough S	Weak Chi Moderate Chi			Depth to water after driling

	(	Stai	nte	С		nt: GE - Unite		orporation						L BORING		HOLE No.:	L1-	2
	Drilling Com	npany: Cascade	Drilling			ct Number: 23: Drilling F	Rig:						" O.D. Auge		S	tart Date:5	ee Sh-	eztl
		/ night): S. Lom sentitive (day / n		guez, J, \	/igueria		Method: Hollov ameter: N				Logged b	y: C. Fritz				nish Date: otal Depth:		
) (\) =	Depth	Sample Number	Blow Count	q <sub>u</sub> (tsf)	Lithology / Symbol				cription				Graphic		Ren	arks		Well Details
50 -		20'A 20'B	13	S	м <u>С</u> . А	liner +BI very v	→ Si	154 S	iana	1.	-	brou	ار در در	S				
17		2	//0	1	,l_ ,	reny v	neurd,	Slig	htiv	mo	7816	, we	ak =		-			
22-	E				1	errier	itatio	>n	1	3			/				1	=
						\	800	<u>, @</u>	2.1.4	A.			1					3
	E								- 1 /				4				-	=
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_	GRAVEL	S GRAVELS W	lell-graded av	avels, gravel-	and mixtures	s, ittle or no fines	jov	y T	Blos	ws/ft*	r	Blows/fi		Term	Size (mm)	Size (inches)	Percentane	of gravel.
	SANDS	SANDS W	ayey gravels.	poorly-graded not, gravely	gravel-san ands, little o	s, little or no fines os, little or no fines it mintures s-clay mintures r no fines	OP Ob OC SW	Term	(SPT)	(modCAL) 0°ID 25°ID 1-2 0-2 2-4 2-4	Very loose loose	0-4 0-5 4-10 5-12	25'ID 3	Boulders Cobbles Coarse gravel	>300 75 to 300 19 to 75	>12 3 to 12 3/4 to 3	stated in ten indicating a percentages	range of a as below
	<50% coar fraction pas #4 sieva	SO with title or no lines   Pt	orly-graded	sands, gravelt	sands, little	or no fines	SP	medium s	8-15 9 15-30 17 30-60 39	4-8 4-8 -17 9-18 7-39 18-42 3-78 42-85	medium den dense very dense	se 10-30 12-37 30-50 37-60	0-7 7-18 18-51 51-86 >86	Fine gravel Coarse sand Medium sand Fine sand	4 75 to 19 2 0 to 4 75 0 425 to 2 0 0 075 to 0 425	3/16 to 3/4 1/16 to 3/16 1/64 to 1/16 0.003 to 1/64	Term Trace Few Little Some	% <5 5-10 15-25 30-45
	lqui lqu	AND CLAVE	ganc sits an organic sits, r	d clays of low misassous or i	platticity Natoma (equi	gravelly clays, sandy		Very hard very hard very hard very grade = poorly Poorly graded = set		78 >85	Field Test Absence of	harranor disposed	term	Sit / clay (fines) Field Test Orundles or treaks with	<0.075	<0.003	Mostly Depth to first y	50-100 ma) III
		In the second	organic clays rganic sits an	of high plastic dictays of mos	ty, fat clays	Antichy	OH OH	Poorly-graded = seeily Poorly-graded = well	sorted S Med	Mois Wet	Damp does	not witt palm	Moderate Strong	Will not crumble or brea	considerable linger	présoure y	Depth to water	rafte other

	( Star	ntec	Client: GE - United Nuclear Corporation	SOIL BORING BOREHOLE No. (1 - 3)  LOG FORM Sheet \( \) of \( \) 2
	Drilling Company: Cascade D Drillers (day / night): S. Lom,	Orilling	Project Number: 233001076   Drilling Rig: ("\LELAVE 75")   Hi TTTAVE   Bit Type: 4.25" I.D., 6" O figueria   Drilling Method: Hollow Stem Auger   Logged by: C. Fritz	
	Field Representitive (day / nig	ght):	Core Diameter: 1 A	Total Depth 21, 5
0	Depth Sample Number	Blow Count Recovery (in.) qu (tsf)	Description	Graphic Graphic Well Details
0 -		S	MSilty sava (SM), few to little	11.
	77		MSilty sand (SM), few to little clay, light brown I tan, slightly	
2 -			moist, medium dense	
4				
4 -				48 4 1
	Ē:			51:000 i
	5'A	9 5	usame as above	Slightly improved Structure in
6-	5'8	12		samples compared
				to previous holes
8 -				
8 =	-			
10 -				
	10'A	5 5	M same as above	
		Ó		
12 -	E			
14 -				
	1 - 1 a	5		
16 -	15'A 15'B	128 2	y same as above	
, 3	1010	12		
18 -	8.			
				10
20 -	S fraction posses GRAVELS 5-8	orly-graded gravels, gravel y gravels, coorly-graded gr yesy gravels, poorly-graded	Ann ministures. Little or co lines	Cat.   Term Gize (meth) Gize (inches)   Percentages of gravet.   STD   Standard   Standa
	SANDS SANDS WE SON TO THE PROPERTY OF THE PROP	in graded sands gravely sorty-graded sands gravely y sands poorly-graded san	ands, take or no fines 5W U 3 oft 2-4 2-4 100se 4-10 5-12 7-1 medium stiff 4-8 4-8 4-8 medium dense 10-30 12-37 18-3 medium stiff 4-8 4-8 4-8 medium dense 10-30 12-37 18-3 medium stiff 4-8 4-8 4-8 medium dense 10-30 12-37 18-3 medium stiff 4-8 4-8 4-8 medium dense 10-30 12-37 18-3 medium stiff 4-8 4-8 4-8 medium dense 10-30 12-37 18-3 medium stiff 4-8 4-8 4-8 medium dense 10-30 12-37 18-3 medium stiff 4-8 4-8 4-8 4-8 medium stiff 4-8 4-8 4-8 4-8 medium stiff 4-8 4-8 4-8 4-8 4-8 medium stiff 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8	8 8 9 7 0 Coarse gravel 1910 75 3/410 3 75 75 76 77 76 77 76 77 76 77 76 77 76 77 76 77 76 77 76 77 76 77 76 77 76 77 76 77 77
	NAME OF STREET OF STREET	panic sits and clays of law p	vary hard >60 >78 >65 * 140 pound number or opped up the	thes Sitt / Clay (fines) <0.075 <0.003 to 1/64 \$ Some 30-45 Monthly 50-100
	SILIS AND CLAYS Inc	rganic clays of high plastics game with and clays of med	issuescoy OS.  Mill Note Mill Note Control of Control o	Term Field Test  West Cumbins or breaks with handling or slight finger pressure  Moderate Crumbies or breaks with considerable finger pressure  Will not crumble or break with linger pressure  Will not crumble or break with linger pressure

(	Sta	nto	ec			Client: Gl				poratio	n								ORING	G BORI	EHOLE No. t <b>2</b> c	Ц-	3
Drilling Com	npany: Cascade				1	Project Nu	mber: 23 Drilling		5					Bit Type	: 4.25" [	I.D., 8" C			FORM		Start Date:	ree s	
Drillers (day	/ night): S. Lom sentitive (day / n	, A. R	odrigu	ez, J.	Vigt	Jeria	Drilling	Method: iameter.			ger			Logged				v			Finish Date Total Depth		
Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	1				D	escript		1					Graphic			marks		
	20' A 20' B	8 22			SH	Say Car	ne bor	as	- j l	NU	cas	ed	ce	cal. un:e	C) U	111701 121701	n						
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gravel	S GRAVELS W	Nº grade	d graves	9210	Lsand	mixtures, little or	no finas		GW GP	T	m ise	Blows/f	(modCW)	Те	(SPT)	Blows/ft*	ICAL D		irm	Size (mm)	Size (inche	Percents so sand an	ages o
S (50% coar fraction pas #4 sieve 5 SANDS	GRAVELS 5	ity graver tayey grav tell grader	s poorly rels poor d sands	graded ty-grade graves	gravel ed grav y sands	mintures, little or d mintures, little sand-sift mintur vei-sand-clay m , little or no fine	of stones		GM	TENCY (Clays)	soft 0	2 0-2 -4 2-4	25 ID 0-2 2-4	very loose loose	0-4 4-10	2010 2 0-5 0- 5-12 7-	-7 18	SIZE	oulders obbles oarse gravel	>300 75 to 300 19 to 75	>12 3 to 12 3/4 to 3	D becour	
# 50% coor fraction pas #4 seve	SANDS SANDS SANDS C	ity sards. Byey san organic s	poorly o ds poorl mayon	raded y grade ine sand	sand-gr d sand ds. sdy	Little or no fine ds. Attle or no fir ravel-sit morture gravel-clay ma- or claytry fire s asbody, gravely	tures ands, sits wi	en sligte plast	SA SC Kry ML	CONSIST Silfs and (Silfs and (Sil	ium stalf 4 8- stalf 15 1 30	-8 4-8 15 9-17 -30 17-39 -60 39-78	18-42	medium de dense very dense	ense 10-30 30-50	12-37 18- 37-80 51- >60 >8		छ  ∾	ne gravel oarse sand ledium sand ne sand	4 75 to 19 2 0 to 4 75 0 425 to 2 0 0 075 to 0 425	3/16 to 3/4 1/16 to 3/16 1/54 to 1/16 0 003 to 1/6	F FeW	
E liqu	O O AND OL AVE	iganic sitt	ts and cla	ys of io	# plaste duton	cay raceous fine sa	and the second	, cays, sity ti			hard >	60 >78	>85	*= 140 pour Field Test	d maisture	fropped 30 in	2	Field	It / clay (fines)	<0.075	<0.003	Depth to fi	
[表] liqu	uld limit >50	norganic ci Inganic silt	itys of his is and cla	gh plast ys of m	odium t	t clays in high planticity h organic contar			CH OH PT	Note: Well-grased * Poorly graded	ooarly sorted well sorted	Medium High	Mos Wes	Absence of Damp_doe Vrslble Fre	if moisture, o as not wet pa e Water	aim aim	West Moders	de Orumi	Pet or breaks w	th haveing or sight to considerable fing tak with finger press	er pressure	Depth to w	are at

	C	Star	nte	ec			lient: GE - United Nuclear Corporation roject Number: 233001076		IL BORING BOREHOLE No.: L1 - 4  OG FORM Sheet 1 of 2
	Drilling Com Dnilers (day	npany: Cascade I y night): S. Lom, sentitive (day / nig	Orilling	drigu	ez, J.	_	Drilling Rig: CNS 1 AP 35 his throw Bit Type: 4.25" I.D., 8" C		
	Depth	Sample Number	Blow Count	Recovery (in,)		Lithology / Symbol	Description	Graphic	Remarks sign
0 -						M	Silty sand (SM), few to little		
2 -		í4					elay, light brown, Slightly moist, medium dense		
4 -					*				
(g -		5' A 5' B	8 113		3	SM	same as above		
8 =									
10 -		10'A	51320		4	SΜ	-> few to little clay, darker brown, trace calcium carbonal	C (100	The state of the s
12								-	3
14 -		2 3				SP	Clean Sand, 100Se, light brown we grey Silica crystals visible, slightly wish moist, medium	000	=
le -		15'A 15'B	257		4		sand		17
(8 -									;—————————————————————————————————————
20 -	GRAVELS  SON common part of the	GRAVELS Sty  GRAVELS Sty  SANDS Wer  SANDS SANDS CSY  AND CLAYS  Id limit <00 Jean	rly-grade gravets ey grave graded rly-grade sands, ey sand gank siz gank cla clays	d grave poorly g its poorly sands of d sands poorly g s poorly s very le ys of low	rs grave praded y-grade gravely grave aded s graded se sand i to med	el sand gravel di gravel sands, lly sand and-gra sand-gra sand-gra sand-gra sand-gra sand-gra sand-gra	Comparison   Com	DENSITY DENSITY 86 66	Term   Size (mm)   Size (inches)   Pencentages of gravel,
	SILTS	AND CLAYS Inch	anic sitts ganic sitt ganic cla	ys of hig	nous of h plasti	distant city, fat a		Term Mega Moderatu	Plaid Test  Cumbes of bedra with handing or bight Inger pressure Cumbes of bedra with nameng or bight Inger pressure Cumbes of bears with nameng or bight Inger pressure Vill not cumble or break with Inger pressure

	Sta	nte	ec			lient: GE - United Noted Number: 23300		Corporation						BORING G FORM	G BORE Sheet	HOLE NO	of	- 2
Drillers (da	npany: Cascade y / night): S. Lom	A. Ro	g odrígu	ez, J.	Vigue	Drilling Rig: eria Drilling Meti	hod: Holk	ow Stem Auger			it Type: 4,25" I.D., ogged by: C. Fritz	8" O.D. A	uger			Start Date Finish Date	see s	
Field Repri	sentitive (day / n	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Core Diame	iter. N		ription				Graphic			Total Depti marks	r.	
	w' Bag	1200 00 1200 00			5P	Same								bag	Savn 3 livl Com	ple ers ibin	ivil ed	
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GRAVE <50% con fraction po #4 sign	DES GRAVELS SE	ty gravels	ed grave s, poorty-	ys, grav graded	gravni sa	stures, little or no fines nistures, little or no tines and-sift mixtures I-sand-clay mixtures the or no fines		Term OM >ON very soft soft	(SPT) 1.4"ID 2.0"ID 0-2 0-2 2-4 2-4	2-4	Term (SP7) 1.4*ID 20*II ery loose 0-4 0-5 pose 4-10 5-12	D 251D 8	NBO	Cobbles Coarse gravel	500 75 to 300 19 to 75	>12 3 to 12 3/4 to 3	stated indexts	ing a ri tages
450% co. fraction po #4 siev	SAND CLAYS	torty-grad ty sands. layey sand organic of organic cl	ed sand poorly-g ts poorly ts very fr ays of los	s grave raded s -graded ne sand v to med	y sands, and-grav sand-gr s, sity or ium plass	hands tay minutes the or no fines , bitle or no fines mi-aid minitures aver-lay minitures clayey fine sands, sats with sags body, gravelly clays, sandy clays	nt plasticity is	Very soft soft soft soft soft soft soft soft	f 4-8 4-8 8-15 9-17 15-30 17-39 30-60 39-78	4-8 9-18 18-42 42-85	nedium dense 10-30 12-37 lense 30-50 37-60 ery dense >50 >60	7 18-51 5 51-86 >86   58	GRAIN	Fine gravel Coarse sand Medium sand Fine sand	4 75 to 19 2 0 to 4 75 0 425 to 2 0 0 075 to 0 425	3/16 to 3/4 1/16 to 3/11 1/64 to 1/11 0 003 to 1/1	Fow Limie	
SILT	S AND CLAYS	ganic sitt organic si organic co	s and cla its, micac ays of hig	eous or eous or the plants	planticity distornations city, fat city	y ceous fine sand or sit		Very hard  OL.  Note:  H Well-graded = poorly so OH Poorly-graded = well so	>60 >78  E Nonplastic	>85 Term	Fleid Test Absonce of moisture, 6's to to Damp, does not well pain.	Such E Viss	K	Sit / clay (fines) field Test Drumbles or breaks with Drumbles or breaks with	th handling or slight	<0.003	Mostly Depth to	frat wa trate)

Drillers (day	Stante  Inpany: Cascade Drilling  y night): S. Lom, A. Rodr  sentitive (day / night):  Land  Monay	q <sub>u</sub> (tsf)  Lithology / Symbol	Project Number: 233001076  Drilling Rig: CME LAR TS HOW Bit Type: 4.25" I.D., 8" of the project Number: Drilling Method: Hollow Stem Auger TOY CVV Logged by: C. Fritz  Core Diameter: 4. 25"  Description	D.D. Auger	Finish Date: 3/10/18 Total Depth: 2/1.5 FF
Drillers (da) Field Repré	y) night): S. Lom, A. Rodrisentitive (day / night):  aquum, population of the control of the con	q <sub>u</sub> (tsf) Lithology / Symbol	Core Diameter: 4 , 255"	ω.	Total Depth: 11.5 TY
0 Hada	Sample Number  Blow Count	q <sub>u</sub> (tsf) Lithology /	Description	O	Remarks sin
2	. /	Su		Graphic	Remarks Remarks Net Details
4	4	9	Sitty sand (SM) will trace calcium carbonale, hard, moderate Cementation Stigntly moist. brown	M	The Principal Constitution
0	Bag 5%.	2c	Clayey sand, dense, dry, light brown (SC)	111777111	
8	8' Bag	sc sc	Clayey sand (SC), Slightly mois very hard, moderate cementation brown		
12	10° 8 12 30	ŠĆ	same as above	14 A SECTION 2 LA 12	Bag sample from I loose sand in sampler very hard cray
14	4			A TENANT	in shoe
10	15' 154 9 50/26	SH	Silty sand (SM), trace silt; light brown, weakly cemented, dry, poorly graded		Material in shice only
18	9	lo l	a 31 board Storred		
Gillary Ilqi	Make a run fines Pecelry galactic for the first program of the first pro	gravets, gravet-sen- only-graded grave- poorly-graded gra- inds, gravelly sands- sands, gravelly sand-graded sand- graded	Assign September   Assign Sept	DENSITY DENSITY BE STORY DENSITY DENSI	

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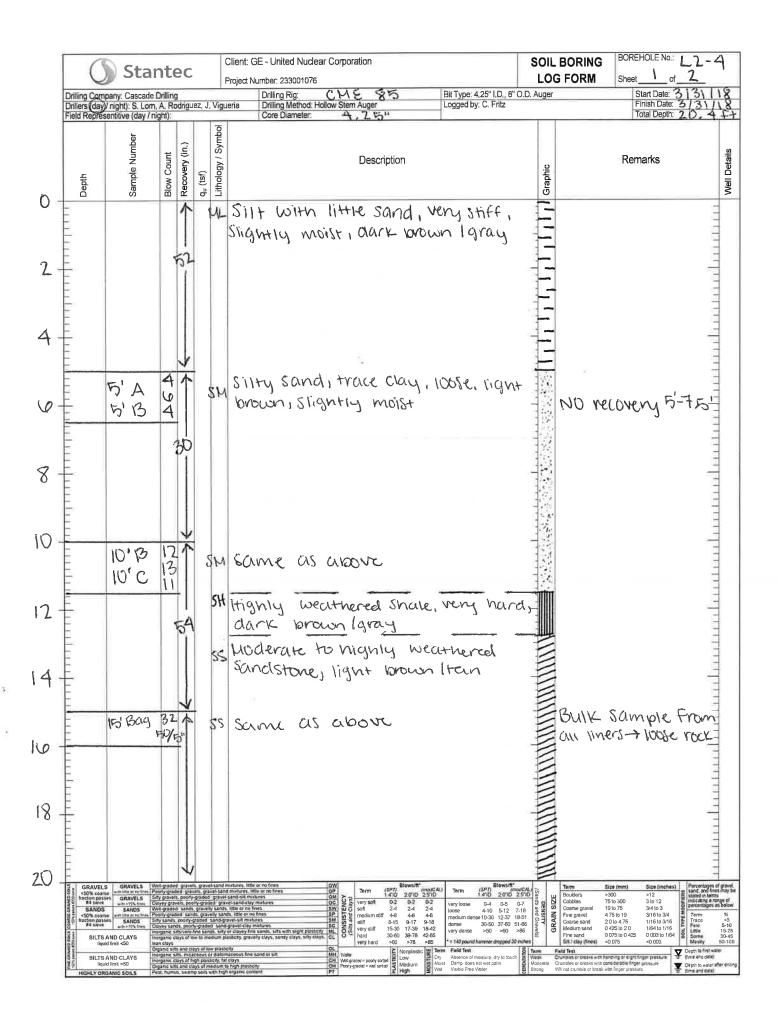
	C	Star	nte	C.	- 1	Client: GE - Un Project Number:		dear Corporation				BORING FORM	BOREHOLE No.: Sheet 2 or	12
1	Drillers (day	pany: Cascade [ / night): S. Lom,	A. Ros	driguez	, J. Vigu	Drillin ueria Drillin	g Rig: g Method	Hollow Stem Auger		Bit Type: 4.25" I,D., 8" ( Logged by: C. Fritz	D.D. Auger		Start Date: 5	ice sheet l
	Field Repres	sentitive (day / nig Samble Number Samble Number	ght):	ry (in.)	q <sub>u</sub> (tsf) Lithology / Symbol		Diameter	A. 15 <sup>th</sup> Descrip	ition		Graphic		Total Depth:	Well Details
20-		20' A 20' B 20' C	にはは				as	above			100 100 100 100 100 100 100 100 100 100		_	
22 -								E03@	21.5	•		-	-	
							R				free free free free free free free free			Longeral
											recent fractal const			madaman
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											Transfer of the state of			antanalana
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	iqu liqu	SANOS SANOS Inc. AND CLAYS Inc.	yey grave il graded only-grade y sands, j yey sand rganic sit rganic sits rganic sits rganic sits	tands, gi d sands, corfy gra s, poorly g svery fine ys of low t and ctays s, micache	graded gra everify sand- gravelly sand- eed sand-graded sand- yaded sands sands sifty to medium p	mintures, little or no fines id minitures, little or no fine licende-set mostures svel-band-clay motures is. attes or no fines, nos. little or no fines, provid-set minitures. Signaved-set minitures, or clayey fine sands, sets statisticky, gravelly clays, set statisticky, gravelly clays, set scopy.		0M 5 B	PI 2010 2510 2010 2510 02 02 02 24 24 24 48 48 48 145 9-17 9-18 15-30 17-39 18-42 0-60 39-78 42-85 	very loose 0-4 0-5 10000 2 10000 4-10 5-12 7 10000 10-30 12-37 18 dense 30-50 37-80 57 very dense >50 >50 >50 >	17 148 and Gravels) 151 66 86 86 86 86 Weak	Boulders   >3	ze (mm) Size (inches) 00 >12 10 300 3 lo 12 10 75 34 lo 3 75 lo 19 3/16 lo 3/4 10 4/75 1/16 lo 3/16 125 lo 2 1/75 lo 19 1/75 lo 425 0/033 lo 1/64 1075 0/035 lo 1/64 1075 0/035 lo 1/64 1075 0/035 lo 1/64 1075 lo 425 0/035 lo 1/64 1075 lo 425 0/035 lo 1/64 1075 lo 425 0/035 lo 1/64	stated in terms of indicating a mage of percentages as below.  Term % Trace <5 Few 5-10

	C	Star	nte	9C		Client: GE - United Nuclear Corporation Project Number: 233001076		IL BORING BOREHOLE No.: (2-1) OG FORM Sheet 1 of 2	
	Drillers (day	pany: Cascade [ ) night): S. Lom, sentitive (day / ni	A. Ro	drigu	ez, J. Vi	Drilling Rig: CM & 85 Bit Type: 4.25" I.D., 8" C gueria Drilling Method: Hollow Stem Auger Logged by: C. Fritz Core Diameter: M A	D Auge	er Start Date: 3/31/18 Finish Date: 3/31/18 Total Depth: 21.75 5+	
	Depth	Sample Number	Blow Count	Recovery (in.)	qu (tsf)	Description	Graphic	Remarks E	
O -	 = -	0,5	ш			Dense silty sand (SM), slightly			1
2 =						moist, light brown Igray, poorly graced, trace carbonates, some weakly cemented cemented clumitrace organics	3.7		
4									
6-		- 1 1/1	28 28	ž.X	SI	1 same as above		Tourdam	
8 -								The state of the s	
10 =		10'A 10'B	121417		51	Same material, medium dense, Slightly finer			
12-							\$100 m		
14									
10-		15'B	925	-	SI	Silty sand (SM), few clay (scatter Small shale pieces), slightly coarser increased cementation possibly due to higher carbonate content	el '		
18 -									
20 -	GRAVELS	C GRAVELS [Will	I-graded	graveis	gravel-san	involumes, table or no fines (gW) Blows/R* Blows/R*		The Singleton Co. Makes Bargantan demand	
	SANDS	Make or in feet. Pool of the p	y graves y graves y graves i gradeo y sands, y y y sand gane sit gane cia y sand sit gane sit gane sit gane sit gane sit gane sit gane sit gane sit gane sit	d grave poorly (s. poo	is, gravelys, raded grav- y-gravely san gravely sand gravely sand gravely sands as sands, to to medium s of low pla- sous or diat h plasticity, s of medium	Rem   Markers   Markers	DENSITY  Term  Vean  Moderate	Term   Size (mm)   Size (inches)	ř.

Description  Descr	Drillers (day / night): S. Lorn. A. Rodriguez, J. Vigueria   Drilling Method: Hollow Stem Auger   Logged by: C. Fritz   Finish Date: Total Depth:	Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING BOREHOLE No.: L2-1  LOG FORM Sheet 2 of 2
Description  Remarks  Remarks  Description  Description  Remarks	Description  Remarks  Remarks  Description  Description  Remarks  Remarks	Drilling Company: Cascade Drilling Drillers (day / night): S. Lorn, A. Rodriguez, J. Vig	Drilling Rig: Bit Type: 4,25' jueria Drilling Method: Hollow Stern Auger Logged by: C.	Fritz Finish Date:
20' A 12 SM Same as above EUB@ 21.5'	20' A 11/2 SM Jame as above EUB@ 21.5'	Depth Sample Number Blow Count Recovery (in.) qu (tsf) Lithology / Symbol		Remarks
		20' A 112 SM	I same as above	
			EUB@ 21.5'	

Ī	0	Star	nte	3C			E - United Nuclear Corp	oration				BORING		HOLE No.:	L2-7	2_
-	Drilling Com	pany: Cascade D	rilling	y			mber: 233001076  Drilling Rig: CL	18.85	Bit "	Type: 4.25" I.D., 8" (		G FORM		tart Date:		18
Ī	Drillers (day)	/ night): S. Lom, entitive (day / nig	A. Ro	drigu	ez, J. Vi	jueria	Drilling Method: Hollow St Core Diameter:		Log	ged by: C. Fritz			Fi	nish Date: otal Depth.	3/31	118
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	3		Description			Graphic		Rem			Well Details
0						Silt	(MD) WITH	little 8	sound, F	ew clay	Œ				=	П
					IC.V.	Slig	intly mois	t, brown	r, Cem	rented of					=	
						mei	intly mois- dium den	se, Signi	ficant	carleono	ue=					
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4	=															
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10																
18											7				=	
											3				=	
											1					
20-	GRAVELS		graded	gravet of con	s graves-san	Smirtures, little o	notines GP	Term (SPT)		Blows/t* erm (SPT) (mod 1.4*ID 20*ID 2	dCAL)		Size (mm)	Size (inches)	Percentages of stand, and fines stated in terms	(gravel
	#4 seye SANDS	GRAVELS Sity	gravels by grave -cracked	poorly els. poo	graded grav dy-graded g	el-sand-sit mixtu avel-sand-clay m ds. little or no fine	es 6M Annes 90 BN ANNES		0°ID 2.5°ID I-2 0-2 veri I-4 2-4 inos	y loose 0-4 0-5 0	7 SE ZIS	Coarse gravel	>300 75 to 300 19 to 75	>12 3 to 12 3/4 to 3	percentages as	a below
	#50% coarse fraction posses g #4 seve	e with little or no fines Pob	ny-grade	ed same	ts, gravelly si raided sand-	inds, little or no fi gravel-till mixture	es OM ADVERSE OC NEW CONTROL OC NEW	medium still 4-8 4 still 8-15 9- very still 15-30 17	H8 4-8 -17 9-18 den -39 18-42 ven	dum dense 10-30 12-37 18	RAIN 89	Fine gravel Coarse send Medium sand	4 75 to 19 2 0 to 4 75 0 425 to 2 0	3/16 to 3/4 1/16 to 3/16 1/64 to 1/16	Term Trace Few	% <5 5-10 15-25
	SILTS A	AND CLAYS inon	gamic eta elays anie sitts	and dis	w to medium nys of law pila	plasticity, gravety thicky		very hard >60 >	1-78 42-85 78 >85	40 pound hammer dropped 30 s	notes E	Fine sand	0 075 to 0 425 <0 075	0 003 to 1/64 <0 003	2 Loine	30-45 50-100
	選条 liquid	inor	gamic cla	ות לם בעו	oh plasticity,	imaceous fine sa at clays to high plasticity gh organic conte	MH 746   CM Vis   CM   Post	Cades + poor , same ST Low Medi	ium Dry Ab Morst Da Wel Vis	osence of moisture, dry to touch amp, does not wel palm sible Free Water	Moderate 0	Jumbles or breaks with the Jumbles or breaks with o Will not crumble or break	considerable finger	pressure	(time and date) Copyrite water after (time and date)	ter enting.

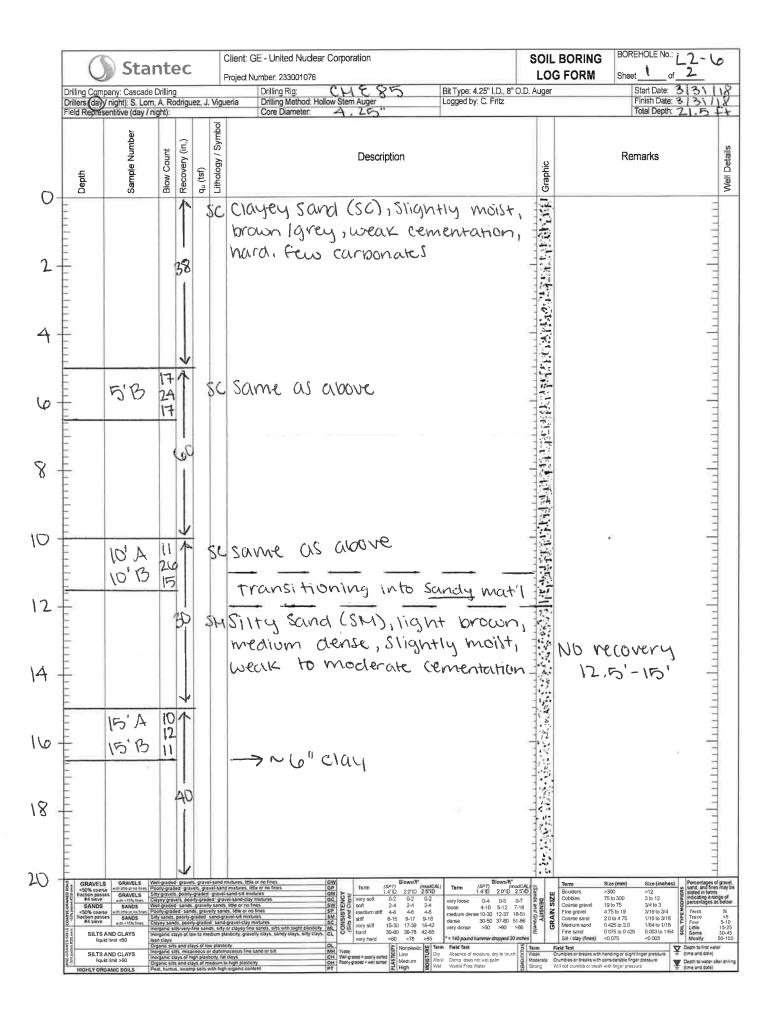
	Sta	ntec		Client: GE - United Nuclear Corporation		SOIL BORING LOG FORM	BOREHOLE No.: L2-3
	Drilling Company: Cascado Drillers (day) night): S. Lor Field Representitive (day /	n, A. Rodrigue night):		Drilling Rig: CM & 85 eria Drilling Method: Hollow Stem Auger Core Diameter: A A	Bit Type: 4.25" I.D., 8" O.D Logged by: C, Fritz	. Auger	Start Date: 3 3 1/18 Finish Date: 3/31/18 Total Depth: 15.2+1
0=	Depth Sample Number	Blow Count Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Description		Graphic	Remarks Remarks
2 -			SM	Silty Sand (SM), Sligna ligna brown, medium few roots/organics	ny moist, dense,	2 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	malanatara
4						- (6) - (7) - (8) - (8)	nidani.
(g -	5'A 5'B	9 9 14	SM	Same as about			
8 -							
- 10 -	10'B	34 50/5"	85	Weathered sandstone	Vedocal .	######################################	
12 -			CO	MECHANELEY SUMMSTONIA	CHECHOCIC		
10-	None	7/2.1		€013 @ 15,	2'		
18 -							Time
20-	Soft Coalmon Mister or mis	Peorly graded grave billy gravels, poorly of Ciayey gravels, poorly Weil graded sands. Peorly graded sands Ciety sands, poorly Ciayey sands, poorly notigenc sitts very fe notigenc clays of fee lean clays Organs sitts and clay Organs sitts and clay	is, gravel-sand maderd gravel-sand maderd gravel-sand gravel-sand-gravely sands, it is gravely sands added sand-gravel graded sand-gravel graded sand-gravel graded sand-gravel to medium past sid low plasticity sout so disatomoto in giasocity. Idi clais sof medium to in soft sand sand sand sand sand sand sand sand	Libble or no lines   1979   2-2   2-4   2-	very loose 0-4 0-5 0-7   loose 4-10 5-12 7-18   medium dense 10-30 12-37 18-51   dense 3-50 37-80 51-85   very dense 5-50 >80 >85   1 = 140 pound hammer dropped 30 inches	Boulders Cobbles Coense gravel Coense gravel Coense sand Coense sa	



	Sta	ntec		Client: GE - Un Project Number:		ear Corporation			SOIL BORI	M Sheet 2 of 2
Drillers (day	pany: Cascade / night): S. Lon	A. Rodrig	uez, J. Vi	Drillingueria Drilling	g Rig: g Method:	Hollow Stern Auger		Bit Type: 4.25" I.D., 8 Logged by: C. Fritz	"O.D. Auger	Start Date: See S M
Field Repres	sentitive (day / r	Blow Count (tub)	[ ]	Core	Diameter:	Descript	ion		Graphic	Total Depth:
=	NR	20/2	55		as	above				
						E0B @	20.4	<u>t'</u>		
						Taxon F	W	22,000		TEN
GRAVELS  SON cours  Factor pass  #4 seve  SANS  SANS  #50% cours  #4 seve  #4 seve	GRAVELS SANOS V	conty-graded gra dry gravels, poor layey gravels, po wel-graded sand borty-graded sand dry sands, poorly	riels, gravelis y-graded gra eny-graded g s, gravely sar ds, gravely s eraded sand	of metures, little or no fines and minitures, little or no fried reli-sand-sit minitures did, little or no fines ands, atte or no fines ands, atte or no fines planes at montains for clayer few sands, sits by or clayer few sands, sits		OW   OF   OW   OW   OW   OW   OW   OW	0 2010 2510 2 02 0-2 4 2-4 2-4 8 4-8 4-8	Term (SPT) 1.4*IID 20*ID very loose 0-4 0-5 loose 4-10 5-12 medium danie 10-30 12-37 danse 30-50 37-60	2510	475 to 19 3/16 lo 3/4 📳 Term

	C	Star	nte	ec			lient: GE - United Nuclear Corporation roject Number: 233001076	LC	L BORING OG FORM	BOREHOLE No	L2-5	
Ī	Onliers (day	pany: Cascade C night): S. Lom, entitive (day / nig	A. Ro	drigu	ez, J.	Vigue	Drilling Rig: CHC \$5 Bit Type: 4.25" I.D., 8"C  inia Drilling Method: Hollow Stern Auger  Core Diarneter: Logged by: C. Fritz	D.D. Auge	r	Finish Dat	3 3 1 1	18
0	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description	Graphic		Remarks		Well Details
					(		Lean clay with some silt (CL), dark brown I grey, hard, trace				Ē	
2							carbonates, slightly moist					
4											-	
6			18 23 34			3L	Same as above					
8		12										
01		10' A 10' B	141422		47	M	Silty Sand (SM) with some clay, medium dense livery stiff, lighter brown, trace to Few sha					
12							Moderate cementation	2.00 mm	i.		T-T-T-T-T-T-T-T-T-T-T-T-T-T-T-T-T-T-T-	
14											=	
16	-	15' A 15' B	1919	,	ν,		Silty sand (SM) with clay, brown, medium dense /very stiff, few carbonates, moderate cementation					
18											angun gun	
20+	9(LTS	in this profession of the prof	y graces y graces y graces grades orly grades y sames y sames organic so rganic so rga	see grav s, peerly sels, pee s sands, led sans peerly s peerl its very ays of le s and cla its inice ays of he s and cla	els, grave graded chy-grade gravely h, grave prodect me sand er to me to me to de to	gravels d gravels d gravels sands. Hy sand- and-gra l sand- s, saty o down pla- v plastice distorma only, fat o down to	### Comparison of the Comparis	(Sand Sand Gravels)	Boulders Cobbles Cobres gravel Fine gravel Coarse sand Medium sand Fine sand Silt / clay (fines) Field Test Chambles or breaks with n	Disp (mm) Bure (mc) 3000 >12 75 lo 3000 3 lo 12 75 lo 3000 3 lo 12 19 lo 75 3 41 lo 3 47 5 lo 19 3/16 lo 3 47 5 lo 19 3/16 lo 3 1/6 10 10 10 10 10 10 10 10 10 10 10 10 10	stated in farms indicating a range percentages on Term  Trace Few Little Some	% <5 5-10 15-25 30-45 50-100

	0	Sta	nt	٥.			Client: GE -	United Nu	ıdear (	Corporat	tion	=						BORING			L2-1	っ
	<u></u>	200				F	Project Numb		076									G FORM		<u></u> of		
1	Drilling Com Drillers (day	pany: Cascade / night): S. Lom	Drilling	g odrigu	iez, J	. Vigu		lling Rig: Iling Metho	d: Hollo	w Stem A	Auger	_		Bit Type Logged		D., 8" O.I ritz	D. Auger		F	inish Date:	ice sne	روا
i	Field Repres	sentitive (day / n	ight):				Co	re Diamete			J/A	Ç.					_		17	otal Depth	À	_
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol					Descri						Graphic		Ren	narks		
+	-	20'A	14		Ť	SC	Claye cana	4 SC	and	(S	۵),	4112	u.	Fe.u			34					=
			14			کر	Carro	no res	- 7 -	C Sive	الدماء	0111	7)(	4.4	OIM	an						1
	3 .	20,3	22				mod.	erah	ינ גיי	2/10	JVLT	19 1	VION	7. W	200							
Ī	5						der	15e.	· (	CCIV	ren	TECH	CV .	4	reco	ww	1				-	
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-	gravels	S GRAVELS V	Nell-grade	d grave	es, grave	i-sand m	sixtures, ittle or no fo	nes	G	iw) I		Blowsit	Y.,,,,,,,,			llows/R*	1	Term	Size (mm)	Size (inches	Percentage	15.0
	% 5 <50% coars in fraction pass #4 seve	Ses GRAVELS	Ctayey graves	vists, plots	arly grad	ed grav	nxtures, ittle or no fi Imixtures, little or no sand-sit mixtures el sand-clay mixture	fnes 1	0	NCY NCY	ary saft	410 2010 0-2 0-2	251D 0-2	Term very loose	1.410	20'ID 25'I		Boulders Cobbles	>300 75 to 300	>12 3 to 12	Percentage sand, and in stated in ter indicating a opercentage	inen ems
	SANDS <50% coars fraction pass #4 sleve	SANDS W	Nyti-grade	d sands	s. graven	y sanos.	state or no times		- 5	W E S	oft nedium stiff tiff	2-4 2-4 4-8 4-8	2-4 4-8 9-16	loose medium de	4-10 ense 10-30	5-12 7-18 12-37 18-51	o d G	Coarse gravel Fine gravel Coarse sand	19 to 75 4 75 to 19 2 0 to 4 75	3/4 to 3 3/16 to 3/4 1/16 to 3/16	Term Trace	
	SILTS	AND CLAYS	nerganic s nerganic s	nds, poor litts very lays of lo	tine san ow to me	d sand- di sity idum pla	evel-sit mintures gravel-clay mixtures or clayey line sands asticity, gravelly clay	elts with slight p s, sandy clays, si	dasticity M ity clays. C	CONS	ery stiff ard	15-30 17-39 30-60 39-78	18-42 1 42-85	dense vary danse	e >50	37-80 51-86 >60 >86	filter	Fine sand	0 425 to 2 0 0 075 to 0 425	1/64 to 1/16 0 003 to 1/64 <0 003	F FeW	
1	\$ 5	AND CLAVE	Organic sit norganic s	ts and cl	ays of io	w plastic matern to	ity accous fine sand or		0	1.99	ery hard	Nonples Low Medium	>65 dic W Term	Field Test	of moisture d	ry to touch in	110000	Sit I clay (fines) Field Test Ourross or treams wit		MAN CONSUM	Depth to first v	wate
- 3			norganic c	200	The Party of the P	Comment State	edition or		lc	H Veligraces H Poorly grad	s w poorly Note	O E LOW	15177	Dean dec	os not wet pa	, Boot 1	Moderate	Crumbles or breaks with	n considerable finge	r pressure	Depth to wate	75.



Stante	C	Client: GE - United Nuclear Corporation		SOIL BORING	BOREHOLE No.: L2-6 Sheet 2 of 2
		Project Number: 233001076  Drilling Rig:	Bit Type: 4.25" I.D., 8"	LOG FORM	
Drilling Company: Cascade Drilling Drillers (day / night): S. Lom, A. Rodi Field Representitive (day / night):	riguez, J. Vig	gueria Drilling Method: Hollow Stern Auge Core Diameter: 4,25	Logged by: C. Fritz	O.D. Magor	Start Date See Since Finish Date: Total Depth:
Depth Sample Number Blow Count	Recovery (in.) q <sub>u</sub> (tsf) Lithology / Symbol	Des	scription	Graphic	Remarks
20' A a 20' B 10		silty sand			1111
			@ 21,5'	and the state of t	
GRAVELS  GRA		d murbures, lettle or no finites. (QW)	(SPT) Blows/R*     (modCAL)       14'ID 20'ID 25'ID     14'ID 20'ID 20'ID		

ĺ	0	Star	)tc			Client: GE - United Nuclear Corporation	SOIL B		BOREHOLE No.:	L2-7
	Ų					Project Number: 233001076	LOG F	ORM	Sheet of	212.110
1	Drillers (day	pany: Cascade [ / night): S. Lom,	A. Ro	drigue	z, J. Vig	Drilling Rig: Bit Type: 4.25" I.D., 8" O.  eria Drilling Method: Hollow Stem Auger Logged by: C. Fritz	D. Auger		Start Date: Finish Date	3131/18
	Pield Repres	entitive (day / nig Samble Number		Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Core Diameter: N A  Description	Graphic		Total Depth:	Well Details
0 -			П	T	_	Silty sand (SIN), trace highly	- i(%4 *j			=
						Weathered Stand Stone & Shale,				3
						trace plant roots, some				=
2						weak cementation, medium dense				
4										Lemen
9-		5 A 5 B	937	<b>£</b> s	SM	Same as above				Lernin
		V) 13	11							מתנויים
8 -										ulmai
10 -			9		CIL	Same as above, less organics,	74 A			ndana
		A,'01	300		31	trace (arbonates				
12-	Terreta									Trace
14 -	100						47			
M o		15'A	13		SM	Same as above, possibly greater clay content	15 15 15 15 15 15 15 15 15 15 15 15 15 1			Lum
10-			20	5		grand day content				
18 -										
20-	-	R GRAVELS W	land:	Mpurb.	gravel sand	mustures, lattle or no lines OW) Blows/ft* Blows/ft*				Description of the second
	GRAVELI 50% coars fraction poin 5ANDS <50% coars fraction pass #4 sleve	em little or mi form Peo ORAVELS Sen or vittle from CD SANOS WW am issue on local Peo SANOS Sen or vittle form CD SANOS Sen or vittle form CD Inco	only grade y gravets yey grave it graded only-grade y sends, g yey sand rgamic set	d gravet poorly gr is poorly sands g d sands coorly-gra s poorly- s very-fin	s gravel san aded grave graded gravely sand gravely sand ded sanu-g graded sanu- graded sanu- s sands sits	Tender   T	ALISMAN SIZ Cos	ulders >30 bbles 75 l larse gravel 19 l ne gravel 4.73 larse sand 2.0 edium sand 0.42	10 300 3 to 12 10 75 3/4 to 3 5 to 19 3/16 to 3/4 10 4 75 1/16 to 3/16 25 to 2 0 1/64 to 1/16	stated in terms reducing a range of percentages as before Trace <5 Few 5-10 Few 5-10
	SILTS	AND CLAYS Institute of the control of the clays Institute of the clay Ins	rganic cla n clays paric sitts rganic sitt rganic cla paric sitts	ys of low and clays s, micace ys of high and clays	to medium plass ous or diate passions, fa of medium	very name >00 >76 >65 >65 >65 >65 >65 >65 >65 >65 >65 >6	es Sitt  Term Field Te  Weak Crumbie  Moderate Crumble	( / ctay (fines) <0 ( lest (so or breaks with hand	ling or signifinger pressure (derable finger pressure	Some 30-45 Mostly 50-100  Departs first water  time and sale)  Depart to water after druing

	C	Star	nte	ec				E - United Imber: 233			oration							BORING FORM		HOLE No.: 2of		7
	Drilling Com	pany: Cascade I / night): S. Lom,	Drilling A Ro	a adrigu	62 J			Drilling Ri	ig:		em Auger			Bit Type: Logged b	4,25" I.D., 8 y: C. Fritz				S		iee sh	eet l
	Field Repres	sentitive (day / n	ght):	i i				Core Dia	meter:		V/A								T	otal Depth		T
0	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol					Descr						Graphic		Rem	arks		Well Details
10=		20'A	9827			SM	coc	ne a rser	, W	vedi:	5,5110	cher SVH11	4 0/0 15°C	to to	oten	se	巻のなる。					
-2 -									5	EOR	30	21	.5	,		1					ä	
																AU INCHES						
_																					=	
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-																Total state					5	
																dia mon					-	
2.	GRAVEL						nistures, lette i i mustures, lette sand-titt mat			GW GP GM	Term	(SPT) 1.4"ID 20"	s/ft* (roodCAL)	Term	(SPT) 1 4'ID 20'II	0 2510		Term Boulders	Size (mm) >300	Size (inches	Percentag	es of gravel, fines may be
	SANDS  SANDS  STATE  SANDS  STATE  SANDS  STATE  SANDS  STATE  SANDS  SA	S SANDS W	Mil-grade softy-gra- ity sanos	ded sands begriv-	ds. grave ds. grav	ny sands nily san sand-gr	sand-sit mixture tand clay in little or no fin ds. other or no avel-sit mixtu- gravel-clay m or clayey the asticky drawn	os loss	s slight plas	SW SP SW	very soft soft medium stiff stiff very stiff hard	0-2 0- 2-4 2- 7 4-8 4- 8-15 9-1 15-30 17- 30-60 39-	2 0-2 4 2-4 8 4-8 17 9-18 39 18-42 78 42-85	dense very dense	0-4 0-5 4-10 5-12 rse10-30 12-3 30-50 37-60 >50 >60	0-7 1 7-18 7 18-51 0 51-86 >86	GRAIN SIZE	Cobbles Coarse gravel Fine gravel Coarse sand Medium sand Fine sand	75 to 300 19 to 75 4 75 to 19 2 0 to 4 75 0 425 to 2 0 0 075 to 0 425	3 to 12 3/4 to 3 3/16 to 3/4 1/16 to 3/16 1/64 to 1/16 0.003 to 1/64	Term Trace Few Little	% <5 5-10 15-25 30-45
	STILE STAND	B AND CLAYS uid limit >50	an slays iganic sit organic s organic c isonic sit	ffs and cit sits, mica cizys of h	ays of io sceous i igh plus ays of in	w plaste or diator dicity, fat nedium to	cey taceous fine s	and or sid			very hard ote: of grated * procy to or grated * well to	>60 >7 Nonpi Low Mediu High	8 >85 lastic W Ten Dry Mos Wel	*= 140 pound Field Test Absence of Demp doe: Visible Free	herrener dropped moisture dry to to s not wet palm Water	ouch Wear	erate Co	Silt / clay (fines)  rid Test rumbles or breaks with full not crumble or break	considerable finge	<0 003  inger pressure pressure	Depth to first it time and dat Depth to was Depth to was Dime and dat	50-100 water (e)

	0	Sta	nte	-C		Client: GE - United Nuclear Corporation			BORING	BOREHOLE No	o: P( - 1 of 2
	Drilling Com	pany: Cascade	Drilling				l Type: 4.25" i.D., 8" O.		G FORM	Start Date	4/3/18
		night): S. Lom entative (day / i		drigu		Core Diameter. 4.35 Inch	gged by: C. Fritz			Finish Dat Total Dept	e: 4 [3] 18 h: 20 ft
0 =	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Description		Graphic		Remarks	Well Details
				$\uparrow$	SM	Silty sand (SM) with clay + gravel dork group black, some orange staining	, light to	4.33			
a -				37							
ч -											
<u>-</u> ما		5'A 5'B	6 8 6	*	SM	Same as above, medium dense, slightly	molst				
8 -				1 42 		-> chunter weathered sandstone			5		imalani
10 =		10'A	5 5 3	*	SM	Same as above					nationalism
13-			T	36							minim
14 -			17	*	SIM	Some as above		The second second			
16 -		15' B	13								
18 -				30	SS	-> Mostly brotzen sandstone pieces, stron moderately hard, gray whome orange weathered	y and , highly				milmi
90 -	GRAVELS  SON coars  Fraction pass  #4 serve  SANDS  SON coars  Fraction pass  #4 serve  SILTS  Riqui	GRAVELS SANDS WE SANDS OF SAND	cony grading grades by grades bury grades bury grades bury grades by sands layey sand organic st organic ct an clays	os grav poorly- els poo- sands os sand poorly-g is poorl says of to	ols gravel-sa graded gravely ny graded gravely sand is gravely sand is gravely sand raded sand y-graded sand re sands, sell w to medium	Hannes am visures   GM   Yes   Anne   Yes   Ye	Torm (SPT) Blows in 1,410 2010 25 2010 25 25 2010 25 25 2010 25 25 2010 25 25 2010 25 25 2010	de and Grane spirit	Boulders 75 Cobbles 75 Coarse gravel 15 Fine gravel 4 Coarse sand 2 Medium sand 0 Fine sand 0	Size (mm)   Size (inch   300   >12   5 to 300   3 to 12   9 to 75   34 to 3   75 to 19   3/16 to 34   0 to 4 75   1/16 to 34   425 to 2 0   1/64 to 1/1   0 75 to 0 425   0.003 to 1   0 0.075   0 0.003 to 1	### stands of the stands of th
	Me liqui	AND CLAYS	organic să organic că rganic sifa	ts, mica sys of hi and cla	gh plassocky, 2 ys of medium	maccous fine sand or set MAI Note  CH Wespaper = poorly sorted   Low Dry A	Field Test Absence of moisture, dry to touch Damp, door not wot palm Fisible Free Water	Weak 6	field Test rumbles or breaks with na- rumbles or breaks with cor Will not crumble or break wi		Displice first water time and date!  Depth to water after drilling time and date)

	0	Star	nt o	20		(	Client: GE - United Nuclear Corp	oration					BORING	BOREHOLE	No.: PI-1	
	<u> </u>					F	Project Number: 233001076	. Die		1.	14 T. may 4 95 11 D. 1911		G FORM	Sheet 2		
	Drillers (day	oany: Cascade I night): S. Lom,	A. Ro	) odrigu	ez, J.	Vigu	Drilling Rig: CME 85 Truckeria Drilling Method: Hollow St	em Auger			Bit Type: 4.25" I.D., 8" C .ogged by: C. Fritz	J.D. Auger		Start D Finish I	Date:	
	Depth Depth	entative (day / n Samble Nnmper	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Core Diameter: 4.29	<u>B</u> inch	cription			Graphic		Total D Remarks	3	Well Details
<b>3</b> 0 +			14				Same as above						No sam after aug boulder	ple collect er bent up	ed. Stopped on hitting	
22				-			EDI	3 Q	21.51			1				
22								, ,,								
24																
26																
28															1	
30																
												1			<u></u>	
												. Harriston				
												4				
												Learning to the second				
=		ORAYELS ON THE POOR ORAYELS ON THE POOR OF	offy-grade y gravels yey grav graded offy-grad y sands yey sand ganic sa	ed grav poorly els poor sands ed sand poorly g ts poorl	els. grave graded- ty-grade gravely s. grave raded s r-graded ne sand	prayet- gravet- d grave sands ty sand and-gra sand- s saty o	whites little or no fines  manufacts. The or no fines  OP A  AND	Term  Very soft soft medium strength wery stiff hard	1.4*ID 2.9*ID 0-2 0-2 2-4 2-4 iff 4-8 4-8 8-15 9-17 15-30 17-39 30-60 39-78	9-18 18-42 42-85	Term (SP)	7 DENSITY DENSITY 86 86 86	Boulders Cobbles Coarse gravel Fine gravel Coarse sand Medium sand Fine send	>300 >12 75 to 300 3 to 1: 19 to 75 3/4 to 4,75 to 19 3/16 to 2,0 to 4,75 to 19 1/16 to 0,075 to 0,425 0,003	3 5 3/4 5 3/16 5 1/16 10 1/64 7 Few Little Some	% <5 5-10 15-25 30-45
	SILTS	AND CLAYS into	anic situ ganic situ ganic situ ganic situ anic situ	and cla ts. mice ays of his and cla	ys of lov cous or on plasti ys of mo	plastic diatomi oty fat o dium to		very hard	>60 >78  Nonplastic Low Medium High	>85 Term Dry Molsi Wet	140 pound hammer dropped 30 in Fleid Test     Absence of moisture, dry to louch     Damp, does not well palm     Visible Free Water	Term West Moderate	Field Test Crumbles or bleaks with h	<0.075 <0.003 anding or sight inger pressure with finger pressure	Mostly  Depth to first wat the date)	50-100 ler

	0	Star	nte				lient: GE - United Nuclear Corporation		BORING G FORM	BOREHOLE No.: Sheet of	
-	Drilling Com	pany: Cascade D				P	oject Number: 233001076  Drilling Rig: CME 85 Truck Rig Bit Type: 4.25" I,D., 8" O.			-	4 (9 (18
l	Drillers (day)	night): S. Lom,	A. Ro	drigu	ez, J. \	/igue	ria Drilling Method: Hollow Stem Auger Logged by: C, Fritz  Core Diarneter: 4, 35 inch	D. 7 lagor		Finish Date: Total Depth:	419118
	rielo Repres	entative (day / ni	911).			回	Cole Diameter. 7, 95 Inch	T		1 Total Depart	.36.9 11
		mpei		Ü.		Sym					w
		e Nu	Count	ery (i		g /	Description	ي.		Remarks	Details
	Depth	Sample Numbe	Blow (	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol		raphic			Well [
P		S	8	E		L	High the completely weathered shale (a) with		Dilled &	raight down	
							CIL I sand cliff and weather comen ted Slight	L :	then be	traight down gan samplir	ng 4
7	=						moist to maist black dock some uleanse brown	/]	coring '	<b>)</b>	7 1 1
1							Highly to completely weathered shale (CL) with silt + sand, stiff and weakly cemented, slightly moist to moist, black/dark gray wlsome brown little gravel	?			
90-				不			hine glaver	7			3 1
				Ш				1			3
	=							1			3
22	E I							4-			- 1
				41				]-			=
								4			3 1
					Н			1			3
94-				1	5	55	Moderately weathered shale + sandstone gray		<b>†</b>		<b>I</b> E
				V			Moderately weathered shale + sandstone, gray w/white carbonates, slightly moist	$\equiv$	1		<u> </u>
		0-1-4	1	1					1		<u> </u>
26-		25' A	3					=	1		4
			6						}		= 1
	13.4							$\equiv$	j		1
				41				$\equiv$	1		3
38-											<b>I</b> E
								$\equiv$	1		∄
	137								1		3 1
30-				*			C 1		1		4
		20/ 4	7	1			Same as above		<del>.</del>		3 1
		30' A	3					$\equiv$	i		3
			3	H		Н		$\equiv$	1		<b>3</b>
32 -							1 Fill	$\equiv$	1		<u> </u>
				42	1	NL	Topsoil, sandy silt to silty sand, (ML), light brow	n, E			∄
							Topsoil, sandy silt to silty sand, (ML), leght brows (native)		']		<u> </u>
34-							two:	+	]	2	4
						20		==	1		= 1
			20	*		ردر	Highly weathered sandstone (55)		1		7
		35' Bag	15				**		I		<b>3</b>
36-		,	9						<del>-</del>		
							EOB @ 36.51				3
								1			3
38-	S. GRAVELS	GRAVELS W	8-graded	gravelt	s, gravel-	and m	tures, little or no fines GW Term (5/FT) (medCAL) T		Term 8	lize (mm) Size (inches)	Percentages of gravel,
	8 £ 450% coars B g fraction pass #4 slove	of oth little or no lines Pool is GRAVELS Sile unto 11th lines Cia	orly-grad y graveis yey grav	od grav L poorty- els, poor	els, grave graded: g rly-graded	ravel-s grave	Term   GSP   Term	Sands	Boulders > Cobbles 7	300 >12 5 to 300 3 to 12 9 to 75 3/4 to 3	sand, and fines may be stated in terms indicating a range of percentages as below:
	SANDS <50% coars faction pass #4 sieve	# MONTH OF FOILTH POS # SANDS SID ##0 #155 Fres Cla	y sands. y sands.	poorly-g	is graveli raded sa y-graded	y sandi nd-gra sand-g	Section   Sect	3.50	Fine gravel 4 Coarse sand 2	75 to 19 3/16 to 3/4 0 to 4 75 1/16 to 3/16 425 to 2 0 1/64 to 1/16	Term % Trace <5 Few 5-10
	SILTS Ilqui	AND CLAYS inci	rganic si rganic ci n clays	ays of lo	w to med	um pta	horty, graveny clays, sandy clays, sitty clays, ICL very hard >60 >78 >85 ** 140 pound hammer diopped 30 inci	hes &	Slit / clay (fines) <	075 to 0 425 0 003 to 1/64 0 075 < 0 003	Entitle 15-25 Some 30-45 Mostly 50-100
		AND CLAYS the	rganis si rganis ci	its, mica ays of h	ph plastic	diatoma ity, tat c	occus fine sand or sill MH Note  Well-graded = poorly sorted  University		Crumbles or breaks with co		Depth to fire! water (firme and date)  Depth to water after drilling (firme and date)
	HIGHLY OR	SANIC SOILS Per	et, huma	s, swam	p sols wi	h high	rigurise content PT 2 High 2 Wel Visible Free Water	Strong	Will not crumble or break w	un inder biesenie	会 (time and date)

	0	Star	nte	<del>-</del> ر		Client: G	E - United Nuclear Cor	poration				BORING		IOLE No.: p	· .	
	Drilling Com	pany: Cascade D				Project Nu	mber: 233001076 Drilling Rig: CME 85 Truc	ck Ria		Bit Type: 4.25" I.D., 8" C		G FORM	Sheet_	of_ art Date:		
	Drillers day	night): S. Lom, entative (day / ni	A. Ro	drigu	ez, J. V	gueria	Drilling Method: Hollow S Core Diameter: N A	item Auger		Logged by: C. Fritz	, D. F. Kagui		Fi	nish Date: 1		
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)		•	Descr		1	Graphic		Rem			Well Details
0	3					M 5:14	y sand (SM) , trace iron F to hard fi	with,	gravel +	· clay, black	1 3			-		П
						gray	, trace iron	stalnin	g of carb	onates, very	1.7				- 5	
						2416	f to hard fi	nes, sl	ightly mo	1st to moist	18				=	1
2									- )		· · ·					
	3															
											1.				5	
4 -											4				-	
	-														Ī	1
	-	z, V	93		s	u San	ie as above	, dens	e sand		1.5				_	
6		5'B	18					•			1:3					
		20	99								1/1				2	
											- 1,5				Ę	
8 -						8					]				Ξ	]
0 -											37				ž	
											3				Ē	
	=										: (i					1
10 -			13		s	M Same	as above, be	st loos	e to med	dium dense	10				-	1
		161 A	3				,								į	
			6								1.0				2	
12 -	10.6										-1.:				-	
											1.3					
	5										]::				72	
14	Ε,										4:/				-	
		161 A	5		s	MSam	e as above,	mediar	n dense		1.0				1	
- ما ۱			9				, ,				1.3				Ē	
.Ψ		18'B	13												Ξ	1
											131				- 4	
10											1.1				=	
18 -											7.7				=	
	Ξ,										1.				Ę	
															=	
90 -	GRAVELS	with little or no lines   Por	orly-grade	ed grav	els. gravel-	nd mixtures, little o	or no tines [GP]		(SPT) Blows/ft* (SPT) (modCAI 1.4*ID 2.0*ID 2.5*ID	D Term (597) Blows/ft* (mod 1,41D 2,01D 2)	62165 1 92	B 11	Size (mm) -300	Size (inches)	Percentages of sand, and fines stated in terms	1000000
	SANDS SANDS	SANDS We set little or no trees Poor	yey grav e-graded ony-grade	sands, od sand	gravelly sa gravelly sa is gravelly	ivel-sand-sit mistu gravel-sand-clay m nds. little or no fine sands. little or no f	GM   GM   GM   GM   GM   GM   GM   GM	soft medium stiff sliff very stliff hard	0-2 0-2 0-2 2-4 2-4 2-4 4-8 4-8 4-8	very loose 0-4 0-5 0- loose 4-10 5-12 7- medium dense 10-30 12-37 18-	7 DE ZIS	Cobbles 7 Coarse gravel 1	'5 to 300 19 to 75 1 75 to 19	3 to 12 3/4 to 3 3/16 to 3/4	indicating a rar percentages at Term	nge of is below %
	Signature Siller	SANDS SIE web.>15% tress Cla AND CLAYS Into	y sands. yey sand rganic sa rganic ch	poorly-g is, poorl ts/very-f	raded san y-graded s inc sands.	s-gravet-sitt mixturi and-gravet-clay mi sitty or clayey fine i	tures SG ands, sits with slight planticity ML, clays, sandy clays, sity clays, CL	sliff very stliff hard	8-15 9-17 9-18 15-30 17-39 18-42 30-60 39-78 42-85	dense 30-50 37-60 51- very dense >50 >60 >6	66 PA	Fine sand 0	0 to 4.75 425 to 2.0 075 to 0.425	1/16 to 3/16 1/64 to 1/16 0 003 to 1/84	Trace Few Little Some	<5 5-10 15-25 30-45
	SILTS	t limit <50 lear	n clays panic sits rganic sit	and cla	ys of low p	asticity itomaceous fine sa		very hard	>60 >78 >85  Nonplastic B Te Low Medium High W	*= 140 pound hammer dropped 39 m im Field Test y Absence of molsiure, dry to touch	Term F	Field Test Crumbles or breaks with his			Depth to first wate (time and date)	50-100 lar
	HIGHLY ORG	Grg Qrg	sanc sits	and cla	ys of medi	m to high plasticity high organic conte	OH PT	bon, preces = well sort	Medium S W	Damp, does not wet paim It Visible Free Water	Moderate C Strong V	Orumbles or breaks with co Will not crumble or break w		ressure.	Depth to water at (time and date)	iter drilling

	C	Star	nte	ЭC			lient: GE - United Nuclear Corporation roject Number: 233001076			BORING FORM	BOREHOLE No.: Sheet 2 of	
	Drilling Com	pany: Cascade E / night): S. Lom,	Orilling	dria	07   \	_	Drilling Rig: CME 85 Truck Rig Bit Type:	: 4.25" I.D., 8" O.D. a by: C. Fritz				ee Sheet 1
	Field Repres	entative (day / ni	ght):	angu		_	Core Diameter. N A	by. C. Fritz			Total Depth:	
20 -	Depth	Sample Number		Recovery (in.)		Lithology / Symbol	Description		Graphic		Remarks	Well Details
		90 Bag	3 4 4		5	M	Same as above		Y.	Analytical A,B, & C	sample from liners	7
ə2 =									(Sep. 25)			
<b>ે</b> મ =								-	36.55.56.55			ina kanai
ə6 -		25'A	5%	#	S	M	Same as above, slightly less weathered		V. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.			
98 -								=	75.56.5			
30 -		30' B			S	щ	Same as above, highly to completely weath	hered -	分が法分	Missing A Blow tou	A liner in sa nts not recon	mple: cled
32 -	-								ないななない			minni
34 -								-	14. 14. 14.			milmi
36 -		35' A 35' B	8 6 0		5	M	Sandy wifewer fines, significant red + your stalming, trace organics	-	4.47.50			mulmi
38 <del>-</del>									一般の これは			mmm
40-		By AND SANDS SAND SAND SAND SAND SAND SAND	orly-grade y gravets, yey gravets, yey graded orly-grade, y sands, yey sand rganic est rganic cta n ctays.	poorly- poorly- els poor sands, od sand poorly-g s. poorly tuvery-fi tys of lov	els, gravel graded gravely gravely s is, gravely raded sar graded ine sands.	sand i avel-s grave ande sands sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra-	reactivity minitures  SC 25 S S S S S S S S S S S S S S S S S S	30-50 37-60 51-86 >50 >60 >86 d hammer dropped 30 inches	ALISNAG GRAIN SIZE	Boutes 75 Cobbles 75 Coarse gravel 19 Fine gravel 4.7 Coarse sand 2.0 Medium sand 0.4 Fine sand 0.0 Silt / cby (fines) <0	lo 300 3 (o 12 lo 75 3/4 to 3 5 to 19 3/16 to 3/4 to 4.75 1/16 to 3/16 25 to 2 0 1/64 to 1/16 75 lo 0.425 0.003 to 1/64 0.75 4.003 to 1/64	Percentages of gravel sand, and feets may be stated in terms of stated in terms of percentages as before 7 form % Trace < 5 Few 5-10 Little 15-25 Some 30-45 Mostly 50-100
	See Ilqu	AND CLAYS inor inor inor	rganic silt rganic cla anic silts	ts. miced tys of re- and cts	ph plashot ys of med	y, fat c um to	coous fine sand or set BM Note Dry Absence of r		ren F rek C iderate C ong V	field Test rumbles or breaks with ham rumbles or breaks with com Vill not crumble or break with	dung or slight finger plessure didenate finger pressure	Depth to first water (time and date) Depth to water after drilling (time and date)

	C	Star	nte	ec			Client: GE - United Nuclear Corporation roject Number: 233001076			BORING G FORM	BOREHOLE Sheet 3	No.: P1-2 _of_4	
ī	Onliers (day	pany: Cascade I / night): S. Lom, sentative (day / n	A. Ro	g odrigu	ez, J.	Vigu	Drilling Rig: CME 85 Truck Rig Bit Type: 4.25" l.D., eria Drilling Method: Hollow Stem Auger Logged by: C. Fritz Core Diameter: N A		uger		Start Da Finish D Total De		ŧ /
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic		Remarks	pa t.	Well Details
10 +		40' Bag			_	SM	Same as above		でなるなど	Analytica A + B I	l sample Iners	from	
.12									The Contract			4	
14									が続き			le en les	
16-		45'A	8			SM	Weathered sandstone & shale mixture, orange & black (respectively), trace traction (or other soft gray material	t , fine,	ないないのと				
			14	€3			gray material		50 500				
18									となった			n la sana da la	
50		50' A	10 14		- 1	SM	Same as above, trace sulfur (yellow)		が過ぎる			-	
5a -		50' B	14				::		関係のな			7	
54									がはありた			-	
56			50]	ō'.		SM	Same as albove	1					
												1	
58-									J. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.				
60	GRAVEL 50 coan fractor par 50% coan fractor par 50% coan fractor par	GRAVELS SE SANDS WAS SENDED TO THE PO	ony-grave ty graves ayey grav on-grade- ony-grad	s poorly vels poo d sands ded sand	graded rly-grade gravet gravet s. grave	graveid graveid od grave sando, sty sand	Hoand-Clay metures QC S very soft 0-2 0-2 very loose 0-4 0-5	5 0-7 12 7-18 37 18-51	DENSITE OIL SIZE	Boulders > Cobbles 7 Coarse gravel 1	Size (mm) Size (mm) 300 >12 510 300 310 12 9 10 75 3/4 10 3 75 10 19 3/16 10	stated in terms indicating a rang percentages as	ge of below % <5
	SILTS liqu	AND CLAYS included in the control of	ayey sand organic so organic so organic so organic so organic so organic so ganic so organic so	ids, poor its/very- lays of kr is and cla its, mica lays of h is and cla	y-grade ine sand w to me ups of lo coous o gh piast sys of m	s sand- te, sity of drum pla v plantic r diatom city, fat odium to	25   25   25   25   25   25   25   25	60 51-86 0 >86 ed 30 inches	m derale	Sit / clay (fines) <		1/16 Few Little Some Mostly S	5-10 15-25 30-45 50-10

		Ct-	-4-	_		Client: GE - United Nuclea	r Corpor	ration					S	OIL	BORING			P1-2	
	(	Star	116	3C		Project Number: 233001076									G FORM		H_of		
	Drilling Con	pany: Cascade I / night): S. Lom,	Drilling A Ro	) Idriau	ez J. Vic	Drilling Rig: CME 8 gueria Drilling Method: Ho	5 Truck F	Rig n Auger				4.25" I.D., 8 /: C. Fritz	" O.D. A	uger		St	art Date: S	see Shee	p# 1
	Field Repre	sentative (day / n	ight):	Jungu		Core Diameter.	NIA				-33					To	tal Depth:		_
60-	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol			Descri	ption					Graphic		Rem	arks		Well Details
	-	60' Bag	4 9 11	• X	STV	Same material presence black black/dork gran	orga orga , tra	above nic w ce or	, but a aterial ange	lpo Vy	oreas esible elleu	ed coal?) u	)	A	Analytica A.B. + C	il sav Lline	nple 1 2rs	from	
6a =														\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\				2.4 2.4	
64															Drilled to Stopping o	65 b	efore Has	-	
							EOB	60	ახ'				1					-	1
66 -													Town town I am		p				
68 -													-						<u> </u>
																			=
	- - -												1						
70 -													-					3	
																		_	
_	- - - - -							i-1					A. D. L.						
										90			1					G	
7.00													-						1
													1						]
	<u> </u>												1						1
7	=												=					-	1
													=	10				9	1
	Ē												3		¥			* 1	1
	SILTS	GRAVELS We will be a control to the	off-grades offy-grades offy-grades by y graves off-grades offy-grades offy-grades y sands. by y sands.	graveli ed graveli poetly- els, poetly- ed sand poetly-g fs, poetl tstvery-f ays of le and cla ts, mea- ts, so the	gravel-sandon graded gravely spraded gravely sandon spraded sandon sando	of mixtures, little or no fines and mixtures, little or no fines and mixtures, little or no fines and services and service	GP G	very set soft medium stiff stiff hard very hard	0-2 0-2 2-4 2-4 4-8 4-8 8-15 9-17	0-2 2-4 4-8 9-18 18-42 42-85 >85	dense very dense *• 140 pound? Field Test	1.4°ID 2.0°ID 0-4 0-5 4-10 5-12 10-30 12-37 30-50 37-60 >50 >60 14 14 15 15 15 15 15 15 15 15 15 15 15 15 15	2510 0-7 7-18 16-51 51-86 >86 0 inches	0	Cobbles 75 Coarse gravel 19 Fine gravel 4.7 Coarse sand 2.0 Medium sand 0.4 Fine sand 0.0	to 300 to 75 5 to 19 to 4 75 25 to 2 0 75 to 0 425 075		sand, son the state of internal state of interna	% <5 5-10 15-25 30-45 50-100
	2.83	GANIC SCILS Pe	ganie sith at, humu	and cla s, swam	soils with h	n to righ plaseony gh erganic content	PT Poorly g	graded = well sorts	12 High	¥ Wel	Visib Free V	Valer	Siron		All not crumble or break with		Santary 1	Depth to water: (time and date)	्राता वाचाराष्ट्र

	Q	Star	nte	ec			Client: GE - United Nuclear Corporation Project Number: 233001076			BORING FORM	BOREHOLE No.	: PI-3 of_3_	
	Drillers (day)	pany: Cascade I / night): S. Lom,	A. Ro	j odrigu	ez, J.	√igue	eria Drilling Method: Hollow Stem Auger	Bit Type: 4.25" I.D., 8" O Logged by: C. Fritz	D. Auger		Start Date: Finish Date Total Depth	4 13 18	
	Depth hield Kepres	entative (day / n Samble Number Samble Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Core Diameter: N A  Description		Graphic		Remarks		Well Details
0 -						M	Silty sand 4 sandstone boulders		131	Large be	sulders on surface in	, vicinity	
<b>a</b> –										J. 100.10		<u> </u>	
Ч -		u							15. 20. 2 m			marlman	
6 -		s'A	39 38		1	in N	Very dense silly sound (SM). Possibly boulder, light brownlyray	291A24eu 6				malana	
8 -											¥2	milmi	
10 -		10' A	an sola	•	Ş	3M	Silty sand wifew day (SM), few broke dense to very dense, slightly moist,	pumu pumu	<b>5,</b>	30		mlmm	
19-												urlinnin	
14 =	- - -	1514	96			jM	Same as above					1	
16 =		15'A 15'B	17										
18-												ulmum	
<i>3</i> 0−	iqui	GRAVELS on SANDS on S	ty gravely gravely gravely gravely grade to grade to sands. By sands ayey sandorganic si oviganic coan clays grave suborganic si oviganic	ed gravit, poorly oils, poorly of same poorly of the poorl	ofs gravel graded rty-graded gravelly graded si y-graded si y-graded into sandi w to med  type of low codus or	ravol-s gravel-s gravel-sands, y sand- sand-j sety o um pla plastici sutorne	### A	Term (SPT) Blows/ft (Model 100 to 100	DENSITY Sands and Gravels)  DENSITY  BESSEN  DENSITY  BESSEN  DENSITY  DENS	Boulders Cobbles Coerse gravel Fine gravel Coarse sand	Size (men) Size (inche 300 > -12	sand, and trees in state of the sand in terms indicating a renge of the sand in the sand i	% <5 5-10 15-25 30-45 0-100
	E& liqui		game sin rat, humu	and cu	gh plastic rys of me p soils wi	hum to	57 OL. MAIN Made: Note and or self MAIN Made: Carry Medignated # portly sone: OL Low Medignated # portly sone: OL Main Main Main Medignated # portly sone: OL Main Medignated Me	I Damp, does not wet palm Vlable Free Water	Moderate	Crumbles or breaks with co Will not crumble or break w	insiderable finger pressure.	Depth to water after (time and data)	· drilling

	Q	Star	nte	C			E - United Nuclear	r Corporation				BORING FORM	BOREHOLE Sheet 2	No.: PI-3 of 3	
	Drillers (day	oany: Cascade I / night): S. Lom, entative (day / n	A. Roc	frigue	z, J. Vigi	ieria	Drilling Rig: CME 89 Drilling Method: Ho Core Diameter:	llow Stem Auger		Bit Type: 4.25" I.D., 8" C Logged by: C. Fritz	D. Auger		Start Da Finish D Total De		et I
20 -	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol				ription	â	Graphic		Remarks		Well Details
		90, B	7 7 17		55	Sand weat	stone, light hered	promu 4	gray , sligh	tly to moderat	ely				
22 - 24 -															
26-			17 18 47		\$5	Same	, as above					Brotzen rec of sample	ck pieces v -> no	Fell out sample	
<b>28</b> –														<u> </u>	
30-		30' A	12 98 96		SS	Same	as above,	wlsome	loose sand						-
32-												(2) (C			
34-												Oid not s	ample @	.35' due	
36=												Did net so to grindle Continued to locate	to 40' in native	k. Attempt ground	
38 -									2			·			
410-	SILTS	SANDS	only-graded y gravate. yey graved il-graded only-graded y sands, p yoy sands, p yoy sands, ganic sitts ganic br>ganic sitts ganic br>ganic sitts ganic sitts ganic sitts ganic	gravel poorly g s. poorly sands, g s sands oorly gri poorly very fin s of low and clay miceces of high and clay and clay	is gravel-san raded gravel- y-graded gra- pravelly sands- gravelly sands- graded sand- graded sands- to radds sity to medium p is of low plast- cous or diator in plasticity, fa- s of medium in	ony naceous fine sar	or no finite tes trhures tes tres tes tures ture	OW OP	8-15 9-17 9-18 15-30 17-39 18-42 30-60 39-78 42-85	Term (SPT) Blows/fit (Med 14/10) 2010 2 10 10 10 10 10 10 10 10 10 10 10 10 10	7 DENSITY DENSITY BE Ches Ches Moderate	Cobbles 75 Coarse gravel 19 Fine gravel 4.7 Coarse sand 2.0 Medium sand 0.4 Fine sand 0.0	10 300 3 to 12 to 75 3/4 to 3 5 to 19 3/16 to 10 to 4.75 1/16 to 25 to 2.0 1/54 to 75 co 0.003 to 0.00	3/4 Few Little Some Mosely  Depth to first way	% <5 5-10 15-25 30-45 50-100

ſ	0	CL	. 4.			Cli	lient: GE - United Nuclear Corporation		SOIL	BORING	BOREHOLE No		
	C	Star	ητε	<b>3C</b>		Pro	roject Number: 233001076		LO	G FORM	Sheet_3		
1	Drilling Com	pany: Cascade I	Orilling	deim	· 1 \	fauor	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" C Logged by: C. Fritz	D.D. Auger		Start Date: Finish Date	See Sheet	
ł	Field Repres	/ night): S. Lom, entative (day / n	A. Ro ight):	angu	2Z, J. V	nguer	ria Drilling Method: Hollow Stern Auger Core Diarneter: N A	Logged by. C. FNIZ			Total Depth	r.	
40-	Depth	Sample Number	Blow Count	Recovery (in.)		Lithology / symbol	Description		Graphic		Remarks		Well Details
		401B	26 47		S	5 6	Sandstone, slightly to moderately we (broken rock in sampler)	athered		Stopped d abrasive to auger	rilling due rock + dam	to - lage -	
			27	_		_			_	to acya	, 		
42 -							EOB @ 41.5'	4				Andrew Transferred mentioned to the contraction of the contraction of the contraction of the contraction of the	
	GRAVELS 50% coars fraction pass	GRAVELS Sim	orty-grade v gravels.	poonly-g	is, gravel- raded: gr	sand mo	stures, little or no fines GW Term (SPT) Blows/R* (modCAL) where, Little or no fines GP GM 14/10 2 0/10 2 5/10	Blows/fi*   Term		D . 14		S stated in terms	00000
	#4 sleve SANDS <50% coarse fraction passe #4 sleve SILTS	SANDS SHOT CIS	yey grave il-graded orly-grade y sands, p yey sandi rganic silti rganic cla n clays	is poorly sands. d'sands coorly-gr sivery-fir ys of low	y-graded gravelly sa gravelly aded san- graded s e sands to medius	gravel-s inda, ktt sands, k d-gravel and-gra sifty or c m plastic	Seam-Claim returners   GC   Seam-Claim returners   GC   Seam-Claim returners   GC   Seam-Claim returners   SW   M   Seam-Claim returners   SM   SM   Seam-Claim returners   SM   SM   SM   SM   SM   SM   SM   S	very loase 0-4 0-5 0- loase 4-10 5-12 7-1 medium dense 10-30 12-37 18- dense 30-50 37-60 51- very dense >50 >60 >8	DENSITY ALISNAG	Fine gravel 4 i Coarse send 2 ( Medium send 0 4 Fine send 0 (	to 300 3 to 12 to 75 3/4 to 3 75 to 19 3/16 to 3/4  to 3 1/6 to 3/4  to 3 1/6 to 3/46  to 3/16  to 3/1	4 Little 1 Some 3 Mostly 5	% <5 5-10 15-25 30-45 0-100
		ND CLAYS inor	rganic sitt rganic cla ranic sitts	s. micac ys of hig and clay	o of media	formace , fat cla- im to his	cous fine sand or sill Mole)  Set	Field Test Absence of moislure, dry lo louch Damp, does not wel palm Visible Free Waler	Moderate	Field Test Crumbles or breaks with ham Crumbles or breaks with con Will not crumble or break will	uderable finger pressure.	Depth to first water (inne and date)  Depth to water after (time and date)	

	Q	Star	nte	C		Client: GE - United Nuclear Corporation Project Number: 233001076		L BORING BOREHOLE No.: P2 - 1 DG FORM Sheet 1 of 2
- 1	Drillers (day)	pany: Cascade I / night): S. Lom, entative (day / n	A. Roc	drigue	z, J. Vigu	Drilling Rig: CME 85 Truck Rig Bit Type: 4,25" l.D., i eria Drilling Method: Hollow Stern Auger Logged by: C. Fritz Core Diameter:	8" O.D. Auge	Finish Date: 4   14   18   18   19   19   19   19   19   19
0=	Depth	Sample Number		Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Description	Graphic	Remarks Remails
a -					SM	Sifty sand (SM), little day (weathered shale) trace gravel, slightly moist, gray witrace black & yellowlorange	4 - 10 - 10 - 10 - 10 - 10 - 10 - 10 - 1	
Ч -		5'A	15		SM	Same as above, medium denso		NOC = 17.2 ppm
6 -		5'B 5'C	18					
10 =		10' Bag	8 10		SM	Same as above, but softer a more weathered		Analytical sample from A,B, & C liners
12 -			7					
16 -		12, V	4 6 5		SM	Same as above, loose		
18,-								
3O-	BlLTS a	e SANDS CLAYS dimit <50 di	only-grader y graves, yey graves, yey graves, yey graves, grades y sands, p yey sands game sits rgame clay game sits game sits game sits	d gravent peorly-gr is, poerly sands, g d sands, corly-gra , poorly- cyery-en ys of low and clays , mosto ys of log and clays	s. gravel-sant aded gravel- graded grav gravely sands gravely sand ded sand-graded sand o sands. sity to medium pl s of too plasts ous or distant plasticity. Its s of medium b	Commonweal   Com	0-2510 0-7-18 0-7-18 17-18-51 0-51-86 -586 330 mches	Term   Gize (mm)   Size (inches)   Percentages of gravel send and fines may be stand fines m

	0	Star	ato	· C		Client: GE	- Unite	d Nuclear	Corpora	ation							L BORING			P9-1	
	D.1111 0	W.				Project Nu			E Tayak Di	ia .		Te	it Time:	4.25" I.D., 8	2" () [)		G FORM		Of Date: S	ee She	o+ 1
	Drillers (day	pany: Cascade [ / night): S. Lom,	A. Rod	irigue	z, J. Vigi	ieria	Drilling N	Rig: CME 8: Method: Hol	llow Stem	Auger			ogged by	: C. Fritz	O.D.	Auger	·	Fi	nish Date: otal Depth:	iee she	e1 1
	Depth hield Kepres	entative (day / n	¥	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol		Core Dia	ameter. 📝	NIW_	Descript	ion					Graphic		Rem			Well Details
30-	0		30 <sup>12</sup> 11 8 8		_		as	above	, exce	pt w/s	ome	Sand	storr	(gray	y )	0	Analytica A+B1		ple fi	rem :	
əə -																				(±	
24 -																1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	H-S-1.0	oom (	n - 80	a am	
26 -		25'A 25'B 25'C	5 7 7		SM	Same	as i	aboue									Has=1.0 LEL=49 (outside 4	op of 1	nole)	- PP	
<b>38</b> –															(e)						
30 -					_				ENR	6 30	( )				_	-	ACI-c LVI	, ,	20 G	۲٠	3-4
										@ 3C						and a few residents and the few of the few o	After drill LEL = 14 HgS = 16. LEL = 56 Both cas	VÕ	C = 17.	6 ppm	
	Olympia IIqu	ORAVELS CITY OF THE PROPERTY O	ony-graded by gravels, typy gravel to-graded ony-graded by sands, gypy sands triganic sits riganic clay in clays ganic sits i	d' grave poorly - le poorl sands o sand oorly gr poorly Livery fu ye of lov	is gravel-sar raded gravely y-graded gra pravely sand gravely sand addd sand graded sand e sands, sit to medium p	send-bill mixtur vel-dand-clay m , attle or no fine- da, lettle or no fine- avel-ski mixture- gravel-clay mix- or clayey fine si- asticity, gravely	or no fines es dures es es es es ands, sitts wit clays, sandy	h sight plasticity clays, sity clays,	SONS!	herd 30 very hard >	1D 2.0°1D -2 0-2 -4 2-4 -8 4-8 -15 9-17 -30 17-39 -60 39-78 60 >78	0-2 2-4 4-8 9-18 18-42 42-85 >85	dense very dense '= 140 pound l	1.4°ID 20°ID 0-4 0-5 4-10 5-12 se 10-30 12-37 30-50 37-60 >50 >60 hammer dropped	0-7 7-18 18-51 51-86 >86 30 mches	and Gravels)	Boulders X Cobbles 7: Coarse gravel 1: Fine gravel 4 Coarse sand 2 Medium sand 0 Sitt / Clay (tines) <	ze (rnm)  00  1 to 300  1 to 75  75 to 19  0 to 4,75  425 to 2,0  0.75 to 0.425	bize (inches) >12 3 to 12 3/4 to 3 3/16 to 3/4 1/16 to 3/16 1/64 to 1/16 0 003 to 1/64 <0 003	Percentage sand, and first stated in term of the stated in t	% <5 5-10 15-25 30-45 50-100
	liqu	d Ilmit >50	rganic clay ganic sitts a	n of hig and clay	n plasticity, to a of medium	clays o high plasticity h organic conten			OH Postly gra	sed = poorly sorted aded = well sorted	Medium High	Moisl Wet	Damp, does i Visible Free V		重り		Crumbles or breaks with ha Crumbles or breaks with co Will not crumble or break wi	alderable finger j		Depth to wate	

	0	Star	nte	20		Client: GE - United Nuclear Corporation	SOIL BORING BOREHOLE No.: P2 -					
	Q	D'				Project Number: 233001076	0" O D /	_	G FORM	Sheet	of 13	
	Drillers day	pany: Cascade I 7 night): S. Lom,	A. Ro	drigu	ez, J. Vi			Auger			e: 4/15/	18
	Field Repres	entative (day / n	ight):			Core Diameter. N A				Total Dept	h: 20 ff	П
	Depth	Sample Number	Blow Count	Recovery (in.)	qu (tsf) Lithology / Symbol	Description		Graphic		Remarks		Well Details
0 -					SC	(layey sand (SC) whome silt & trace grave),	some :	7				
						clayey sand (SC) whome silt + trace gravel, areas very black wlorganics, brown in sandier	spots.	W. F. 1.1				
J -								निर्मित्रिया ।				
Ч -							in .	PSNE apple				
- ما		5'A 5'B	11 5 8		S	Same as above, medium dense, slightly mois	st to ist	大小では	*A liner clayey ma	has very	black =	
8 -								indentaria				
10		×						11 m 11		ÂεΛ	14 Co	
10 -		10' Bag	711 20		S	Same as above, considerable weathered shale, b + black withour orange, few salts in black clayer spots	News	W. L. L. W.	Analytical A,B,+C li Has=O,L	sample (s ners EL=0, (0)	seo ppm	
12 -						3-3-3-3-4-17		4. S. S. L. L.				
14 =								3640			117	
\b -			3 7 18	NP	S	No recovery. Library similar to above. Driller thought it was perhaps clayey material that shrunk fell out of sampler.	and	<b>建一种工程</b>	Hz5=0.4 p CO>500 p	hw bw (enume	1000)	
18 -								Line I		ous a	- - - - - -	
3O -	GRAVELS	e woulded rufnes Por	only-grad	ed grav	els. gravel-s	nd mutures, little or no fines QP Term (SP1) (modCAL) Term (SP1)	ms/ft* (modCAL) O'ID 2.51D	à	Budfant and	a princip. Since proper	or sand, and fines	s may be
		SANDS CIA SANDS CIA SANDS CIA SANDS CIA SANDS CIA	eyev gra- only-grade only-grade by sands, syey sand organic si organic cl on clays ganic sitte	els, poor sands, ed sand poorly g is, poorl ts, very f rys of lo	rly-graded g gravelly sar re gravelly s raded sand y-graded sa ine sands, s w to medium	Section   Sect	0-5 0-7 5-12 7-18 7-60 51-86 5-60 >86 pped 30 mches	ALIBNAD GRAIN SIZE	Cobbles 75 0 Coarse gravel 19 0 Fine gravel 4.79 Coarse sand 2.0 Medium sand 0.42	io 300 3 to 12 io 75 3/4 to 3 5 to 19 3/16 to 3/4 to 3/6 to 19 1/16 to 3/4 to 20 1/64 to 1/4 5/5 to 2.0 1/64 to 1/4 5/5 to 0.003 to 1/64 to 1/	6 Few Little Some	% <5 5-10 15-25 30-45 50-100
	발출 liqui	d limit >50	rganic ci ganic sitt	ays of his and cla	gh plasticity. Iys of medici	Di laur Di Dru Abranca of moleluro del	to louch 🙎 🚧	ak ( derale (	Crumbles or breaks with cons Will not crumble or break with	derable finger pressure.	Use (time and date)  Depth to water af (time and date)	

	a	Star	)to			C	ient: GE - United Nuclear Corporation			BORING	BOREHOLE No.:	P3-1	
	V	<i>P</i> .				Р	oject Number: 233001076	_	_	G FORM	Sheet of		0
	Drillers (day)	oany: Cascade D night): S. Lom,	A. Roo	drigue	ez, J. V	figue	Drilling Rig: CME 85 Truck Rig Bit Type: 4.25" I.D., 8" and Drilling Method: Hollow Stem Auger Logged by: C. Fritz	U.D. AI	uger		Finish Date:	4 (18/18	8
	Field Repres	entative (day / ni	ght):		-	ō	Core Diameter: N A				Total Depth.	16.5 f	Н
0	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / symbol	Description		Graphic		Remarks		Well Details
0 -					5.	M	Silty sand (SM) with grovel, trace sandstone colobles, light grow witrace darker grow in mo- comented spots, trace iron exidention, trace	(Q	行人方は				
2 -							cemented spots, trace iron exidedton, trace green discoloration	and second					
Ц _		s՝ A	2		S	M	Same on above, slightly moist, dense (though	a culta salas	言語のかには	Hit veid fi	irst 6" dr\v	و =	
<b>6</b> -		5'B	39 38				Same as above, slightly moist, donse (though possibly Just due to cobbles)		当分のは方 大川				
8 -												almana	
10 =		10' A	ч 5 8	œ.	S	<b>'</b> M	Same material as above, medium-growned sand loose + moist, light brown + gray wlgreen	,	ないなってはかな	co : 300	ppm		
12 = 14 =								انتفينا فيتناب	である。 では、 では、 では、 では、 では、 では、 では、 では、			dan mara	
v I	-	15\ A	5 7	•	5	iP iC	Top of sampler (C): poorly-graded medium sand, light group lutitie with some green thoge A liner & part of B liner: clayey sand (SC) & weathered shale, silty, dark group black whight group, orange & yelligo	nt	***	H25=0 pp	m, LEL= { n (and still	nising)	
\b =		15'B	13				shale, silty, hark gray/black which gray, crange 4 yelly	odien	72				
18 -								and the state of					
<b>3</b> 0 -	SILTS liqu	be the time or can hose a pool of GRAVELS Simulation of the time of ti	orly grade by gravels, by by grade only grades by sands, sy by sand wganic sife ganic sife wganic sife wganic sife wganic sife wganic sife	poorly con man and cite and	oil grave graded g ity graded g gravelly s is gravelly graded sa y graded line sands w to mode yys of low coous or o gh plasho yys of mod	-sand ravel-s grave sands, v sand nd-gra sand-j sitty o um pla plastic platomi ty, fat o ium to	Article   Arti	0-7 7-16 18-51 Grave(s) 0 mches	k erate	Boulders   >30     Cobbles   75     Coarse gravel   19     Fine gravel   4.7     Coarse sand   2.0     Medium sand   0.4	10 300 3 10 12 10 75 3/4 10 3 14 10 3 3/16 10 3/4 10 4 75 1/16 10 3/16 125 10 2 0 1/64 10 1/16 75 10 0 425 0 003 10 1/64 0075 0 003 10 1/64 100 00 003 10 1/64	sand, and lines stated in terms indicating a ra- percentages at Term Trace Few	% <5 5-10 15-25 30-45 50-100

Drilling Company: Cascadd Drillers (a) night): S. Lor Field Representative (day)  In the second of t	Blow Count Blow Count Guideline Blow Count Guideline Gui	Description  N Silty sound (SM), little fines (~20%), trace cobbles, slightly moist, light gray lishite with green tinge trace brown, loose to medium donse, medium	Finish Date: 4 11 118 Total Depth: 4 1
O Sample Number	Blow Count Recovery (in.)  qu. (tsf)	Description  N Silty sound (SM), little fines (~20%), trace cobbles, slightly moist, light grow lishite with green tinge to trace brown, loose to medium donse, medium	Graphic Graphic Mell Defails
3 5' A 5' B	↑ SA	slightly moist, light grow lishite with green thinge to trace brown, loose to medium donse, medium	
6 5 A 6 5 B		grain-size sand	
8	90 89 18 X SI	M Same as albevile	Higher blow counts likely due to cobbles
E			
10' A	8 * SI	4 Same as above	
14 =	44		
15'B	ч X 5 3	I Same material as above, but moist ulderker green coloring in wettest spots	
18	   \ 		
SANDS SANDS SANDS SANDS SANDS SANDS	Sity gravels, poorly-graded gra Clayey gravels, poorly-graded g Well-graded sands, gravely san	and mixtures. With or no fines	Bouldars   -300   >12

	0	Sta	nte	ec			Client: GE - United Nuclear Corporation roject Number: 233001076	SOIL BORING	BOREHOLE No.: P3-2 Sheet 2 of 3
	Orilling Com	pany: Cascade	e Drilling	1			Drilling Rig: CME 85 Truck Rig Bit Type: 4.25" I.D., 8" O.		Start Date: See Sheet 1
F	ield Repres	/ night): S. Lor entative (day /	n, A. Ro / night):	odngu		_	Pria Drilling Method: Hollow Stem Auger Logged by: C. Fritz Core Diameter: 4.35 Inch		Finish Date: Total Depth:
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description	Graphic	Remarks Remails
		90, Y	7	1		SM	Same as above	±37	3
E		30'B	3						=
E			-	H				]\;'.\	
ŧ	The state of			l				1/3	-
				44					3
E								]:[	
F								4::1	3
E								13	3
F			35	*		SM	Same as above, trace cobbles	1.	=
E		96, V	9				•	183	3
E			10						=
E								13)	₫
				44				14	=
-				П				131	- 1
E									=
								1.	=
E				V		00.025		<u> </u>	
E			7	个		SM	Same as above	1. <i>(</i> )	=
-	1	30'B	9						4
ŧ			7					10	3
F									7
E				44					3
-									=
E								42	4
E									3
-			5	*		SM	Some as above with increased shall know fines	) = ( )   (	4
E		35'B	5			dint	Same as above, with increased shale/some fines, dark gray/green	7 [2]	∄
E		J- D	4				8411- g(m) 19:0011		<b>E</b>
E			П						<u> </u>
E				    44					<u> </u>
ŧ				1	,		22		4
E									3
									国
E				1				1/1	3
\$ 200 CJN	GRAVELS #50% coarse fraction passe #4 sleve	GRAVELS 1	Poorly-grade Litty gravels	off grave	ols, grave graded g	H-sand r graver-s	Tures. little or no fines		Size (mm) Size (loshes) Percentages of gravel, sand, and lines may be stated in terms
ARSE GRA	SANDS +50% coarse fraction passe #4 sieve	SANDS V with later or no times. F SANDS I	Not-graded Poony-grade Sity sands	sands od sand poerly-gr	gravelly s s, gravell raded: sa	sands, i y sands and-grav	tile or no fines SW 23 soft 2-4 2-4 10000 4-10 5-12 7-18 1180 of no fines SP 20 10000 4-10 5-12 7-18 10000 4-10 5-12 7-10 5-12 7-10 5-12 7-10 5-12 7-10 5-12 7-10 5-12 7-10 5-12 7-10 5-12 7-10 5-12 7-10 5-12 7-10 5-12 7-	Coarse gravet	75 to 300 3 to 12 5 indicates a range of 475 to 19 3/16 to 3/4 5 7 Trace 45
SOUS CO	SILTS A	AND CLAYS	Ctayov sand	s. pporty	bobero-	sand-d	www.clay.markures	Medium send	0.425 to 2.0 1/64 to 1/16 Few 5-10 15-25 0.075 to 0.425 0.003 to 1/64 0.
CONTRACT.	SILTS A	AND CLAYS	Diganic sits norganic sits	ts, micac	court or a	diatoma	very nation > 00 3/8 > 85 = 16 power among outproposed or formation of the cook time same or sist. MM   Note: A power among outproposed or formation of the cook time same or sist. MM   Note: A power or sist.	Term Field Test	handling or slight linger pressure.   Depth to first water (lime and date)
FRECHAN	SILTS A	AND CLAYS	Diganic sits norganic sit norganic cli Diganic sits	ts, micas rys of hig and clay	oous or a ph plastic ys of med	diatoma ity, fat c dium to i	OL Nonplastic W Term Field Test	Term Field Test	handling or elight linger pressure.  Doubt to first water time and date)  Doubt to water after drilling

ſ	0	Star	ato			C	Client: GE - United Nuclear Corporation					SOIL BORING BOREHOLE No.: P3-2						
1	Q					P	roject Number: 2330							G FORM		3_of		
-	Drilling Com	pany: Cascade V night): S. Lom	Drilling A. Ro	driau	ez. J.	Vigue	Drilling Rig eria Drilling Me	: CME 85 T	ruck Rig v Stem Auger		Bit Type Logged	e: 4,25" I.D., 8" l by: C. Fritz	O.D. Auger		Si	art Date: 5 nish Date:	ee Shee	+ 1
1	Field Repres	entative (day / r	night):			_	Core Diam	eter: 4.3	5 inch						To	tal Depth:		
40-	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol			Desci	ription			Graphic		Rem	arks		Well Details
		40' A	5 6 9	^		M	Same as a	above									*	
43				 44 														
44		45'B	7 21	1			AFILL Sandy silt d	o silty	sand (M	L) brow		y motst. N	lative					
46		100	21 50/1	16			Sandstone	pegroc	.k				_=	Auger S	hetusal			
48 –								E	E03 @	46'			سنمياء مطهدينا					
50 -																		
_																		
								4					Junior					
									140				Learning					
ē											T					i :		
E	liqui	AND CLAYS Id Imit <50	porty grade ity graveta layey gravet lett graded borty grade ity sands layey sand organic site organic site an clays	ed grav poorly- els, poor sands, ed sand poorly-gis, poorl survey-f sys of to	gravely graded of gravely graded size gravely raded size graded inc sandt with med	risand pravel s 1 grave sands. y sand and-gra sand-gra sand-gra sand-gra sand-gra sand-gra sand-gra sand-gra sand-gra sand-gra sand-gra sand-gra	shures. Ifthe or no fines minutures, Ifthe or no fines and-sit midures sid-and-day mixturos side or no fines		very set soft soft medium stiff very stiff hard very herd	1.4 TID 2.0 TID 0-2 0-2 2-4 2-4 1 4-8 4-8 8-15 9-17 15-30 17-39 30-60 39-78 >60 >78	0-2 very loos 2-4 loose medium 9-18 dense 18-42 very den 42-85 140 po.	4-10 5-12 dense 10-30 12-37 30-50 37-60 8 se >50 >60	0-7 7-18 18-51 51-86 >86 0 iaches	Fine sand Sitt / clay (fines)	\$100 (rnm)  300  75 to 300  19 to 75  4.75 to 19  2.0 to 4.75  0.425 to 2.0  0.075 to 0.425  <0.075	3/10 (Inches) 3/12 3/10 12 3/4 10 3 3/16 10 3/4 1/16 10 3/16 1/64 10 1/16 0 003 to 1/64 <0.003	Percentages sand and fine stated in term indicating a rapercentages in Term Trace Few Little Some Mostly  Depth to first wa	% <5 5-10 15-25 30-45 50-100
	真奇 jidn	ld limit >50	organic cla rganic sitts	ays of hi	gh plastic ys of mo	ity, fat o	iceous fine sand or set Jays high plesticity organic content	OF PT	Note   Welgisted = poorly so   Poorly-graded > well so	Low Medium High	Dry Absence Moist Damp, d Wel Visible F	of moislure, dry to touch bee not wel palm roe Waler	h 🙎 Weak	Crumbles or breaks with Crumbles or breaks with Will not crumble or break	considerable finger p		Depth to first wa (time and date)  Depth to water a (time and date)	

Field Representative (day / night):  Core Diameter.  Blow Count Recovery (in.)  Lithology / Symbol Lithology / Symbol	Hollow Stem Auger Logged by: C. Fritz	Remarks
Depth Sample Number Sample Number Second (in) Blow Count Recovery (in.) Recovery (in.) Recovery (in.) Recovery (in.) Recovery (in.) Recovery (in.)	Description	Graphic Remarks Well Details
SM Silty sand (SI moist, light be grained sand	n), trace weathered shale/clay rown wltrace black + orange, m	nedism
grained sand	LONZY MILLOUSE BLOOMS & PLONINGS IN	veo.sm
		][3]
ц	and the state of t	H-5- Down (O-Dom
6 51A 11 SM Same as about	ue, loose to medium dense	H25=Oppm, CO=Oppm
8 =		
10' A 5 SM Same as abe moist, now in	ove, fine to medium sand, slight achides trace green coloring	Has-Oppm, co=Oppm
19		
15' A 9 SM Same as about brown widow	ue, medium sand, moist, loose le gray	e, Has=Oppm, co=Oppm
18		
GRAVELS  GRA	GM 5 Term (SPT) (MOCCAL) Term (SPT) 1.4 ID 2.0 ID 2.5 ID Term (SPT)	Term Size (mm) Size (inches)   Percentage of gravity   Size (inches)   Percentage of gravity   Size (inches)   Size (inches)     Size (inches)
SANDS	SP 77 medium stiff 4-8 4-8 4-8 medium dense 10-30 12- stiff 8-15 9-17 9-18 dense 30-50 37-	7-18   2-7

	C	Sta	nte	С		Client: GE - United Nuclear Corporation Project Number: 233001076			BORING FORM	BOREHOLE No.: $\rho$ Sheet $\lambda$ of	3-3 3
	Drillers (day	npany: Cascade //night): S. Lom sentative (day / r	, A. Rodr	iguez, J	. Vigu	Drilling Rig: CME 85 Truck Rig Bii eria Drilling Method: Hollow Stem Auger Lo Core Diameter: N   A	Type: 4.25" I.D., 8" O.I gged by: C. Fritz	D. Auger	=======================================	Start Date: See Finish Date: Total Depth:	Sheet)
- OG	Depth	Sample Number				Description		Graphic		Remarks	Well Details
22 -		90,8 90,8	366		SM	Same as above, brown/tan with trace growel	ce gray, black				a ferentree
<b>3</b> 4 =					cu	Same as above, increased presence grea	un material		Has = Open	n , CO = Oppn	s menulman
<b>2</b> 6 =		30, B 30, Y	3 5 5		MC	same as moves more pro-		- 1 2 1 2 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4		·) — • • • • • • • • • • • • • • • • • •	
38 =											morning
30 =		30, 8	3 4 7		514	Same as above, trace to Few grave	\		HaS = Oppn (material g	o, co=9 ppr exting darker	3
3a = 34 =								113000000000000000000000000000000000000			Lumman
36 =		35'A 35'B	3 4 3		SM	Same as above, few sandstone chunhs			CO = 2 ppn	, H&S= 0 pf	om =
38 =		*									utuuluut
40 =	GRAVEL SS% coan station pass station s	with lattle or in times Fig. GRAVELS Sample GRAVELS Sample GRAVELS Sample GRAVELS Sample GRAVELS SANDS	porty-graded dry gravels, so tayery gravels, self-graded sus porty-graded dry sands, pool tayery sands, c streganic settili- terganic citya an clayer yganic sitts an	gravels, gra- gravely-graded poorly-graded sance, gravel sance, gravel sance, gravel sance, gravel sance, gravel edy-fine san ef low to me dictays of ice	evol-sand gravel- led grav ly sands, elly sand sand grav ed sand- edium pla ow plastic	Anni-stati restures	1827   Blows/#   1827   1820	(Heneral pue spues	Fine gravel 4.75 Coarse sand 2.0 to Medium sand 0.425	300 3 to 12 75 3/4 to 3 to 19 3/16 to 3/4 4.75 1/16 to 3/16 to 2 0 1/64 to 1/16 tillo 0 425 0.003 to 1/64 5 <0.003	Percentages of gravel, sand, and fines may be stated in fection stated in the stated i
	₹∯ llqu	uld Ilmit >50	rganic sitts an	of high plat dictays of m	body, fat redium to	CONTROL TIPE SUPER OF	Damp, does not wet palm Jable Free Water	Moderale C	rundles or breats with handle Drumbles or breats with consid Vill not crumble or break with fi		bne and date) Depth to water after diffing Nime and date)

	C	Stai	nte	ec			Client: GE - United Nuclear Corporation Project Number: 233001076			BORING G FORM	BOREHOLE No.: P3. Sheet 3 of 3	-:
1	Drillers (day	pany: Cascade / night): S. Lom, sentative (day / n	A. Ro	) odrigu	ez, J.	Vigu	Drilling Rig: CME 85 Truck Rig Prilling Method: Hollow Stem Auger Core Diameter: N A	Bit Type: 4.25" I.D., 8" C Logged by: C. Fritz	D.D. Auger		Start Date: Sec. S Finish Date: Total Depth:	iheet 1
40	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic		Remarks	Well Details
		40' A 40'B	5 7 12			SM	Sand whilt + day (SM), increased (>40%), trace growel, maist, brow	Anes content n witrace black shale		LEL = 19 %		3 1
42							EOB @ 41.5'			Stopped de increasing Possibly of that cours	rilling due to Has, co, & LEL ust above mater ad issues wigas ns holes.	ial-
44									عيديا يتينين	at previou	rs holes.	
46-				22							ž×	
48									Andrews.			
50-									بالمتعالم بهمتان فيميآ بالمعاف فالمعاه والمعام وعاماتها السميميا فيبيدا المتعادية والمتعادية والمتعادية والمتعادة			
	SILTS	AND CLAYS and limit Specified and limit Specif	porty-grad by graveti ayey oray cel-graded forty-grad by sanite ayey sanite organic class ganic sati organic sati organic sati organic sati organic sati organic co	ed grav s poorly s sands ed sans poorly ds poo	ols, grave graded fly-graded gravelly is, gravelly saden a y-graded w to mice y-graded w to mice graded a y-graded w to mice	er-sand gravel- d grave sands. By sand- sa	SAL	very loose 0-4 0-5 0- loose 4-10 5-12 7-1 medium dense 10-30 12-37 18- dense 30-50 37-60 51- very danse >50 >60 >8 5 ** 140 pound hammer dropped 30 ini	DENSITY DENSITY OF Term	Boulders >38 Cobbles 75 Coarse gravel 19 Fine gravel 4.7 Coarse sand 2.0 Medium sand 0.4 Fine sand 0.0 Silt / clay (fines) <0	10 300 3 10 12 10 17 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	<ul> <li>&lt; 5</li> <li>5-10</li> <li>15-25</li> <li>30-45</li> <li>y 50-100</li> </ul>
	麗奈 liqu	id limit >50	organic ci	ays of h	gn place vs. of me	city, fat i	clays CH Welfunded = poorly sorted by high plasticity CH Poorly grated = well sorted =	Moist Damp, does not well palm Wet Visible Free Water	Mnderele Strong	Crumbles or break with Will not crumble or break with		Depth to (time and

	0	Star	ato	20		Client: G	E - United Nuclear Corporation			BORING	BOREHOLE No		
	V	<i>P</i>				Project Nu	umber: 233001076	DATE - A OFFILE OF		FORM		of 3	
	Drillers (day)	pany: Cascade   night): S. Lom,	A. Ro		ez, J. Vig	ueria	Drilling Rig: CME 85 Truck Rig Drilling Method: Hollow Stem Auger	Bit Type: 4.25" I.D., 8" C Logged by: C, Fritz	D.D. Auger		Finish Dat	: 4 12 18 : 4 12 18	
	Field Repres	entative (day / r	night):		<u></u>		Core Diameter: N A		11		Total Dept	h: 41.5 A	$\vdash$
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol		Description		Graphic		Remarks		Well Details
0 -	ă	ιχ	商	ž			- 1 (01)	I C					<
					SM	Silty	sand (SM), medium grain-	Size, trace to tel	۳ ا				1
						grav	rel + cobbles, few shale p e orange + yellow exida	ieces brown will	/ 周			-	1
_						trac	e orange & yellow excoo	men, moist					1
7 -									3 1				3
	_								3 1)				1
	=								17				1
4									1:1				1
'	-												1
15		<u> </u>	10		CAR	Sam	e as above, medium den	<0	1.7			-	1
	Ē	5' A	6		Ji	John	e on above, memori our	30	1			- 8	1
<b>(</b> - <b>(</b>		2, B	7									_	1
37	-		Ť										1
	=								3/3/			3	]
ન ક									]				1
J	3								1.31				1 1
												(	1
												-	1
10 -		10' A	3		SP.	Poort	y-araded sand with silt (	SP-SM), loose,	00			-	1
		io A	a		SM	medi	um sand, trace gravel, ligh	it brown wlaray,					]
	=	10, B	4			green	y-graded sand with silt () um sand, trace gravel, ligh n, and orange spots, mois	st J	00			-	1
12 -							SSC 98 1 1 1 1 1		4.1			<u>, i</u>	1
												(=	1
									4			-	1
	=											- 1	1
14 =	-								7.1			7 <u>4</u>	1
	2								1			Ę	1
9		151 A	3		92 42	Sam	ne as above, trace green f	tnes o shale piece	5			Ξ	1
- 16	=		9		42	`		•					1
,,,		15'B	1						1			1	1
	=								-			I	1
	Ē											Ξ	1
18 -	=								7			7	
									]			Ē	
	Ē								1			Ξ	]
9O -	=						1203		4	r			
<i></i>	GRAVELS <50% coars fraction pass #4 sieve	e am in or colors Po	ourly graves	ed grave i, poorty-	ols. gravel-sa graded: grav	mixtures, little on and mixtures, little of-sand-silt mixturates avel-sand-clay n	corno fines GP1 Term (SP1)	D 251D Term (SP1) Image D 251D 141D 201D 2	510 S W	Boulders >	lize (mm) Size (inch 300 >12 5 to 300 3 to 12	stand, and line stated in terms indicating a rai	is inge of
	5 SANDS <50% coars	SANDS W	eli-graded soriy-grad ity sands.	d sands. od sand poorly-d	gravely sand s. gravely sa raded sand-	ns, little er ne fini nds, little er ne f prævel-ski mixtur	16 SW 11 Soft 2-4 2-4	2-4 loose 4-10 5-12 7- modium demse 10-30 12-37 15	INSUE S NIN	Coarse gravel 1 Fine gravel 4	9 to 75 3/4 to 3 75 to 19 3/16 to 3/4 0 to 4 75 1/16 to 3/4	16 Trace	% <5
		AND CLAYS	organic sa organic sa organic cl	ts. popily ts. very-h	r-graded 64r	d-gravel-clay.mi y or clayey fine t	ands are wen paper plasticity ML 0 5 hard 30-80 39-7 yetry hard >60 >78	99 18-42 18 42-85 13 >85	86	Medium sand 0 Fine sand 0	425 to 2 0 1/64 to 1/ 075 to 0.425 0.003 to 1 0.075 <0.003	16 Little Some	5-10 15-25 30-45 50-100
	SILTS	AND CLAYS	organic si organic cl	its, micas ays of his	gh plasticity, t	maccous fine sa at clays	and or silt MH Note: E Nonple CH Weilgroods a poolly sorted to Weilgroods a poolly sorted to Weilgroods and St. Cow	. Indraw Field Total	Term F	eld Test rumbies or breaks with ha	ndling or slight linger pressure	Depth to first war gime and date)	nor
	£ 7	d limit >50	rganic sitts	s and cla	ys of modium	to high plastich ph organic conte	y OH Foorly grades a well sated High	m S Meint Damp, does not wel palm Viet Visible Free Visitor	Strong V	fumbles or breaks with co fill not crumble or break w	nsiderable Enger pressure th Enger pressure	Depth to water a	gnifith ran.

	C	Sta	nte	ec			lient: GE - United Nuclear Corporation roject Number: 233001076	SOIL BORING BOREHOLE No.: P3 -L1 LOG FORM Sheet 2 of 3				
ı	Drillers (day	pany: Cascade / night): S. Lorr	1, A. Ro	) odrigue	ez, J. \	vigue	Drilling Rig: CME 85 Truck Rig Bit Type: 4.25" I.D., 8" O Drilling Method: Hollow Stern Auger Logged by: C. Fritz	.D. Auger		Start Date: See		
	Depth Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Core Diameter N (A  Description	Graphic		Total Depth:	Well Details	
9D -		90'B	13 9	•8	9	SP- SM	Same as above, trace course gravel, medium dense				a a la rata a	
24		<b>25</b> 'A	50/6		5	P-	Same as above, fine to medium sand, trace		High You	u counts lite	ly l	
96 - 96 -						SM.	coarse gravel	Linear	due to co	PPIEZ	huadraulm	
30-		30'B	17		9	P.	Same as albeve				umhunium	
39 -			11	58 Y			38				minutin	
34 -		35' A	10		5	5P-	Same as above, brown widork gray, few shale [black), trace yellow, pronge, & light gray				ulmin	
36-		35'B	31 11		3	im	(black), trace yellow, prange, & light gray				ulmini	
38 -							±					
-iO T	SILTS gard	MAND CLAYS Id Immt >50 Per Immt	corty grade ity gravets layey gravet cell graded oony grade ity sands layey sand sorganic cut an claye riganic sits organic sits organic sits organic sits	od grave poorly-g bis, poorly sands, ; od sands poorly-gr s, peorly- is-very-fir tys of low and clay and clay and clay and clay	is, gravel- praced gravelty s. gravelty s. gravelty s. gravelty s. graded sam graded samds. to media s. of low procus or d in plassors s. of media	sand ravel sa graver ands, it sands ad-grav sand-g sity or m plas vasticm atoma y, fat co um to it	cous fine sand or sit MH Note:	Sends and Gravesty Sends and Gravesty Sends and Gravesty Sends and Gravesty Moderale Moderale	Bousers >3 Cobbles 75 Coarse gravel 19 Fine gravel 4 Coarse sand 2 ( Medium sand Fine sand 0 of Sill / Ear (fines) <0	10 300 3 to 12 to 75 3/4 to 3 5/5 to 19 3/16 to 3/4 to 3 5/5 to 19 3/16 to 3/4 to 4/5 5/5 to 19 3/16 to 3/6	Percentages of gravel, sand, and finals may be asked in terms and state of terms indicating a range of percentage as below.  Term % Trace <5 Few 5-10 Little 15-25 Some 30-45 Meetity 50-100 opth to final valor me and date)	

	Stantec  Drilling Company: Cascade Drilling  Drillers (day / night): S. Lorn, A. Rodriguez, J. Vi						Client: GE - United Nuclear C Project Number: 233001076					LO	_ BORING G FORM	Sheet	DLE No.: P3 3_of_3	_
	Drillers (day	pany: Cascade / night): S. Lom. sentative (day / r	, A. Ro	drigu	ez, J. '	Vigue	Drilling Rig: CME 85 T Drilling Method: Hollov Core Diameter:	ruck Rig v Stem Auger		Bit Tyr Logge	e: 4,25" I.D., 8 d by: C. Fritz	" O.D. Auger		Finis	t Date: See S sh Date: I Depth:	Sheet 1
40 -	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol		Descr		•	R	Graphic		Remai	ks	Well Details
		40'B	7 42 38			ML	Sandy silt wifew hard to very hard	clay (M)	L), moi	st, blac	k + gray		Encountry drilling work.	ered Has From 40	while 's stepped	,
42			100			7	EC	B @ 41	1.51							
().												t to the second				
44	-															ullandı
46-												7				Title I
48																mulmi
50																
-	-															
-												distribution.				
																The first
												and the same				
	- - - - -								(4)	13		Leatherne				<u> </u>
		GRAVELS INTO SANDS SANDS SANDS SANDS SANDS SANDS SANDS SAND SAND	nony-grade by gravels, ayey grave ell-graded corty-grade by sands, ayey sand organic sit organic cla	poorly- els poor sands ed sand poorly-g s, poorly severy-fi	ols grave graded c ty-graded gravelly s gravell raded sa graded ne sands	ravel-si grave grave lands, i y sands nd-grav sand-g	initudes, little or no fines minitudes, little or no fines and-self instatures and-self instatures and self instatures and sel	ON SIZENCY Soft medium stiff stiff very stiff	4-8 4-8 8-15 9-17 15-30 17-39 30-60 39-78	2-4 very lao (laose 4-8 medium 9-18 dense 18-42 very der	1.4"ID 20"ID	2510 C-7 7-18 18-51 51-86 >86	Coarse gravel	>300 >1 75 to 300 3 19 to 75 3/ 4 75 to 19 3/ 2 0 to 4 75 to 1 0 425 to 2 0 1/ 0 075 to 0 425 0		tce <5 W 5-10 He 15-25 me 30-45
	SILTS Iqu	AND CLAYS	organic cla Iganic sitts	ya of fix and cla	ph plusho ys of med	tatorna ty, fat c turn to t	by Other Street Mit Mit May Co. May Co	Note: Well-graded = poorly sort Poorly-graded = well sort	Nonplastic Low Medium	Term Field To Dry Absence Most Damp, Wet Visible	e of moisture, dry to touc loes not wet palm free Water	Term West Moderale	Field Test Crumbles or breaks with	handing or slight linger possible finger pres	Depth interest	te first water and date) to water after drilling and date)

		Star	nte	20		Client: G	E - United Nuclea	ar Corporati	on				BORING		№: P3 -5	
	Drilling Compa					Project Nu	umber: 233001076 Drilling Rig: CME 8	85 Truck Ric		Bit Type: 4.25"	מס"א מוי		G FORM	Sheet	_of <u>}</u> te: 4 / 14 / 18	2
I	Drillers (day) r Field Represer	night): S. Lom, a	A. Ro	drigue	ez, J. Vi	gueria	Drilling Method: H	ollow Stem A	uger	Logged by: C.		. Auger		Finish D	ate: 4/14/1	8
	Deptt	Sample Number	ŧ	Recovery (in.)	qu (tsf)		Core Diameter.		Description			Graphic		Remarks	M. 19.5 17	Well Details
0 -					SI	-	y sand (SM ly moist, to	an I gray	vel & few ultrace o	shale piece range	-5,					
۵ <u>=</u>							l	١,		La dense		されている。これできる		40	-	
8 -		E ( ()	7 27 31		21	n Sam	e as above	, mean	AN DONZE	E OCIVSE		ないないというないないかん	O ppm go	مع الأهوب	- - -	
13 -	Ξ.	011	10 39 14		S	a Silte den	y sand (SN se, some e	A wltra brange :	ce day, q	iray d black	۸,	こうからいかればくいがればからない	Has=2.9 p Has=3.9 p	pm (eutsid pm (4' de pm LEL	e hale) - wn hale) =19% -	
14 -			11 39 10		S	M Silled brown	sand (SM) on wlblack			e coboles, li	ght		HOS=4.7/ LEL=1499 -> Stopped	opm (41 di co=1 work	own hole) 199 ppm	
18 -								EOB	@ 16.51			er transportation of the second				
9O →	GRAVELS 450% coarse fraction passes SANDS 400% coarse fraction passes SANDS 400% coarse fraction passes SANDS 400% coarse fraction passes Highlight Highligh	SANDS with the care to be care to	ny-gradec graveis, ey gravei -graded ny-gradec sands, p ey sands garic clay clays sand sits garic sits garic sits garic sits garic sits	of grave poorly of sunds, sands, sands outly gr poorly very fir y of low and clay meach s of hig and clay	is gravel-s praced gra y-graded gravelly sa- s, gravelly sa- s, gravelly sa- aded sand graded sa- re-sands sa- vice medium is of liny plu- ceus or dia in plasticity, is of medium	el-send-silf millu quyel-sand-clay m ds, little or no fine ands, little or no fine gravel-silf misstan di-gravel-clay mill ty or clayey fine s plasticity, gravell; secty ornaceous fine sa	or no fines res victures is is, nes s sture s stures y clays, sandy clays, sitly clays ind or sitt.	GC ON STATE OF THE SECOND SECO	2-4 2-4 2 dium stiff 4-8 4-8 4-8 4-8 15-30 17-39 18 d 30-60 39-78 4 hard >60 >78 >  Nonplastic	Term (371)  Very loose 0-4  loose 4-10  medium dense 10-30 dense 30-50	0-5 0-7 5-12 7-18 0 12-37 18-51 0 37-60 51-86 >60 >86 dupped 30 actes	Noak Apdorate	Boulders >30 Cobbles 75 Coarse gravel 19 Fine gravel 4.7 Coarse sand 2.0 Medium sand 0.4	10 300 3 10 12 10 75 3/4 10 3 5 10 19 3/16 10 3 10 4 75 1/16 10 3 25 10 2 0 1/84 10 1 75 10 0 425 0 003 10 0075 < 0003	Hand, and in the state of in t	% <5 5-10 15-25 30-45 50-100

	0	Star	nte	-c			Client: GE - United Nuclear Corporation			L BORING BOREHOLE No.: P3 - G	0
	Drilling Com	pany: Cascade D			_	1	roject Number: 233001076  Drilling Rig: CME 85 Truck Rig B	lit Type: 4.25" l.D., 8" O			18
l	Drillers day	night): S. Lorn,	A. Ro	drigu	ez, J. \	Vigue		ogged by: C. Fritz		Finish Date: 4 [14] Total Depth: 55 F	
	Depth	Sample Number	Blow Count	Recovery (in.)	qu (tsf)	Lithology / Symbol	Description		Graphic	Remarks	Well Details
0					:	M	Silty sand (SM), fine to medium-gr	woned sand,	į.	n e e e e e e e e e e e e e e e e e e e	=
							trace growel + sandstone drunks, I + grow, trace orange, slightly make	ight brown	16.		3
	-					1	+ gray, trace orange, slightly mak	5+			3
2	<u> </u>								1.,		1
ч -											
6	-	5'A 5'B	10 50/4			5H	Same as above, trace cobbles			H2S=0 ppm , CO=0 ppm	
8 -											a clean class
۱٥ -						-14	Con Long Lot and Lote L	man dam		Oppm gas readings	
		10,B	5			<b>.</b> ۳	Same as above, but mostly durte light brown, gray, and orange, sli loose to medium dense	ghtly moist	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	J years (accord)	
13 -											d randli
14 -											
16-		151 A 151 B	3 5 6			SM	Sand with silt (SM), loss silty than medium-grained, moist, brown + to little black + gray	n above, loose un wlfew to			
18 -									100000000000000000000000000000000000000		
3O -	SILTS	GRAVELS Sith and reclaims Pool of SANDS Sith and CLAYS SITH AND CLAY	ody grade y gravels way gravel il graded only grade y sands, yey sand regame sta n clays pane sits regame call regame sits regame call regame call	od gravi- poprty- ols poor- sands, od sands poorly g s, poorly sys of lo- series and cla- te, mica- tys of ho	els gravel graded gravely sy-graded gravely s gravel raded sa y-graded ine sands w to med ys of low coous or gh plastic	ri-sand gravel-e ir grave sands, y sand- sand-gra sand-gr	United or no fines	Term 15P7 14710 2010 2 5 very loose 0.4 0.5 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	DENSITY DENSITY OF Term Vieta Modorate	Boulders   >300   >12	% <5 5-10 15-25 30-45 50-100
	27	1 Ord	at, humus	and cla	ys of med soils wi	n nigh	high plastorty OH Poorly-gladed × well sorted Well with High Well	Visible Free Water	Strong	Crumbles or breaks with considerable finger pressure.  Will not crumble or break with finger pressure.	(e)

	C	Star	nte	ec			ent: GE - l			rporation						L BORIN	_			0
	Drillers (day	pany: Cascade I / night): S. Lom, sentative (day / n	A. Ro	odrigu	ez, J. \		Dri ia Dri	ling Rig: Cl	ME 85 Tru d: Hollow S	Stem Auger			ype: 4,25 ged by: C.	'I.D., 8" O. Fritz				Start Date: Start Date: Start Date: Total Depth:		eet [
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	100	o Danielo		•	ription				Graphic			marks		Well Details
30+		20' A	3 4 4		5	M S	same (	rz upo	ve, to	race gro	evel, trac	e gre	en co	loring						II De le
39														,		1				
24																				
a6 -		25' A 25' B	2 5 12		3	SM S	same a	s abo	ue, tra	ice sha	le I sam	dston	e pie	લ્લ્ડ	Contractor and					
38 -																				
30 -		30'A 30'B	2 3 10		2	w v	Medium noist	to co	ist, g	sand u gray + ale, loo	sith silt dark br se to m	(SM) own ediun	, sligh w/ora n dei	tly nge nse	さんじん かんかい				8	
39 -																			S	
34 -										lc .	<b>C</b>	١ -							8	
36 -		35' B	446			JN :	)ame	مرج حکی	00 E , W	olteus c	lay + fer	o gra	.ve1, 1	0026		•			8	
38 -	- - - - - - -																		i i	
40 -	GRAVELS: 450% coars fraction paiss #4 sories 450% coars fraction paiss #4 sories 450% coars fraction paiss #4 sories 550% coars fraction paiss #4 sories 550% coars fraction paiss #4 sories 550% coars fraction paiss 560% coars 560%	e os GRAVELS ST ett HTM fores Cla SANDS We ett HTM or on fines Pool SANDS SE with 15% fores Cla SANDS SE with 15% fores Cla SANDS SE with 15% fores Cla SANDS SE with 15% fores Cla	priy-grad y graveli yey grav il-graded priy-grad y sands yy sands ryby sani	ed gravi poorly- ets, poor sands, ed sand poorly-g ts, poorly ts, years	ets, gravel graded ig ly-graded gravely s s, gravely raded sai r-graded ne sands	send ma avel-sam gravel-sands, little sands, little sand-gravel- sand-gravel- sand-gravel- sand-gravel- sand-gravel-sand-gravel-	ures, little or no fir furres, little or no d-sit mustures and-clay mixtures a or no fines title or no fines -sit mixtures rel-clay mixtures ally fine sands, oky, gravety clays	its with slight pl	GW GP GM GC SW SP SM SC MLC/y ML	Term  very soft medium st sliff very sliff hard	0-2 0-2 0- 2-4 2-4 2-	very l toose mediu dense	0-4 0-4 4-10 um dense 10-3	0-5 0-7 5-12 7-18 0 12-37 18-5 0 37-60 51-86	DENSITY Sands and Grav	Term  Boulders Cobbles Coarse gravel Fine gravel Coarse sand Medium sand Fine sand	>300 75 to 300 19 to 75 4 75 to 19 2 0 to 4.75 0 425 to 2.0 0.075 to 0.425	Size (inches) >12 3 to 12 3/4 to 3 3/16 to 3/4 1/16 to 3/16 1/64 to 1/16 0.003 to 1/64	Percentage stand and stand	pes of gravel. If there may be comb a range of jets so below % <5 5-10 15-25 30-45
	SILTS liqui	AND CLAYS Inc. Inc. Inc. Inc. Inc. Inc. Inc. Inc.	n clays pane sitt rganic si rganic cl panic sitt	and cla te, miced ays of hig and cla	ys of low p cous or d ph plashor ys of mod	lasticity atomacin y, fat clay um to filg	ous fine sand or t		Sec. 201 1998	very herd	>60 >78 >8  Nonplastic Low Medium High	5 ** 140		dry to touch	Term West Moderale Strong	Sit / clay (firms) Field Test Crumbles or breaks w Crumbles or breaks w Will not crumble or bre	<0.075	<0.003	Depth to limit (time and da	50-100 it water also) for after drilling

	( Stantec						Client: GE - United Nuclear Corporation		SOIL	BORING	BOREHOLE No.:	_	
		Stai	ILI	ec		F	Project Number: 233001076		LO	G FORM	Sheet 3_of_		
	Drilling Com Drillers (day	pany: Cascade I / night): S. Lom,	Drilling A. Ro	g odriau	ez J.V	hau	Drilling Rig: CME 85 Truck Rig B eria Drilling Method: Hollow Stem Auger L	it Type: 4.25" I.D., 8" C ogged by: C. Fritz	D. Auger		Start Date: S. Finish Date:	ee Shee	+1_
	Field Repres	entative (day / n	ght):	1			Core Diameter.				Total Depth:		
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic		Remarks		Well Details
40 =		40' A	7			_	Clayey sand (SC) with gravel, moist	Artz brown					
	=		7				trace black weathered shale, few a	range	が表			2	
	-	40'B	6				weathered sandstone, medium dens	<b>ક</b> ્				2	
42 -	Ē								1/2				
44 -									<b>建筑经过海</b> 草			rated baraftan	
	- 170	45' A	7		S	M	Sand with silt (SM) and gravel, trav	ce shale, trac	e	CO = 72 ppn	n, HaS=01	Shu	
46 -	-	45'B	9				coal, brown & gray when orange, tro	ice Hacky	-			4	
							slightly moist to moist, medium du	vz6				1	
_												=	
48 -	=								-			, –	
	Ē											ā	
	=											Ē	
50 -	-	50' A	8	1	S	М	Sand with silt (SM), few gravel, me	ist dark	-	co = 105 ppn	n, LEL = 50	/o =	
	=		6			81	Sand with silt (SM), few gravel, me gray + brown, trace black + yellowlor to medium dense	range, loose		H2S = 0 PF	im		
		50'8	5				to medium dense					$\equiv$	
52 -	-								7,5			ş <u>-</u>	
	-											目	
	5								37			=	
54 -	Ξ.								3%			$\exists$	
<i>3</i> \	-									495=4.2 pp	n, co=500pp *Stopped u	m,	
	=			-			5-2 0 551		1	LEL=15%	*Stopped u	sork -	
<u></u>	=						EOB @ 55'		3			Ξ	
5b -	=											Ξ	
	2								4			Ξ	
									1			Ξ	
58 -									-			-	
	=								3			Ξ	
												=	
60 -	- GRAVELS	GRAVELS Well	-graded	gravels	i, gravel-sa	ind m	atures, liftle or no fines GW Slows/ft*	Term (SPD Blows III I I I I I I I I I I I I I I I I I	1	Term Size	(mm) Size (inches)	Percentages of	gravel.
	% 50% coars % fraction pass #4 sieve SANDS	Mth lette or no trees Pool SARVELS Sity SANDS West	gravels gy grav -graded	els, poorly- els, poor	graded graded gravely sa	gravo gravo inda,	Term   (SPT)   (modCAL)   And Antiques   (SPT)   (modCAL)   And Antiques   (SPT)   (modCAL)   And Antiques   (SPT)   (modCAL)	Term (SPT) (mod 14'ID 20'ID 25 rery loose 0-4 0-5 0-7 cose 4-10 5-12 7-1	a spues	Boulders >300 Cobbles 75 to	>12 300 3 to 12	Percentages of sand, and fines stated in terms indicating a rang percentages as	may be ge of below:
	<50% coarsi fraction passi #4 sleve	SANOS Sitty	ny-grad sands. ny sand	poorly-g is poorly	s, gravely reded san r-graded s	sandr d-grav and-g	Notice of no fines	nedium dense 10-30 12-37 18-5 Jense 30-50 37-60 51-6	RAIN	Fine gravel 4 751 Coarse sand 2 0 to Medium sand 0 425	o 19 3/16 to 3/4	Term Trace Few	% <5 5-10 15-25
		AND CLAYS Inci- I limit <50 loan	ganic el elays anic sitt	ays of lo	w to mediur ys of low pi	m plan	very hard >60 >78 >85 *:	= 140 pound hammer dropped 30 inc	thes (i)	Fine sand 0.075 Silt / clay (fines) <0.07	to 0.425 0.003 to 1/64 6 <0.003	Some S Mostly 5	15-25 30-45 50-100
		AND CLAYS inon	ganic sit ganic cli	ts, micso sys of his and cla	ph plasboly ys of medic	fat c	sports fine sand or sill MH (Note: Low Dry Says OH Will gladed a poorly sorted Low Medium Mississipped Med	Absence of moisture, dry to touch Demp, does not wel palm Visible Free Water	Weak C	Feld Test Crumbles or breaks with hendlin Crumbles or breaks with conside Mill not crumble or break with fir	walth Santananana	Depth to first water (time and date) Depth to water after (time and date)	- 1

	0	C.				Client: Gl	E - United Nucle	ar Corporation			SOIL	BORING	BOREHOLI	No.: P4-3	5
	Q	Star	nte	3C		Project Nu	mber: 233001076				LO	G FORM	Sheet\	of <b>\</b>	
	Drilling Com	oany: Cascade (	Orilling				Drilling Rig: CME			Bit Type: 4.25" I.D., 8"	O.D. Auger		Start I	Date: 4/14/18	8
	Drillers day Field Repres	/ night): S. Lom, entative (day / n	A, Ro	drigu	ez, J. Vigi	епа	Drilling Method: H Core Diameter:		21	Logged by: C, Fritz			Total D	Date: 4 [16]] Depth: 15 F1	8
0 =	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol			Des	scription		Graphic		Remark		Well Details
					54	Sand	iz altiw h	1+ (SM) an	d govel (u	peathered					3
						sands	stone + Sh	hale), gray	, slightly n	peathered poist to moist				3	
<b>a</b> -	F1 177.1													3	
Ч -										8					
6 -		51 Bag	50k	,,	SM	Same	e as abov	ne			7	î		ē.	
8 -															
10 -		10' A	30		SM	Sand	with little	th some	<\1+ (5M)						
		10, C	14				·			black, slightly		Bottom of	- A liner	haq	
13 =					115	Weis	ot, trace t	s few gra	ysand	7 • • • • • • • • •	1444	black cl	ay	-	
14 =									ii		77.7.7.	4 Pt down l LEL= 170/0	hole: H <sub>2</sub> 5: 0,00>500	: 6.5 ppm,	
16 -								EOB @	15'			*Stopped	. work d	ve to gas	
18 -															
<b>2</b> 0 -	GRAVELS SON coan fraction pass #4 sove SANDS	GRAVELS SHE SANDS WE	orly-grad ty gravels tycy grav eli-graded	ed grav i, poorly els. poor i sands.	ols, gravel-san graded grave rly-graded grave gravelly sands	matures, little or d mixtures, tittle sand-silt mixtur el-sand-clay m little or no line	or no fines rec situres	GW OP GM Very sol soft	2-4 2-4 2-4	1.4"ID 2.0"ID 2	0-7 S PE	Boulders > Cobbles 7.	300 >12 5 to 300 3 to 9 to 75 3/4 t	3 S berceunades	range of s as below
	450% coars Fraction pass Stance Sill TS liquit Sill TS	with kille or no (nes Person SANDS SANDS SANDS SANDS SANDS SANDS SANDS SANDS SANDS SAND CLAYS SAND	orly grad by sands, ayey sank organic si wganic cli in clays ganic silb organic silb organic silb organic silb	ed sand poorly g is, poorl talvery arys of lo s and cla is, mos ays of his s and cla	is, gravely sandined and graded sandine sands, sifty or to medium pays of low plast coous or dutor gh plasboly, fays of medium.	os, little or no fir avel-sit mixture gravel-clay mu- or clayey fine s- asticity, gravelly city naccous fine sa-	ngs is it.  tures ands, sits with slight plastic clays, sandy clays, sity cla nd or sit	SM SIGNOOD medium stiff very stiff hard very har	n sliff 4-8 4-8 4-8 8-15 9-17 9-18 ff 15-30 17-39 18-42 30-60 35-78 42-85	medium dense 10-30 12-37 10 dense 30-50 37-60 5 very dense >50 >60 30 30 30 30 30 30 30 30 30 30 30 30 30	8-51 Gravels 1-86 vels inches Velah Moderate	Fine gravel 4 Coarse sand 2 Medium sand 0 Fine sand 0	75 to 19 3/16 0 to 4.75 1/16 425 to 2 0 1/64 075 to 0 425 0 00 0 075 0 0 00 0 075 0 0 00 nding or singht ringer pressur	to 3/4 to 3/16 Trace Few Little Some 203 Depth to fall w. Sharing	

Ī	Stantec					7	Dient: GE - United Nuclear Corporation		SOIL	BORING	BOREHOLE No.: PL	1-5
	Q	Star	TE	<b>5</b> C	_	P	Project Number: 233001076			G FORM	Sheet of	Charles
		oany: Cascade [ night): S. Lom,			ez J.	Viau		it Type: 4.25" I.D., 8" O ogged by: C. Fritz	D. Auger		Start Date: 4/	16118
		entative (day / n			_		Core Diameter: N   A				Total Depth: 21	·5 f4
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic		Remarks	Well Details
0	=				_	5M	Sand with silt (SM), trace shade pie	ces brown	14.			=
							Sand with silt (SM), trace shade pie w/some green + purple, medium den	se (light)	1.7			3
							to dense		1.0			=
2									4.7			
									]			3
ц -							ما مد ایا ایا در ا		ىدارىيىدىسالىيىدىيىدان ئۇيغىدىكارگىيىدىدان	Analytical	samole From	umulmin.
	=	51 Bog	19			SM	Same as above slightly moist			A, B, & C	sample from liners (bulk)	3
6 -	_	5 1506	21						1,5	,-,-	•	-
	-		0-1						1.33			3
	-								11.			=
_									3.5			=
8 -	=								1.:			$\exists$
									1.			∄
	3											=
۱0 -								1	-			<u>-</u>
10		10'A	3			SM	Same material, but loose, moist, bro green, trace growel	wn wisome				3
		10'B	4				green, trace gravel					=
		10 6	5						33.			3
19 =									1.7			4
									1,			3
	-								10			7
									1.			3
14 =	_						· ·		3.7			$\exists$
	=							. (.	1.7	70 W	n 9 <b>m</b> 25:	=
	=		5	1		SM	Same as above. Black shale + organ	ites in tip	7.	Analytical	l sample from Uners (bulk) Vo (no other rea	3
16-	=	15' Bog	5				of sampler		34	A,B,7 C	liners (bulk)	لتحديد
10 -	_	,	2	1			,		1	LEL = 3°	% Ino other rea	south
	E								3.3			=
	Ē								100			3
18 -	=								10.1			$\exists$
												4
*)	=								1.1			
_	Ē								10.			3
<i>ao</i> =	GRAVEL:	and the or no tree Po	only-grad	sed gra	vols, grav	el-sand	Instruces, title or no fines GW   Term (5P7)   Blows/R* (modCAL)   Term (4P7)   2-010   2-510	Term (SPT) (mod 1.4*ID 20*ID 25*	510 S		ze (mm) Size (inches)	Percentages of gravel, sand, and fines may be stated in terms
	ST SANDS	GRAVELS 56 attachtis lines Cli SANDS We	ey gravel ayey gra eli-grade	rels, poorly disande	r-graded only-grade L gravely	gravet- di grav sands	SW   SW   SW   SW   SW   SW   SW   SW	very loose 0-4 0-5 0- loose 4-10 5-12 7-1	7 DET	Cobbles 75 Coarse gravel 15	to 300 3 to 12 to 75 3/4 to 3	recentages as below
	<50% coan fraction pass #4 sieve	SANDS SE	ty sands avey san	poorly- ds. poor	graded a ly-graded	and-gra	medium stiff 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8	medium dense 10-30 12-37 18- dense 30-50 37-60 51- very dense >50 >60 >8	OC 15 1 IE	Fine gravel 4. Coarse sand 2. Medium sand 0.	0 to 4.75 1/16 to 3/16 425 to 2.0 1/64 to 1/16	Term % Trace <5 Few 5-10 Little 15-25
		AND CLAYS Inc. d limit <50	trganic c sn clays ganic sit	lays of h	ays of lov	frum plu piastic	very hard >60 >78 >85	= 140 pound hammer dropped 30 m	ches	Fine sand 0	075 <0.003	Some 30-45 Mostly 50-100
	liqu	d limit >50	ganic sit	lays of t	ays of mo	city, fat raium to	account fine sand or sit MH   Note: City's CH   Well-graded * poetly sortes Dry   Doorly graded * mell sortes Negligible   Dry   Dry   Modelum   Dry   Modelum	Absence of moisture, dry to louch Damp, does not well palm Visible Free Water	Vvosk Moderale	Crumbies or broaks with had Crumbies or broaks with cor Will not crumble or break with		reth to first water me and cale) upth to water after drilling
	HIGHLY OR	GANIC SOILS PO	at hums	is, swan	np soils w	ith high	organic content PT 로 High 호 Wel	Visible Free Water	B Strong	Will not crumble or break wil	h finger pressure	me and date)

	Stantec						Client: GE			ar Corpo	ration							L BORING	- 1	EHOLE No.:		,
Dril	lling Com	pany: Cascade I				P	Project Nur			85 Truck F	Ria		T <sub>E</sub>	Bit Type:	4.25"1.0	D., 8" O.D		G FORM		Start Date:		et
Dri	llers (day	/ night): S. Lom, sentative (day / n	A. R	odrigu	iez, J.	Vigue	eria	Drilling I	Method: Fiameter.	follow Ster	n Auger		i	ogged b	y: C. Fri	itz				Finish Date: Total Depth:		
i ie	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol		OGIC EN	arreter.	NIA	Descr	iption	!-				Graphic			marks		
-		30'A	4		1	- 1	Same	2 05	above	2 . also	, wit	h som	<u>د</u> ۵۸	arae	State	nina	11.	41 down	hole:	HaS = 6	1.2 ppm	-
			4				,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	•		- ) -030	,	., 59-11		79-	010(1	ر		IEL-	0%	0 > 50	nan C	=
		30,B	6															LEL=	ed wo	ck	· (T	$\exists$
										EOB	@ 6	71.51					1					=
-											<b>( 0</b>						7					=
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2004	GRAVELS <50% coarsi fraction passi	e with little or no times   Po	orly-grad	dad, dean	reis, grave	el-sand t	nistures, little or o mixtures, little o	or no finos		GW GP	Term	(SPT) Blows/ft*	modCALI 25 ID	Term	[SP])	(modCAL)	(Sa	Term Boulders	Size (mm) >300	Size (inches) >12	Percentages sand, and fin	nes ines
Taure F.3	#4 sieve SANDS <50% coarse	SANDS We	yey grader	vels, poor di sands.	graveity	d grave sands, i	sand-sill mexture el-sand-clay mix little er no fines is, little er no fine	dures		STENCY C Cleyal	very soft soft	0-2 0-2 2-4 2-4	0-2 2-4	very laose loose	0-4 4-10 5	0-5 0-7 5-12 7-18	DE	Cobbles Coarse gravel	75 to 300 19 to 75 4,75 to 19	3 to 12 3/4 to 3 3/16 to 3/4	indicating a r	CON
	fraction passes #4 sieve									SM SISN	medium stiff stiff	8-15 9-17 15-30 17-39	9-18	dвпье	30-50 3	2-37 18-51 7-80 51- <b>8</b> 6	CLA.	Fine grevel Coarse sand Medium sand	2 0 to 4 75 0 425 to 2 0	1/16 to 3/16 1/84 to 1/16	Trace Few	
-405 A	100000000	line	rganic s	ms very-t	ine sands	s, suity or	x clayey fine sar	nds, sits wit	th slight prastic	ML OG	1019 50111		10-42	very dense	>50 >	>60 >86	12	FI-	0.040		봉 Little	
MAY COO seve - 10%	SILTS /	d liffik 450	panic sift	ta and cla	ays of low	plastici	gravel-clay mixto or clayey fine san asticity, gravely o ity account fine sans		in slight prastici y clays, sitty cla	0.00	ABLA USTO	30-60 39-70 >60 >78 Nonplastic Low Medium High	42-85 >85	* 140 pound		>60 >86	2	Fine sand Sit / clay (fines)	0.075 to 0.425 <0.075	0 003 to 1/64 <0.003	Depth to first w	1 3 5 water

	0	Star	sto			Client: GE - United Nuclear Corporation	SOIL	BORING	BOREHOLE No.: P	4-6	
	V	Star	116	: C		Project Number: 233001076			G FORM	Sheet of	<u> </u>
		oany: Cascade E rnight): S. Lom,		frigue	2   \/m		Bit Type: 4,25" I.D., 8" ( Logged by: C. Fritz	D.D. Auger		Start Date: 4 Finish Date: 4	116/18
		entative (day / ni		inguc	c, u. vig	Core Diameter. N/A				Total Depth: 1	1.5 #
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Description		Graphic		Remarks	Well Details
9 - O -		ů,			SM	Sandy silt to silty sand, loose, slight brown light gray	ly moist, ligh				
ц -		5¹ A	3		SM	Silty sand (SM), with weathered san loose, slightly moist, light brown	dstone dwnk	s)	co=20pf	om, H <sub>a</sub> S=O, LE	L=0
6 -		S'B	14			Cuttings turned derta gray I block @ 7					majam
8 -											
10 =		10, B	7 27 14		M	Sandy silt (ML), few to little highly shale, moist, brown & dork gray wlord trace salts	weathered nge staining,	11111	H2S=J.8pp LEL=18% of auger)	om, CO>500 Gust Inside to	PPM =
\3 -						EOB @ 11.5'		بمثل بمحميل ميميدال ميميدات محيلات بمع	* Driller smell of -> stop	neted sudden HaS sped work	يباييينييين ايتينيين بايتين
	SITA PILOT III III III III III III III III III I	GRAVELS Gith SANDS	inty-grades, y gravets, yesy graves in graded inty-grades y sands, p yesy sands game sitts	d gravel poorly-gr b, poorly santas, g d santa confly-gra poorly- sivery-fin ye of low and cray t, riveace ye of high and cray	aded gravel-sa- graded gravely sand gravely sand gravely sand gravely sand ded sand-graded san e sands, sin to modum to a of low plas ous or dato s of modum to modum	maccous fine sand or sid MH Note	Term (SPT) Blows/IT: (moc/moc/moc/moc/moc/moc/moc/moc/moc/moc/	DENSITY  DENSITY  OCHUS  Term  Weak  Moderale	Bouters   30   Cobbles   75   Coarse gravel   19 1   Fine gravel   4 75   Coarse sand   2 0   Medium sand   0 47	0 300 3 to 12 0 75 34 to 3 15 to 19 34 to 3 16 to 34 to 4 75 1/16 to 34 to 4 75 1/16 to 34 to 4 75 to 10 4 25 to 20 1 178 to 11/16 to 11/1	Percentages of gravities and state of the st

	C	Star	nte	ec.			E - United Nuclea	r Corporation				BORING G FORM	BOREHOLE No.	P4-7	
	Drillers day	pany: Cascade night): S. Lom,	A. Roo	frigue	z, J. V		Drilling Rig: CME 8 Drilling Method: Ho	llow Stem Auge		Bit Type: 4.25" I.D., 8" Logged by: C. Fritz	O.D. Auger		Finish Date	4/15/18	8
	Field Repres	Sample Number Sample Number		Recovery (in.)	qu (tsf)		Core Diameter:		cription		Graphic		Total Depth	: <u>30 ft</u>	Well Details
о - а - ч -				↑	S	Brother	sand topsoi en + weath , brown + p	il, brown hered san gray wloo	, slightly m dstone w range iron	wist, few clay lisit (SM), few staining					
6 -		51 A 51 B	12 6 15	*		Same	as above			g.				= = = = = = = = = = = = = = = = = = =	
8 -				46			" groy weat	hered sand	nstone						
10 -		/0'A	а 0 2	*			e brown sav	nd				Poor samy	ple recovery		
10 =				     		->tra	ce brown so	and							
16 -		\5'B	1 2 4	*	Si	Modes little			weathered ck shale, eas loose	sandatone wi gray witrace + sandy, o the	3	Has = 0 pp LEL = 4 9 Poor CA :	om , (0 = 40 6 Sample (Peco)	ppm	designation of the state of the
18 -				45											
ao -	SILTS /	and the second s	and state of the s	grave poorly- iii. poorly sands. s sands oorly-gr poorly ivery fe is of lor and clay and clay and clay	is gravel-s raded gra y-graded; y-gravely sa , gravely sa dos sarx graded sarx graded sa e sards s r to medium s of low pil cous or do h placeory s of medium	plasticity, gravely story ismaceous fine sa	or no fines es studies b h h h h h h h h h h h h h h h h h h	GW GP OM Term GG GS SW JS GS Soft Soft Soft Soft Soft Soft Soft Sof	1410 2 010 25 02 02 02 24 2-4 2-4 stiff 4-8 4-8 4-8 6-15 9-17 9-1 15-30 17-39 18- 30-60 39-78 42-1 >60 >78 >8	very loose 0-4 0-5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	DENSITY DENSITY 1-86 8-51 1-86 mathes Term Moderate	Bouders 75 Cobbles 75 Coarse gravel 19 Fine gravel 4. Coarse sand 2.0 Medium sand 0.4 Fine sand 0.0	siderable finger prossure.	bano, and trees indeed in terms indeeding a ran percentages at  Term Trace Few Little Some	% <5 5-10 15-25 30-45 50-100

	Stantec  Drilling Company: Cascade Drilling					Client: GE - United Nuclear C	Corporation			L BORING G FORM	BOREHOLE No.:		
	Drillers (day	/ night): S. Lom,	, A. Ro	drigue:	z, J. Vig	Drilling Rig: CME 85 To Junia Drilling Method: Hollow	w Stern Auger	Bit Type: 4.25" i.D., 8" C Logged by: C. Fritz	D.D. Auger		Finish Date:	See Sheet 1	
20	Field Repres	sentative (day / r Samble Number		Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Core Diameter: Ч.2	Description		Graphic		Total Depth:	Well Details	
30 -		30,8 30,4	6 8 17	1	5M	Same as above						3	
92 -				45								ata a ta	
24 -				¥								afaan	
26 -		92, B	15 21 11		SIA.	Same as above						and Lance	
28 -				52					1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	Has = 4.2 p LEL = 10% 10'down h	pm (outside au 5, CO > 500 p ole: H <sub>3</sub> 5 = 5:3 76, CO > 500	ger) pm 3.ppm	
30 -				1		E	OB @ 30'		1::	* Stopper		APA =	
39 -													
3H =						¥7			يسياسينيان				
36 -									يتطينيهان				
38 -		E							and some prince			uthumin	
40 -	GRAVELS  50% coars fraction pass #4 sieve  SANOS  50% coars fraction pass #4 sieve  SILTS A  Ilqui	B SANDS WAS SANDS CANDOLLAYS AND CLAYS  AND CLAYS  MINISTER OF THE PROPERTY OF	ony-grader by gravets, by by grave ory-graded ony-graded by sands, p syby sands organic sits organic clays in clays	d gravets poorly-gra is, poorly- sands, gr o' sands, corry-grad poorly-grad poorly-grad poorly-grad poorly-grad poorly-grad	gravel-sam died gravel graded gra- avely sands gravely sand- sed sand-gravel sand- sands say o medium pr	extures, little or no fines GW mixtures, little or no fines GP sand-sid mixtures GM retarnat-clay mixtures GG, little or no fines SW little or no fines SW little or no fines SW gravef-clay mixtures GG, crops fine sands, allo with slight placetor, Mixtures sands, gravefy clays, sandy clays, sidy clays, ct.	very soft 0-2 0-2 oft 2-4 2-4 readium stiff 8-15 9-17 very shiff 15-30 17-39 hard 30-60 39-78 very shiff 8-15 0-17 oft 30-78 o	>85 * 140 pound hammer dropped 30 mg	7 18 25 OENSITY OENSITY OF SERVICE STATE	Boulders   >3   Cobbles   75   Coarse gravel   19   Fine gravel   4.7   Coarse send   2.0   Medium sand   0.4   Fine sand   0.0	ze (mm) Size (inches) 00 >12 10 300 31 to 12 10 75 3/4 to 3 75 to 19 3/16 to 3/4 176 to 3/4 176 to 3/4 1775 to 0 4/25 0 003 10 1/64 0/75 0 0 003	Percentages of gravel, and gravel	
	l)qui	AND CLAYS ind	rganic sitts organic clay partic sitts	s of high and clays	plasticity, fat of medium t	account fine sand or sitt. MH Citys Gays. GH ingh plaspoity GH organic content PT	Nonplaste Weil-graded = poorly sorted Poorly-graded = well sorted Medium	Professional Profe	Moderale	Field Test Crumbles or breaks with tace Crumbles or breaks with com- Will not crumble or break with		Depth to first water (firme and date)  Depth to water after drilling time and date)	

	Q	Star	nte	ec		Client: GE - United Nuclear Corporation Project Number: 233001076		BORING BOREHOLE No.: P4 - 8  G FORM Sheet 1 of 1
	Drillers day	pany: Cascade [ / night): S. Lom, entative (day / n	A. Ro	drigu	ez, J. Viç	Drilling Rig: CME 85 Truck Rig Bit Type: 4,25" I.D., 8" Countries Drilling Method: Hollow Stem Auger Logged by: C. Fritz Core Diameter: N A	),D. Auger	Start Date: 4   15   18   Finish Date: 4   15   18   Total Depth: 20 ff
ě	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Description	Graphic	Remarks Remarks
0 -	_ O	σ	В	ж	SC	. Clayey sand (SC) whilt & weathered shale,		>
	=					Clayey sand (SC) whilt & weathered shale, brown + dorte gray/black, trace iron staining, slightly moist	4.13.13	3
٦ -								
Ч -						Same as above, medium dense	FRO STANDARDE	
6 -		51A 51B	13		20	Jame as above, medicin overse		
8 -		5'C	14				11.71.71	
_							441.14	
(0 -		10, B	7 8 9		SM	Silty sand (SM) when to little day + trace gravel (weathered sandstone pieces), black + gray, medium dense	1.28.00.00	
(S -							100000000000000000000000000000000000000	
14 -							1	4
\७ -		15' A 15' B	566		SM	Same as above, black whome gray & orange	1.5.	
/8 -							1	
								LEL=99%, CD>500ppm H <sub>3</sub> S=60ppm (top of hole) *Stupped work
90-	GRAVELS 450% coarse fraction passe 50 SANDS 50 Faction passe 64 sieve	GRAVELS Sin with the Color SANDS We with title or no fines. For SANDS. Sin with 10 c and 10 c	orly-grade y gravels yey graw il-graded orly-grade y sands, yey sand rganic sil	poorly- els poorly- els poorl sands od sand poorly-g s poorly-	ora gravel-sa graded gravity-graded gr gravely same s, gravely same aded sand- graded same ne sands same	EOB	ALISNAG ALISNA	Term
	SILTS /	AND CLAYS Inc. I limit >50	n clays panic sills rganic sill rganic cla panic sits	and cla is, micar tys of his and cla	ys of low plan eous or dust phiplasticity, t ys of medium	very hard >60 >78 >85 ** 140 pound harmony dropped 30 in Very hard of six	Term Fr	Silt clay (fines) <0.075 <0.003 Softe Soft Soft Soft Soft Soft Soft Soft Soft

1	Drillers (day	pany: Cascade E y night): S. Lom, entative (day / ni language lang	A. Ro ight):				umber: 233001076 Drilling Rig: CME 85	Truck Rig		Bit Type: 4.25" I.D., 8" (		G FORM	100000	or <u>2</u> 4[15][8	
	Drillers (day Field Repres	y night): S. Lom, entative (day / ni	A. Ro ight):			gueria	Partition and add a state of the High			Dit 1 100. 1.20 1.0., 0 0	J.D. / lugui		Oldit Date	-1112110	
							Core Diameter. N	ow Stem Auger		Logged by: C. Fritz			Finish Date	40 f	
0		(0)	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)		Core Distriction	Descript	ion		Graphic		Remarks		Well Details
1	-				SA		sand (SM) (	topsoil), tro	uce grow	el + shale	į.į.			-	
						plea	es, light brow	wn within	gray, sl	el + shale ightly moist					
а											10 10 10 10 10 10 10 10 10 10 10 10 10 1			, <u> </u>	
4							e as above	لد مسئلمس	۵، <i>۱</i> ∕∕۵		1	V0C= - 35	лл- HaS-г	, -	
6	-	5'A 5'B	716		5)	Moc	e as above	) MESICOLL S				co = 0 ,	ppm ,HaS=C LEL=O		
8												×		- Francisco	
10		10'A	14		S	l Sam	e as above,	little sands	lone		7	Auger cutt	tngs conto rounded, a "diameter	in Nursal	
12			11									10005 (1-1	MALINETE	, [	
14															
16		151 Bag	91242		Si	1 Sam	e an above,	w/sandston	ie chunte	ৰ্ণ		Bulk sam liners (ac liners the analytica	ple from a cidentally on tring it wo I sample	4+B cmptied= as =	
/8												, y		attent from	
90-	SILTS	GRAVELS GRAVEL	ony-grad- y gravels yey grav- il-graded only-grad- y sands, yey sands reganic sit- reganic sit- n clays ganic sit- reganic cli- reganic cli-	od grav  poorly  sands  od sand  poorly  sands  poorly  sands  poorly  sands  aps  of sand   els, gravel- graded: gra ify-graded: gravelly sa is, gravelly sa is, gravelly sa y-graded: sa ine sands, s w to modun y-graded sa ine sands, s w to modun	ret-sand-slit mar revel-sand-clay ds. little or no fil- ands, little or no gravel-six rext, nd-gravel-slay m by or clayey fine plasticity, grave shorty emacoous fine in	e or no fines ures matures es fines intures in	Very stiff 15 hard 30 very hard >6	10 20 ID 25 ID 2 0-2 0-2 4 2-4 2-4 8 4-8 4-8 15 9-17 9-18 30 17-30 18-42 -60 39-78 42-85	Very loose	DENSITY  18 and Graves)  18 and Graves)  18 and Graves)  18 and Graves)	Boulders 75 Cobbles 75 Coarse gravel 19 Fine gravel 4, Coarse sand 2,0 Medium sand 0,0 Fine sand 0,0 Sit / tay (fines) <0 Fletd Test	Le (mm) Size (inchi 00 >12 10 10 300 31 61 2 10 75 34/10 3 176 10 34/10 3 176 10 44/75 17/16 10 3/16 1775 10 0.425 0.003 10 1/ 075 0.003 10 1/ 075 10 0.003 10 1/ 075	Term Trace Few Little Some	% <5 5-10 15-25 30-45 50-100	

	C	Star	nte	ec			Client: GE - United Nuclear Corporation			BORING	BOREHOLE N	10: P4-9	
	Drilling Com	pany: Cascade D	Orilling			-	Project Number: 233001076  Drilling Rig: CME 85 Truck Rig	Bit Type: 4,25" I.D., 8" O.D.		G FORM	Start Date	e: See Shee	v+ 1
	Drillers (day Field Repres	/ night): S. Lom, entative (day / ni	A. Ro	odrigu	ez, J.		Prila Drilling Method: Hollow Stem Auger Core Diameter: N A	Logged by: C. Fritz			Finish Da Total Dep		
30 =	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic	11	Remarks		Well Details
:		20'Bag	665			SM	Same as above, loose to medium de	w26		Analytica A,B,E W	i sample ners	from	
əə - ə4 -									100 mm 10			2 2 2 3 3 4 3	
Ə6 -		95' A	14 21 14			ML	Sandy silt (ML) w/sandstone duntes shale pieces, brown & gray w/white orange exidation	salts and some		Bliner≈s	andstone	2 2 2 3 3 3 3 3 3 3	
30 -										1. d. 1. d. 1.	-cauala		
32 -		30' Bag	13			ML	Same as above, dense	-		Analytral A,B line	sample of	-	
34 =								-			č	1	
36-		35'A 35'8	15 50/	5		ML	Soundy sitt (ML) with clay & grovel black white salts, very dense (conform hitting rock)	, brown and old just be	11111111	Samples g water peur ofter stop	ot souted ed down pping de	hole to gas	
<i>3</i> 8 -								<u>2</u> 3 8		Drillers no smell Has=18.3	ppm, LE	_ L=47%_	
40-	SILTS AND SILTS	with table or colones, Pro- Se GRAVPLS Shift such 3-5% Lean Sanota Sanot	only-grad y gravelil y gravelil you gravel j-gradec only-grad y sames yey sam toganic si toganic si to clays anac sim granic si toganic si	led grave  poorly- less poor  sande, led sande, led sand  poorly- gde poorh  tavery- flays of less  and cla  its mice- lays of his  and cla  s and cla	els. grave graded- h-grade gravelly s. grave rated s - graded ne sand w to med ys of lov cours or gh plass ys of me	gravol-sand gravol-sands, dy sands, dy sand- and-gra sand	accountine sand or set MH. Note:	dense 30-50 37-60 51-86 very dense >50 >60 >86 *= 140 pound hammer despect 30 inches	eak (	Cobbles 75 Coarse gravel 19 Fine gravel 47 Coarse sand 20 Medium sand 04	t (mm) Size (inc 0 310 310 12 0 75 3/4 (o 3 3/16 (o 3 16 19 3/16 (o 3 15 10 2 0 1/6 (o 3 15 10 2 0 1/6 (o 3 175 10 0 425 0 0031 (o 1 1775 0 0 003 ling or sight inger pressure.	Percentages of sand, and fine and sand sand sand sand sand sand sand	% <5 5-10 15-25 30-45 50-100

ĺ	0	Star	ato	26		Client: G	E - United N	Nudear C	orporation						BORING	BORE	HOLE No.:	TN-	1
	(	200				Project Nu	mber: 23300				- 1-				G FORM	Sheet		1	1.15
	Drillers (day	npany: Cascade I // night): S. Lom,	A. Ro	drigue	z, J. Viç	gueria		nod: Hollow	ソラッ v Stern Auge			it Type: 4.: ogged by:	25" I.D., 8" ( C. Fritz	D. Auger		F	Start Date: inish Date:	4/1	118
	Field Repré	sentitive (day / ni	ight):	ery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol		Core Diame	eter. 🕦	Des	cription				Graphic	ė.		otal Depth	1.21	Well Details
0 =	_		П			tire	y sa	vvA,	mech	Who	Clen	50,5	Slian	+(a. 'x					
) -	- - - -					MO	( , + Zi	ng'n	10 7.	OWN		, , ,	, , ,					Ξ	
-	-																		
4-		47												7					near Linear
9 =	-	5' A 5' B	10/8/21		54	45CLV	ne (	213 (	*VOOV	Č									
8 -										- 4								÷	
10-		10'A 10'B	10119		<1	1	Fill	Sava	177 6	n: (<					Hore	й <.	(Cilly)		
12=			), <u>S</u>		0.0	resi	tive : prove stano jutili	0 5 ce ;	much mare arke	ured Car	0000	ptur ates vi (i	i NCreci	Service Services	.01010		orrej		
14 -														4				=	Dr coa Do
10=		15'A	+11+		21	1211	ty so	und wit	, carr	Sam Sam	ed, in	ntac ,s	t por	0 1				-	
18-								EL	1B (Q)	101	၁'			استاستنان				-	
20-	SILTS	AND CLAYS individual control of the	certy grade by gravets, by ay gravet will grades only grade by sands, in ayey sand organic site on clays game site organic site organic site organic clays organic clays organic clays organic clays	of grave poorly-grass, points, sands, go of sands, so poorly-grass, poorly-grass, poorly-grass, so poorly-grass, so poorly-gr	s, gravelsa raded grav -gravelly san gravelly san gravelly san gravelly san gravelly san e sands, sit to medium s of low plan outs or dath in planticity, it is of medium	sticity greaceous fine sa	or no fines with with s s s s s s s s s s s s s s s s s s s		very soft soft medium stilf very stilf hard	9-2 0-2 2-4 2-4 stiff 4-8 4-8 8-15 9-17 15-30 17-39 30-60 39-76	2-4 4-8 9-18 9-18-42 3-42-85 8-85	very loose loose medium dense dense very dense		77 DE 1517 N V C C C C C C C C C C C C C C C C C C	Boulders > Cobbles 7: Coarse gravel 1' Fine gravel 4 Coarse sand 2 Medium sand 0 Fine sand 0	isiderable finge	r pressure	Personage stand, and in stated in the state in the	% <5 5-10 15-25 30-45 50-100 water

	a	Star	)to			Client	: GE - Unite	ed Nudea	r Corpora	ation						BORING		HOLE No,:		- 2
	0					Project	Number. 23		0 1 1 5	- (1)		l'au a				G FORM	Sheet		2	1.0
	Drillers (day)	nany: Cascade E (night): S. Lom,	A. Rod	Ingue	z, J. \	Vigueria		Method: Ho		Auger			ype: 4.25" ged by: C.		D. Auger		F	tart Date: inish Date:	4/1	11X
	Pield Repres	entitive (day / nig Samble Namber Samble Namber		Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Core Dia	ameter:	4.15	Descript	ion				Graphic			otal Depth	31.5	Well Details
2 -			g	↑   9   — — — — — — — — — — — — — — — — — — —		20	oose was orse	10 N	vrecii Vivi	llyvi gint	ctevi	15E	siir Sii	y Giviti	10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					alterateralisation
\(\text{9} - \\ \text{8} - \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		5 A 5 も	599		20 8	iM Se	ame	as	CNA	200					A Section of the Section Secti	partic Fcose	illy			olomanandomo
10-		10' B	200	\ \ \	-	iM.	→TYC Clv	nen	(Elv) Itáfil	oona on (	res Still	ivi we	Crea	asca 1		9				
12-			2	96																for an order
10 =		15'A 15'B	588	<b>√</b>	4	5( P	Clynux rece!	CLS S	(1,00.	VČ , }	Taca	C Q0	evols	tone						unauluan
18 -			,	9			> trai	ice.	to 1	Feir	. C.I	Clu	da	ر. د. د-ک\ <sup>س</sup> ې						Tarra learer
20-	SILTS A	GRAVELS  SANDS  SANDS  SANDS  SANDS  GRAVELS  GR	orly-graded y gravers, yey gravers orly-graded y sands, p yey sands riganic sitts orlys panic sitts or riganic sitts or riganic sitts.	I grave posity s poor sands I sand cony g poorl very l s of lov and cia micac a of he	int, grave graded of ty-graded gravelly a graded saced sa graded he saced v to med ys of low secus or an plastic	is and metirus. If and medium provides and section of the control	title or no fines  a. title or no fines masters clay mentures or fines minutures or fines minutures by minutures by minutures fine sends, sitts will reverly clays, sandy	ace	P F Shill and Chara	Term (SP 1.47) very soft 0 soft 2 medium stiff 4 stiff 15 hard 30	Blows/R* 77 201D 201D 20 2 0-0 4 2 4 2 4 8 8 4-8 15 9-17 9 300 17-39 11 600 39-78 8	5/1D Te 5/1D 0-2 vary 2-4 loos 4-8 med 4-18 dens 4-2 vary 8-42 vary	(SPT) 1.41D rloose 0-4 loo 4-10 lium dense 10-3 se 30-5 dense >50	Biows # (mode) 2010 25 1 0-5 0-7 2 5-12 7-16 0 12-37 18-5 0 37-80 51-9 0 >60 >66	Stands and Gravety	Boulders Cobbles Coarse gravel Fine gravel Coarse sand Medium sand Fine sand Sir Clay Cool	Nize (mm) 300 9 to 75 175 to 19 20 to 4 75 0 425 to 2 0 1075 to 0 425 10 0075	Size (inches) >12 3 lo 12 3/4 lo 3 3/16 to 3/4 1/16 to 3/16 1/64 lo 1/16 0 003 to 1/64 <0 003	Term Trace Faw Limie Same Mostly	% <5 5-10 15-25 30-45 50-100
	E 21	One One	sanic silts.s	and clar	vs of mor	from to high pla th high organic	shorty content		OH POOPS	sond = wer sonnel	Medium High	Moist Dar Wet Visi	mp, does not wet ble Free Water	dry to touch paim	Moderate Strong	Crumbles of treeks with to Will not crumble or break v	ora derapia finge nth finger pressu	re spessore	Depth to we give and d	elor after drilling lete)

BOREHOLE No.: TW-2 Client: GE - United Nuclear Corporation **SOIL BORING Stantec** Sheet 2 of 2 Project Number: 233001076 LOG FORM Drilling Company: Cascade Drilling Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria Start Date: SEE Shee4 \
Finish Date: Bit Type: 4,25" I.D., 8" O.D. Auger Logged by: C. Fritz Total Depth: Field Representitive (day / night): Lithology / Symbol Sample Number Recovery (in.) Details Blow Count Description Remarks q<sub>u</sub> (tsf) Well 20'A m same as above 2013 3 > Few sandsfore chungs THI Notive sirry sand, trace 25 A Carsonates, greater comentation 156 20 + angularity 28 40 Same as above trace clay 30'A & organics (noots) 32 >300 75 to 300 19 to 75 4 75 to 19 2 0 to 4 75 0 425 to 2 0 0 075 to 0 425 very loose 0-4 0-5 0-7 100se 4-10 5-12 7-18 medum deme 10-30 12-37 16-51 danse 30-50 37-60 51-86 very dense >50 >60 >86 SILTS AND CLAYS SILTS AND CLAYS liquid limit >50

Ì	0	Ctor	2±2	_	(	Client: GE - United Nuclear Corporation		SOIL BORING	BOREHOLE No.: TO - 1
	Q	Star		<u></u>	F	Project Number: 233001076		LOG FORM	Sheet of
	Drilling Comp	oany: Cascade I night): S. Lom,	Orilling A. Rodr	iguez	, J. Vigu	ieria Drilling Method: Hollow Stem Auger L	Bit Type: 4.25" I.D., 8" ( .ogged by: C. Fritz	D.D. Auger	Start Date: 3   30   18 Finish Date: 3   30   18
		entative (day / n			_	Core Diameter: N/A			Total Depth: 7\.5F1
		Sample Number	Count	recovery (iii.)	qu (tst) Lithology / Symbol	Description		U	Remarks 🗒
	Depth	ample	Blow C		q <sub>u</sub> (tst) Litholog			Graphic	Remarks Well Details
0 -	ă	Sa	<u> </u>	2 (	공 별	C I still till de la Casalle sal	, Cl. L.) (	ı) <u>-</u>	3
					ML	Sandy sitt wllitle shale (weathered slightly moist, medium dense, light darker gray shale	4 +(a(a)),(A	٦٢),	
	- -					slightly moist, medium dense, light	promu,	<del>1</del> -	=
	=					darker gray shale		<b>₹</b> =	3
<b>3</b> -								扫	-
	3							77	2
									=
ц -									3
`								<b>H</b>	3
	-		17		ML	Same as above		1-4	
	7	5'A	16						3
6 -	=	2,B	16					17	
								=	3
								7-4	
<b>g</b> -	-								
	-					÷		121	3
	=							扫	
	-							3	=
10 -	7	10'A	14		ML	Same as above		<u> </u>	
	31.63		16			James day disaster		<u> </u>	<u> </u>
		10'B	30					巨	
12-								==	-
								=	3
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								· [=	=
14-								扫	
								=	=
	Ē	15'A	8		WL	Same as above		扫	
16=		15'B	10					<u>-</u>	
10			16	-				扫	
								亖	
10								1	
18 -	Ē							1-	
									=
								==	=
<b>20</b> -	GRAVELS	worlde or notines Po	oll-graded g only-graded	gravets. g	ravel-sand m gravel-sand	Term   Service   Term   Term   Service   Term   T	Term (SP7) (May 14'10' 2 0'10' 2	Cio 190	Bize (mm) Size (inphes) Percentages of gravet
	#4 sieve	GRAVELS CIE	ty gravols, po systy gravols oli-graded so	poorly-gra poorly-grands, gra	ided gravel- graded grav avely sands	vel saind city motules GC ON very soft 0-2 0-2 0-2 soft 2-4 2-4 2-4	very loose 0-4 0-5 0 loose 4-10 5-12 7-	D-7 Cobbles Coarse gravel	75 to 300 3 to 12 indeeding a range of percentages as below.
	<50% coarse fraction passe #4 sleve	SANDS SANDS CIT	ty sands, por ayey sands, p organic sitts/	orly-grad coorly-gr ery-fine	sed sand-gra redod sand- sands, sity of	street in the st	medium dense 10-30 12-37 18 dense 30-50 37-60 51 very dense >50 >60 >	S51 Coarse sand Coarse sand Medium sand	4 75 to 19 3/16 to 3/4 2 0 to 4/75 1/16 to 3/16 0 425 to 2 0 1/64 to 1/16 0 075 to 0 425 0 0 003 to 1/64 0 075 to 0 425 0 003 to 1/64 0 075 to 0 425 0 003 to 1/64
	figul	AND CLAYS inc d limit <50 kea On	organic clays in clays panic sits ar	of low to	e medium pla of low plastic	very hard >60 >78 >85	= 140 pound hammer dropped 30 is	Fine sand Silt / clay (fines)	<0.075 <0.003 Mostly 50-100  Depth to first water
		d limit >50	organic clays ganic sitts ar	of high d clays	of medium to	cety OS.  Manuscoux tine sans or sill MM Note; Note of the sans or sill Nonplastic Vietname Sans or sill Note of the sans	Absence of moisture, dry to touch Damp, does not wet palm Visible Free Water		onsiderable finger pressure Depth to water after drilling

	0	Star	nt e	٥٢		C	Client: GE - United Nuclear Corporation		BORING	BOREHOLE No.	
	Drilling Com	pany: Cascade I				P	roject Number: 233001076  Drilling Rig: CME 85 Truck Rig Bit Type: 4.25" I,D., 8"		FORM		f <u>4</u> See Sheet 1
l	Drillers (day	/ night): S. Lom, entative (day / ni	A. Ro		ez, J.	Vigue	eria Drilling Method: Hollow Stern Auger Logged by: C. Fritz  Core Diameter: N   A	O.D. Augei		Finish Date Total Depth	
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description	Graphic		Remarks	Well Details
30-		90, Y	11 15 15	<b>30</b>	_	ML	Silt, some moderately to slightly weathered shale (lean clay), darts brown I gray, slightly me very stiff silt, very hard shalle	ist, it			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
24_											
26-		as'A	10 0 10			CL	Lean clay (moderately to highly weathered shale)	14.14.14.14.14.14.14.14.14.14.14.14.14.1			
30		30'A	Q 14			CL	Same as above	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			
32 -			15					1 1 1 1 1 1 1		8	
34-		35' A	7	70.		ML	Sandy silt, light brown, trace moderately	1111111			
36=		32, B	70 8				Sandy silt, light brown, trace moderately weathered sandstone, slightly moist, stif	THE PROPERTY.			
38-								THE PARTY			1
40-	SILTS (Iqui	GRAVELS Soffine Class Soffine	orly-grad y graveli yey grav i-graded orly-grad y sands, yey sand ganic si in clays alone situ yganic si in clays in cla	ed grave poorly- els poor sands, od sand poorly g is poorly is year! is wery-! eys of low and class is mid class is and class and	ers. grave graded ly-graded gravely s. grave raded s r-graded ne sand w to med ys of low recous or sp plasti- rs of me	el-sand gravel-s d grave sands. Ify sands and-gra- sand-	Time or no fines	O-7 7-18 8-51 51-86 8-51 Sinches DENSITY DENSI	Boulders 75 Cobbles 75 Coarse gravel 19 Fine gravel 47 Coarse sand 20 Medium sand 0.4 Fine sand 0.0 Skt / Lay (times) <0	10 300 3 to 12 10 75 3/4 to 3 15 to 19 3/16 to 3/4 10 4.75 1/16 to 3/16 25 to 2 0 1/64 to 1/16 75 to 0 425 0.003 109 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	sand, and lives may be started in terms in dicating a range of percentages as below Term % Trace 45 Few 5-10 ii limbe 15-25

	C	Star	nte	)C		Client: GE - United Nuclear ( Project Number: 233001076	Corporation		l .	BORING G FORM	BOREHOLE No.: Sheet _3 of	- •	
	Drillers (day	pany: Cascade I / night): S. Lom, entative (day / n	A. Roc	drigue	z, J. V	Drilling Rig: CME 85 7 gueria Drilling Method: Hollo Core Diameter:		Bit Type: 4.25" I.D., 8" ( Logged by: C. Fritz	O.D. Auger		Start Date:   Finish Date: Total Depth:	See Sheet 1	1
	Depth	Sample Number		Recovery (in.)	qu (tsf)		Description		Graphic		Remarks	Well Details	Non Colonia
40-		40' A 40' B	13 17 16		c	Highly weathered dark brown, tra	d shale wisand ce iron oxidation	t some silt	t, ===				
ч3 =													
<b>44</b> =			8		2	L Sandy silt to si	ilty sand, weakly	cemented,					
46 -		45'B	10	0		medoum dense few carbonate	ilty sand, weakly , hight brown, sli s, trace weather	ightly moisted sandston	to 111111				
48 -												dumini	
<b>SO</b> -		50' A	13 21 22		c	L'Highly to comp silt & sand, sli brown I gray, ve	detely weathered ghthy moist to mo ery stiff to hard	shale, littl ist, dartz	19 111111			dan tan	
<b>52</b> -									144111			denomina	
54=		SS' A	13	e l	N	AFILL Sandy Silt (ML)	, very stiff, light b	nown, signat		Native m unsure du	nay be at 61 ve to a bit naterial in 1601	o', eF	
56-		22, B	13			moist (native)			111111111	clayey n liner @	naterial in	obber —	
58-									THEFT			Timetrum	
60 -	SILTS A	with title of no forms. People of the Carbon States	orly-graded y gravels, p yey gravels il-graded is il-graded by sands, pe yoy sands, rganic sitts ganic sitts a ganic br>a ganic a ganic a ganic a ganic a ganic a ganic a ganic a ganic a ganic a ganic a a ganic a ganic a ganic a a ganic a a a ganic a a a ganic a a a a a a a a a a a a a	gravels soonly-gra- s, poorly- s, poorly- sands, sorry-gra- poorly-gravery-free s of low t and clays micated s of high and clays	L gravet-suded gra- graded of avery sa- gravety sa- gr	d missurgs. little or no fines d missurgs. little or no fines d missurgs. little or no fines d missurgs. d missurgs. Greenand-pit missurg	Term   1,470   2010   2510		2 CRAIN SIZE	Boulders >3 Cobbles 75 Coarse gravel 19 Fine gravel 4 Coarse sand 0 Medium sand 0 Fine sand 0 Coby (fines) <0	ze (rim) Gize (Inches) 000 >12 16 300 3 16 12 16 75 314 10 3 75 10 19 3/16 10 3/4 10 14 75 11/16 10 3/16 10 14 75 11/16 10 3/16 10 14 75 10 14/5 10 15 10 14/5 10 15 10 14/5 10 15 16/5 10 16/	Percentages of gravel sand, and fines may be sand, and sand,	550

Ì	0	Star	ntec			E - United Nuclea	ar Corporation				BORING	BOREHOLE No		
	Drilling Com	pany: Cascade I	Drilling			Imber: 233001076 Drilling Rig: CME 8	35 Truck Rig	-	Bit Type: 4.25" I.D., 8"		G FORM	Sheet H Start Date:	See Sheet	1
	Drillers (day	/ night): S. Lorn, entative (day / n	A. Rodrig	uez, J. Vi	jueria	Drilling Method: Ho Core Diameter.	ollow Stem Auger		Logged by: C. Fritz			Finish Date Total Depti	9:	
. 5	Depth	Sample Number	Blow Count Recovery (in.)	q <sub>u</sub> (tsf)				ription		Graphic		Remarks		Well Details
60-		60, V	14 15 17	M	- Sand	ly silt, few stiff, ligh	o clay, sl of brown	ightly mor weak ce	nentation	HIMI				
63-													duniiun	
64		65'A	7 10	M	San	ne as abo	9 <b>V</b> &			14444			1	
- Job - 80	-		19											
										4114114				
10 -		JO, V	12 15 84	M	LSar	ne as al			ā	141414				
_							EOB (	211.5		-			=	
_										بينيانين والمتنياة				
										ويتقاله ويتما يترجعا			7	
8	GRAVELS		ell-graded grave	its, gravel-san	5 morbures, little na morbures, little	or no lines.	GW Term	Blows/ft* (SPT) (modCAL)	Term (SPT) (mo	BCALL (S)		itze (mmi) – Size (inchi	Percentages of gra-	avel.
	SILTS :	BB GRAVELS SHE WITH 15% fines CI SANDS WITH 15% fines	thy gravels, poon ayey gravens, our graded sand sorly-graded sand to sands, poorly ayey sands, poor grants satts very organic clays of an clays game sits and co- grants sats, mic- organic sats, mic- organic sats, mic-	y-graded gra- only-graded g s. gravely sa- ds, gravely s- graded sand- try-graded sa- line sands s- low to medium tays of low pits account or dist high plassicity.	el-sand-sit mixto avel-sand-clay in de, little or no fin- inds, little or no fin- gravel-sit mixtor degravel-sit mixtor by or clayby fine plasticity, gravel discry- omaceous fine si lat clays	res institutes is institutes is institutes is institutes institute	OC Very soft soft soft soft soft soft soft soft	1.4"ID 2.0"ID 2.5"ID 0-2 0-2 0-2 2-4 2-4 2-4 7 4-8 4-8 4-8 8-15 9-17 9-18 15-30 17-39 18-42 30-60 39-78 42-85 >60 >78 >85	1.4*ID 2.0*ID 2 very loose 0-4 0-5 12 7 loose 4-10 5-12 7 medium dense 10-30 12-37 18 dense 30-50 37-60 5 very dense >50 >60 > *= 140 pound hammer dropped 30 0	Sends and Gravels)  Sends and Gravels)  Jensel 1886  Jens	Cobbles 7 Coarse gravel 1 Fine gravel 4 Coarse sand 2 Medium sand 0 Fine sand 0 Sit / ctay (fines) <	300 >12 5 to 300 3 to 12 9 to 75 3/4 to 3 75 to 19 3/16 to 3/4 00 to 4.75 1/16 to 3/4 4.25 to 2.0 1/64 to 3/11 0/75 to 0.425 0.003 to 1/6 0.075 0.003  solaho or signt faceu pressure	7erm % Trace < 5-1 Little 15- Some 30- Mostly 50-1  Depth to finit water (time and date)	% -5 -10 -25 -45 -100
	麗哥 liqui	AND CLAYS Inc	organic sitts, mic organic clays of i ganic sitts and c	accous or diat high plasficity. lays of modius	omaceous fine si		MH Note CH Well-graded - poorly so OH Poorly-graded - well so PT	Nonplastic H Terry Low E Medium High Wot	Absence of moisture, dry to touch at Damp, does not wet palm Visible Free Water	Moderate C	Pield Test Crumbles or breaks with he Crumbles or breaks with co Will not crumble or break w	nsiderable finger pressure	-	Cepth to water after of three and date)

Ī	0	Star	nte	ec.			ient: GE - United Nuclear Corporation oject Number: 233001076		OIL BORING BOREHOLE No.: TIO - 2 LOG FORM Sheet 1 of 2
	Drillers (Day)	any: Cascade I night): S. Lom,	A. Ro	drigue	ez, J.	Vigue	Drilling Rig: CME LAR 75 High Torque Track Rig ria Drilling Method: Hollow Stem Auger Core Diameter: N A	O.D. Au	uger Start Date: 3 18 8 Finish Date: 3 18 8 Total Depth: 3 6.5 Ft
	Oeptest the Appression	entative (day / ni Samble Number		Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic Skewarks Well Details
0						ML	Sandy Silt (ML) whoseathered shale, light to da brown (darter in daying spots), slightly moist	rk	14 ft [p]
2									41111111111111111111111111111111111111
ч -			20			ML	Same as above		Auto-hammer was
۔ ہا		5'A	16						Auto-hammer was double bounding"
8 -									
10 -		10, Ч	18			ML	Same as above		4. Applete
13-								4.4.1.4.18.1	
14 -							Same as above		HP441
16-		15'A	10			ML	Saute of speci		
18-									
<b>9</b> 0 -	GRAVELS  <50% coan bacton pass fraction pass	GRAVELS SINGLE SANDS WITH THE PROPERTY OF THE	orry grave by graves ayey gra- ell-grade- loorly-grade by sands. ayey san organic s	ted grants s poorly rais poorly poorly ds poorly ds poorly ds poor	reis, grave graded orly-grade by grave graded of ty-graded dine sand	gravel- od gravel- od grav y sands olly sand- sand-grad d sand- ze, sity (		0-7 7-18 18-51 51-86 >86	Term   Size (innh)   Size (inches)   Forcetages of greet.
	SILTS liqui	AND CLAYS	on clays gamic sit organic si organic s	s and cli its, mica	ays of lov scrous or sph plast	w plastic r diatom icity, fat	ty OL Nonplastic Term Face Test Test Test Test Test Test Test Tes	Term Week	m Field Test  as Crumbies or breaks with handling or eight linger pressure derate Crumbies or breaks with considerable finger pressure.  Depth to final water (time and date)  Oppih to water after drilling

ĺ	1	O.C.	_	_		Client: Gl	E - United Nuclea	ar Corporation					SOII	L BORING	BORE	HOLE No.:	TID-	2
		Star	nte	;C		Project Nu	mber: 233001076						LO	G FORM	Sheet	2_of	<u>a</u>	
		pany: Cascade i					Drilling Rig: CME L	LAR 75 High Tord	jue Track Rig		Type: 4.25		). Auger		S	tart Date:	ice Shee	<del>1</del> 1
		/ night): S. Lom, sentative (day / n		angu	ez, J. Vigi	ena	Drilling Method: Ho Core Diameter:		((	Lo	gged by: C.	FNIZ		-11		inish Date: otal Depth:		
	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol				cription				Graphic		Rem	ıarks		Well Details
90-	= -		8	-	ML	Sand	u silt (MI	Mative	Licht	proud	m, me	dium	+					
		30'A	16 20	ia		ders	y silt (MI e, slightly	moist	i agai		,,,						0.	
22													#				=	1
													E					1 E
	3												E				85	<b>=</b>
																		1
२५ -													- 4	†			-	∃
	=												+					<u> </u>
			11		SS	Mode	rately to hi	chly wear	thered <	andst	one her	rock.	Ė	‡				<u> </u>
<u>, ,                                  </u>		25'A	13		19378	dark	rately to his	י" פי ו				,,,,,,	$\equiv$	<u> </u>				<b>4</b>
26-			90			J'unio								1				
Ī							E	OB @ 3	6.5				1					∄
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1	-	T comma la	S.amaza .	6my 64	aravat - 200	ortugos samo es	no fires	Tawl	Dieserit			Steer *	1	<u></u>		_		Щ
	GRAVELS 450% coars fraction pass #4 slove	GRAVELS Sitt	orly-graded y gravels, s	coony-g	s, gravet-sand raded gravet-	extures. little or meetures, little i sand-silt meeture of-sand-clay me	or no lines	GM Term	(SPT) Blows/h* 1.4°ID 2.0°ID 0-2 0-2	2 5 ID	Term (5PT)	2.010 2.510		Boulders	Size (mm) >300 75 to 300	>12 3 to 12	Percentages sand, and fine stated in term indicating a re	onge of
	SANDS <50% coarsi fraction passe #4 sleve	SANDS Wo	ony-graded s ony-graded visuods or	sands g	ravelly sands gravelly sand ideal sand-or	little or no fines s. little or no fin voi-sult mustures	99	SW TO Soft medium s	2-4 2-4 tiff 4-8 4-8	2-4 loc 4-8 me	dlum dense 10-30	5-12 7-18 0 12-37 18-51	DENSIT	Coarse gravel	19 lo 75 4 75 lo 19	3/4 to 3 3/16 to 3/4	Term Trace	% <5
	SILTS	AND CLAYS Ince	iyoy sands rganic sitti rganic clay	very-fir	graded sand- e sands, sity	gravel-clay mut or clayey fine sa	ores inde, salts with slight plasticity clays, sandy clays, sifty clays	SC O Stiff very stiff hard	8-15 9-17 15-30 17-39 30-60 39-78	9-18 de 18-42 vei 42-85	nse 30-50 ry dense >50	0 37-80 51-86 >60 >86	VSITY nd Gravels)	Fine sand	2 0 to 4 75 0 425 to 2 0 0 075 to 0 425	1/16 to 3/16 1/64 to 1/16 0.003 to 1/64	Few Little Some	5-10 15-25 30-45
	liqui	f limit <50 lear Org	n clays panic silts a rgariic silts.	nd clay	s of low plastic	ny accous fine san		very hard	>60 >78	>85 *=	140 pound hammer leld Test bsence of moislure,			Silt / clay (fines) Fleid Test Crumbles or breaks with h	<0.075	<0.003	Mostly Depth to first we (time and date)	50-100
	I liquid	limit >50 Ore	rganic clay panic sits a	s of hig	n plastoly, fat s of medium to	clays high plasticity organic conten		OH Will-graded = poorly s OH Poorly-graded = well s	orted Medium	Moint D Wet Vi	amp, does not wel p sible Free Water	palm Palm	Moderate	Crumbles or breaks with c Will not crumble or break	onsiderable finger		Depth to water : (time and date)	

[	0	Star	<b></b>	~		С	lient: GE - United Nuclear Corporation			BORING	BOREHOLE No.:	T/0-3
	V	Star				Pi	oject Number: 233001076	77 T 4 057 I.D. 011		G FORM	Sheet\ of	21/00/18
	Drillers (day)	oany: Cascade I night): S. Lom	A. Ro	drigue	z, J.	Vigue	ria Drilling Method: Hollow Stem Auger L	Bit Type: 4.25" I.D., 8" ( Logged by: C. Fritz	O.D. Auger		Finish Date:	3/30/18
	Pield Repress	entative (day / n Samble Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Core Diameter: 4.35 Inch  Description		Graphic		Total Depth:	Well Details
0-				个		41	Sandy silt (ML), few to little graye	d, little to	, E	Flakes	of broken s	shale =
<b>a</b> -				48			some shale. Light brown (shale do motst, medium donse very shift, m comentation whereas of strong rock comentation. Trace carbonates.	rk gray). Sligh Noderate nz-lilze	W = = = = = = = = = = = = = = = = = = =			ng maga
ц							9					. Trining
6		5' A 5' B	9 9 14				> mostly shale, some silt & sand, we and weakly comented	eathered	11111			
8 -		w		23     			= mostly sand		111111			umlum
10 =	-	10, V	11	*			=> shale wisilf + sand => mostly sand		111111			111111111111111111111111111111111111111
13-				44			s sandy silt a shale					urfiniti
14 -			1.50	*								ntimit.
16 -		151 B	10						1,11,1,			111
18 -				36				8	111111			mmmm
3O-	GRAVELS	GRAVELS (W	elf-grader	gravah	. gravel-	sand m	stures title or no fines GW Ison Blows Tr	Blowshi		Term (	Size (mm) Size (inches)	Percentages of gravel,
	# 50% coarse ## active ## serve	SANDS WITH THE PROPERTY OF THE	sorty-grade by gravitative grades of grades only-grades by sands, ayey san organic si organic san organic san	ed graves, poorly- els, poorly- els, poorly- els, poorly- ed, poorly- da, poor	praded ly-praded ly-praded ly-praded gravetly s. gravet seded for said with med ly-praded me said with med longer or physical for the prade ly-prade ly-prad	or sand gravet s or gravet sands, ny sand- and gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- sand-gra- gra- plastic- diatoma oby, fat or diatoma oby, fat or diatoma oby, fat or diatoma oby, fat or	Team   1   1   2   2   1   2   2   1   2   2	very loose 0-4 0.5 1005 4-10 5-12 7 medium dense 10-30 12-37 40 5 very dense >50 >60 3 140 pound hammer dropped 30	0-7 -18 -551 1-86 -86 mches Term Weak Moderale	Bouters Cobbles Coerse gravel Fine gravel Coerse sand Medium sand Fine sand Silt / clay (fines) Fired Test Coumbles or breaks with h	100   12   15   15   15   15   15   15   15	as send, and lines may be stated in terms. The madeshing a range as below. Term 9 Term 9 Term 15-25 Little 15-25 Mostly 50-100  Depth to first well films and dale)  Depth to water after onling. Who said dale)  Depth to water after onling. Who said dale if the said dale it was a said to said the said that the said the said that the said

	0	Cton	.+.	-			Client: GE - United Nuclear Corporation		IL BORING	BOREHOLE No.: T	
	Q	Star	116			F	roject Number: 233001076		OG FORM	Sheet 2 of 5	
	Drilling Com Drillers (day	pany: Cascade [ / night): S. Lom,	Orilling A. Ro	drigu	ez, J.	Vigu	Drilling Rig: CME LAR 75, CME 85 (below 35')  Bit Type: 4.25" I.D., 8"  Drilling Method: Hollow Stem Auger  Logged by: C. Fritz	O.D. Auge	er	Start Date: See Finish Date:	Sheet 1
		sentative (day / n				_	Core Diameter. 4.35 Inch		1	Total Depth:	
00	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description	order of the control		Remarks	Well Details
90 -	_	ao' B=3	4	1		ML	Loose sandy silt wheathered shale (liners)				=
		al' Bag	5				cores show medium dense-dense sand w/moderate cementation	1			
<b>32</b> -				42				F			
<b>9</b> 4 =	- - - - - -										mulmin
26 <u>-</u>		25'A	8 7 9	*		NL	Sandy silt (ML), medown dense				mulmi
28 -				42							uuluu
30 -		30' A	7 10 14	*		SM	Silty sand (SM) and slightly to completely weathered shale, medium dense sand, very stiff Shale, light brown (sand) of dark gray I black (shale), slightly moist				minit
32 -				49 			<b>3</b>				بىلىسى
34 =				1						nhde (manua	
36-			13				Il al la malanta comentation corrects	4	hammer ( using CME beyond 3	@ 35'. Began E 85 rig to d 15' bgs.	rill
38 -				48			-> mostly shale, moderate comentation, pockets of hard rock, trace IDN oxide a carbonates		c		mulmin
40=	SILTS	SANDS	orty grade ty gravely sylvy grandol off grade orty grad ty sands, ayey san organic si organic si organic si organic si organic si organic si organic si organic si	see graves, poorly relia, poorly of annels lood same poorly of a p	els, gra- gravelled gravelleds, gravelleds, gravelleds, gravelleds, gravelleds, gravelleds, graded five same to me to make the total graded gr	vel sand gravel- ed grav y sands elly sand sand-gr d- sand- ds, silly dism pli w plaste or diatom ticny, tat edium h	14*10 20*10 25*10	0-7 7-18 8-51 61-86 >86	Boulders   >3	to 300 3 to 12 to 75 3/4 to 3 (5 to 19 3/16 to 3/4 to 3 (5 to 19 3/16 to 3/4 to 3 (5 to 19 3/16 to 0.003 to 1/84 to 7/5 0.003 to 1/84 to 7/5 0.003	Percentages of gravel, sand, and firsts may be stand, and firsts may be standed and firsts may be standed and firsts may be standed and first may

	0	Star	nto.	_		Client: GE - United Nucle	ear Corporation		SOIL	BORING	BOREHOLE No.	_
	V	D.		_		Project Number: 233001076				G FORM	Sheet 3	
		pany: Cascade [ / night): S. Lom,		riguez	z, J. V		LAR 75, CME 85 (below 35') follow Stern Auger	Bit Type: 4.25" I.D., 8" ( Logged by: C. Fritz	O.D. Auger		Start Date: Finish Date	See Sheet 1
		sentative (day / n		T	1.	Core Diameter.	4.25 inch			T	Total Depth	î:
40 <b>-</b>	Depth	Sample Number	Blow Count		qu (tst)	.	Description		Graphic		Remarks	Well Details
40 -		40' A	10/	1	5	1 Sand + shale	mixtures (contid)	, medoum	1			=
		40'B	10			denselvery state	F, slightly moist,	silty				
42 -			ų	19		> mostly shale cementation	, sandy , moderate to , few gypsum, trace	o strong c carbonates	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			
니니 _							*					
Цb -		us'A	9	*	51	shale	1), liftle highly weo slightly moist. Som	athered shale, he chunks of				
48 -			٤	66		> mostly sand,	poetly-graded ad, slightly weath	nered shale		Auger work	ishy much	- Parent
						1	d + shale mixtur			harder, bu greaning vibration	d grinding nuises, pr s	us =
S0 =		50'B	11 7	*	S	4 Silty sand						The state of the s
<b>5</b> 3 =			13								m drilling m drilling hole	
<b>54</b> =	-	53' Bog					lightly to highly contest hard rock, takes		1			milim
S6 -		55' B	11 / 9 10		S	Liner samples: few stiff da	ented hard rock, that so wented hard (SM), mund (SM), m	eddun dense, ered shale)				
58 -			5	55					ىيىتىلىيىتىيلى ۋاخ ئائىتىي كېزى			milim
60-	GRAVELS	GRAVELS Wel	-graced or	grott o	rayol-ta-	of minhures, little or no finos.	GW Blows/it*	Blows/R*	17.	7000	Anna Maria	Percentages of gravel
	SANDS SANDS SANDS SON coars Fraction pass Fr	GRAVELS by the state of the sta	ry-graded prayers, po prayers, po prayers and ry-graded sa ry-graded sands, po you sands, po game sats vi game clays clays and this an game sats u game sats u sats sats an game sats u sats sats u game sats u sats sats u game sats u sats u sats sats u sats sats u sats sats u sats u sats sats sats u sats sats sats u sats sats sats u sats sats sats sats u sats sats sats sats sats u sats sats sats sats sats sats sats sat	graveis, poorly-gra- poorly-grads, gra- sands, gra- sands, gra- poorly-grad- poorly-grad- orly-fine of low to de clays- meases	gravely sa gravely sa gravely sa gravely sa gravely sa sands so sands so o medium of few plays ours or dia	and mistures, little or no finde: vel-band-sitt makel-band-sitt mistures ons, titlle or no finde ands, little or no finde ands, little or no finde gravel-ait methures no-gravel-sitt matures if or clarger find spands, sittle with sught plastices prisascery, gravely clays, sandy clays, sittly clay sittle or no finde prisascery, gravely clays, sandy clays, sittly clay story.	OP   Torm (SFT)   OP   OP   OP	Term   SFPT   14710   2 0/10   2   2   2   2   2   2   2   2   2	5°ID Sand Graves See See See See See See See See See S	Boulders >300 Cobbles 75 to Coarse gravel 19 to Fine gravel 4.75 Coarse sand 2.0 to Medium sand 0.42	o 300 3 to 12 o 75 3/4 to 3 ide 19 3/16 to 3/4 o 4,75 1/16 to 3/16 5 to 2.0 1/64 to 1/16 5 to 0.425 0.003 to 1/64 75 <0.003	sand, and fines may be stated in terms indicating a range of percentages in below Term % Trace <5 Few 5-10 Little 15-25
	[章] (Iqui	d Ilmit >50	ganic clays anic sits an L. humus, si	ed crays:	of mediu	n to high plasticity ngh organic content	CAN Poorly content = well sorted 5 Medium 12	Moist Damp, does not wet palm Wet Visible Free Waller	Moderate (	Crumbles or breaks with const Will not crumble or break with f	enuasorq regnil eldereb	Depth to water after drilling (time and date)

	0	Star	nte		(	Client: GE - United Nuclear Corporation	1	L BORING	BOREHOLE No.		
	Drilling Com	pany: Cascade I		_	F	Project Number: 233001076   Drilling Rig: CME LAR 75, CME 85 (below 35')   Bit Type: 4.25" I.D., 8"		G FORM	Sheet LI c	See Sheet	
	Drillers (day	/ night): S. Lom, sentative (day / n	A. Rodr	iguez	J. Vigu	eria Drilling Method: Hollow Stern Auger Logged by: C. Fritz  Core Diameter: 4.25 \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	O.D. Mage		Finish Date Total Depth	-	
	Depth	Sample Number		Recovery (iii.)	الا Symbol Symbol الله الله الله الله الله الله الله الل	Description	Graphic	-	Remarks		Well Details
60 -		60' B	9 /			Sandy silt (ML), few clay, reddish brown, han moderate comentation	), <u>=</u>				
62-			5	4						Leonal constlu	
(elo -		66' B	24 / 20 23	*	Mr	Silf (ML), little day (weathered shale), Few sand	111111111	-		elenelen	
(g·8 -				8			1111111	-		māmina	
<b>10</b> =		70' B	21 33 37	*	ML	Same as above, trace gravel				o formalismosti	
72 =				8				-		mineral Îm	
74-			6	*	MI.	^F''\ 					
76 -		75' A 75' B	9 9			Sandy silf (ML) (native), light brown, slight moist, stiff	79 -			minulin	
78-			L	0		→Few clay				minimi	
80 -	GRAVEL: 450% coan fraction pass #4 serve To see the serve #4 serve #4 serve #4 serve #4 serve #4 serve	e with little or no filers Po ORANVELS Sill with stiffs lones City SANDS Vivi with little or no filers Po ess SANDS Sill with stiffs filers City	ody-graded by gravels, but ayey gravels, sti-graded si- ody-graded by sands, pos- ayey sands, pos- ayey sands, pos- ayey sands, pos- ayey sands, pos- ayey sands, pos- ayey sands, pos-	gravets, poorly gra- poorly g ands, gra- sands, g ocry-grad- poorly-gr	grave-sand ded gravel- raced grav very sands navely sand- ed sand-gra aded sand- sands, saty of	## construct	0-7 SS E	Cobbles 7 Cobres gravel 1 Fine gravel 4 Coarse sand 2 Medium sand 0	Size (inche   1000   112   1	stated in terms indicating a rain percentages in Term Trace Few Little	gravel   may be
	SILTS	AND CLAYS Inc. Inc. Inc. Inc. Inc. Inc. Inc. Inc.	in clays ganic sits ar organic sits, organic clays ganic sits ar	nd clays o micecody of high p	of low plastic us or diatom fasticity, fat of medium to	very hard >60 >78 >85 ** 140 pound harmer dropped 30  QL  OCH  Account fine sand or sit!  MMH  Note:  Nonplastic W  Term: Field Test	g Term	Silt / clay (fines) <	0 075 <0 003		50-100 er

	0	Star	nto	ec		- 1	Client: GE - United Nuclear Corporation		L BORING	BOREHOLE No.: T	
	Drilling Com	pany: Cascade [				P	Project Number: 233001076    Drilling Rig: CME LAR 75, CME 85 (below 35')   Bit Type: 4.25" I.D., 8"		G FORM	Start Date: See Finish Date:	Sheet
	Drillers (day	/ night): S. Lom, entative (day / n	A. Ro	drigu	ez, J.	Vigu	eria Dilliing Method: Hollow Stern Auger Logged by: C. Fritz  Core Diameter: 4.35 inch			Finish Date: Total Depth:	. O. Ico
	Depth	Sample Number	Blow Count	Recovery (in.)	qu (tsf)	Lithology / Symbol	Description	Graphic		Remarks	Well Details
80 -	-	80' A	6			ML	Same as above	12			=
		80, B	777					E			
	-		Ė				EOB A 81.5'	+			=
89-	=						200 % 01.5				Ē
								8			Ξ
								1			- 13
3-											-
	=							1			<u> </u>
	<b>E</b>							=			Ξ
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											-
-	GRAVELS	GRAVELS W	п-дга ос	gravet	E. grave	sand m	watures, little or no fines GW Blows/ft* matures, little or no fines GP Term (SPT) Term (SPT) (modCAL)  Term (SPT) (modCAL)	dCAL	Term 3	Ize (mm) Size (inches) P	ercentages of gravei.
	<50% coars fraction pass #4 sleve SANDS	GRAVELS Set Cu	y gravol yey grav	poorly-	graded rly-grade	gravel-s	and-still mixtures GM 2 2 10 2 5/10 1.4/10 2 0/10 2 5/10 1.4/10 2 0/10 2 0/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 2 0/10 2 0/10 1.4/10 1.4/10 2 0/10 1.4/10 1	1-7 E E	Boulders > Cobbles 7	300 >12 5 to 300 3 to 12 9 to 75 3/4 to 3	ercentages of gravel, and, and fines may be tated in terms occating a range of ercentages as below
	<50% coers fraction pass #4 sieve	SANDS WE SANDS SANDS SANDS	offy-grad y sands	ed sand	is, grave raded i	ly sand	Section   Sect	1-7 DENSITY 0-86	Fine gravel 4 Coarse sand 2	75 to 19 3/16 to 3/4 0 10 to 4 75 1/16 to 3/16	Term % Trace <5 Few 5-10
	SILTS	AND CLAYS income in the income	rganic si rganic ci n clavs	ays of io	ine sand	s. sity o	c clayey line eards. Nins with sight pleaserty ML. 15-30 17-39 18-42 very done > 50 > 80 > 80 > 80 > 80 > 80 > 80 > 80	8	Fine sand 0	425 to 2.0 1/64 to 1/16 075 to 0.425 0.003 to 1/64 0.075 <0.003	httle 15-25 Some 30-45 Mostly 50-100
	SILTS	AND CLAYS Inc	rganic sit rganic si rganic ci	and cia ds. mica ays of hi	ys of ion copus o gh plast	r plastice diatoms icity, fat o	For Substitution and the sand or sit MM Note:  Conscious fine sand or sit MM Mode:  Conscious fine sand or sit MM MM MM Mode:  Conscious fine sand or sit MM	Term Vvcak	Field Test Crumbles or breaks with ha	ndling or alight linger pressure	oth to first water se and date)
	HIGHLY ORG	ANIC SOILS Per	anic sit	and cla	ys of me p soils y	odium to	Poorly graded = well sorted  Medium  Medium  Metil Damp, does not wel palm  Porty graded = well sorted  Medium  Wet Visible Free Water	Moderale Strong	Crumbles or breaks with co Will not crumble or break wi	th finger pressure	pth to water after drilling se and date)

	C	Star	nte	ec				- United Nucl	-	tion				BORING G FORM	BORE		70-L	ł
I	Drillers (day)	pany: Cascade I / night): S. Lom, sentative (day / n	A. Ro	drigu	ez, J. \	√igue	ria	Orilling Rig: CM Orilling Method: Core Diameter.	Hollow Stem A	i Torque Tra Auger		Bit Type: 4,25" I.D., 8 Logged by: C. Fritz	" O.D. Auger		F	tart Date: inish Date: otal Depth:	3   29   1 3   29   1 36.5	18
0 -	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol				Descriptio	on		Graphic		Rem	arks		Well Details
					1	41	Sand	y silt to	psoil (N	(L)			E				3	
a -																		
ц -																		
6 =		5' B	13		N	AL.	Weat silt i stiff	nored shi mutrix U trace	ala (brol ML), gra carbona	ten 4 f wy, slig tes	laky ph htly me	eces) in san NSt, very	ا ا					
8 -					3												:-	
\D =		10' A	8		•	чL	Same	as ab	<b>0</b> 46									
13 -		10, B	19	×									1-					
14 =							•			N Voc	· \ (							
16 -		15'A 15'B	13			WLC.	same	. as aloe	ove, 51791	ning neo	) Shale							
18 -																		
aO_	GRAVEL: -50% coan fraction pass -50% coan	GRAVELS Sin acts of the GRAVELS Sin acts of the Gravels Colored SANDS We SA	orty-grade y graveli lydy grade il-gradec orty-ortid	ed grav s, poorly- els, poor sands ed sands	ols, gravel graded g ty-graded gravely s	ravel-sa gravel ands, lo sands	-sand-clay must de or no lines little or no lines	no fines ures	TENCY MS	Term (\$P77 1,410 ery soft 0-2 oft 2-4 nedium stiff 4-8 tiff 8-15 ery stiff 15-30		very loose 0-4 0-5 toose 4-10 5-12 medium dense 10-30 12-37 dense 30-50 37-60	2.57ID DENSIT	Boulders Cobbles Coarse gravel	Size (mm) >300 75 to 300 19 to 75 4.75 to 19 2.0 to 4.75 0.425 to 2.0	3/10 12 3/10 12 3/16 10 3/16 1/16 10 3/16 1/64 10 1/16	Stated in term indicating a rapercentages a Term Trace Few	ange of
	SILTS IIqu	AND CLAYS included in the control of	n clays panic site rganic si rganic ci panic site	s and cla its. mica ays of his and cla	ys of low a coous or o gh plasbo ys of mod	plasticity laternac ty, tat ci lum to h	y ceous fine sand		OL MH Note OH Pearly rac	ard 30-60	39-78 42-85	* = 140 pound hammer dropped	Term Weak Moderate	Fine sand (	0 075 to 0 425 0 075 and no or sight fin onsiderable finger	0 003 to 1/64 <0 003	Little Some Mostly Depth to first wa (time and date) Depth to water a	30-45 50-100

	0	Star	nte				lient: GE - United Nuclear Corporation		L BORING	BOREHOLE No.: T/O -	4
	Drilling Com	pany: Cascade I		_		JF	roject Number: 233001076    Drilling Rig: CME LAR 75 High Torque Track Rig   Bit Type: 4.25" I.D., 8" (		G FORM	Start Date: See See	reet l
	Drillers (day	/ night): S. Lom, entative (day / n	A. Ro	drigu	ez, J.	Vigu			411	Finish Date: Total Depth:	
٥A	Depth	Sample Number	Blow Count	Recovery (in.)	qu (tsf)	Lithology / Symbol	Description	Graphic		Remarks	Well Details
aa -		20'B	14			ML	Soudy silt (ML), little shale (moderately weathered pieces), mostly light brown with dorter shale, weak comentation, trace carbonates (less than above)				es lecra fores
Э <b>4</b> -			-			<b></b>			Mostly so	and in C (topmos	
۵6-		351 B	90 11			<i></i>	Same as above, increased shale presence		liner, mis	and in C (topmost ctures in A+B	arriterar Lear
28 - 30 -										3 ( 100	
38 -		30, B	10			SM	Silly sand (SM) (native), medium dense, trace to few carbonates, slightly moist, light brown	でながから	more unitables she mixed	soil structure, form material de + rock Inter-	
34-											
36-		35'B	11 16 24			SS	Weathered soundstone bedrock, very stiff, dorte gray EOB @ 36.5'		Rock in A	liner @ 36'	
38 -							EOB @ 36.5'				
40 -	SILTS liqu	MAND CLAYS  AND CLAYS  MINISTER OF THE PROPERTY OF THE PROPERT	ority-grade by gravels uyey gravels uyey gravels bely grades by sands, uyey sand organic sill erganic sill organic sill	od grav  poorly ols, poor sands oo sand poorly gls, poor ls, voor says of lo and cla ts, mea- ays of h and cla and cla and cla and cla and cla and cla	els graded graded or graded or graded or graded or grade	yer-sand graver- ed grav y sands, city sand sand-gra d	### of res fines	DENSITY 1-86 1-86 86	Cobbles 75 Coarse gravel 19 Fine gravel 47 Coarse sand 20 Medium and 04	10 300 3 10 12 10 75 10 10 10 10 10 10 10 10 10 10 10 10 10	% <5 5-10 15-25 30-45 50-100 st water

	0	O CL.	- 4				Client: GE - United Nuclear Corporation		SOIL	BORING	BOREHOLE	No.: TIO - 9	5
	Q	Star	TE	<b>9C</b>		F	roject Number: 233001076		LO	G FORM	Sheet	_of_ 2_	
	Drilling Com	oany: Cascade I	Drilling	1			Drilling Rig: CME LAR 75 High Torque Track Rig Bit Type: 4.25" I.D.,		). Auger		Start Da	te: 3 27	8
		/ night): S. Lom, entative (day / n		drigu	ez, J	. Vigue	Pria Drilling Method: Hollow Stem Auger Logged by: C. Fritz Core Diameter: 4.95 Inch				Total De	ate: 3   27 / pth: 29 ff	18
	Depth .	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic		Remarks		Well Details
0 -				个	_	ML	Silt (ML) and shale mixtures, few to little sar interlayered light + dark brown, stiff, moder cementation, slightly moist	nd,	上			= = = =	
						1.00	interlanered light + dark brown, stiff moder	ate	1			-	]
							cementation slightly moist					-	<u> </u>
^							- 1 1 1		1-			2	1
<b>a</b> -				1			> mostly shale		1-			-	1
				56					-				1
	=												]
ц =	=								]-				1
7			8										‡
				V			-s westly silt		1-			_	1
	=	5' A	6	1		ME			_				<u> </u>
6		5' B	8						1-				1
	=	2 0	11						1-				1
									1-			<u>_</u>	1
				sŚ					1				] [
8 -				1					1-			2_	3
									_			=	1
							-mostly shake		1-			=	1
							,		1			= =	1
10 =			14	*		ML	Sandy silt (ML), moderate commentation, little sh	مام	]-				1
	=	10'B	17			10.70=	series sur ( 15) I moderate our survey . July 16 su		1			Ξ	1
	= 1	5	16									=	1
. ^	-		10	1			1 1 . w		1-			Ę	]
13=	7						- few shale, still mostly silf		1-			72	1 1
				48								į.	1
				П			-> clayey					1	]
111 -				П					3-1				1 1
14 -				П					4			1	1
	<u> </u>			4		. 797			-			7	]
		151 A	7	1		ML	Same as above, trace gravel, less clay		1-			Œ	1
16 -	_	15' B	9	П					4_			1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	1
,		13 15	10	$\  \cdot \ $					1			1	]
				П					1-1			Ξ	1
	품 .			48					1-			9	1
18 -				1					1				1
				П					1			2	1
									<b>]</b> —[				1
^^	=								1-			=	
90 =	GRAVELS	wm itte er na fines   Po-	orty-grad	od grav	tris, gra	vel-sand	dures, little or no finos  GW   GP   Term (SPT)   Selows/fit (modCAL)   Term (SPT)   Term (SPT)   14"D 2.0"ID 2.5"ID   14"D 2.0"ID 2.5"ID   14"D 2.0"ID 2.0	(medCA)	(Sa	- A1	lize (mm) Size (in 300 >12	S stated in terms	
	SANDS <50% coarse	SANDS We	ayey grav oli-graded	els, poo	dravell	ed grave y sands.	Sand-clay meturos GC ON very soft 0-2 0-2 0-2 very loose 0-4 0-5	0-7 2 7-18	DEI ZIS	Cobbles 7 Coerse gravel 1	5 to 300 3 to 12 9 to 75 3/4 to 3 175 to 19 3/16 to	indicating a ran percentages as	inge of is below
	fraction passe #4 sleve	SANDS 5	ty sands.	poorly-g	raded -	sand-graded	stall matures   SM   SZ   S   S   S   S   S   S   S   S	0 51-86	ALISA GRAIN	Coarse sand 2 Medium sand 0	0 to 4 75 1/16 to :	3/16	<5 5-10 15-25
	SILTS /	limit <50	in clays. ganic sim	and cla	ys of lo	w plasho	very hard >60 >78 >85 *140 pound hammer dropped	d 30 inche	1 6	hine sand 0	075 to 0 425	Some	30-45 50-100
	SILTS /	AND CLAYS Inc	organic sil organic cii oanic silb	ays of hi and cla	gh plast ys of m	r diatoma ticity, tat o odium to	codus tine sand or sit. Mr. Note	ouch Wildiams	Moderate C	rumbles or breaks with ha	ndling är slight finger prossu nsiderable finger pressure. Itt finger pressure	Depth to water at	

	0	Cto	nto			C	lient: GE - United Nuclear Corporation		SOII	BORING	BOREHOLE No.:		
ļ		Sta				Р	roject Number: 233001076			G FORM	Sheet 2 of		_
İ	Drillers (day	pany: Cascade / night): S. Lom	, A. Roc	drigue	z, J. \	Vigue	ria Drilling Method: Hollow Stern Auger Log	Type: 4.25" I.D., 8" C gged by: C. Fritz	D.D. Auger		Finish Date:		1_
-	Field Repres	entative (day / r	night):		_	_	Core Diameter: 4.85 Inch				Total Depth:		
200	Depth	Sample Number	Blow Count	Recovery (in.)		Lithology / Symbol	Description		Graphic		Remarks		Well Details
30 -		SD, Y	11	$\uparrow$	١	٩L	Silt (ML), few sand & clay, light br slightly moist, very stiff	roun Itan,	=			3	
		2013	10				slightly moist, very stiff		1			3	
		30, B	15						1	1		7	
99 -	-			H					1	1		크	
	=			50					1-	1		3	
ļ									1_	-		Ē	
94-	_								_] -	1		3	
,									E	1		3	
1	-		5	*	,	ML	Same as above		-	•		=	
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40-	GRAVELS <50% coars fraction pass #4 sleve	e with title or no times Po	corly-grades try gravets.	s grave soody-g	is, grave	ravels		Elows/fit* Term (SPT) (mod 1.4*ID 2.0*ID 2.5	5*ID		lize (mm) Size (inches) 300 >12 5 to 300 3 to 12	# I stated in tentra	
	SANDS <50% coers fraction pass #4 sleve	SANDS W	leli-graded nody-graded lity sands, p	sands. (	graveby s, graveb adod sa	sands. y sands ind-gra-	me or no lines SW LO soft 2-4 2-4 2-4 Ion	adium dense 10-30 12-37 18-	7 DENSITY	Coarse gravel 1 Fine gravel 4	9 to 75 3/4 to 3 .75 to 19 3/16 to 3/4 .0 to 4.75 1/16 to 3/16	Trace -	% <5
	SILTS	AND CLAYS IN	layey sands organic sits	poorly svery-fir	-graded ne sands	sand-g	Calvery fine sainds, sitts with sight plasticity Mil. O.5 very stiff 15-30 17-39 18-42 very stiff 16-30 39-78 42-85	nse 30-50 37-60 51- ry dense >50 >60 >6 140 pound hammer dropped 30 m	36 Vaj	Fine sand	425 to 2 0 1/64 to 1/16 075 to 0 425 0 003 to 1/64 0 075 <0 003	Few 5	5-10 5-25 10-45 0-100
	SILTS	AND CLAYS	iganic sits i organic sits organic clay	s of hig	cous or e	tiatomi ity: fat c	7 OL Man Total Term F1 coous fine sand or sixt Min Thotal Low Low Dry All sixty CH Wespraces coors sond		Term Weak	Field Test	indling or slight linger pressure	Depth to first water (time and date)	$\neg$
	2.3	10	rganic sits cat, humus,	and clay swamp	soils wit	h high o	righ plastory OH Poor passes and some A Medium Programmer High Vel VI	Isible Free Water	Strong	Will not crumble or break w	th finger pressure	Depth to water after (time and date)	Ampli

Ì	0	Ct	-4-			Client: G	GE - United Nuclear (	Corporation			S	OIL	BORING	BORE	IOLE No.:	T10-6	5
	Q	Star	nte	5C		Project N	umber: 233001076				_	_	FORM	Sheet_	l of		
	Drilling Comp	oany: Cascade (night): S. Lorn,	Drilling	drigu	ez, J. Vi	ueria	Drilling Rig: CME LAF Drilling Method: Holla		Track Rig	Bit Type: 4.25" I.D., Logged by: C. Fritz	. <u>.</u> 8" O.D. Al Z	uger			art Date: * nish Date: *	3   29   3   29	18
	Field Repres	entative (day / n	night):			_	Core Diameter: N	/A						To	otal Depth:		FI
	Depth	Sample Number	Blow Count	Recovery (in.)	qu (tsf)			Descr				Graphic		Rem	arks		Well Details
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						sligh	with sand ( ntly moist, a	ray brow	on, very s	HFF	1	Ξ					∄
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<del>9</del> 0 -	☐ GRAVELS	GRAVELS W	Vell-grader	d' grave)	ls, gravel-sar	d mixtures, little	or no fines	GW Term	(SPT) Blowsitt* (modCA)	L) Term (SPT) Blow	WBIR*	۲	Term (	lize (mm)	Size (inches)	Percentages sand, and fin stated in term	of gravei
	S < 50% coans	GRAVELS S	iny gravel layey grav	s, poorly yels, poo	Alfaded du	and mixtures, it rel-sand-silt mix ravel-sand-slay rds, little or no f	tures 4	OM S very soft	14"ID 20"ID 25"ID 0-2 0-2 0-2 2-4 2-4 2-4	1_4*ID 2.0	0°ID 2.5°ID	SIZE	Cobbles 7 Coarse gravel 1	300 5 to 300 9 to 75	>12 3 to 12 3/4 to 3	stated in tern indicating a r percentages	ns ange of as below
	SANDS <50% coan fraction pass #4 slove	SANDS S	oony-grad ity sands. Izyey san	poorty o	ds gravelly: graded same ly-graded s	ands, little or no -gravel-silt mixt nd-gravel-clay i	ures :	SIS SIFF			-37 18-51 -60 51-86	GRAIN	Fine gravel Coarse sand Medium sand	75 to 19 0 to 4.75 425 to 2 0	3/16 to 3/4 1/16 to 3/16 1/64 to 1/16	Trace Few	% <5 5-10
	SILTS Siqu	AND CLAYS in	norganic s norganic c non clays	its/very- lays of to	are sands, to mediur	ity or clayey fin plasticity, grave	o sande, sits with sight positiony   pay clays, sandy clays, sity clays.	very hard	30-60 39-78 42-65 >60 >78 >85	very dense >50 >6 * # 140 pound hammer dropp	ped 30 inches		Sit / clay (fines)	075 to 0 425 0 075	0 003 to 1/64 <0 003	Mostly	15-25 30-45 50-100
		AND CLAYS	organic s organic d	its, mea tays of n	igh plasticity	omaceous fine	sand or sit	OH Well-graded = poorly so	Nonplastic W Te Low Dr Medium High W	rm Field Test y Absence of mosture, dry to sel. Damp, does not wet palm	₫ Mod	erate	Field Test Trumbles or breaks with A Crumbles or breaks with co	nsiderable finger		Depth to first w time and date)	
	WOULD SO		eat home	of America	to some with	n to night prests	teril	TO	IZI Hlah I 및 WA	el Visible Free Water	Stron	ng 1	Will not crumble or break vi	m finger pressure	E	Dopth to water time and date)	- 1

	0	Star	\ \+	26		7	lient: GE - United Nuclear Corporation		SOIL	BORING	BOREHOL	ENO.: 75-1	
	V	Stai	ILC	<del>-</del>		F	roject Number: 233001076			G FORM	Sheet	of <del></del> _	
		oany: Cascade ( night): S. Lom,			ez J	Viau		25" I.D., 8" O.[ C. Fritz	D. Auger			Date: 4 / 2 / Date: 4 / 2 /	
		entative (day / n		ungu	CE, 0.	vigu	Core Diameter. N (A			r	Total	Depth: 35 f	1
0 -	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic		Remark	is.	Well Details
					1	SM	Silty sand topsoil (SM), few weathered oh	ale	**				<b>=</b>
							Silty sand topsoil (SM), few weathered sh pieces, brown, slightly month, loose		1.27.7.5				
2 -													
ч -									1				
		S'A	93			SM	Silty sand (SM) and weathered shale, brown	iv 4	المسالية الأراج، في				
- ما		5 B	25 25				Silty sand (SM) and weathered shale, brown gray, donse + weakly cemented, slightly frace corbonates	moist,					
8 -											2		
0													
10 -		10' A	10			ML	Sandy silt (ML), few shale pieces, brown stiff, slightly motst	(est.)_ n, very				ā	
. ^		10, B	10				stiff, slightly moist	,					
13 =													=
14 =								( <u>es+</u> )_	1				
- ما\		15' A 15' B	15			ML	Silt (ML), little weathered shale + sandsto brown + gray, slightly moist, very stiff	ne,				9	
18 -									111			y	
3D -	GRAVELS 450% coars	with little of notines I Por	pray-grad	oo grav	ois, grave	ti-sand		Blows/ft* (modCA (10 2010 25)	38			e (inches) Percenta;	ges of gravet fines may be
	SANCOS SANCOS STACTOR DASS SONCOS STACTOR DASS SONCOS STACTOR DASS SONCOS STACTOR DASS SONCOS STACTOR DASS SONCOS SONCOS SONCOS STACTOR DASS SONCOS SO	GRAVELS SITE WEST STANDS WEST STANDS SITE	y gravate yey grav fl-graded orly-grad y sands yey sand rganic si rganic ct	els, poorly els, poor sands ed sand poorly-g is, poor lis-very-	graded of rly-graded gravelly is gravelly graded ac y-graded fine sands	gravel-s d grave sands iy sand and-gra sand-gra sand-gra s. sitty of	And-set rectures	0-4 0-5 0-7 4-10 5-12 7-18 10-30 12-37 18-51 30-50 37-60 51-86 >50 >60 >86	(Sleve) pue spu ALISNAG GRAIN SIZE	Cobbles Coarse gravel Fine gravel Coarse sand Medium sand Fine sand	175 to 19 3/1 2 0 to 4.75 1/1 0 425 to 2 0 1/6 0 075 to 0 425 0 0	12   10 3   10 3 16   16 10 1 16 1	% <5 5-10 15-25 30-45
	SILTS /	AND CLAYS India >50	n clays panic sith rganic si rganic cl panic sith	s and cla is, mice ays of his and cla	rys of low coous or gh plastic rys of moi	plastic diatems only, fat of dium to	Ty OL Note: S Noplastic The Floid Teach Cooput fine sand or wit MM! Note: S Noplastic The Floid Teach Cooput fine sand or wit MM! Note: S Noplastic The Floid Teach Cooput fine sand or wit MM! Note: S Noplastic The Floid Teach Cooput fine sand or with the Floid Teach Cooput fine sand	wel palm	т'	Sitt / clay (fines) Field Test Crumbles or breaks with his Crumbles or breaks with control of the second of the se	onsiderable finger pressu	Depth to first	ter after drilling

Ì	a	Star	ate			Client: G	E - United Nuclea	ar Corporation				BORING		No.: TS-1	
	Drilling Com	0				Project Nu	mber: 233001076 Drilling Rig: CME 8	35 Truck Ria		Bit Type: 4.25" I.D., 8" C		G FORM	Sheet 2	of_ <del>_}</del> ate: See She	n+ 1
İ	Drillers day	pany: Cascade I y night): S. Lom, entative (day / n	A. Roc	irigue	z, J. V	gueria	Drilling Method: Ho Core Diameter:	ollow Stem Auger	1	Logged by: C. Fritz	.D. Augei		Finish I	Date:	.611
	Depth	Sample Number		Recovery (in.)	qu (tsf)		Oue Diameter.		cription		Graphic		Remarks		Well Details
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26_		25' A 25' B	8 15 14		SI	Silty	sand (SM) t, trace c	o(native) arbonates	medium , light bro	dense, slightly wn		9		ž	
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38 -														)	
40-	GRAVELS <50% coarse fraction passes fraction p	GRAVELS SITE SANDS	ony-grade ty gravets, ayey grave ell-graded ony-graded ty sands, p ayey sands organic sills	d grave poorly-g is poorly sands, a sands oorly-gr poorly uvery-fir ys of lose	is gravel- raded gra- r-graded gravely sa gravely saded sam- graded sam- graded sam- e sands, to mediur	plasticity, gravelly	or no fines es intures s nes	s, CL O hard	8-15 9-17 9-18 15-30 17-39 18-4 30-60 39-78 42-8 560 >78 >85	very loose 0-4 0-5 0-1 10se 4-10 5-12 7-7 medium dense 10-30 12-37 18-dense 30-50 37-80 51-12 7-7 very dense 550 500 58	DENSITY DENSITY OF STREET	Boulders >: Cobbles 75 Coarse gravel 15 Fine gravel 4 Coarse sand 2 Medium sand 0 Fine sand 0 Silt / clay (fines)	Size (mm)   Size (final)	3 3 4 Term Trace Few Little Some Mostly	% <5 5-10 15-25 30-45 50-100
	<b>建築</b> liqui	AND CLAYS IN	organic sits organic clay	s of hig and clay	nous or du h plasticity s of modiu	omaccous fine sa		MH Nate CH Well-graded = poorly OH Poorly-graded = well PT	sorted Sorted High	Term Fleid Test Dry Absonce of moisture, dry to touch Moist Damp, does not wet palm Wot Visible Free Water	Moderale C	leid Test rumbles or breaks with co- crumbles or breaks with co- will not crumble or break wi	nsiderable finger pressure	Ute Clepth to first Utime and dai Utime and dai Utime and dai Utime and dai	e) er after dolling

	Q	Star	nte	ec			E - United Nucle	ar Corpora	ation							BORING G FORM	BORE	HOLE No.:	^	)
l	Drillers (day)	pany: Cascade I night): S. Lom,	A. Ro	drigu	ez, J. Vi	jueria	Drilling Rig: CME Drilling Method: H	iollow Stem	Auger				4.25" I.D. y: C. Fritz		Auger		F	Start Date: Inish Date:		8
0	Depth Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)		Core Diameter:		Descrip						Graphic			fotal Depth:	36.5	Well Details
				1	М	grav	y silt topse ,, slightly :	noist,	Inose Inose	11 prav	on w	olspec	.ks ef		E					
<b>a</b> =				38											FILL				-	
Ц -					SI	Highl Most	y weather by broken se mederal	rock, rely we	ndsto gray eathe	to per	silty own te	sand	L (SM	2' _	10-20 10 10 10 10 10 10 10 10 10 10 10 10 10				-	
<b>6</b> -		5'B	13	\ -										,					-	
8 -	Eng di mad			39															-	
10 -		10' A	15 21 12	*	SI	Weat	hered sand staining, s	slone ilty	+ sho	de, ba	)wh	w sor	ne gn	ay,	14.7.00 A. W. Y.				-	
19-				49		> me	stly sand a	· silt (	(less n	och)									_	
14 =				<b>\</b>					, 16.	т	. 0	ı	ا .د						-	
- ما\		\5' A	10		S	t so few	sand (SM modstone, earbonat	increas es	to lit	menta	Hon	of a	sand	Z 200 1000 1000 1000 1000 1000 1000 1000			:1:		10 A 10 H	
18 -	rea la colta			53										Tool Book And He						
90 -	GRAVELS  SON coarts  Francisco  F	GRAVELS SITE SANDS SIN	only-grade y gravels yey gravels graded only-grade y sands typy sand rganic sal rganic co n clays	poorly- poorly- pands, and sand poorly g s, poorly sivery f rys of lov	product gravely sur- product gravely sur- sur- sur- product sur- product essand-out mitto avel-sand-ctay m skylete or no fine inds. Itilit or no fine gravel-sift mixture ad-gravel-clay mit by or clayery fine a plasticity, gravely sholly	or no finds. es stitutes \$ \$ thores three three clays, sandy clays, sity clay clays, sandy clays, sity clay	ONSISTER	tery soft soft medium stiff stiff very stiff	4'ID 20'ID   0-2 0-2 2-4 2-4 4-8 4-8 8-15 9-17 15-30 17-39	0-2 2-4 4-8 9-18 18-42	dense very dense	(SPT) 1.4'ID 2.0' 0-4 0.4 4-10 5-1 se 10-30 12-3 30-50 37-4 >50 >60	5 0-7 2 7-18 37 18-51 50 51-96 0 >86	(Sands and Graves) Altisuag	Boulders Cobbles Coatse gravel Fine gravel Coatse sand Medium sand Fine sand	Dize (nvm) -300 75 to 300 19 to 75 1.75 to 19 2.0 to 4.75 1.425 to 2.0 0.075 to 0.425 c0.075	8ize (inches) >12 3 to 12 3/4 to 3 3/16 to 3/4 1/16 to 3/16 1/64 to 1/16 0 003 to 1/64 <0.003	Percentage Sand and I stand in the	% <5 5-10 15-25 30-45 50-100	
	SE SILTS	d limit >50	rganic sits	and cla	th plasticity, to of mediu	imacrous fine sa ut clays i to high plasboty gh organic comm		MH Note CH Welge: OH Poorly &	#### poorly sorted	30-60 39-78 >60 >78 Nonplastic Low Medium High	Term Dry Moist Wal	Absence of a Damp, does Visible Free	noisture, dry to not wet palm Vibitor	\$ M	loak loderate	Crumbles or breaks with bu Crumbles or breaks with or Will not crumble of break w	onsiderable finger	125 rate (100 rate)	Depth to water	

	0	Star	ata	_		Client: GE - United Nuclear Corporation		SOIL	BORING	BOREHOLE No.:	-
	Ų	Sta		<u>_</u>		Project Number: 233001076			FORM	Sheet 2 o	
	Drilling Com Drillers (day	pany: Cascade / night): S. Lom	Drilling , A. Rod	igue	z, J. Vigi		tType: 4.25" I.D., 8" O.D gged by: C. Fritz	). Auger		Start Date: Finish Date:	See Sheet 1
		sentative (day / r		1		Core Diameter: 4.35 Inch		-		Total Depth:	
a0 -	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol	Description		Graphic		Remarks	Well Details
	=	90' B	H V			Same as above			Topsoil In	C (top) li	ner, =
<b>2</b> 2-		90,⊂	30 50	, o	SS	Highly weathered sandstone, gray, some (darker patches, possibly weathered she cemented, considerable from staining easily along horizontal planes	fines iale), weakly , breaks	-	rock in m	rid-B 4 A	mulmin
24 -			18	*	ec.	Same as above					inniliani
<b>36</b> -		as' A	29 19		22			11111111			عقالمعناه
<b>38</b> –				9							minnin
30 -		30, B	8 7 6	*	SS	Same as above					ulmin
3 <del>2</del> =			30 23	٠     	SS	Same as above			Initially ha @ 33'. Dr were able to	ad auger ref ove sampler to continue	isal then
36 =			13 15 10		SS	Same as above			35 <sup>1</sup> . No so due to bre	mples colli liken rock.	ected
				7		EOB @ 36.5'	-				Ē
38 -											
<b>-</b> 1∪ =	SILTS Rqui	with the or of fees Po- GRAVELS SAMDS SAMDS With the or of fees Po- GRAVELS SAMDS WITH THE OR OF T	onty-graded by gravets, pa syoy gravets, pa syoy graded ty sands, po syoy sands, po syoy sands, po syoy sands, po syoy sands, po syoy sands, po game sits ar riganic sits ar riganic clays game sits ar game sits ar	grave poorly poorly inds, c sands inty-gra- coorly ory fir of low a clay meace of high it clay	is graver-nameraded graver y graded gravery sands gravery sands gravery sands graded sands sittly to modum plus of low plashours of diaton in plashour, for so of modum's	-same still mistures	adium dense 10-30 12-37 18-51 inse 30-50 37-60 51-86 ry dense >50 >80 >86 140 pound hammer drapped 30 inches leid Test baence of moislure, dry to touch amp, does not wet palm	Sand Gravety Term Week Co	Boulders   >300   Cobbles   75 to   Coarse gravel   19 to   Fine gravel   4,75   Coarse sand   2,01   Medium sand   0,42	300 3 to 12 75 34 to 3 to 19 3/16 to 3/4 o 4/5 11/16 to 3/16 5 to 2 0 1/64 to 1/16 5 to 0 425 0 003 to 1/64 75 < 0.003	Fercestages of grows grand and first may be started and first may be st

	0	100				C	Client: GE - United Nuclear Corporation		SOIL BO	ORING BC	REHOLE No.: T	<u>S-3</u>	
	Q	Star	ITE	3C		F	Project Number: 233001076		LOG F	ORM Sh	eet <u>\</u> of	<u>a_</u> _	
	Drilling Com	oany: Cascade D	Orilling	1	an 1	· Court	Drilling Rig: CME 85 Truck Rig eria Drilling Method: Hollow Stem Auger	Bit Type: 4.25" I.D., 8" C Logged by: C. Fritz	D.D. Auger		Start Date: 4 Finish Date: L	11118	5
	Field Repres	night); S. Lom, entative (day / ni	ght):	angu	ez, J.	vigu	Core Diameter: N A	Logged by. C. Thiz			Total Depth:	1.5 f	Έ
D -	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol	Description		Graphic	R	emarks		Well Details
	_				1	NL	Sandy silt/silty sand topsoil		1=			_	
2							sand "" [ XI. ] and after					1	,
3 =									7-				
ч _													
د کا		J /\	30 34 36			ML	Mostly silt, little weathered sandstone gravel. (ML). Brown, slightly moist	+ shale, trace Few sand.				 	
8 -												-	
10 -		10, B	16 30			ML	Same as above		111111				
12-			83										
14 -		15' A	15			ML	weathered shale, sand, + silt mixtures	. Mostly silt (M	7			-	
<b>∖</b> 6 =		15' B	39 39					•				1	
18 -													
20-		SANDS WHITE OF THE PROPERTY OF	orly-grad y gravels ymy grav il-graded orly grad y sands, yey sand ganic si	ed grav poorly els, poor sands ed sand poorly 5 ts, poor ts, very	rols, gravely-graded, gravely os, gravely graded silv-graded silv-graded fine sand-	el-sand gravel-s d grave sands ly sand and-gra sand-s	### A PA PA PA PA PA PA PA PA PA PA PA PA P	Torm (SPT)   Blowsit* (moc)	77 Cohe Coar Fine Coar Media See See See See See See See See See Se	ders >300	0 1/64 to 1/16 425 0,003 to 1/64 <0.003		% <5 5-10 15-25 30-45 50-100
	SILTS	AND CLAYS incoming in	anic site ganic si ganic ci anic site	ts, mica ays of h and the	igh piasto sys of me	diatom: dy fat i dum to	Ty OL Nonplastic E Terr	m Field Test	Term Field Text Value Crumbies Moderate Crumbies		ight linger pressure.	Depth to first water time and dafe) Depth to water aft time and date)	le/

1	1	0.01	_	_		70	Client: GE - United Nuclear Corporation		SOIL E	BORING	BOREHOLE No.	TS-3
	$\mathcal{C}$	Star	ITE	9C		P	roject Number: 233001076		LOG	FORM	Sheet 2	of_2_
		pany: Cascade [				f		Bit Type: 4.25" I.D., 8" ( Logged by: C. Fritz	D.D. Auger		Start Date: Finish Date	See Sheet 1
		night): S. Lom, entative (day / n		ongu	82, J.	vigue	Core Diameter: N A	Logged by. C. Thiz			Total Depth	
a0 -	Depth	Sample Number	Blow Count	Recovery (in.)	qu (tst)	Lithology / Symbol	Description		Graphic		Remarks	Well Details
40		90, B	19		Š	35	Weathered sandstone, light gray who oxidation	ted towards		Native (	@ ~30'	111111
ə <b>&gt;</b> -												
<b>J</b> lo –		25¹A	13 24 33		Ç	55	Same as above, but darter gray/black grained but possible shale influen	L.Still coarse ce (?)				
28 - 30 -			10			20	Sandstone, highly weathered, gray					1
		30' A	14			<i>.</i>	_	The second second second				
32-							EOB @ 31.5'					The state of
34=	-											njunian
36-	-											u promotorio de la composición dela composición de la composición dela composición de la composición d
38-												
40-	SILTS	Bands Charles Control	only-grade y graveit y graveit grade only grad y sands, yoy san rganic si rganic si rganic si rganic si rganic si rganic si	ed gray  , poorly els, poor  sands ed sans  poorly-g  ts, poor  ts	els. gravel graded : if graded gravely s. gravel raded sa graded on sands w to med ys of low securs or gh plastic ys of mod	sand gravities di gravities sands, y sand and gra- sand- um pla um pla prastic diatomi by, fat dum to	verbund merkuhrers  SML  SV  SV  SV  SV  SV  SV  SV  SV  SV  S	1.4'10 20'10 2 very loose 0-4 0-5 0 loose 4-10 5-12 7 medium dense 10-30 12-37 18 dense 30-50 37-60 51 very dense >50 >60 > *= 140 pound hammer drupped 30 #	5-1D Send and Carry Term Feel Carry Weak Carry Weak Carry	Boulders >3 Cobbles 75 Coarse gravel 9 Fine gravel 4./ Coarse sand 2.C Medium sand 0.4 Fine sand 0.0 Sixt/ clay (fines) <0 4 Yest	ze (mm) Sizo (linche 00 >12 10 300 310 12 10 75 341 to 3 75 to 19 316 to 34 125 to 20 164 to 175 1375 to 0.425 00.003 to 1/6 1075 00.425 00.003 to 1/6 1075 00.003 to	stated in terms indeed in terms indeeding a range of percentage as below  Term %  Trace <5 Few 5-10 IMM 12-25

	(8	0.0.	_			70	lient: GI	E - United Nuclea	ar Corporation			SOIL	BORING	BOREH	IOLE No.: 7	5-4	
	Q	Star	nte	ec		F	roject Nu	mber: 233001076				LO	FORM	Sheet _	of	3	
	Drilling Com	pany: Cascade I	Drilling	]		-		Drilling Rig: CME 8			Bit Type: 4,25" I.D., 8" (	O.D. Auger		St	art Date: 4	11118	
		/ night): S. Lom, sentative (day / n		odrigu	ez, J.	Vigu	eria	Drilling Method: Ho Core Diameter.	ollow Stem Auger		Logged by: C. Fritz			To	nish Date: 4 tal Depth: 2	5.25 F	E
6	Depth	Sample Number	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf)	Lithology / Symbol			Desc	cription		Graphic		Rema			Well Details
0 -						SM	Dens	e silty sou	nd, few to	little weat	hered shale,	7				=	
4	1-1-1-1-1						slogh	e growel a Hy moist	sandstone	preces, lie	hered shale, ht brown,	15					
გ -												13.				=	
Ч -			000			SIA	C	: 				**************************************					Company of the Compan
6-		5' A 5'B	27			2m	Jam	e as abov	e								
		J 0	35									7.1.7.33				1	
8 -																	
	8											1.5				=	
10 -	-	10, Y	13	1		sc	Dens	e sand wl	clay + gr	avel (SC),)	brown, slighth	134				킄	
		10, B	22 23				wois	4	J		, ,	P. P. C.			1	1111	
18-						SS	Weat Weat	thered some	dstone, fe	w fines (u + gray, iron	weathered shall statuting		Estimated	d contr	act wln	ative	
14 -																	
- ما\		15' A 15' B	15				Sam	e as abov	<b>'e</b>								
			24														
\8-																	
20-	GRAVEL	S GRAVELS LW	ell-grade	d' grave	is, grave	sand m	intures, little o	r no fines	GW	Blows/R*	Blows/h*		Term 8	Size (mm)	Size (inches)	Percentages of sand, and fines	gravet
	#50% coan fraction pass #4 serve SANDS #50% coan pass #50% coan pa	militie or no lines   Po- grave   GRAVELS   GR	borry grave ayey grave ell-grade sorry-grade by sands ayey san organic s organic so an clays rganic so organic so	sed graves, poorly sele, poorly poorly says of to says	graded by graded	gravel- od gravel- od gravel- od gravel- od gravel- y sands. ody sand- sand-gravel- disand- di	mixtures, little wand-six mixture id-sand-clay mixture sittle or no fine e, little or no fine vol-six mixture pravel-clay mix or clayey fine satictly, gravely sy accous fine satictly.	or no fines res intures is nes s nes s fulles s s fulles s fulles s fulles s r s fulles s r s s fulles s r s s s s s s s s s s s s s s s s s	very hard	1410 2010 2510  2-4 2-4 2-4 8-15 9-17 9-18 15-30 17-39 18-42 30-60 39-78 42-85 560 >78 >85	very loose 0-4 0-5 (loose 4-10 5-12 7 medium dense 10-30 12-37 14 dense 30-50 37-60 5 very dense >50 >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 50 5 cery dense >50 5	0-7 -18 opensity 0-51 1-86 9-51 1-86 9-86	Boulders > Cobbles 77 Coarse gravel 1 Fine gravel 4 Coarse sand 4 Medium sand 0 Fine sand 0	×300 75 to 300 19 to 75 1 75 to 19 2 0 to 4 75 1 425 to 2 0 0 075 to 0 425 50 075	>12 3 to 12 3/4 to 3 3/16 to 3/4 1/16 to 3/16 1/64 to 1/16 0 003 to 1/64 <0 003	Term Trace Few Little Some	% <5 5-10 15-25 30-45 60-100
	울듯 liqu	id Ilmit >50	organic c rganic sill	lays of h	igh plast ays of m	ecity, fat odium to	clays high plasticity organic contor		OH Poorly grades = well PT	sorted Nonplestic W Dry Low Dry Medium Mo	Ausence of moisture, dry to touch list Damp, does not well palm vi Visible Free Water	Moderale	Crumbles or breaks with co Afill not crumble or break w	onsiderable finger p		Depth to water affe	

	C	Star	nte	ec		Client: GE - U	nited Nuclear Co	rporation						BORING	-	HOLE No.:	75-4 2	
	Drillers (day	npany: Cascade I //night): S. Lom,	A. Ro	drigu		Drilli Ieria Drilli	ng Rig: CME 85 Tr. ng Method: Hollow	Stem Auger		Bi	t Type: 4.25 ogged by: C	5" I.D., 8" O.C . Fritz	). Auger		F	inish Date:	see She	et I
20	Depth Depth	sentative (day / n	Blow Count	Recovery (in.)	q <sub>u</sub> (tsf) Lithology / Symbol		Diameter: N	Descr	iption				Graphic			otal Depth:		Well Details
		90, Y	28/5 28 12			Same as Mederosh	above ely weather	red sha	.le –					shak s	tarting i	in B li	Mer	
93													باليبيينان					
24			50/	Žu.									i la caracte					
ac -		1.5					EO	3 @ 3º	5. 25'		211	amene an					-	
28 -																	-	
30-																	-	
32-															930			
34-	- - - - -									ē							-	
36-																	_	
38-																	-	
40-	SILTS	Market S AND S AND S SAND nony-grade thy gravels layey gra- roll grades only-grade thy sands, layey sand organic si organic si an claye iganic sill organic sill organic sill organic sill organic sill	ed graves, poorly- els, poorly- els, poorly- ed sand poorly- ds, poorl ts, vory- lays of lo	ent, gravel-san- graded grave gravely sand to, gravely sand to, gravely sand prodod sand-g y-graded sand- fre sands, sin- w to modum p	iasticity, graveily clays, i city naceous fine sand or sil	or GP GG GG SW SP SP SM SC Its with slight plasticity ML Landy clays, sifty clays, CL	SSN See a stiff	1.4"ID 2.0"ID 0-2 0-2 2-4 2-4 1.4-8 4-8 8-15 9-17 15-30 17-39 30-60 39-78 >60 >78	0-2 2-4 4-8 9-18 18-42 42-85 >85	medium dense 10- dense 30- very dense >5	6 2010 251 4 0-5 0-7 10 5-12 7-18 -30 12-37 16-51 50 37-60 51-86 50 >60 >86  re, dry to touch	DENSITY Sands and Graveis)	Coarse gravel		\$12 3.10 12 3.41 to 3 3.416 to 3.44 to 3.416 to 3.416 to 3.416 to 3.416 to 1.416 to 1.416 to 1.416 to 0.003 to 1.64 <0.003	Term Trace Few	% <5 5-10 15-25 30-45 50-100	



### **Attachment C. Photos**





Photograph 1. BS-3: 0' (left) to 5' (right) bgs

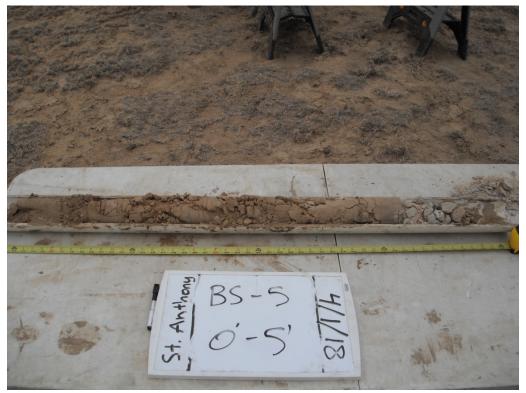


Photograph 2. BS-3: 5' (left) to 10' (right) bgs





Photograph 3. BS-3: 10' (left) to 15' (right) bgs

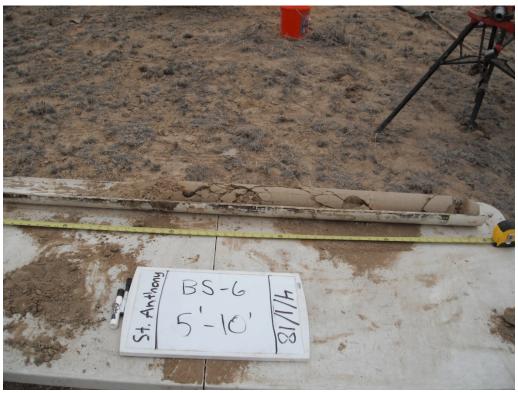


Photograph 4. BS-5: 0' (left) to 5' (right) bgs



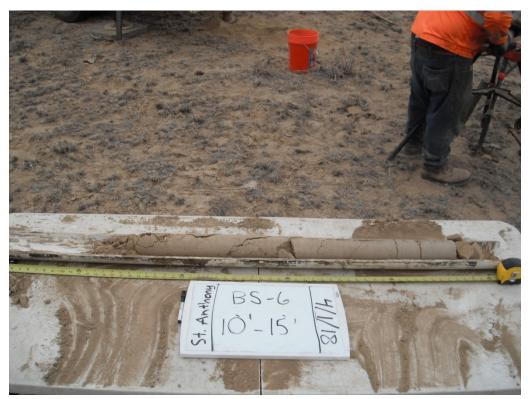


Photograph 5. BS-6: 0' (left) to 5' (right) bgs



Photograph 6. BS-6: 5' (left) to 10' (right) bgs





Photograph 7. BS-6: 10' (left) to 15' (right) bgs



Photograph 8. BW-1: 0' (top left) to 10' (bottom right) bgs





Photograph 9. BW-1: 10' (top left) to 20' (bottom right) bgs



Photograph 10. BW-1: 20' (top left) to 30' (bottom right) bgs





Photograph 11. L1-1 (all cores): 0' (bottom left) to 20' (top right) bgs



Photograph 12. L1-5 (all cores): 0' (bottom left) to 20' (top right) bgs





Photograph 13. L2-4 (all cores): 0' (bottom left) to 20' (top right) bgs



Photograph 14. L2-6 (all cores): 0' (bottom left) to 20' (top right) bgs





Photograph 15. P1-1 (all cores): 0' (bottom left) to 20' (top right) bgs



Photograph 16. P1-1A (all cores): 20'-30' (bottom two boxes) & 30'-35' (top box) bgs





Photograph 17. P3-2: 0' (left) to 5' (right) bgs



Photograph 18. P3-2: 5' (left) to 10' (right) bgs





Photograph 19. P3-2: 10' (left) to 15' (right) bgs



Photograph 20. P3-2: 15' (left) to 20' (right) bgs





Photograph 21. P3-2: 17.5' (bottom left) to 45' (top right) bgs



Photograph 22. P4-7: 0' (left) to 5' (right) bgs





Photograph 23. P4-7: 5' (left) to 10' (right) bgs



Photograph 24. P4-7: 10' (left) to 15' (right) bgs





Photograph 25. P4-7: 15' (left) to 20' (right) bgs



Photograph 26. P4-7: 20' (left) to 25' (right) bgs





Photograph 27. P4-7: 25' (left) to 30' (right) bgs



Photograph 28. TN-2 (all cores): 0' (bottom left) to 30' (top right) bgs





Photograph 29. T/O-3: 0' (top right box) to 35' (bottom left box) bgs



Photograph 30. T/O-3: 35' (top left) to 80' (bottom right) bgs





Photograph 31. T/O-5 (all cores): 0' (bottom left) to 29' (top right) bgs



Photograph 32. TS-2 (all cores): 0' (bottom left) to 30' (top right) bgs



# **Attachment D. Daily Field Reports**



Date Mon, 3/26/2018

PROJECT: St. Anthony Mine										_				
JOB NO: 233001076		Weather		Bright Sun	İ	☐ Suni	ny	⊠ O ca	ver- ast		Rain		Snow	
CLIENT: United Nuclear Corpora	ation	Temp. °F		<32		32-50	$\boxtimes$	50-70	□ <b>7</b>	0-85	□ 85- 100		□ >100	
CONTRACTOR: Cascade Drillin	ng	Wind		Still		⊠ Mode	er.	☐ Hiç	gh	Rep	ort No.			
PROJECT MANAGER: Melanie	Davis	Humidity	′ 🗆	Dry		⊠ Mode	er.	☐ Hu	ımid			1		
Onsite Personnel														
Name	Company				200	sition				-	Remar	ke		
Cameron Fritz	Stantec					Engine	n.			<u>'</u>	Cilian	NO		
		ما												
Rob Murphy	Cedar Cree	eK				cientis								
Arnold	Cascade					Supervi	SOI	ſ						
Sopotyn Lorn	Cascade													
Anthony Martinez	Cascade													
Joey Vigueria	Cascade				не	elper								
Equipment														
Item				Comp	nar	nv			0	p Hr	S			
CME LAR 75 track rig w/hol	llow stem auger			Casc						<u> </u>				
OWE EAR 13 tracking willow	low stern auger			Casc	Jac									
Safety:		•												
No incidents reported														
Activities Summary:														
First day of St. Anthony work. I then met Breanna Van (Stanted Patel (AVM) for rad and site sa in the Lobo Tract borrow area, deep.	c) and followed her fety training. After	to the Sit finishing t	te. V rain	Ve arr ing at	ive 10	ed at 8a 0:30, we	am e m	and n	net w to th	rith N e firs	lat and st drillir	l V ng	ictor location	
After completing L1-1, we move and completed drilling to 20' at leave and were off-site by 5:15	4:30. After frisking													
Total depth drilled: 60 ft Total depth cored: 40 ft Total CA brass liner samples co	ollected: 17													
	By: C. F	ritz				7	Γitle	e: Fie	eld Er	ngine	eer			



Date Tue, 3/27/2018

PROJECT: St. Anthony Mine				_			ı	1	
JOB NO: 233001076		Weather	☐ Bright Sun	☐ Sunny	⊠ O ca	ver- ast	⊠ Rain		Snow
CLIENT: United Nuclear Corpora	ation	Temp. °F	□ <32	⊠ 32-50 □	50-70	7	100	)	] >100
CONTRACTOR: Cascade Drillin	ıg	Wind	☐ Still	⊠ Moder.	□ Hi	gh	Report No		
PROJECT MANAGER: Melanie	Davis	Humidity	□ Dry	☐ Moder.	⊠ Hu	ımid		1	
Onsite Personnel									
Name	Company		Po	osition			Remai	ks	-
Cameron Fritz	Stantec		Field			rtoma			
Rob Murphy	Cedar Cree	k		Scientist					
Arnold	Cascade	,,,		Superviso	r				
Sopotyn Lorn	Cascade								
Anthony Martinez	Cascade			Oriller Helper					
Joey Vigueria	Cascade			lelper lelper					
Joey vigueria	Cascade			ieihei					
Equipment									
Item			Compa	any		0	p Hrs		
CME LAR 75 track rig w/hol	low stem auger		Casca	ade					
Safety:									
No incidents reported									
Activities Summary:									
Arrived to site at 7:10am and has support trucks back onto the rother moved to L1-4 location, ar The drillers then went to retriev hole. Drilling was completed at across the arroyo to the L2 hole blocked access to the borehole topsoil/overburden pile. Rob an	ad before addition and drilling began at the flatbed truck 11:00 after drilling as. However, upon locations on the e	al rain can t 8:30. Afte to prepare to 20' and arrival at east side o	ne and ma er drilling to e for loadin d the rig wa the L2-1 lo f the arroyo	de it too m o 20' at 9:1 og up the rig as loaded to ocation, we o. As a res	uddy : 5, the g to m ip onto disco ult we	and or rig who we have a contracted with a contracted and	difficult. The vas moved areas after flatbed to d a cattle fored on to the	e rig to L1 the i move ence ie ne	was 1-3. next e that earby
Drilling began at 1:10 at T/O-3 awe had to stop work due to ligh refusal (and a 50-for-bounce material)	tning. After a 1-hr	delay, woi							
At 4:30, the rig was moved to T frisking all persons and trucks for					rt first	thing	g tomorrow	. Afte	ər
Total depth drilled: 69 ft Total depth cored: 29 ft Total CA brass liner samples co	ollected: 21								
	By: C. F	ritz		Titl	e: Fie	eld Ei	ngineer		



PRO IECT: St. Anthony Mine

#### Daily Field Report

Date Wed, 3/28/2018

T TOOLOT. Ot. 7 and only will to								
JOB NO: 233001076		Weather	□ Bright Sun	⊠ Sunny	□ Overcast	- □ Rai	in [	□ Snow
CLIENT: United Nuclear Corpor	ation	Temp. °F	□ <32	□ 32-50 🗵	50-70	70-85	85- 100	□ >100
CONTRACTOR: Cascade Drillin	ng	Wind	□ Still	⊠ Moder.	□ High	Report	No.	
PROJECT MANAGER: Melanie	Humidity	⊠ Dry	☐ Moder.	☐ Humio	t	1		
Onsite Personnel								
Name	Company	/	F	Position		Re	marks	
Cameron Fritz	Stantec		Field	d Engineer				
Rob Murphy	Cedar Cre	ek	Soi	I Scientist				
Arnold	Cascade	:	Drilling	g Superviso	r			
Sopotyn Lorn	Cascade	:		Driller				
Anthony Martinez	Cascade			Helper				
Joey Vigueria	Cascade	:		Helper				
Equipment								
Item			Com	pany		Op Hrs		
CME LAR 75 track rig w/ho	llow stem auger		Caso	cade				

#### Safety:

No incidents reported

#### **Activities Summary:**

Arrived to the rig at 7:15am and had safety tailgate. After our meeting and warming up the rig, drilling began at T/O-3 and 8:20. Drilling continued until 10:15 before encountering mechanical issues with the rig. The transmission partially broke down, resulting in 2<sup>nd</sup> and 4<sup>th</sup> gears being the only functional gears. While Arnold went to make a phone call to determine a course of action to fix the rig, the rest of us drove to the top of pile 4 to evaluate the possibility of using a full-size truck rig to access and drill the upcoming locations. Soap said his truck rig would be much faster for drilling the holes throughout the site, and should be able to access all of the locations, other than the 3 northernmost holes on pile 4, which appeared to be blocked by erosion channels that were too deep to drive (or even track) over. We'll need to discuss with Ricky Spitz how to access these locations.

After returning to the rig at 11:45, Arnold was there already and said he would be taking Jose back to Arizona to retrieve the full-size truck rig. They left the site, with the intention to return with the truck tomorrow morning. Soap noted he would have brought the truck rig from the start had he known the true nature of the terrain on site, however he was told a track rig would be required. We discussed and agreed that a pre-job site visit would have solved many of the problems we encountered today, as the track rig was clearly not the best option for this job.

At noon, I drove back up to pile 4 to find cell phone service and call Jason Cumbers (Stantec) to discuss the day's events. We decided we would go ahead with bringing in the new rig and would discuss additional costs at a later date with Cascade.

Drilling resumed at T/O-3 at 12:30, though speed and power were limited due to the lack of a fully functional transmission. After sampling at 35', Soap stopped drilling because the rig lacked enough power to drill deeper without the risk of the auger getting stuck. We then walked around the remaining T/O holes to determine how to proceed with the track rig. It was decided to leave T/O-3 at 35' and finish it when the truck rig arrives, and in the



meantime to move to T/O-2. This hole is estimated to involve only 25' of drilling and thus will be doable with the
track rig. Also, this location would not be accessible with the truck rig. Drilling started at 2:15 and was completed
at 3:30 after drilling into shale bedrock at 25'. All parties left the site at 4:30pm.

Total depth	drilled: 60 ft
Total depth	cored: 35 ft

Total CA brass liner samples collected: 12

Dv. C Eritz	Title: Field Engineer
By: C. Fritz	Title: Field Engineer



Date Thu, 3/29/2018

PROJECT: St. Anthony Mine										
JOB NO: 233001076		Weather		Bright Sun	⊠ Sunny		ver- ast	□ Ra	ain	☐ Snow
CLIENT: United Nuclear Corpor	ation	Temp. °F		<32	□ 32-50 🗵	50-70	70	0-85	35- 100	□ >100
CONTRACTOR: Cascade Drillin	ng	Wind		Still	⊠ Moder.	□Hi	gh	Repor	t No.	
PROJECT MANAGER: Melanie	Humidity		Dry	☐ Moder.	□Нι	umid		1	l	
Onsite Personnel										
Name	Company			Po	sition			Re	emarl	<b>KS</b>
Cameron Fritz	Stantec			Field	Engineer					
Rob Murphy	Cedar Cree	ek Soil Scientist								
Sopotyn Lorn	Cascade	de Driller								
Anthony Martinez	Cascade			H	elper					
Joey Vigueria	Cascade			H	elper					
	·									
Equipment										
Equipment				0						
Item				Compa			О	p Hrs		
	llow stem auger			Compa			0	p Hrs		
Item	llow stem auger						O	p Hrs		

#### Safety:

No incidents reported

#### **Activities Summary:**

Arrived to the front gate at 7am, had safety tailgate at 7:45 after bathroom breaks. At 8:15, the rig was moved from T/O-2 to T/O-4 location and drilling was started. This hole was finished at 11:15 after drilling to 35'. Some extra time was involved due to stopping at 30' and 35' to examine surrounding terrain and our soil samples to determine if we had reached native soil at the bottom of the pile.

The rig was then moved to T/O-6 and drilling started at 11:45. This hole was completed after encountering native soil at only 10' depth, and sandstone bedrock at 15'. At this location, the pile is likely located atop a sandstone shelf similar to those in the surrounding area.

Soap and Anthony then left the site to go back to the casino for lunch and to contact Joey, who at the time was driving the truck rig from Phoenix to the site, for an ETA on his arrival with the rig. In the meantime, Rob and I drove up to scout pile 4 locations again to re-evaluate access for the truck rig. We were able to find a route that should allow the rig to reach all borehole locations atop the pile. We then went to evaluate access to the Topsoil North pile, and widened an opening in the road berm that should allow the rig to pass through and access the pile.

Soap and Anthony returned at 2:15 and we all proceeded to go evaluate most of the remaining borehole locations at piles 1, 2, and 3, as well as the Topsoil South pile. We returned to the rig at 3:15 and Joey still had not arrived, so Soap and Anthony loaded the track rig onto the flatbed and prepared it for transport back to Albuquerque, where the transmission will be worked on.

At 4:30, Joey finally arrived with the truck rig. All three drillers then began work setting it up and making mechanical adjustments to prepare it for drilling tomorrow. The finished up and left the site at 5:50 after being frisked for radiological contamination. I left the site soon after at 6pm.



By: C. Fritz	7 Title: Field Engineer	
Total depth drilled: 50 ft Total depth cored: 0 ft Total CA brass liner samples collected: 12		



Date Fri, 3/30/2018

PROJECT: St. Anthony Mine									
JOB NO: 233001076		Weather	☐ Bright Sun	☐ Sunny	□ O	ver- ast	□ F	Rain	☐ Snow
CLIENT: United Nuclear Corpora		Temp. °F	□ <32	□ 32-50 □	50-70	□ 70	)-85	□ 85- 100	□ >100
CONTRACTOR: Cascade Drillin	ng	Wind	☐ Still	⊠ Moder.	☐ Hig	gh	Repo	ort No.	
PROJECT MANAGER: Melanie	Davis	Humidity	⊠ Dry	☐ Moder.	□ Hu	ımid		1	
Onsite Personnel									
Name	Company		P	osition			R	Remark	(\$
Cameron Fritz	Stantec			l Engineer				Cilian	
Rob Murphy	Cedar Cree	L I		Scientist					
Sopotyn Lorn	Cascade	^		Driller					
Anthony Martinez	Cascade			Helper					
Joey Vigueria	Cascade			Helper					
Joey Vigueria	Cascade		Į.	leipei					
Equipment									
Item			Comp	any		O	o Hrs	5	
CME 85 drill rig w/hollow	stem auger		Casc	ade					
Safety:									
No incidents reported									
Activities Summary:									
Arrived to gate at 7am, and to rup LAR track rig to make sure idrilling resumed at T/O-3 at 35 in the hole). Shortly thereafter, after drilling to 80 ft. The actual some time and came to different have to be revisited to make a	t was secure, then ft after the rig was Joey left to drive the depth of contact was conclusions. He	began pro aligned when track right with native	epping the rith the exing back to A remains f	e CME 85 tro sting hole a Albuquerque ully unknow	uck rion nd co e. T/O n, Ro	g for onections of the second	drillin ted to as fin d I dis	g. At 8 the a ished a scusse	Bam, ugers (still at 2pm ed for
Around 2:45, Bryan Nydoske (0 discuss the work thus far. At 3: completed after drilling to 70 ft  Total depth drilled: 115 ft	15, drilling began a	it the near	by T/O-1	location and					
Total depth cored: 45 ft Total CA brass liner samples co	ollected:								
	By: C. F	ritz		Title	e: Fie	eld Er	ngine	er	



Title: Field Engineer

Date Sat, 3/31/2018

		Date	<b>Cat</b> , 0/0	172010					
PROJECT: St. Anthony Mine					1		ı		
JOB NO: 233001076		Weather	□ Bright Sun	⊠ Sunny	□ Ov		□ F	Rain	☐ Snow
CLIENT: United Nuclear Corpora	ation	Temp. °F	□ <32	□ 32-50 🗵	50-70	⊠ 70	)-85	□ 85- 100	□ >100
CONTRACTOR: Cascade Drillir	ng .	Wind	⊠ Still	☐ Moder.	☐ Hig	h	Rep	ort No.	
		Humidity	⊠ Dry	☐ Moder.	☐ Hur	nid		•	1
PROJECT MANAGER: Melanie	Davis								
Onsite Personnel									
Name	Company	/	Р	osition			F	Remar	ks
Cameron Fritz	Stantec		Field	l Engineer					
Rob Murphy	Cedar Cree	ek		Scientist					
Sopotyn Lorn	Cascade		I	Driller					
Anthony Martinez	Cascade		H	Helper					
Joey Vigueria	Cascade		ŀ	- Helper					
Equipment									
Item			Comp	anv		Or	Hrs	3	
CME 85 drill rig w/hollow	stem auger		Casca						
3	3.								
Safety:									
No incidents reported									
Activities Summary:									
Arrived on-site at 7am, had saf									
equipment to move areas, and									
(east of the arroyo) and began									
before moving on to L2-2. In th									
same conditions were encounted									
drilling began at L2-5, and was									
mechanical issue with the auto								-7 ther	n was
completed after 20' of drilling. T	he drillers then to	ok a 30 m	inute break	k due to wa	rm wea	ather			
At 2:30, the first hole with corin	a was begun at L3	2-6 and fin	siched afte	r 20' of cori	na ana	l cam	nnlin	a The	ria was
then moved to the other coreho									
sampling. We then moved over									
drillers. It was determined that									
both sides of the narrow pile. A									opes on
	, , , , ,		. ,						
The drillers left the site at 5:30p				reafter once	we ha	ad fin	ishe	d unlo	ading
core samples near the site entr	ance and covering	g with a tar	p.						
Total depth drilled: 130 ft									
Total depth cored: 40 ft									
Total CA brass liner samples of	ollected: 38								

By: C. Fritz



Date Sun, 4/1/2018

PROJECT: St. Anthony Mine										
IOP NO: 222001076		Weather		⊠ Sunny	□ Ov			Rain		Snow
JOB NO: 233001076		Temp. °F	Sun □ <32	<u> </u>	50-70		0-85	□ 85-	1	□ >100
CLIENT: United Nuclear Corpora	ation	remp. r		_ 32-30 A	30-70	□ <i>(</i>	0-03	100		_ >100
		Wind	⊠ Still	☐ Moder.	☐ Hig	h	Rep	ort No.		
CONTRACTOR: Cascade Drillir	ng				J					
PROJECT MANAGER: Melanie	Davis	Humidity	⊠ Dry	☐ Moder.	☐ Hur	mid			1	
					I					
Onsite Personnel										
Name	Company	′		osition			F	Remar	ks	
Cameron Fritz	Stantec	_		Engineer						
Rob Murphy	Cedar Cree			Scientist						
Sopotyn Lorn	Cascade			Driller						
Anthony Martinez	Cascade			lelper						
Joey Vigueria	Cascade		F	lelper						
Equipment										
Item			Compa			0	p Hr	S		
CME 85 drill rig w/hollow	ı stem auger		Casca	ade						
Safety:										
No incidents reported										
No incidents reported										
Activities Summary:										
-		7.45					TL	مد مالاداد	41	_
Arrived on-site at 7am, began										
refueled the rig and drilling and drilling 30' and encountering na										
completed at 10:15am.	ative soil. The fig w	vas illeli li	ioved to 11	<b>N-</b> 1 III III IE S	anie p	iie, a	anu i	15 UI C	11 111111	iy was
completed at 10.10am.										
At 10:30, we moved across the	site to the Borrow	South are	ea. Drilling	began at B	S-1 at	11.	and	contin	ued	until
bedrock was encountered at 15										
in the CA sampler just past 20'.										
completing BS-3, we decided n	ot to drill at location	on BS-4 du	ie to expos	ed bedrock	c at the	sur	face	in the	ger	neral
vicinity, which was of no interes	st to us in terms of	potential I	oorrow mat	terial. Ther	efore, v	we n	nove	d on to	b BS	S-5.
However, this location also had	I shallow bedrock,	resulting i	n only 5' of	f soil coring	j. BS-6	exh	iibite	d impr	ove	d
borrow materials, with 20' of co	ring completed an	id no bedro	ock encour	ntered.						
After a second of the final beautiful and								. 9		
After completing the final borro										
location TS-4. Drilling began at										
TS-3 and drilling was complete After 30 mins of work on the ha										
autohammer, which was still or									JK 11	y s
				<b>.</b>						
Total depth drilled: 160 ft										
Total depth cored: 70 ft	allogtod: FO									
Total CA brass liner samples co	Directed: 52									
	By: C. F	-ritz		Title	e: Fiel	ld Er	ngine	er		



Date Mon, 4/2/2018

		Date	101011, 172	./2010						
PROJECT: St. Anthony Mine			ī	T			1			
JOB NO: 233001076		Weather	☐ Bright Sun	⊠ Sunny	□ O	ver- ist	□ F	Rain		Snow
CLIENT: United Nuclear Corpor	ation	Temp. °F	□ <32	□ 32-50 🗵	50-70	⊠ 70	0-85	□ 85- 100		□ >100
CONTRACTOR: Cascade Drillin		Wind	□ Still	☐ Moder.	⊠ Hig	jh	Rep	ort No.		
PROJECT MANAGER: Melanie		Humidity	⊠ Dry	☐ Moder.	□ Hu	mid			1	
T TOOLOT WINTER TOOLING	Bavio									
Onsite Personnel										
Name	Company	/	P	osition			F	Remar	ks	
Cameron Fritz	Stantec		Field	Engineer						
Rob Murphy	Cedar Cree	ek		Scientist						
Sopotyn Lorn	Cascade		[	Driller						
Anthony Martinez	Cascade		F	Helper						
Joey Vigueria	Cascade			lelper						
, ,		I .			ı					
Equipment										
Item			Comp			O	p Hrs	3		
CME 85 drill rig w/hollov	v stem auger		Casca	ade						
Safety:										
No incidents reported										
The melderne reported										
Activities Summary:										
Arrived on-site at 7am, the drill	are than want to e	alvana tha	hammer n	art from the	۱ΔΡ	ria'e	ham	mar v	whil	ام
unloaded cores and buckets of										
The drillers then worked on atta										
10am, drilling was completed a										
Significant amounts of rock we										
determine whether the rock wa										
for such rocky material. The absteam. We took a break from 1								e noie	ar	ıa
Steam. We took a break from 1	1.45-12.15 to allow	w tile toolii	ig to cool i	Jeiore III IISI	iiig u	16 110	ic.			
Drilling then began at TS-1 at 1	1:20 after moving t	he original	location to	the top of	the ni	le ne	ar th	e road	d th	at
comes up from pile 1. The original										
35', again hitting rocky materia										
rock shelf, with topsoil material below.	pilea on the north	SIUE OI THE	s snen, abo	Jul OU IT ao	WII (O	uie f	ialive	grou	ııu	suriace
DGIOW.										
At 3:15, the rig was moved to le	ocation P1-3 and to	owered un	. However	. drilling wa	is not	starte	ed at	this l	oca	tion
due to an increase in wind spe										
(hard hats were being blown of										
radiation.	,, and an marriage	4.5 545564	ability loft	and only at t	J. 10 a		. J. 19		<i>,</i> u 1	<b>.</b> .
Total depth drilled: 125 ft										
Total depth cored: 35 ft										
Total CA brass liner samples c	ollected: 30									
	By: C. F	Fritz		Title	e: Fie	ld Er	naine	er		
	_j. J. i						ىى			



Date Tue, 4/3/2018

PROJECT: St. Anthony Mine										
JOB NO: 233001076		Weather	☐ Bright Sun	⊠ Sunny	□ Ov			Rain		Snow
20001010		Temp. °F		□ 32-50 🖂	<del></del> ,		0-85	□ 85-	1	□ >100
CLIENT: United Nuclear Corpora	ation	•						100		
CONTRACTOR: Cascade Drilling		Wind	☐ Still	⊠ Moder.	☐ Hig	h	Rep	ort No.		
OONTRACTOR. Oddoddo Dillill	<u> </u>	Humidity	☑ Dry	☐ Moder.	☐ Hur	mid			1	
PROJECT MANAGER: Melanie	Davis									
Onsite Personnel										
Name	Company	,	Po	osition			F	Remar	ks	
Cameron Fritz	Stantec			Engineer						
Rob Murphy	Cedar Cree	ek		Scientist						
Sopotyn Lorn	Cascade			Oriller						
Anthony Martinez	Cascade			lelper						
Joey Vigueria	Cascade			lelper						
, ,	Cascade			. J. P J.						
Equipment		T								
Item			Compa			O	p Hrs	S		
CME 85 drill rig w/hollow	v stem auger		Casca	ade						
Safety:										
No incidents reported										
No moldents reported										
Activities Summary:										
Arrived to site at 7:10cm bags	n warming up rig o	and had to	lanto mont	ting At Oon	a baar	an di	rilline	n D1 2		
Arrived to site at 7:10am, bega Encountered numerous boulde	re with voide in he	twoon roc	ulted in let	ung. At oan	n, bega	all UI	ron	the au	aor	c
Around 10am, Victor Patel (AV										
drillers' working area. At this tin										
upcoming maintenance on the										
hole. Resumed drilling at 40' at										
continued grinding on rock. So										
so they could return to the short										
would risk breaking augers bey										
replacement costs at Stantec's stop after today.	expense. I men ca	alled my S	upervisor to	บ นเรียนธร แ	iis opt	1011 6	ilia v	we agr	eeu	ιο
Stop after today.										
At 12:15, moved the rig to locate	tion P1-1 and hear	an coring	After drillin	a to 20' de	nth dr	illere	atte	mntec	l to	lower
the sampling rod but encounter										
the bottom. Apparently, the aug										
from the hole and noted cracks										agois
significant dame to additional a										rkshon
I left the site at 2:45 after organ										
		J			J			•	•	
Total depth drilled: 60 ft										
Total depth cored: 20 ft	ollogtod: 10									
Total CA brass liner samples co	onected: 12									
	5 6 5			<b></b>	. F.					
	By: <u>C.</u> F	-ritz		Title	e: <u>Fiel</u>	<u>ld E</u> r	igine	er		



Date Mon, 4/9/2018

PROJECT: St. Anthony Mine											
JOB NO: 233001076		Weather		right Jun	⊠ Sunı	ny	□ Ov ca:			Rain	☐ Snow
CLIENT: United Nuclear Corpora	ation	Temp. °F	_	32	□ 32-50	⊠ 50	)-70	□ <b>7</b> 0	)-85	□ 85- 100	□ >100
CONTRACTOR: Cascade Drillin	ng	Wind	□ S	itill	⊠ Mode	er. 🗆	] Hig	h	Rep	ort No.	
PROJECT MANAGER: Melanie Davis		Humidity	√ ⊠ D	ry	☐ Moder. ☐ Hun		umid 1				
Onsite Personnel											
Name	Compar	ny Position						Remarks			
Cameron Fritz	Stanted	;	Field Engineer								
Rob Murphy	Cedar Creek		Soil Scientist								
Sopotyn Lorn	Cascad	е		Driller							
Anthony Martinez	Cascad	е		Helper							
Joey Vigueria	Cascad	е		He	elper						
					-						

Equipment		
Item	Company	Op Hrs
CME 85 drill rig w/hollow stem auger	Cascade	

#### Safety:

At 12pm, at a depth of 60' while drilling boring P1-2 in shale pile 1, a very loud bang came from the hole. I was standing next to the rig at the time and would describe it as a deafening (I didn't have earplugs in at that moment), percussive boom from underground. Rob was standing about 50 feet away behind his truck and could feel the impact of it. We immediately stopped work and gathered away from the rig. After waiting about 30-40 minutes to let things settle (and air out in case there was any gas of some sort), the driller slowly drilled down a couple more feet and continued to hear a couple of small pops from inside the hole. We then shut down the rig without continuing further and I went to call Stantec and Cascade supervisors.

Cascade operations manager requested that we immediately stop work (which we already had) and leave the area as a precaution until we could get more information and figure out what we were dealing with. With the augers still in the hole, we then left the site. Later in the day, I had a conference call with Cascade management, health and safety, and the drilling crew to discuss the events. It was decided that their ops manager would meet me and the drillers in the morning with a gas meter to see if there were any detectable gases in the borehole.

#### **Activities Summary:**

Arrived to site at 7am, collected materials from staging area near entrance, then began warming up rig where it had been left on 4/3 on shale pile 1 and had tailgate meeting at 7:30. At 8am, the rig was moved about 5' over from location P1-1 and drilling commenced at P1-1A, with the intention to avoid the rock that bent the auger in P1-1. Stopped from 8:15-8:45 while helpers refueled rig and Sop went to retrieve materials from support truck. Drilling then resumed, with coring from the surface down to 20' without collected SPT samples. P1-1A was completed after drilling to 35' and encountering native bedrock. We then moved to location P1-2, towered up at 10:30, and began drilling at 10:45. At 12pm, while drilling from 55-60', the safety incident described above occurred. All parties left site at 2pm after I made the initial phone calls to inform Cascade and Stantec supervisors of the incident.

Total depth drilled: 100 ft Total depth cored: 35 ft

Total CA brass liner samples collected: 14





Date Tue, 4/10/2018

PROJECT: St. Anthony Mine					T	1	
JOB NO: 233001076		Weather	□ Bright Sun	⊠ Sunny	□ Over- cast	☐ Rain	☐ Snow
CLIENT: United Nuclear Corpor		Temp. °F	□ <32	□ 32-50 🗵	50-70		5-
CONTRACTOR: Cascade Drillin	ng	Wind	⊠ Still	☐ Moder.	□ High	Report No	0.
PROJECT MANAGER: Melanie	Davis	Humidity	⊠ Dry	☐ Moder.	☐ Humid		1
Onsite Personnel							
Name	Company			osition		Rema	arks
Cameron Fritz	Stantec	_		Engineer			
Rob Murphy	Cedar Cree	k		Scientist			
Bryan Nydoske	Cascade		•	ons Manage	er		
Sopotyn Lorn	Cascade			Driller			
Anthony Martinez Joey Vigueria	Cascade Cascade			lelper lelper			
	Cascade		ı	ieipei			
Equipment		1	0		1 4	2.11	
Item			Compa Casca		(	Op Hrs	
CIME 85 drill rig w/nollov	CME 85 drill rig w/hollow stem auger			ade			
Safety:							
No incidents reported							
Activities Summary:							
At 7:15am, I met the drilling creyesterday's HSSE incident. At approaching the borehole. We including measuring gas levels a radiation dosimetry badge on stated the requirements for onon the site today, without a bad with fresh air readings, Bryan a of the gas meter just inside the ppm carbon monoxide gas. We the findings with Cascade heal discuss. It was decided that the that will be used to proceed with At 11am, Rob and Bryan left we borehole. We then let the site as	8am, after arriving to discussed the method and removing tooling his person and recesite personnel having, to address the approached the hole top of the auger operall then left the site of the and safety. I also de drillers would return the tooling removal for thile the drillers and	to location nods that ng from t quested a ng said b current se while the pening and gat o called mrn to Alburom P1-2	n P1-2, Bry would be ended he hole. At variance fadges. I prafety situate rest of used measure hered at any supervisurquerque would to the rig	ran led a sa employed to this time, E rom the he- ovided verb ion. At 9am s stayed band 4.6 ppm location with or and Star vith Bryan to	afety mee o safely a Bryan not alth and s oal affirmant, after can ck about hydrogen th cell phontec healt o prepare	ting prior to ddress the ed that he safety plan, ation that h llibrating th 150'. He pl sulfide ga one service h and safe engineerii	situation, did not have, which he could be he gas mete laced the tip s and 346 he to discuss hty to hg controls ound the
methods for tooling removal. It the chance of igniting gases. We gas is not pulled up into the wo Total depth drilled: 0 ft	was decided that d Ve will also record g	rilling mu jas readir	d would be	mixed and	l placed o	lown-hole t	to reduce
Total depth cored: 0 ft Total CA brass liner samples c	ollected: 0						
	By: C. F	ritz		Title	e: Field E	Engineer	



Date Wed, 4/11/2018

PROJECT: St. Anthony Mine								
JOB NO: 233001076		Weather	Sun	☐ Sunny	□ Over- cast	□ Rain	□ Snow	
CLIENT: United Nuclear Corpor	ation	Temp. °F		□ 32-50 □		10	0	
CONTRACTOR: Cascade Drillin	ng	Wind		⊠ Moder.	☐ High	Report No		
PROJECT MANAGER: Melanie	Humidity	√ ⊠ Dry	☐ Moder.	☐ Humid		1		
Onsite Personnel								
Name	Compan	v	Po	osition		Rema	rks	
Cameron Fritz	Stantec			Engineer		rtoma	110	
Rob Murphy	Cedar Cre			Scientist				
Sopotyn Lorn	Cascade			Ocientist Oriller				
Anthony Martinez	Cascade			lelper				
Joey Vigueria	Cascade			lelper				
Joey vigueria	Cascaut	<del>,</del>	I I	ieipei				
Equipment								
Item			Compa	any	С	p Hrs		
CME 85 drill rig w/hollov		Casca			- σρ τ πσ			
9	OWE 03 drilling withollow sterm adder			0400440				
		I			l l			
Safety:								
No incidents reported								
Activities Summary:								
Began day on standby while waiting for Stantec health and safety to approve the updated health and safety plan, which will address procedures related to the gases encountered at P1-2. At 10am, I received the updated version of the HASP and we drove to the site. At 11am, we had a safety meeting to discuss procedures for tooling removal from the borehole. Work began at 12:45, with drilling mud being mixed and placed down the hole. Immediately after pumping the mud into the hole, a spike in H2S and CO was detected at top of the hole (3ppm H2S and 200 ppm CO). We then waited 10 mins to air out the hole before proceeding. Sop then pulled the AWJ sampling rods in 30' increments, with gas readings between increments. He then began pulling up augers in 5' increments, again with gas readings between each increment. At 2pm, with 25' of auger still in the hole, H2S spiked to 5ppm. We took a 20 min break until the gas meter stopping beeping (indicative of elevated readings). At 2:30, backfilling of the hole with cuttings was completed and the drillers began packing up to move to the next location. The drillers then took the mud mixer and other equipment back to the staging area.  At 3:30, the rig was moved to location P3-2 and coring began at 4pm. Auger refusal was encountered at 45',								
consistent with expected depth rig and work area to move to no	to native bedrock	k based on	assessmer	nt of surrou				
Total depth drilled: 45 ft								
Total depth cored: 45 ft								
Total CA brass liner samples c	ollected: 12							
	By: C	Erit-		T:41	o: Field F	nginoor		



Date Thu, 4/12/2018

		Date	1110, 17	12/2010						
PROJECT: St. Anthony Mine							1			
JOB NO: 233001076		Weather	□ Bright	t ⊠ Sunr	-	Over- cast		Rain		Snow
CLIENT: United Nuclear Corpora		Гетр. °F	□ <32	□ 32-50	□ 50-7	0 🗵 7	0-85	□ 85- 100		□ >100
CONTRACTOR: Cascade Drillir	na	Wind	☐ Still	☐ Mode	er. 🛭 H	ligh	Rep	ort No.		
PROJECT MANAGER: Melanie		Humidity	√ ⊠ Dry	□ Mode	er. 🗆 H	lumid			1	
					<b>.</b>		l			
Onsite Personnel										
Name	Company			Position			F	Remar	ks	
Cameron Fritz	Stantec		Fiel	d Enginee	r					
Rob Murphy	Cedar Creek	(	So	il Scientist	:					
Sopotyn Lorn	Cascade			Driller						
Anthony Martinez	Cascade			Helper						
Joey Vigueria	Cascade			Helper						
Equipment										
Item			Com	pany		0	p Hrs	S		
CME 85 drill rig w/hollow	stem auger		Caso							
Safety:										
No incidents reported										
Activities Summary:										
Arrived to site at 7:10am, bega location P3-2 to P3-4, and drilli was seen at P1-2 just prior to the have significant organics. Robe caution. After connecting a smach CO were measured at 22 ppm explosive limit for methane. We site to make phone calls to suppull out of the hole as previously the same pile using drilling much manager noted that mud could better option for this site. I told that he would have to speak with We then returned to the rig, who read 32 ppm H2S, 499 ppm C0 hole. By this time, winds were particular to the rig.	ng began at 8:30. And the explosion was not suggested that we stall hose to the gas not and 500 ppm, respectively employed at P1-2d to suppress gas and the circulated us him that I could not the Stantec manager with the gas meter with the gas meter with the gas meter with the gas meter with the gas meter with grand 99% LEL. The bicking up significant	round 9:: oted in the stop and neter and rectively. A least the make the make the rective and was still rece also tily and well a	30, after of e auger of take a gad taking a Also, the moved aw d safety the ervisor are final callow stemme final callout that powers an owere strong after the eading from th	drilling to a cuttings. It is reading a reading a LEL reading ay from the old their dead I discussion tial, howe auger rig I of whether ossibility and om 4' down ticeable reading than (	HO', black was verified in the half bout 4' and the er to brand its and the control of the contr	ck maery bla nole a down at 62 hole. A o use e pose e Cas at mu- ring in associa- ole. Ti gg sm le's 35	terial teck ar s a p the formal formal the s sibilit tecade d rota a dif ated he m ell do mpl	similard apprace of the low am, we came ray of community of community and the low and the	H2S wer e le metl ontir ation rig,	o what red to and fit the hods to nuing in and at time of the safe
drilling. Because of the wind an tomorrow to pull tooling from th					p work	for the	e day	and r	etu	rn
Total depth drilled: 40 ft										
Total depth cored: 0 ft										
Total CA brass liner samples of	ollected: 13									
	By: C. Fr	itz		Т	itle: F	ield E	naine	er		



Title: Field Engineer

Date Fri, 4/13/2018

PROJECT: St. Anthony Mine					1		1	
JOB NO: 233001076		Weather	□ Bright Sun	⊠ Sunny	□ O	ver- ast	☐ Rain	⊠ Snow
CLIENT: United Nuclear Corpor		Temp. °F	□ <32	⊠ 32-50 □	50-70	□ <b>7</b> 0	0-85 🗆 85 10	_
CONTRACTOR: Cascade Drillin	ng	Wind	☐ Still	☐ Moder.	⊠ Hig	gh	Report No	).
PROJECT MANAGER: Melanie	Davis	Humidity	□ Dry	⊠ Moder.	□ Hu	mid		1
Onsite Personnel								
Name	Company		Р	osition			Rema	rks
Cameron Fritz	Stantec			Engineer				-
Rob Murphy	Cedar Cree	k		Scientist				
Jesse Dillon	Cedar Cree			cologist				
Sopotyn Lorn	Cascade			Driller				
Anthony Martinez	Cascade		ŀ	Helper				
Joey Vigueria	Cascade			Helper				
Equipment		_						
Item			Comp	oany		0	p Hrs	
CME 85 drill rig w/hollov	v stem auger		Casc	ade				
Safety:								
No incidents reported								
Activities Summary:								
Arrived on-site at 7:10am, had stopping work again if more da the gas meter. Did not detect hextending the measurement tu remained below 8%. Ectraction backfilling of the hole with cutti however, the wind was too strough.	ngerous gas levels 12S anywhere outs be as deep as 20' o n of tooling began a ngs was completed	are enco ide boreho down the it 8am with d at 9:15.	untered. A ole, thougl hole. CO r h gas read The rig wa	at 7:45, drille h levels up reached as dings record is moved to	ers be to 2 pr high a led aft the no	gan tom was 400 er ea	taking read vere meas 0 ppm, bu ach 5' incre ocation (P3	dings with ured after t LEL ement, and 3-3) at 9:40
Total depth drilled: 0 ft Total depth cored: 0 ft Total CA brass liner samples of	ollected: 0							
L								

By: C. Fritz



Date Sat, 4/14/2018

PROJECT: St. Anthony Mine				1	1	T	
JOB NO: 233001076		Weather	☐ Bright Sun		☐ Over- cast		☐ Snow
CLIENT: United Nuclear Corpo		Temp. °F	□ <32	□ 32-50 🗵	50-70		5- 00 □ >100
CONTRACTOR: Cascade Drilli	ng	Wind	☐ Still				0.
PROJECT MANAGER: Melanie	e Davis	Humidity	⊠ Dry	☐ Moder.	☐ Humid	I	1
Onsite Personnel							
Name	Company		P	osition		Rema	arks
Cameron Fritz	Stantec			l Engineer			
Rob Murphy	Cedar Creek	(		Scientist			
Jesse Dillon	Cedar Creek	(		cologist			
Sopotyn Lorn	Cascade			Driller			
Anthony Martinez	Cascade		ŀ	Helper			
Joey Vigueria	Cascade			- Helper			
Equipment							
Item			Comp	anv		Op Hrs	
CME 85 drill rig w/hollo	w stem auger		Casc			Op 1.110	
<b>3</b>	3						
Safety: No incidents reported							
Activities Summary:							
Arrived to site at 7am, had saf 8am, and was completed upor 40'. The rig was then moved to much blacker. Gas readings o Work was then stopped for 30 11:30-12pm. At 12:30, the rig the rig was moved over several elevated gas readings was end	n measuring 2 ppm Ho location P3-6 and of 4 ppm H2S, >500 pmins to allow the howas moved to P3-5 all feet and drilling be	H2S, 499 drilling be opm CO, ole to air o and drilling ogan agai	ppm CO, gan at 9:4 and 15% I but. Extrac ig began. n at 1pm a	and 12% LI	EL in the appending then we have a second a seco	hole after of auger cutting the top of was compled der at the s	drilling to ngs became f the hole. eted from surface, so
The rig was then moved back the problematic black, organic we took a break to air out the l backfilled, and all parties left th	material at greater on ole before extractin	depths. E	levated ga	as levels we	re measi	ured after c	drilling 30',
Total depth drilled: 140 ft Total depth cored: 0 ft							
Total CA brass liner samples of	collected: 48						
	By: C. Fr	ritz		Title	e: Field I	Engineer	



Title: Field Engineer

Date Sun, 4/15/2018

PROJECT: St. Anthony Mine		<b>VA</b> / (1)	D. D. Jack				D Dein	
JOB NO: 233001076		Weather	☐ Bright Sun	⊠ Sunny	□ O	ver- ist	☐ Rain	☐ Snow
		Temp. °F	□ <32	□ 32-50 □	50-70	⊠ 70		
CLIENT: United Nuclear Corpora	ation			1		<u> </u>	100	
CONTRACTOR: Cascade Drillin	ng	Wind	⊠ Still	☐ Moder.	☐ Hig	gh	Report No.	
DDO IEOT MANAGED, Malacia	D. '.	Humidity	⊠ Dry	☐ Moder.	□ Hu	mid		1
PROJECT MANAGER: Melanie	Davis							
Onsite Personnel								
Name	Company		Po	osition			Remar	ks
Cameron Fritz	Stantec			Engineer				
Jesse Dillon	Cedar Creek	(		cologist				
Sopotyn Lorn	Cascade			Driller				
Anthony Martinez	Cascade			lelper				
Joey Vigueria	Cascade			lelper				
Equipment								
Item			Compa	anv		Or	Hrs	
CME 85 drill rig w/hollow	v stem auger		Casca			<u> </u>	71110	
	v otom aagor		Ouou	144				
Safety:					•			
No incidents reported								
A - the title - Commence								
Activities Summary:								
Arrived on-site at 7am, had saf	ety tailgate at the rig	g at 7:30.	Drilling be	gan at loca	ition F	2-2 a	at 8am and	d continued
until encountering elevated gas								
extracted and the hole backfille	ed, and we began th	e move to	o pile 4 at	9:30. Becai	use of	the c	difficult acc	cess to
several of the pile 4 holes, Jess								
began at location P4-7 at 10:45								
depth. Work was then stopped								
was moved to location P4-9 at	12:45. After drilling	to 40' de <sub>l</sub>	pth at P4-9	, the driller	s exp	eriend	ced a sudo	den puff of
gas from the hole and work wa								
waiting for the hole to air out, to	ooling was pulled ar	nd the rig	was move	d to locatio	n P4-	8. Dri	lling begai	n at
3:40pm. Shortly thereafter, elev	vated gas levels we	re record	ed at 20' d	epth. At 4:3	30, all	partie	es left the	site to
allow the hole to air out overnig	ght before extracting	tooling.						
Total dopth drillad: 110 ft								
Total depth drilled: 110 ft Total depth cored: 30 ft								
Total CA brass liner samples of	ollected: 23							
Total OA blass liner samples of	oncolou. 20							

By: C. Fritz



Date Mon, 4/16/2018

PROJECT: St. Anthony Mine					_			
JOB NO: 233001076		Weather	Sun	☐ Sunny	⊠ Over- cast		☐ Snow	
CLIENT: United Nuclear Corpora		Temp. °F		□ 32-50 □		10	00	
CONTRACTOR: Cascade Drillin	-				☐ High			
PROJECT MANAGER: Melanie	Davis	Humidity	⊠ Dry	☐ Moder.	☐ Humid		1	
Onsite Personnel								
Name	Company		P	osition		Rema	arks	
Cameron Fritz	Stantec			Engineer		110111	ano	
Jesse Dillon	Cedar Creek			cologist				
Sopotyn Lorn	Cascade	`		Driller				
Anthony Martinez	Cascade			Helper				
Joey Vigueria	Cascade			lelper Helper				
, ,	Cascade			ieipei				
Equipment		_						
Item			Comp		(	Op Hrs		
CME 85 drill rig w/hollow	v stem auger		Casca	ade				
Safety:								
No incidents reported								
The melacine repented								
Activities Summary:								
Arrived on-site at 7:15am and u	unlaadad samalas a	at etanina	area near	entrance l	Had cafet	v meeting	at 7:45	
while rig was warming up. At 8:								
encountered elevated gas leve								
hole was backfilled. Cuttings ha								
in the water poured over the to								
at 9:45. Gas was encountered								
was moved to P4-3 and drilling								
12:45, augers were pulled and								
feeling well and was acting slig								
measuring gas levels with his f								
noted they were much more tire								
temperatures and amount of w	•	•				stop work	and left the	
site at 1:30. All drillers later said	d they felt much bet	ter shortl	y after leav	ving the wo	rk area.			
Total depth drilled: 45 ft								
Total depth cored: 0 ft								
Total CA brass liner samples c	ollected: 11							
·								
	By: C. Fr	ritz		Title	e: Field E	Engineer		



Date Tue, 4/17/2018

PROJECT: St. Anthony Mine							1		
JOB NO: 233001076		Weather	Sun	⊠ Sunny	_	ast	□ Ra		☐ Snow
CLIENT: United Nuclear Corpora		Temp. °F		□ 32-50 □	50-70	⊠ 7	0-85	85- 100	□ >100
CONTRACTOR: Cascade Drillin	ng	Wind	☐ Still	☐ Moder.	☐ Moder. ☐ High Report			t No.	
PROJECT MANAGER: Melanie	Davis	Humidity ⊠ Dry ☐ Moder. ☐				Humid 1			I
Onsite Personnel									
Name	Company		Po	osition			Re	mark	
Cameron Fritz	Stantec			Engineer			- 110	man	
Jesse Dillon	Cedar Cree	k		ologist					
Sopotyn Lorn	Cascade	.`		Oriller					
Anthony Martinez	Cascade			lelper					
Joey Vigueria	Cascade			lelper					
					ı			_	
Equipment		1	0						
Item			Compa	_		0	p Hrs		
CME 85 drill rig w/hollow	v stem auger		Casca	iae					
Safety:									
No incidents reported									
Activities Summary:									
At 7am, met drillers at location near site with cell phone service. We had a brief conference call with Cascade and Stantec supervisors and decided to abandon drilling on pile 4, and return to pile 3 to complete one unfinished hole. We then arrived to the site at 7:45, I met with other Stantec personnel who had recently arrived on-site to discuss drilling an additional hole to obtain samples for their purposes. However, after retrieving the rig from pile 4, no accessible drilling location was found in the immediate vicinity of where they had wanted to obtain samples. By this time (9am) the wind had increased and was blowing dust off the nearby piles containing material with elevated radiation levels. The on-site radiation safety officer (with subcontractor AVM) recommended stopping work, as all other on-site personnel (there to collect radiological samples from test pits) were planning on leaving due to the winds. Wind speeds above 35 mph were expected soon as well, meaning drilling could not proceed. As a result, I informed the drillers we would not be drilling today and they left the site.  Because radiological sampling was not being conducted for the rest of the day, I was able to have Mark Spitz (backhoe operator) use his equipment to create access for the drill rig onto the section of pile 3 where the last remaining borehole was located. While Mark worked on the access, Jesse and I went to examine a potential									
borrow area near the large pit then left at 10am, and I returne return from conducting separat being frisked for radiological coarea in preparation for delivering Total depth drilled: 0 ft Total depth cored: 0 ft	d to where Stantec e sampling in the a ontaminants. I then	and AVM rroyo. At left at 11:	1 personne 10:45, all ir 15 after do	l were stag ndividuals l ing invento	ged to beside	wait es my	for two self let	indi ft the	viduals to site after
Total CA brass liner samples of	ollected: 0								
	By: C.F	ritz		Titl	e: Fie	eld Er	ngineei	ſ	



PROJECT: St. Anthony Mine

## Daily Field Report

Date Wed, 4/18/2018

· · · · · · · · · · · · · · · · · · ·							
JOB NO: 233001076		Weather	r □ Bright Sun	⊠ Sunny	☐ Over- cast	☐ Rain	☐ Snow
CLIENT: United Nuclear Corpor	ation	Temp. °F	□ <32	□ 32-50 🗵	50-70 🗆 7		5- 00
CONTRACTOR: Cascade Drillin	ng	Wind	⊠ Still	☐ Moder.	☐ High	Report N	0.
PROJECT MANAGER: Melanie	Davis	Humidity	/ ⊠ Dry	☐ Moder.	☐ Humid		1
Onsite Personnel							
Name	Company	,	Р	osition		Rema	arks
Cameron Fritz	Stantec		Field	Engineer			
Sopotyn Lorn	Cascade		[	Oriller			
Anthony Martinez	Cascade		F	Helper			
Joey Vigueria	Cascade		H	Helper			
Equipment							
Item			Comp	any	С	p Hrs	
CME 85 drill rig w/hollow	stem auger		Casca			•	

#### Safety:

No incidents reported

#### **Activities Summary:**

Arrived on-site at 7am. We then went to survey the new access to pile 3, as well as access to newly proposed locations in the west borrow area near the large pit. At 7:45, we had a safety meeting while the rig warmed up at location P3-1. Drilling then began, with the additional use of a blower fan the drillers retrieved from Albuquerque yesterday. This fan will be more effective at removing gases from the borehole, and depositing them away from the working area such that the effects felt by the drillers yesterday will not be an issue again. At 8:30, after drilling to 15' depth, CO and LEL began to slowly increase at the top of the borehole. Work was then stopped so we could monitor the gas levels, which continued to increase inside the hole. Although H2S was not detected, CO and LEL increased to as high as 140 ppm and 5%, respectively. We decided not to continue drilling the hole, as we expected levels to further increase if we kept drilling deeper. Upon removing the sampler from the hole, black shale was evident in the tip of the sampler from ~16' depth.

The rig was then moved to location BW-1 in the west borrow area and coring began at 9:15. At 10:30, elevated H2S, CO, and LEL were detected in the borehole after drilling to 35' depth. Because this location was in a clean, undisturbed borrow area, it was believed that we had drilled through the potential borrow material (alluvium) and into the native shale at a depth consistent with where the shale layer is visible in the walls of the open pit just to the north, at which point gas levels began to increase. Tooling was then extracted and the rig moved to location BW-4. Drilling was completed at 20' depth without any gas issues, as we did not drill deep enough to encounter materials other than the alluvium. We then completed drilling at locations BW-3 (hit bedrock at 15') and BW-2 (drilled to 20') without incident.

After completing the final borehole of the drilling program, the drillers went to prepare the rig and support vehicles for demobilization back to the Cascade shop. While they did that, I did sample inventory and collected buckets to bring to the geotechnical testing lab in Albuquerque. After the drillers had already left the site, I left at 5pm along with the remaining on-site Stantec and AVM personnel.



	Bv: C. Fritz	Title: Field Engineer
Total CA brass liner samples collec	neu. 20	
Total depth cored: 35 ft Total CA brass liner samples collect	ted: 26	
Total depth drilled: 105 ft		



# **Attachment E. Laboratory Results**



Table E-1. Laboratory Results – Initial Properties

Sample ID	Gravimetric Moisture Content (%, g/g)	Volumetric Moisture Content (%, ft³/ft³)	Dry Bulk Density (pcf)	Wet Bulk Density (pcf)	Calculated Porosity (%)
L1-1 (10'A)	6.3	8.7	86.6	92.1	47.6
L1-2 (20'B)	10.2	17.8	109.4	120.5	33.9
L1-3 (5'A)	4.2	6.3	93.7	97.6	43.4
L1-4 (5'B)	7.5	10.6	88.2	94.8	46.7
L2-1 (5'B)	4.1	7.0	105.4	109.7	36.3
L2-1 (15'A)	5.0	8.7	108.6	114.0	34.4
L2-3 (5'A)	3.8	6.1	100.5	104.3	39.3
L2-5 (5'B)	11.8	19.8	104.8	117.2	36.6
L2-6 (10'B)	14.4	21.9	97.3	111.4	41.3
T/O-1 (20'A)	11.4	19.5	106.6	118.8	35.6
T/O-1 (45'B)	7.2	10.9	94.5	101.3	42.9
T/O-2 (15'A)	11.3	18.5	101.6	113.1	38.6
T/O-3 (15'B)	9.9	18.4	116.6	128.1	29.5
T/O-3 (40'B)	6.8	10.9	100.5	107.3	39.3
T/O-4 (5'A)	8.9	16.4	115.8	126.1	30.0
T/O-5 (20'A)	6.3	9.4	94.2	100.1	43.1
T/O-6 (5'A)	6.9	12.0	108.9	116.5	34.1
TN-2 (20'A)	6.0	7.8	81.5	86.3	50.8
BS-1 (10'A)	8.4	12.3	91.2	98.9	44.9
BS-6 (20'A)	7.0	9.5	84.7	90.6	48.8
TS-1 (5'A)	7.8	14.4	114.4	123.4	30.8
TS-2 (15'A)	8.9	14.3	99.9	108.8	39.6
1 S-2 (15'A)	8.9	14.3	99.9	108.8	39.6



TS-3 (10'A)	6.0	9.6	100.4	106.4	39.3
TS-4 (10'A)	7.0	13.8	123.4	132.0	25.4
P1-1 (15'B)	10.0	13.4	84.2	92.6	49.1
P1-1A (30'A)	3.9	4.8	76.6	79.7	53.7
P1-2 (50'A)	4.3	6.9	99.7	104.0	39.7
P2-1 (5'A)	13.2	24.6	115.8	131.2	30.0
P2-1 (25'B)	15.4	25.6	104.1	120.1	37.1
P3-1 (5'A)	7.3	13.6	116.4	124.8	29.7
P3-1 (15'A)	9.4	8.8	58.3	63.8	64.8
P3-2 (10'A)	6.6	11.1	105.5	112.4	36.2
P3-2 (20'A)	11.3	18.8	104.1	115.8	37.1
P3-3 (20'A)	8.1	13.7	105.5	114.1	36.2
P3-3 (40'A)	14.7	26.3	112.0	128.4	32.3
P3-4 (10'A)	9.3	14.4	96.2	105.2	41.8
P3-4 (30'A)	6.0	9.1	95.2	100.9	42.4
P3-4 (40'A)	7.1	13.3	117.0	125.3	29.3
P3-5 (10'A)	8.3	15.5	115.8	125.4	30.0
P3-6 (5'A)	4.8	7.8	101.8	106.7	38.4
P3-6 (20'A)	9.3	16.1	107.9	117.9	34.8
P3-6 (50'A)	6.0	10.7	110.8	117.4	33.1
P4-5 (20'A)	7.3	12.6	108.6	116.4	34.4
P4-6 (10'A)	10.0	15.9	99.0	108.9	40.2
P4-7 (5'A)	9.8	14.6	93.1	102.2	43.7
P4-7 (25'B)	6.2	11.0	110.1	117.0	33.5
P4-8 (15'B)	13.0	21.0	101.1	114.2	38.9



P4-9 (5'A)	4.4	8.3	116.7	121.9	29.4
P4-9 (35'B)	13.5	22.4	103.7	117.7	37.3
BW-1 (30'A)	9.3	13.0	87.2	95.3	47.3
BW-2 (10'A)	5.9	8.9	94.7	100.3	42.8
BW-3 (5'A)	3.8	6.1	101.0	104.8	38.9



Table E-2. Laboratory results – Particle Size Analyses

Sample ID	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	Cu	Cc	
L1-1 (10'A)	0.0	33.2	43.1	23.7	2.2E-05	0.046	0.061	2773	33	(Est)
L1-2 (20'B)	0.1	2.3	68.1	29.5	2.8E-05	0.0092	0.015	536	12	(Est)
L1-3 (5'A)	0.0	46.5	40.8	12.7	6.4E-45	0.066	0.088	1.4E+43	2.1E+42	(Est)
L1-5 (20'B)	0.0	49.7	37.7	12.6	0.0011	0.074	0.093	85	17	(Est)
L2-1 (5'A)	0.0	32.5	49.0	18.5	0.00040	0.045	0.060	150	9.4	(Est)
L2-2 (5'A)	0.0	46.3	37.5	16.2	0.00019	0.067	0.085	447	60	(Est)
L2-3 (5'A)	0.0	51.2	36.8	12.1	0.00094	0.076	0.089	95	26	(Est)
L2-4 (10'B)	0.0	28.8	50.0	21.2	3.9E-05	0.045	0.057	1462	65	(Est)
L2-5 (5'A)	0.0	2.8	48.6	48.6	4.4E-05	0.0022	0.0047	107	0.50	(Est)
L2-6 (5'A)	0.0	14.8	55.2	29.9	0.00031	0.013	0.030	97	0.43	(Est)
L2-7 (10'A)	0.0	40.1	48.2	11.7	1.9E-09	0.057	0.075	3.9E+07	4.4E+06	(Est)
T/O-1 (20'A)	0.2	3.2	66.0	30.6	0.00030	0.0088	0.016	53	0.75	(Est)
T/O-1 (45'B)	0.0	47.9	31.0	21.1	5.1E-05	0.070	0.099	1941	51	(Est)
T/O-2 (5'A)	0.0	23.0	71.5	5.5	0.0025	0.010	0.022	8.8	0.15	



T/O-3 (40'A)	0.0	51.5	34.4	14.1	0.00083	0.078	0.10	120	20	(Est)
T/O-3 (70'B)	0.5	8.7	73.8	17.1	0.00032	0.034	0.045	141	8.4	(Est)
T/O-4 (20'B)	0.0	24.8	57.7	17.5	0.00059	0.034	0.050	85	4.1	(Est)
T/O-5 (10'B)	0.0	10.1	75.3	14.6	0.0011	0.028	0.039	35	2.3	(Est)
T/O-6 (5'A)	0.0	24.3	59.7	16.0	0.00066	0.043	0.054	82	9.1	(Est)
TN-1 (5'A)	0.4	50.9	33.3	15.4	0.00074	0.077	0.097	131	17	(Est)
TN-2 (20'A)	0.0	51.9	34.4	13.8	0.00077	0.079	0.10	130	18	(Est)
BS-1 (10'A)	0.0	40.8	36.1	23.0	0.00029	0.052	0.076	262	4.4	(Est)
BS-2 (15'A)	0.0	43.0	51.6	5.3	0.0039	0.061	0.082	21	0.61	
BS-6 (20'A)	0.0	26.3	55.8	17.9	0.00018	0.054	0.062	344	43	(Est)
TS-1 (20'A)	0.0	18.2	65.1	16.7	0.0010	0.035	0.048	48	2.0	(Est)
TS-2 (10'A)	0.0	53.9	35.3	10.8	0.0019	0.087	0.12	63	3.0	
TS-3 (10'A)	0.0	16.1	68.6	15.2	0.00086	0.043	0.051	59	3.9	(Est)
TS-4 (5'A)	0.7	63.1	22.7	13.5	0.0011	0.11	0.13	118	20	(Est)
P1-1 (5'A)	18.8	49.8	20.8	10.6	0.0012	0.13	0.17	142	23	(Est)
P1-2 (30'B)	20.3	43.0	24.9	11.8	0.0010	0.11	0.16	160	21	(Est)



P2-1 (25'A)	0.3	54.0	30.7	15.1	0.00071	0.087	0.12	169	11	(Est)
P2-2 (5'B)	5.1	53.2	27.1	14.6	0.00078	0.089	0.11	141	28	(Est)
P3-1 (5'A)	19.7	64.9	15	.3	NA	0.23	0.33	NA	NA	(Est)
P3-2 (15'B)	0.0	78.8	21	.2	NA	0.20	0.25	NA	NA	(Est)
P3-2 (35'B)	1.1	68.2	30	.7	NA	0.15	0.19	NA	NA	(Est)
P3-3 (5'A)	0.3	67.7	31	.9	NA	0.15	0.19	NA	NA	(Est)
P3-3 (40'B)	1.4	56.3	42	.3	NA	0.085	0.099	NA	NA	(Est)
P3-4 (20'A)	0.0	92.7	7.	3	0.11	0.25	0.29	2.6	0.91	_
P3-4 (30'A)	0.0	92.3	7.	7	0.10	0.19	0.22	2.2	0.89	_
P3-4 (40'A)	0.0	48.1	44.2	7.7	0.0029	0.072	0.087	30	7.7	_
P3-5 (10'A)	0.0	68.6	27.8	3.6	0.020	0.099	0.12	6.0	2.2	
P3-6 (20'A)	0.0	85.2	14	.8	NA	0.20	0.24	NA	NA	(Est)
P3-6 (50'A)	7.2	76.4	16	.4	NA	0.23	0.30	NA	NA	(Est)
P4-5 (20'A)	24.9	61.0	14	.1	NA	0.30	0.39	NA	NA	(Est)
P4-6 (10'A)	0.0	48.0	41.0	11.0	0.0012	0.072	0.084	70	23	(Est)
P4-7 (5'A)	7.2	43.9	49	.0	NA	0.077	0.095	NA	NA	(Est)



P4-7 (25'B)	0.0	77.0	17.5	5.5	0.0052	0.28	0.34	65	9.6	
P4-8 (15'B)	0.5	51.9	35.5	12.1	0.0011	0.085	0.13	118	5.1	(Est)
P4-9 (35'B)	15.7	26.6	46.4	11.4	6.7E-06	0.061	0.087	1.3E+04	1160	(Est)
BW-1 (20'A)	0.0	45.4	34.9	19.7	0.0012	0.047	0.083	69	1.2	(Est)
BW-2 (10'A)	0.0	44.1	38.1	17.8	0.00035	0.062	0.084	240	18	(Est)
BW-3 (5'A)	0.0	53.1	35.9	11.0	0.0011	0.080	0.099	90	23	(Est)

d<sub>50</sub> = Median particle diameter

 $<sup>(</sup>Est) \ = \ Reported\ values\ for\ d_{10},\ C_u,\ and\ C_c\ are\ estimates,\ since\ extrapolation\ was\ required\ to\ obtain\ the\ d_{10}\ diameter$ 



**Table E-3. Laboratory Results – Atterberg Limits** 

Sample ID	Liquid Limit	Plastic Limit	Plasticity Index	Classification
L1-2 (20'A)	41	19	22	CL
L2-2 (5'B)				ML
L2-6 (5'A)	34	17	17	CL
T/O-1 (25'A)	30	16	14	CL
T/O-2 (10'A)	48	23	25	CL
T/O-3 (60'A)				ML
P1-1 (10'A)				ML
P1-2 (15'A)				ML
P2-2 (5'A)	39	15	24	CL
P3-1 (15'A)				ML
P3-3 (40'A)				ML
P3-4 (40'B)				ML
P3-5 (10'B)				ML
P3-6 (50'A)				ML
P4-8 (15'A)				ML

<sup>--- =</sup> Soil requires visual-manual classification due to non-plasticity



**Table E-4. Laboratory Results – Proctor Compaction** 

	Meas	sured	Oversize	Corrected
Sample ID	Optimum Moisture Content, (% g/g)	Maximum Dry Bulk Density (pcf)	Optimum Moisture Content (% g/g)	Maximum Dry Bulk Density (pcf)
L1 Auger Cuttings (1 & 2)	14.6	112.7		
L2 Auger Cuttings (1 & 2)	14.1	113.1		
T/O Auger Cuttings (1 & 2) (T/O-1 & T/O-3,4)	14.5	114.1		
Topsoil North Cuttings (1 & 2)	12.6	118.1		
Borrow South Cuttings (1 & 2)	13.0	115.1		
Topsoil South Cuttings (1 & 2) (TS-2 & TS-3,4)	15.2	112.7	12.3	120.0
Borrow West Auger Cuttings (1 & 2)	12.7	116.8		
P1-2 Auger Cuttings	12.8	113.8		
P3 Auger Cuttings (1 & 2)	9.9	122.4	9.2	124.6
P4 Auger Cuttings (1 & 2)	11.1	121.1	9.0	127.7

<sup>--- =</sup> Oversize correction is unnecessary because coarse fraction is <5% of composite mass



Table E-5. Laboratory Results – Triaxial Shear

Sample ID	Effective Consolidation Stress (psf)	Effective Minor Stress at Failure (psf)	Effective Major Stress at Failure (psf)	Pore- Water Pressure at Failure (psf)	Total Minor Stress at Failure (psf)	Total Major Stress at Failure (psf)	% Strain at Failure* (%)	Cohesion, c' (psf)	Friction Angle, φ' (°)
L2-1 (15'A) CU Stage 1 (6.0 psi)	861.0	367.1	1,212.6	10,803.2	11,170.3	12,015.8	2.12		
L2-1 (15'A) CU Stage 2 (12.0 psi)	1,734.8	724.2	2,597.1	11,313.4	12,037.6	13,910.5	2.96	0	35
L2-1 (15'A) CU Stage 3 (24.0 psi)	3,460.9	1,376.8	5,152.1	12,396.6	13,773.4	17,548.8	7.73	_	
L2-5 (5'B) CU Stage 1 (2.0 psi)	283.9	105.9	753.1	11,796.0	11,901.9	12,549.1	1.88		
L2-5 (5'B) CU Stage 2 (4.0 psi)	577.7	290.7	1,347.1	11,885.8	12,176.5	13,232.9	0.97	129.6	35.8
L2-5 (5'B) CU Stage 3 (8.0 psi)	1,151.2	471.6	2,222.1	12,303.9	12,775.5	14,526.0	1.13	<del>-</del>	
L2-6 (10'B) CU Stage 1 (3.5 psi)	501.3	305.2	501.2	11,945.9	12,251.1	12,447.1	0.69		
L2-6 (10'B) CU Stage 2 (7.1 psi)	1,016.3	456.6	1,483.0	12,308.7	12,765.4	13,791.8	3.02	0	32.3
L2-6 (10'B) CU Stage 3 (14.0 psi)	2,016.8	871.0	3,224.1	12,914.0	13,784.9	16,138.1	11.74	-	

<sup>\*</sup>Noted percent strain used as failure criterion.



Table E-6. Laboratory Results – Analytical Testing

Borehole ID	Sample Depth (ft)	Ra-226 (pCi/g)	Uranium (μg/kg)	Thorium-230 (pCi/g)	Gross Alpha (pCi/g)
P1-2	20	11.5 +/- 1.5	36,000	16.6 +/- 2.6	48.2 +/- 9.6
P1-2	20 (duplicate)	16.1 +/- 2.0	36,300	-	-
P1-2	40	1.25 +/- 0.30	3,700	1.11 +/- 0.23	5.3 +/- 2.1
P1-2	60	1.31 +/- 0.28	530	0.99 +/- 0.22	3.7 +/- 1.7
P2-1	10	3.85 +/- 0.58	1,000	4.11 +/- 0.69	10.5 +/- 3.2
P2-1	20	1.25 +/- 0.31	2,000	1.15 +/- 0.23	2.1 +/- 1.5
P2-1	20 (duplicate)	-	-	1.05 +/- 0.21	4.9 +/- 2.1
P2-2	10	0.91 +/- 0.21	1,000	0.89 +/- 0.19	2.7 +/- 1.5
P4-3	5	2.15 +/- 0.41	1,600	1.60 +/- 0.29	6.8 +/- 1.6
P4-5	5	29.5 +/- 3.6	29,000	19.5 +/- 3.1	65 +/- 11
P4-5	15	18.6 +/- 2.3	24,000	15.4 +/- 2.4	67 +/- 11
P4-9	20	3.14 +/- 0.48	5,300	2.51 +/- 0.42	7.0 +/- 1.5
P4-9	30	1.26 +/- 0.27	580	0.93 +/- 0.20	4.8 +/- 2.1
BW-1	10	0.76 +/- 0.22	480	0.90 +/- 0.20	6.0 +/- 2.5
BW-4	5	1.15 +/- 0.27	550	1.20 +/- 0.24	5.0 +/- 2.3
BW-4	15	0.81 +/- 0.25	610	0.90 +/- 0.20	6.6 +/- 2.5
BW-3	10	0.83 +/- 0.20	510	0.85 +/- 0.19	3.3 +/- 1.9
BW-2	5	0.73 +/- 0.22	520	0.78 +/- 0.18	5.4 +/- 2.2
BW-2	20	0.82 +/- 0.23	460	0.64 +/- 0.17	2.2 +/- 1.6



# Attachment F. Geotechnical Laboratory Testing Report

# Laboratory Report for Stantec

St. Anthony Geotech Investigation PO# 233001076-DBS

June 20, 2018 Revised July 2, 2018



Daniel B. Stephens & Associates, Inc.

4400 Alameda Blvd. NE, Suite C • Albuquerque, New Mexico 87113



June 20, 2018, Revised July 2, 2018

Cameron Fritz Stantec Consulting Services Inc. 3325 South Timberline Road Suite 150 Fort Collins, CO 80525-2903 (970) 482-5922

Re: DBS&A Laboratory Report for the Stantec St. Anthony Geotech Investigation, PO# 233001076-DBS Project

Dear Mr. Fritz:

Enclosed is the report for the Stantec St. Anthony Geotech Investigation, PO# 233001076-DBS project samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to Stantec and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC. SOIL TESTING & RESEARCH LABORATORY

Joleen Hines

Laboratory Manager

Enclosure

**Summaries** 



#### **Summary of Tests Performed**

	0		aturate					. ,								
Laboratory	itial S operti		lydraul nductiv				Moi Charac	isture :teristi			Particle Size <sup>4</sup>		ecific vity <sup>5</sup>		Atterberg	Proctor
Sample Number		VD		FW	НС	PP			WHC	$K_{unsat}$		F	C	CU <sup>6</sup>	Limits	Compaction
SA-GM 1B											Х					
SA-GM 1T											Х					
SA-GM 2B											Х					
SA-GM 2T											Х					
SA-GM 3B											Х					
SA-GM 3T											Х					
SA-GM 4B											Х					
SA-GM 5B											Х					
SA-GM 5T											Х					
SA-GM 6B											Х					
SA-GM 6T											Х					
SA-GM 7B											Х					
SA-GM 8B											Х					
SA-GM 8T											Х					
L1 Auger Cuttings (1 & 2)																Х

<sup>&</sup>lt;sup>1</sup> G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

<sup>&</sup>lt;sup>2</sup> CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

<sup>&</sup>lt;sup>3</sup> HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box,

EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

<sup>&</sup>lt;sup>4</sup> DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

<sup>&</sup>lt;sup>5</sup> F = Fine (<4.75mm), C = Coarse (>4.75mm)

<sup>&</sup>lt;sup>6</sup> CU = Consolidated Undrained Triaxial



				S	aturate	ed																
		itial S			lydrau						sture					Particl			cific			
Laboratory		operti			nducti					Charac			:			Size <sup>4</sup>			vity <sup>5</sup>	0.16	Atterberg	Proctor
Sample Number	G	VM	VD	СН	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K <sub>unsat</sub>	DS	WS	Н	F	С	CU <sup>6</sup>	Limits	Compaction
L2 Auger Cuttings (1 & 2)																						Х
T/O Auger Cuttings (1 & 2) (T/O- 1 & T/O-3,4)																						Х
Topsoil North Cuttings (1 & 2)																						Х
Borrow South Cuttings (1 & 2)																						Х
Topsoil South Cuttings (1 & 2) (TS-2 & TS-3,4)																						Х
Borrow West Auger Cuttings (1 & 2)																						Х
P1-2 Auger Cuttings																						Х
P3 Auger Cuttings (1 & 2)																						Х
P4 Auger Cuttings (1 & 2)																						Х
L1-1 (10'A)	Х	Х														Х	Х					
L1-2 (20'A)																					Х	
L1-2 (20'B)	Х	Х														Х	Х					
L1-3 (5'A)	Χ	Χ														Х	Χ					
L1-3 (5'B)																						
L1-4 (5'B)	Χ	Χ																				

<sup>&</sup>lt;sup>1</sup> G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

<sup>&</sup>lt;sup>2</sup> CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

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<sup>&</sup>lt;sup>4</sup> DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

<sup>&</sup>lt;sup>5</sup> F = Fine (<4.75mm), C = Coarse (>4.75mm)

<sup>&</sup>lt;sup>6</sup> CU = Consolidated Undrained Triaxial

		itial S		H	aturate Iydraul	lic				sture			Particle			ecific			
Laboratory Sample Number		operti VM	es · VD		nductiv FH	FW	НС	PP	Charac DPP		WHC	K <sub>unsat</sub>	Size <sup>4</sup> WS		Gra F	vity <sup>5</sup>	CU <sup>6</sup>	Atterberg Limits	Proctor Compaction
L1-5 (8' Bag)																			
L1-5 (20'B)													Х	Χ					
L2-1 (5'A)													Х	Χ					
L2-1 (5'B)	Х	Х																	
L2-1 (15'A)	Х	Х											Х	Χ			Х		
L2-2 (5'A)													Х	Х					
L2-2 (5'B)																		Х	
L2-3 (5'A)	Х	Х											Х	Х					
L2-3 (5'B)																			
L2-4 (10'B)													Х	Х					
L2-5 (5'A)													Х	Χ					
L2-5 (5'B)	Х	Х															Х		
L2-6 (5'A)													Χ	Χ				Х	
L2-6 (10'B)	Х	Х															Х		
L2-7 (10'A)													Х	Χ					

<sup>&</sup>lt;sup>1</sup> G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

<sup>&</sup>lt;sup>2</sup> CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

<sup>&</sup>lt;sup>3</sup> HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box,

EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

<sup>&</sup>lt;sup>4</sup> DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

<sup>&</sup>lt;sup>5</sup> F = Fine (<4.75mm), C = Coarse (>4.75mm)

<sup>&</sup>lt;sup>6</sup> CU = Consolidated Undrained Triaxial

		10		aturate										0	·c			
Laboratory		itial S operti		lydrau nducti				ivioi Charac	isture cteristi			Particle Size <sup>4</sup>			ecific vity <sup>5</sup>		Atterberg	Proctor
Sample Number			VD		FW	НС	PP			WHC	K <sub>unsat</sub>	WS		F	С	CU <sup>6</sup>	Limits	Compaction
T/O-1 (20'A)	Х	Х										Х	Χ					
T/O-1 (25'A)																	Х	
T/O-1 (45'B)	Х	Х										Х	Χ					
T/O-2 (5'A)												Х	Χ					
T/O-2 (10'A)																	х	
T/O-2 (15'A)	Х	Х																
T/O-3 (15'B)	Х	Х																
T/O-3 (40'A)												Х	Χ					
T/O-3 (40'B)	Х	Х																
T/O-3 (60'A)																	Х	
T/O-3 (70'B)												Х	Χ					
T/O-4 (5'A)	Х	Х																
T/O-4 (20'B)												Х	Χ					
T/O-5 (10'B)												Х	Χ					
T/O-5 (20'A)	Х	Χ															_	_

<sup>&</sup>lt;sup>1</sup> G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

<sup>&</sup>lt;sup>2</sup> CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

<sup>&</sup>lt;sup>3</sup> HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box,

EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

<sup>&</sup>lt;sup>4</sup> DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

<sup>&</sup>lt;sup>5</sup> F = Fine (<4.75mm), C = Coarse (>4.75mm)

<sup>&</sup>lt;sup>6</sup> CU = Consolidated Undrained Triaxial

Laboratory	Pr	itial S operti	es <sup>1</sup>	H Co	aturate Iydrau nductiv	lic vity <sup>2</sup>				Charac		cs <sup>3</sup>			Particle Size <sup>4</sup> at DS WS H				ecific vity <sup>5</sup>		Atterberg	Proctor
Sample Number	G	VM	VD	СН	FH	FW	НС	PP	FP	DPP	RH	EP	WHC	$K_{\text{unsat}}$	DS	WS	Н	F	С	CU <sup>6</sup>	Limits	Compaction
T/O-6 (5'A)	Х	Х														Х	Х					
TN-1 (5'A)																Х	Χ					
TN-2 (20'A)	Х	Х														Х	Χ					
TN-2 (20'B)																						
BS-1 (10'A)	Х	Х														Х	Х					
BS-1 (10'B)																						
BS-2 (15'A)																Х	Х					
BS-6 (20'A)	Х	Х														Х	Χ					
BS-6 (20'B)																						
TS-1 (5'A)	Х	Х																				
TS-1 (20'A)																Х	Χ					
TS-2 (10'A)																Х	Х					
TS-2 (15'A)	Х	Х																				
TS-3 (10'A)	Х	Х														Х	Χ					
TS-3 (10'B)																						

<sup>&</sup>lt;sup>1</sup> G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

<sup>&</sup>lt;sup>2</sup> CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

<sup>&</sup>lt;sup>3</sup> HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box,

EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

<sup>&</sup>lt;sup>4</sup> DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

<sup>&</sup>lt;sup>5</sup> F = Fine (<4.75mm), C = Coarse (>4.75mm)

<sup>&</sup>lt;sup>6</sup> CU = Consolidated Undrained Triaxial

	ln	itial S	oil		aturate Iydraul					Moi	sture					Particle	2	Sne	cific			
Laboratory		operti			nductiv				(	Charac						Size <sup>4</sup>			vity <sup>5</sup>		Atterberg	Proctor
Sample Number			VD	СН	FH	FW	НС	PP	FP	DPP	RH	EP	WHC	$\mathbf{K}_{\text{unsat}}$	DS	WS	Н	F	С	CU <sup>6</sup>	Limits	Compaction
TS-4 (5'A)																Х	Χ					
TS-4 (10'A)	Х	Х																				
P1-1 (5'A)																Х	Χ					
P1-1 (10'A)																					Х	
P1-1 (15'B)	Х	Х																				
P1-1A (30'A)	Х	Х																				
P1-2 (15'A)																					Х	
P1-2 (30'B)																Х	Χ					
P1-2 (50'A)	Х	Х																				
P2-1 (5'A)	Х	Х																				
P2-1 (25'A)																Х	Χ					
P2-1 (25'B)	Х	Х																				
P2-2 (5'A)																					Х	
P2-2 (5'B)																Х	Χ					
P3-1 (5'A)	Χ	Χ														Х						

<sup>&</sup>lt;sup>1</sup> G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

<sup>&</sup>lt;sup>2</sup> CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

<sup>&</sup>lt;sup>3</sup> HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box,

EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

<sup>&</sup>lt;sup>4</sup> DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

<sup>&</sup>lt;sup>5</sup> F = Fine (<4.75mm), C = Coarse (>4.75mm)

<sup>&</sup>lt;sup>6</sup> CU = Consolidated Undrained Triaxial

				aturate														
Laboratory		itial S operti		lydrau nducti				اMo Charac	sture teristi			Particle Size <sup>4</sup>			ecific vity <sup>5</sup>		Atterberg	Proctor
Sample Number			VD		FW	НС	PP			WHC	$K_{\text{unsat}}$			F	С	CU <sup>6</sup>	Limits	Compaction
P3-1 (5'B)																		
P3-1 (15'A)	Х	Х															Х	
P3-2 (10'A)	Х	Х																
P3-2 (15'B)												Х						
P3-2 (20'A)	Х	Х																
P3-2 (35'B)												Х						
P3-3 (5'A)												Х						
P3-3 (20'A)	Х	Х																
P3-3 (40'A)	Х	Х															Х	
P3-3 (40'B)												Х						
P3-4 (10'A)	Х	Х																
P3-4 (20'A)												Х						
P3-4 (30'A)	Х	Х										Χ						
P3-4 (40'A)	Х	Х										Χ	Χ					
P3-4 (40'B)																	Х	_

<sup>&</sup>lt;sup>1</sup> G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

<sup>&</sup>lt;sup>2</sup> CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

<sup>&</sup>lt;sup>3</sup> HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box,

EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

<sup>&</sup>lt;sup>4</sup> DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

<sup>&</sup>lt;sup>5</sup> F = Fine (<4.75mm), C = Coarse (>4.75mm)

<sup>&</sup>lt;sup>6</sup> CU = Consolidated Undrained Triaxial

Laboratory		itial S operti		F Co	aturate Iydraul nductiv	ic ⁄ity²				Charac		ics <sup>3</sup>			Particle Size <sup>4</sup>				ecific vity <sup>5</sup>		Atterberg	Proctor
Sample Number	G	VM	VD	СН	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	$K_{\text{unsat}}$	DS	WS	Н	F	С	CU <sup>6</sup>	Limits	Compaction
P3-5 (10'A)	Х	Х														Х	Х					
P3-5 (10'B)																					Х	
P3-6 (5'A)	Х	Х																				
P3-6 (20'A)	Х	Х														Х						
P3-6 (50'A)	Х	Х														Х						
P4-3 (10'B)																					Х	
P4-5 (20'A)	Х	Х														Х						
P4-6 (10'A)	Х	Х														Х	Х					
P4-6 (10'B)																						
P4-7 (5'A)	Х	Х														Х						
P4-7 (5'B)																						
P4-7 (25'B)	Х	Х														Х	Х					
P4-8 (15'A)																					Х	
P4-8 (15'B)	Х	Χ														Χ	Χ					
P4-9 (5'A)	Х	Х																				

<sup>&</sup>lt;sup>1</sup> G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

<sup>&</sup>lt;sup>2</sup> CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

<sup>&</sup>lt;sup>3</sup> HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box,

EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

<sup>&</sup>lt;sup>4</sup> DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

<sup>&</sup>lt;sup>5</sup> F = Fine (<4.75mm), C = Coarse (>4.75mm)

<sup>&</sup>lt;sup>6</sup> CU = Consolidated Undrained Triaxial



		Initial Soil			Saturated Hydraulic						isture				Particle Size <sup>4</sup>			-	ecific			
Laboratory			vD	Conductivity <sup>2</sup> D CH FH FW F			110	DD		Charac			W/110	V				Gra F	vity <sup>5</sup> C	CU <sup>6</sup>	Atterberg	Proctor
Sample Number	G	VIVI	٧D	Сп	гп	FVV	пС	PP	۲P	שרע	ΚП	EP	WHC	Nunsat	סט	W 5	П	Г	C	00	Limits	Compaction
P4-9 (35'B)	Х	Х														Х	Х					
BW-1 (20'A)																Х	Х					
BW-1 (30'A)	Х	Χ																				
BW-2 (10'A)	Х	Χ														Χ	Х					
BW-2 (10'B)																						
BW-3 (5'A)	X	Χ														Х	Х					
BW-4 (20'A)																						
BW-4 (20'B)																						

<sup>&</sup>lt;sup>1</sup> G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

<sup>&</sup>lt;sup>2</sup> CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

<sup>&</sup>lt;sup>3</sup> HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box,

EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

<sup>&</sup>lt;sup>4</sup> DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

<sup>&</sup>lt;sup>5</sup> F = Fine (<4.75mm), C = Coarse (>4.75mm)

<sup>&</sup>lt;sup>6</sup> CU = Consolidated Undrained Triaxial



#### **Notes**

#### Report Revision July 2, 2018:

This revised report includes all results previously submitted in the report dated June 20, 2018, as well as initial properties test data for sample L2-1 (5'A) and particle size analysis test data for sample L2-1 (15'A). Other than the addition of these test results, no changes were made to the previously submitted data.

#### Sample Receipt:

Three hundred ninety five samples were hand delivered between April 4, 2018 and May 4, 2018. Ten samples were received, each as loose material in two full 5-gallon buckets sealed with a lid. Fourteen samples were received each as loose material, double-bagged in 1/4 full 1-gallon Ziploc bag. The remaining three hundred seventy one samples were received each in a 2" x 6" brass sleeve sealed with end caps.

#### **Sample Preparation and Testing Notes:**

One hundred fifteen samples were tested. Forty nine samples were subjected to initial properties testing. Sixty seven samples were subjected to particle size analysis, forty two of which included hydrometer analysis. Fifteen samples were subjected to Atterberg limits testing. Ten of the samples were subjected to standard proctor compaction testing. And, three samples were selected for 3-stage consolidated undrained triaxial shear testing.

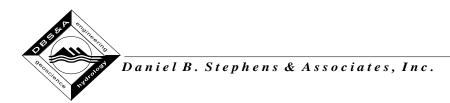
Porosity calculations, and the particle diameter calculations in the hydrometer portion of the particle size analysis testing, are based on the use of an assumed specific gravity value of 2.65.

#### **Consolidated Undrained Triaxial Shear Testing:**

Each of the staged consolidated undrained (CU) triaxial shear tests were performed using a single sample. The test samples were extruded from the sampling sleeves and the ends were trimmed using a blade. Each three-stage CU triaxial shear test was performed using test parameters and effective confining stresses specified by the client.

The first stage was performed by consolidating the sample at the lowest specified effective stress and then shearing to 3% strain, unless there was a clear peak or leveling off of the deviator stress prior to the 3% strain, in which case the Stage 1 test was halted. Upon completion, the specimen was unloaded and returned to the starting pre-compression load. The effective stress was increased to the next highest confining stress for the second stage, and was once again consolidated and sheared to 3% strain unless there was a clear peak or leveling off of the deviator stress prior to the 3% strain, in which case the Stage 2 test was halted. Upon completion, the specimen was unloaded and returned to the starting pre-compression load. The effective stress was then increased to the highest requested confining stress for the third and final stage, and the sample was consolidated and sheared to 15% strain. In all cases 'failure' was interpreted as the peak deviator stress achieved for each stage.

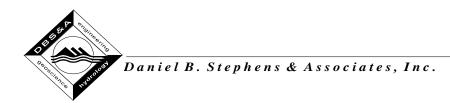
The cohesion and friction angle provided represent one possible interpretation of a Mohr-Coulomb failure envelope. Qualified persons familiar with the material and the site should evaluate the test results independently prior to use in the intended application.



**Moisture Content** 

		Moistare					
	As Re	ceived	Rem	olded	Dry Bulk	Wet Bulk	Calculated
Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm <sup>3</sup> /cm <sup>3</sup> )	Gravimetric (%, g/g)	Volumetric (%, cm <sup>3</sup> /cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )	Porosity (%)
L1-1 (10'A)	6.3	8.7			1.39	1.47	47.6
L1-2 (20'B)	10.2	17.8			1.75	1.93	33.9
L1-3 (5'A)	4.2	6.3			1.50	1.56	43.4
L1-4 (5'B)	7.5	10.6			1.41	1.52	46.7
L2-1 (5'B)	4.1	7.0			1.69	1.76	36.3
L2-3 (5'A)	3.8	6.1			1.61	1.67	39.3
T/O-1 (20'A)	11.4	19.5			1.71	1.90	35.6
T/O-1 (45'B)	7.2	10.9			1.51	1.62	42.9
T/O-2 (15'A)	11.3	18.5			1.63	1.81	38.6
T/O-3 (15'B)	9.9	18.4			1.87	2.05	29.5
T/O-3 (40'B)	6.8	10.9			1.61	1.72	39.3
T/O-4 (5'A)	8.9	16.4			1.86	2.02	30.0

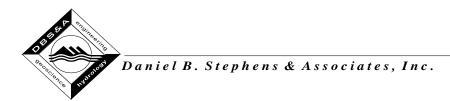
<sup>--- =</sup> This sample was not remolded



**Moisture Content** 

	As Re	eceived	Rem	olded	Dry Bulk	Wet Bulk	Calculated
 Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Density (g/cm <sup>3</sup> )	Density (g/cm³)	Porosity (%)
T/O-5 (20'A)	6.3	9.4			1.51	1.60	43.1
T/O-6 (5'A)	6.9	12.0			1.75	1.87	34.1
TN-2 (20'A)	6.0	7.8			1.30	1.38	50.8
BS-1 (10'A)	8.4	12.3			1.46	1.58	44.9
BS-6 (20'A)	7.0	9.5			1.36	1.45	48.8
TS-1 (5'A)	7.8	14.4			1.83	1.98	30.8
TS-2 (15'A)	8.9	14.3			1.60	1.74	39.6
TS-3 (10'A)	6.0	9.6			1.61	1.70	39.3
TS-4 (10'A)	7.0	13.8			1.98	2.11	25.4
P1-1 (15'B)	10.0	13.4			1.35	1.48	49.1
P1-1A (30'A)	3.9	4.8			1.23	1.28	53.7
P1-2 (50'A)	4.3	6.9			1.60	1.67	39.7

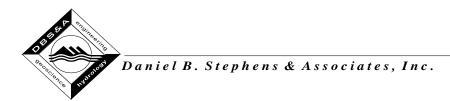
<sup>--- =</sup> This sample was not remolded



**Moisture Content** 

		Moistare					
	As Re	As Received Remolded		olded	Dry Bulk	Wet Bulk	Calculated
Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Density (g/cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )	Porosity (%)
P2-1 (5'A)	13.2	24.6			1.86	2.10	30.0
P2-1 (25'B)	15.4	25.6			1.67	1.92	37.1
P3-1 (5'A)	7.3	13.6			1.86	2.00	29.7
P3-1 (15'A)	9.4	8.8			0.93	1.02	64.8
P3-2 (10'A)	6.6	11.1			1.69	1.80	36.2
P3-2 (20'A)	11.3	18.8			1.67	1.86	37.1
P3-3 (20'A)	8.1	13.7			1.69	1.83	36.2
P3-3 (40'A)	14.7	26.3			1.79	2.06	32.3
P3-4 (10'A)	9.3	14.4			1.54	1.69	41.8
P3-4 (30'A)	6.0	9.1			1.53	1.62	42.4
P3-4 (40'A)	7.1	13.3			1.87	2.01	29.3
P3-5 (10'A)	8.3	15.5			1.85	2.01	30.0

<sup>--- =</sup> This sample was not remolded



**Moisture Content** 

		Moistare					
	As Re	eceived	Rem	olded	Dry Bulk	Wet Bulk	Calculated
 Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Gravimetric (%, g/g)	Volumetric (%, cm <sup>3</sup> /cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )	Density (g/cm³)	Porosity (%)
P3-6 (5'A)	4.8	7.8			1.63	1.71	38.4
P3-6 (20'A)	9.3	16.1			1.73	1.89	34.8
P3-6 (50'A)	6.0	10.7			1.77	1.88	33.1
P4-5 (20'A)	7.3	12.6			1.74	1.87	34.4
P4-6 (10'A)	10.0	15.9			1.59	1.74	40.2
P4-7 (5'A)	9.8	14.6			1.49	1.64	43.7
P4-7 (25'B)	6.2	11.0			1.76	1.87	33.5
P4-8 (15'B)	13.0	21.0			1.62	1.83	38.9
P4-9 (5'A)	4.4	8.3			1.87	1.95	29.4
P4-9 (35'B)	13.5	22.4			1.66	1.89	37.3
BW-1 (30'A)	9.3	13.0			1.40	1.53	47.3
BW-2 (10'A)	5.9	8.9			1.52	1.61	42.8

<sup>--- =</sup> This sample was not remolded



Moisture Content

		Moisture	Content				
	As Re	As Received		olded	Dry Bulk	Wet Bulk	Calculated
	Gravimetric	Volumetric	Gravimetric	Volumetric	Density	Density	Porosity
Sample Number	(%, g/g)	(%, cm <sup>3</sup> /cm <sup>3</sup> )	(%, g/g)	(%, cm <sup>3</sup> /cm <sup>3</sup> )	(g/cm <sup>3</sup> )	(g/cm <sup>3</sup> )	(%)
BW-3 (5'A)	3.8	6.1			1.62	1.68	38.9

<sup>--- =</sup> This sample was not remolded



### **Summary of Particle Size Characteristics**

 Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	_
SA-GM 1B	NA	NA	NA	NA	NA	WS	NA	NA	(Est)
SA-GM 1T	NA	NA	NA	NA	NA	WS	NA	NA	(Est)
SA-GM 2B	NA	NA	0.071	NA	NA	WS	NA	NA	(Est)
SA-GM 2T	NA	NA	NA	NA	NA	WS	NA	NA	(Est)
SA-GM 3B	NA	0.18	0.25	NA	NA	WS	NA	NA	(Est)
SA-GM 3T	NA	0.18	0.37	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
SA-GM 4B	NA	0.11	0.13	NA	NA	WS	NA	NA	(Est)
SA-GM 5B	NA	0.21	0.28	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
SA-GM 5T	0.16	0.38	0.43	2.7	1.3	WS	NA	Sand	
SA-GM 6B	NA	NA	NA	NA	NA	WS	NA	NA	(Est)
SA-GM 6T	NA	NA	NA	NA	NA	WS	NA	NA	(Est)

d<sub>50</sub> = Median particle diameter

Est = Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

DS = Dry sieve

= Hydrometer

 $^{\dagger}$  Greater than 10% of sample is coarse material

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{20})}$$

WS = Wet sieve



### **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	
SA-GM 7B	NA	0.11	0.13	NA	NA	WS	NA	NA	(Est)
SA-GM 8B	NA	0.12	0.16	NA	NA	WS	NA	NA	(Est)
SA-GM 8T	NA	0.37	0.52	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
L1-1 (10'A)	2.2E-05	0.046	0.061	2773	33	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
L1-2 (20'B)	2.8E-05	0.0092	0.015	536	12	WS/H	Classification by ASTM 2487 requires Atterberg test	Silty Clay Loam	(Est)
L1-3 (5'A)	6.4E-45	0.066	0.088	1.4E+43	2.1E+42	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
L1-5 (20'B)	0.0011	0.074	0.093	85	17	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
L2-1 (5'A)	0.00040	0.045	0.060	150	9.4	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
L2-1 (15'A)	0.00024	0.056	0.065	271	11	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
L2-2 (5'A)	0.00019	0.067	0.085	447	60	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
L2-3 (5'A)	0.00094	0.076	0.089	95	26	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)

d<sub>50</sub> = Median particle diameter

 $C_u = \frac{d_{60}}{d_{10}}$ 

DS = Dry sieve

= Hydrometer

WS = Wet sieve

<sup>†</sup> Greater than 10% of sample is coarse material



### **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	
L2-4 (10'B)	3.9E-05	0.045	0.057	1462	65	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
L2-5 (5'A)	4.4E-05	0.0022	0.0047	107	0.50	WS/H	Classification by ASTM 2487 requires Atterberg test	Silty Clay	(Est)
L2-6 (5'A)	0.00031	0.013	0.030	97	0.43	WS/H	Lean clay (CL)	Clay Loam	(Est)
L2-7 (10'A)	1.9E-09	0.057	0.075	3.9E+07	4.4E+06	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
T/O-1 (20'A)	0.00030	0.0088	0.016	53	0.75	WS/H	Classification by ASTM 2487 requires Atterberg test	Silty Clay Loam	(Est)
T/O-1 (45'B)	5.1E-05	0.070	0.099	1941	51	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Clay Loam	(Est)
T/O-2 (5'A)	0.0025	0.010	0.022	8.8	0.15	WS/H	Classification by ASTM 2487 requires Atterberg test	Silt Loam	
T/O-3 (40'A)	0.00083	0.078	0.10	120	20	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
T/O-3 (70'B)	0.00032	0.034	0.045	141	8.4	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
T/O-4 (20'B)	0.00059	0.034	0.050	85	4.1	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
T/O-5 (10'B)	0.0011	0.028	0.039	35	2.3	WS/H	Classification by ASTM 2487 requires Atterberg test	Silt Loam	(Est)
									_

d<sub>50</sub> = Median particle diameter

 $C_{u} = \frac{d_{60}}{d_{10}}$ 

DS = Dry sieve

= Hydrometer

WS = Wet sieve

<sup>†</sup> Greater than 10% of sample is coarse material



### **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	C <sub>c</sub>	Method	ASTM Classification	USDA Classification	_
T/O-6 (5'A)	0.00066	0.043	0.054	82	9.1	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
TN-1 (5'A)	0.00074	0.077	0.097	131	17	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
TN-2 (20'A)	0.00077	0.079	0.10	130	18	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
BS-1 (10'A)	0.00029	0.052	0.076	262	4.4	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Clay Loam	(Est)
BS-2 (15'A)	0.0039	0.061	0.082	21	0.61	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	
BS-6 (20'A)	0.00018	0.054	0.062	344	43	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
TS-1 (20'A)	0.0010	0.035	0.048	48	2.0	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
TS-2 (10'A)	0.0019	0.087	0.12	63	3.0	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	
TS-3 (10'A)	0.00086	0.043	0.051	59	3.9	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
TS-4 (5'A)	0.0011	0.11	0.13	118	20	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P1-1 (5'A)	0.0012	0.13	0.17	142	23	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam <sup>†</sup>	(Est)
d <sub>50</sub> = Median particle diameter	C <sub>u</sub> =	<u>d<sub>60</sub></u> d <sub>10</sub>		DS = Dry sie	eve	† Greater tha	an 10% of sample is coarse material		

Est = Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

= Hydrometer WS = Wet sieve



### **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_{c}$	Method	ASTM Classification	USDA Classification	
P1-2 (30'B)	0.0010	0.11	0.16	160	21	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam <sup>†</sup>	(Est)
P2-1 (25'A)	0.00071	0.087	0.12	169	11	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P2-2 (5'B)	0.00078	0.089	0.11	141	28	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P3-1 (5'A)	NA	0.23	0.33	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
P3-2 (15'B)	NA	0.20	0.25	NA	NA	WS	NA	NA	(Est)
P3-2 (35'B)	NA	0.15	0.19	NA	NA	WS	NA	NA	(Est)
P3-3 (5'A)	NA	0.15	0.19	NA	NA	WS	NA	NA	(Est)
P3-3 (40'B)	NA	0.085	0.099	NA	NA	WS	NA	NA	(Est)
P3-4 (20'A)	0.11	0.25	0.29	2.6	0.91	WS	NA	Sand	
P3-4 (30'A)	0.10	0.19	0.22	2.2	0.89	WS	NA	Sand	
P3-4 (40'A)	0.0029	0.072	0.087	30	7.7	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	

d<sub>50</sub> = Median particle diameter

 $C_{u} = \frac{d_{60}}{d_{10}}$ 

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

<sup>†</sup> Greater than 10% of sample is coarse material



### **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	
P3-5 (10'A)	0.020	0.099	0.12	6.0	2.2	WS/H	Classification by ASTM 2487 requires Atterberg test	Loamy Sand	_
P3-6 (20'A)	NA	0.20	0.24	NA	NA	WS	NA	NA	(Est)
P3-6 (50'A)	NA	0.23	0.30	NA	NA	WS	NA	NA	(Est)
P4-5 (20'A)	NA	0.30	0.39	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
P4-6 (10'A)	0.0012	0.072	0.084	70	23	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P4-7 (5'A)	NA	0.077	0.095	NA	NA	WS	NA NA	NA	(Est)
P4-7 (25'B)	0.0052	0.28	0.34	65	9.6	WS/H	Classification by ASTM 2487 requires Atterberg test	Loamy Sand	
P4-8 (15'B)	0.0011	0.085	0.13	118	5.1	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P4-9 (35'B)	6.7E-06	0.061	0.087	1.3E+04	1160	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam <sup>†</sup>	(Est)
BW-1 (20'A)	0.0012	0.047	0.083	69	1.2	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
BW-2 (10'A)	0.00035	0.062	0.084	240	18	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
BW-3 (5'A)	0.0011	0.080	0.099	90	23	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)

d<sub>50</sub> = Median particle diameter

Est = Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>o</sub>, and soil classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

<sup>†</sup> Greater than 10% of sample is coarse material

H = Hydrometer

WS = Wet sieve



Daniel B. Stephens & Associates, Inc.

### Percent Gravel, Sand, Silt and Clay\*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
SA-GM 1B	0.0	15.0	85.0	**
SA-GM 1T	0.1	34.3	65.6	**
SA-GM 2B	0.0	39.4	60.6	**
SA-GM 2T	0.0	24.4	75.6	**
SA-GM 3B	0.0	69.0	31.0	**
SA-GM 3T	15.1	48.0	36.9	**
SA-GM 4B	0.0	64.2	35.8	**
SA-GM 5B	14.6	61.8	23.6	**
SA-GM 5T	0.1	94.9	5.1	**
SA-GM 6B	0.0	20.4	79.6	**
SA-GM 6T	0.0	17.6	82.4	**
SA-GM 7B	0.0	62.6	37.4	**
SA-GM 8B	0.0	61.1	38.9	**
SA-GM 8T	13.4	70.7	15.8	**
L1-1 (10'A)	0.0	33.2	43.1	23.7
L1-2 (20'B)	0.1	2.3	68.1	29.5

<sup>\*</sup>USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

<sup>\*\*</sup>Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.

Daniel B. Stephens & Associates, Inc.

### Percent Gravel, Sand, Silt and Clay\* (Continued)

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
L1-3 (5'A)	0.0	46.5	40.8	12.7
L1-5 (20'B)	0.0	49.7	37.7	12.6
L2-1 (5'A)	0.0	32.5	49.0	18.5
L2-1 (15'A)	0.0	31.5	50.5	18.0
L2-2 (5'A)	0.0	46.3	37.5	16.2
L2-3 (5'A)	0.0	51.2	36.8	12.1
L2-4 (10'B)	0.0	28.8	50.0	21.2
L2-5 (5'A)	0.0	2.8	48.6	48.6
L2-6 (5'A)	0.0	14.8	55.2	29.9
L2-7 (10'A)	0.0	40.1	48.2	11.7
T/O-1 (20'A)	0.2	3.2	66.0	30.6
T/O-1 (45'B)	0.0	47.9	31.0	21.1
T/O-2 (5'A)	0.0	23.0	71.5	5.5
T/O-3 (40'A)	0.0	51.5	34.4	14.1
T/O-3 (70'B)	0.5	8.7	73.8	17.1
T/O-4 (20'B)	0.0	24.8	57.7	17.5

<sup>\*</sup>USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

<sup>\*\*</sup>Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.



Daniel B. Stephens & Associates, Inc.

### Percent Gravel, Sand, Silt and Clay\* (Continued)

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
T/O-5 (10'B)	0.0	10.1	75.3	14.6
T/O-6 (5'A)	0.0	24.3	59.7	16.0
TN-1 (5'A)	0.4	50.9	33.3	15.4
TN-2 (20'A)	0.0	51.9	34.4	13.8
BS-1 (10'A)	0.0	40.8	36.1	23.0
BS-2 (15'A)	0.0	43.0	51.6	5.3
BS-6 (20'A)	0.0	26.3	55.8	17.9
TS-1 (20'A)	0.0	18.2	65.1	16.7
TS-2 (10'A)	0.0	53.9	35.3	10.8
TS-3 (10'A)	0.0	16.1	68.6	15.2
TS-4 (5'A)	0.7	63.1	22.7	13.5
P1-1 (5'A)	18.8	49.8	20.8	10.6
P1-2 (30'B)	20.3	43.0	24.9	11.8
P2-1 (25'A)	0.3	54.0	30.7	15.1
P2-2 (5'B)	5.1	53.2	27.1	14.6
P3-1 (5'A)	19.7	64.9	15.3	**
P3-2 (15'B)	0.0	78.8	21.2	**

<sup>\*</sup>USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

<sup>\*\*</sup>Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm. 27



Daniel B. Stephens & Associates, Inc.

### Percent Gravel, Sand, Silt and Clay\* (Continued)

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)	
P3-2 (35'B)	1.1	68.2	30.7		**
P3-3 (5'A)	0.3	67.7	31.9		**
P3-3 (40'B)	1.4	56.3	42.3		**
P3-4 (20'A)	0.0	92.7	7.3		**
P3-4 (30'A)	0.0	92.3	7.7		**
P3-4 (40'A)	0.0	48.1	44.2	7.7	
P3-5 (10'A)	0.0	68.6	27.8	3.6	
P3-6 (20'A)	0.0	85.2	14.8		**
P3-6 (50'A)	7.2	76.4	16.4		**
P4-5 (20'A)	24.9	61.0	14.1		**
P4-6 (10'A)	0.0	48.0	41.0	11.0	
P4-7 (5'A)	7.2	43.9	49.0		**
P4-7 (25'B)	0.0	77.0	17.5	5.5	
P4-8 (15'B)	0.5	51.9	35.5	12.1	
P4-9 (35'B)	15.7	26.6	46.4	11.4	
BW-1 (20'A)	0.0	45.4	34.9	19.7	
BW-2 (10'A)	0.0	44.1	38.1	17.8	
BW-3 (5'A)	0.0	53.1	35.9	11.0	

<sup>\*</sup>USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

<sup>\*\*</sup>Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.



## **Summary of Atterberg Tests**

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
L1-2 (20'A)	41	19	22	CL
L2-2 (5'B)				ML
L2-6 (5'A)	34	17	17	CL
T/O-1 (25'A)	30	16	14	CL
T/O-2 (10'A)	48	23	25	CL
T/O-3 (60'A)				ML
P1-1 (10'A)				ML
P1-2 (15'A)				ML
P2-2 (5'A)	39	15	24	CL
P3-1 (15'A)				ML
P3-3 (40'A)				ML
P3-4 (40'B)				ML
P3-5 (10'B)				ML
P3-6 (50'A)				ML
P4-8 (15'A)				ML

<sup>--- =</sup> Soil requires visual-manual classification due to non-plasticity



## **Summary of Proctor Compaction Tests**

	Meas	sured	Oversize Corrected		
Sample Number	Optimum Moisture Content (% g/g)	Maximum Dry Bulk Density (g/cm <sup>3</sup> )	Optimum Moisture Content (% g/g)	Maximum Dry Bulk Density (g/cm <sup>3</sup> )	
L1 Auger Cuttings (1 & 2)	14.6	1.81			
L2 Auger Cuttings (1 & 2)	14.1	1.81			
T/O Auger Cuttings (1 & 2) (T/O-1 & T/O-3,4)	14.5	1.83			
Topsoil North Cuttings (1 & 2)	12.6	1.89			
Borrow South Cuttings (1 & 2)	13.0	1.84			
Topsoil South Cuttings (1 & 2) (TS-2 & TS-3,4)	15.2	1.81	12.3	1.92	
Borrow West Auger Cuttings (1 & 2)	12.7	1.87			
P1-2 Auger Cuttings	12.8	1.82			
P3 Auger Cuttings (1 & 2)	9.9	1.96	9.2	2.00	
P4 Auger Cuttings (1 & 2)	11.1	1.94	9.0	2.05	

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

NR = Not requested

NA = Not applicable

### **Summary of Consolidated Undrained (CU) Triaxial Shear Testing**

Sample Number	Effective Consolidation Stress (psi)	Effective Minor Stress at Failure (psi)	Effective Major Stress at Failure (psi)	Pore-Water Pressure at Failure (psi)	Total Minor Stress at Failure (psi)	Total Major Stress at Failure (psi)	% Strain at Failure* (%)
L2-1 (15'A) CU Stage 1 (6.0 psi)	6.0	2.5	8.4	75.0	77.6	83.4	2.12
L2-1 (15'A) CU Stage 2 (12.0 psi)	12.0	5.0	18.0	78.6	83.6	96.6	2.96
L2-1 (15'A) CU Stage 3 (24.0 psi)	24.0	9.6	35.8	86.1	95.6	121.9	7.73
L2-5 (5'B) CU Stage 1 (2.0 psi)	2.0	0.7	5.2	81.9	82.7	87.1	1.88
L2-5 (5'B) CU Stage 2 (4.0 psi)	4.0	2.0	9.4	82.5	84.6	91.9	0.97
L2-5 (5'B) CU Stage 3 (8.0 psi)	8.0	3.3	15.4	85.4	88.7	100.9	1.13
L2-6 (10'B) CU Stage 1 (3.5 psi)	3.5	2.1	3.5	83.0	85.1	86.4	0.69
L2-6 (10'B) CU Stage 2 (7.1 psi)	7.1	3.2	10.3	85.5	88.6	95.8	3.02
L2-6 (10'B) CU Stage 3 (14.0 psi)	14.0	6.0	22.4	89.7	95.7	112.1	11.74

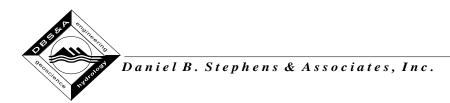
<sup>\*</sup>Noted percent strain used as failure criterion.

## Summary of Consolidated Undrained Estimated Effective Friction Angle and Cohesion

	c' Cohesion	φ' Friction Angle
Sample Number	(psi)	(°)
L2-1 (15'A) CU	0	35
L2-5 (5'B) CU	0.9	35.8
L2-6 (10'B) CU	0	32.3

<sup>&</sup>lt;sup>1</sup>The cohesion and friction angle provided represent one possible interpretation of a Mohr-Coulomb failure envelope. Qualified persons familiar with the material and the site should evaluate the test results independently prior to use in the intended application.

**Initial Properties** 



**Moisture Content** 

		Wolstare Content						
		As Re	eceived	Rem	Remolded		Wet Bulk	Calculated
	Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Gravimetric (%, g/g)	Volumetric (%, cm <sup>3</sup> /cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )	Density (g/cm³)	Porosity (%)
	L1-1 (10'A)	6.3	8.7			1.39	1.47	47.6
	L1-2 (20'B)	10.2	17.8			1.75	1.93	33.9
	L1-3 (5'A)	4.2	6.3			1.50	1.56	43.4
	L1-4 (5'B)	7.5	10.6			1.41	1.52	46.7
	L2-1 (5'B)	4.1	7.0			1.69	1.76	36.3
	L2-3 (5'A)	3.8	6.1			1.61	1.67	39.3
	T/O-1 (20'A)	11.4	19.5			1.71	1.90	35.6
	T/O-1 (45'B)	7.2	10.9			1.51	1.62	42.9
	T/O-2 (15'A)	11.3	18.5			1.63	1.81	38.6
	T/O-3 (15'B)	9.9	18.4			1.87	2.05	29.5
	T/O-3 (40'B)	6.8	10.9			1.61	1.72	39.3
	T/O-4 (5'A)	8.9	16.4			1.86	2.02	30.0

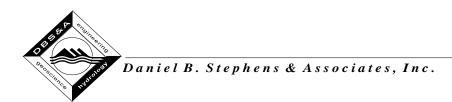
<sup>--- =</sup> This sample was not remolded



**Moisture Content** 

	Wolstare Content						
	As Received Remolded		Dry Bulk	Wet Bulk	Calculated		
 Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Density (g/cm <sup>3</sup> )	Density (g/cm³)	Porosity (%)
T/O-5 (20'A)	6.3	9.4			1.51	1.60	43.1
T/O-6 (5'A)	6.9	12.0			1.75	1.87	34.1
TN-2 (20'A)	6.0	7.8			1.30	1.38	50.8
BS-1 (10'A)	8.4	12.3			1.46	1.58	44.9
BS-6 (20'A)	7.0	9.5			1.36	1.45	48.8
TS-1 (5'A)	7.8	14.4			1.83	1.98	30.8
TS-2 (15'A)	8.9	14.3			1.60	1.74	39.6
TS-3 (10'A)	6.0	9.6			1.61	1.70	39.3
TS-4 (10'A)	7.0	13.8			1.98	2.11	25.4
P1-1 (15'B)	10.0	13.4			1.35	1.48	49.1
P1-1A (30'A)	3.9	4.8			1.23	1.28	53.7
P1-2 (50'A)	4.3	6.9			1.60	1.67	39.7

<sup>--- =</sup> This sample was not remolded



**Moisture Content** 

	Woisture Content						
	As Received Remolded		olded	Dry Bulk	Wet Bulk	Calculated	
 Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Density (g/cm <sup>3</sup> )	Density (g/cm³)	Porosity (%)
P2-1 (5'A)	13.2	24.6			1.86	2.10	30.0
P2-1 (25'B)	15.4	25.6			1.67	1.92	37.1
P3-1 (5'A)	7.3	13.6			1.86	2.00	29.7
P3-1 (15'A)	9.4	8.8			0.93	1.02	64.8
P3-2 (10'A)	6.6	11.1			1.69	1.80	36.2
P3-2 (20'A)	11.3	18.8			1.67	1.86	37.1
P3-3 (20'A)	8.1	13.7			1.69	1.83	36.2
P3-3 (40'A)	14.7	26.3			1.79	2.06	32.3
P3-4 (10'A)	9.3	14.4			1.54	1.69	41.8
P3-4 (30'A)	6.0	9.1			1.53	1.62	42.4
P3-4 (40'A)	7.1	13.3			1.87	2.01	29.3
P3-5 (10'A)	8.3	15.5			1.85	2.01	30.0

<sup>--- =</sup> This sample was not remolded



**Moisture Content** 

	Wioistare Content						
	As Received Remolded		olded	Dry Bulk	Wet Bulk	Calculated	
 Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Density (g/cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )	Porosity (%)
P3-6 (5'A)	4.8	7.8			1.63	1.71	38.4
P3-6 (20'A)	9.3	16.1			1.73	1.89	34.8
P3-6 (50'A)	6.0	10.7			1.77	1.88	33.1
P4-5 (20'A)	7.3	12.6			1.74	1.87	34.4
P4-6 (10'A)	10.0	15.9			1.59	1.74	40.2
P4-7 (5'A)	9.8	14.6			1.49	1.64	43.7
P4-7 (25'B)	6.2	11.0			1.76	1.87	33.5
P4-8 (15'B)	13.0	21.0			1.62	1.83	38.9
P4-9 (5'A)	4.4	8.3			1.87	1.95	29.4
P4-9 (35'B)	13.5	22.4			1.66	1.89	37.3
BW-1 (30'A)	9.3	13.0			1.40	1.53	47.3
BW-2 (10'A)	5.9	8.9			1.52	1.61	42.8

<sup>--- =</sup> This sample was not remolded



Moisture Content

		Moisture	Content				
	As Re	As Received Remol		olded	Dry Bulk	Wet Bulk	Calculated
	Gravimetric	Volumetric	Gravimetric	Volumetric	Density	Density	Porosity
Sample Number	(%, g/g)	(%, cm <sup>3</sup> /cm <sup>3</sup> )	(%, g/g)	(%, cm <sup>3</sup> /cm <sup>3</sup> )	(g/cm <sup>3</sup> )	(g/cm <sup>3</sup> )	(%)
BW-3 (5'A)	3.8	6.1			1.62	1.68	38.9

<sup>--- =</sup> This sample was not remolded



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L1-1 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

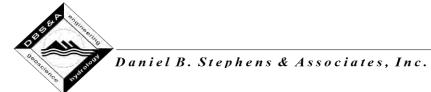
	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g): Tare weight, ring (g):	584.09 0.00	
Tare weight, hing (g). Tare weight, pan/plate (g): Tare weight, other (g):	294.41 0.00	
Dry weight of sample (g):  Sample volume (cm <sup>3</sup> ):	272.52 196.40	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	6.3	
Volumetric Moisture Content (% vol):	8.7	
Dry bulk density (g/cm <sup>3</sup> ):	1.39	
Wet bulk density (g/cm <sup>3</sup> ):	1.47	
Calculated Porosity (% vol):	47.6	
Percent Saturation:	18.3	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L1-2 (20'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

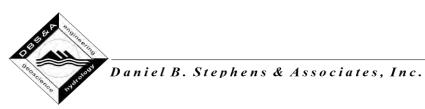
	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):	813.19 0.00 271.60 0.00 491.56 280.53 2.65	
Gravimetric Moisture Content (% g/g):	10.2	
Volumetric Moisture Content (% vol):	17.8	
Dry bulk density (g/cm <sup>3</sup> ):	1.75	
Wet bulk density (g/cm <sup>3</sup> ):	1.93	
Calculated Porosity (% vol):	33.9	
Percent Saturation:	52.6	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L1-3 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):	736.63	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	283.35	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	434.95	
Sample volume (cm <sup>3</sup> ):	289.93	
Assumed particle density (g/cm³):	2.65	
Gravimetric Moisture Content (% g/g):	4.2	
Volumetric Moisture Content (% vol):	6.3	
Dry bulk density (g/cm <sup>3</sup> ):	1.50	
Wet bulk density (g/cm <sup>3</sup> ):	1.56	
Calculated Porosity (% vol):	43.4	
Percent Saturation:	14.6	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L1-4 (5'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	720.27 0.00 295.01 0.00	
Dry weight of sample (g): Sample volume (cm³): Assumed particle density (g/cm³):	395.59 279.95 2.65	
Gravimetric Moisture Content (% g/g):	7.5	
Volumetric Moisture Content (% vol):	10.6	
Dry bulk density (g/cm <sup>3</sup> ):	1.41	
Wet bulk density (g/cm <sup>3</sup> ):	1.52	
Calculated Porosity (% vol):	46.7	
Percent Saturation:	22.7	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-1 (5'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

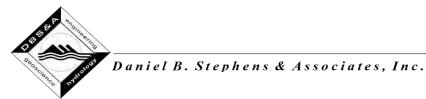
	As Received	Remolded
Test Date:	25-Jun-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):  Dry weight of sample (g): Sample volume (cm <sup>3</sup> ):	43.78 0.00 6.50 0.00 35.80 21.20	
Assumed particle density (g/cm³):	2.65	
Gravimetric Moisture Content (% g/g):	4.1	
Volumetric Moisture Content (% vol):	7.0	
Dry bulk density (g/cm <sup>3</sup> ):	1.69	
Wet bulk density (g/cm <sup>3</sup> ):	1.76	
Calculated Porosity (% vol):	36.3	
Percent Saturation:	19.2	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-3 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	785.37 0.00 298.50 0.00	
Dry weight of sample (g):	469.13	
Sample volume (cm³):	291.47	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	3.8	
Volumetric Moisture Content (% vol):	6.1	
Dry bulk density (g/cm <sup>3</sup> ):	1.61	
Wet bulk density (g/cm <sup>3</sup> ):	1.67	
Calculated Porosity (% vol):	39.3	
Percent Saturation:	15.5	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-1 (20'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):	771.59	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	268.53	
Tare weight, other (g):	0.00	
	454.54	
Dry weight of sample (g):	451.54	
Sample volume (cm <sup>3</sup> ):	264.39	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	11.4	
Volumetric Moisture Content (% vol):	19.5	
Dry bulk density (g/cm <sup>3</sup> ):	1.71	
Wet bulk density (g/cm <sup>3</sup> ):	1.90	
Calculated Porosity (% vol):	35.6	
Percent Saturation:	54.8	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-1 (45'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Field weight* of sample (g): 757.08 Tare weight, ring (g): 0.00 Tare weight, pan/plate (g): 284.52 Tare weight, other (g): 0.00  Dry weight of sample (g): 440.68 Sample volume (cm³): 291.25 Assumed particle density (g/cm³): 2.65  Gravimetric Moisture Content (% g/g): 7.2  Volumetric Moisture Content (% vol): 10.9 Dry bulk density (g/cm³): 1.51 Wet bulk density (g/cm³): 1.62 Calculated Porosity (% vol): 42.9 Percent Saturation: 25.5		As Received	Remolded
Tare weight, ring (g): 0.00 Tare weight, pan/plate (g): 284.52 Tare weight, other (g): 0.00  Dry weight of sample (g): 440.68 Sample volume (cm³): 291.25 Assumed particle density (g/cm³): 2.65  Gravimetric Moisture Content (% g/g): 7.2  Volumetric Moisture Content (% vol): 10.9 Dry bulk density (g/cm³): 1.51 Wet bulk density (g/cm³): 1.62 Calculated Porosity (% vol): 42.9	Test Date:	10-May-18	
Volumetric Moisture Content (% vol): 10.9  Dry bulk density (g/cm³): 1.51  Wet bulk density (g/cm³): 1.62  Calculated Porosity (% vol): 42.9	Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):  Dry weight of sample (g): Sample volume (cm <sup>3</sup> ):	0.00 284.52 0.00 440.68 291.25	
Volumetric Moisture Content (% vol): 10.9  Dry bulk density (g/cm³): 1.51  Wet bulk density (g/cm³): 1.62  Calculated Porosity (% vol): 42.9			
Dry bulk density (g/cm³): 1.51  Wet bulk density (g/cm³): 1.62  Calculated Porosity (% vol): 42.9	Gravimetric Moisture Content (% g/g):	7.2	
Wet bulk density (g/cm³): 1.62 Calculated Porosity (% vol): 42.9	Volumetric Moisture Content (% vol):	10.9	
Calculated Porosity (% vol): 42.9	Dry bulk density (g/cm <sup>3</sup> ):	1.51	
• • • • • • • • • • • • • • • • • • • •	Wet bulk density (g/cm <sup>3</sup> ):	1.62	
Percent Saturation: 25.5	Calculated Porosity (% vol):	42.9	
	Percent Saturation:	25.5	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-2 (15'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g):     Tare weight, ring (g):     Tare weight, pan/plate (g):         Tare weight, other (g):         Dry weight of sample (g):         Sample volume (cm³):	720.49 0.00 210.97 0.00 457.59 281.26	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	11.3	
Volumetric Moisture Content (% vol):	18.5	
Dry bulk density (g/cm <sup>3</sup> ):	1.63	
Wet bulk density (g/cm <sup>3</sup> ):	1.81	
Calculated Porosity (% vol):	38.6	
Percent Saturation:	47.8	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-3 (15'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

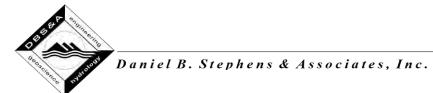
	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g):     Tare weight, ring (g):     Tare weight, pan/plate (g):         Tare weight, other (g):         Dry weight of sample (g):         Sample volume (cm³): Assumed particle density (g/cm³):	772.95 0.00 268.52 0.00 459.12 245.75 2.65	
Gravimatric Maistura Contant (% ala):	9.9	
Gravimetric Moisture Content (% g/g):		
Volumetric Moisture Content (% vol):	18.4	
Dry bulk density (g/cm <sup>3</sup> ):	1.87	
Wet bulk density (g/cm <sup>3</sup> ):	2.05	
Calculated Porosity (% vol):	29.5	
Percent Saturation:	62.5	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-3 (40'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	781.23 0.00 288.04 0.00	
Dry weight of sample (g):	461.86	
Sample volume (cm³):	286.89	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	6.8	
Volumetric Moisture Content (% vol):	10.9	
Dry bulk density (g/cm <sup>3</sup> ):	1.61	
Wet bulk density (g/cm <sup>3</sup> ):	1.72	
Calculated Porosity (% vol):	39.3	
Percent Saturation:	27.8	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-4 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

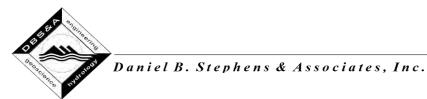
	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g):	873.18 0.00 291.00 0.00 534.78 288.20	
Assumed particle density (g/cm³):	2.65	
Gravimetric Moisture Content (% g/g):	8.9	
Volumetric Moisture Content (% vol):	16.4	
Dry bulk density (g/cm <sup>3</sup> ):	1.86	
Wet bulk density (g/cm <sup>3</sup> ):	2.02	
Calculated Porosity (% vol):	30.0	
Percent Saturation:	54.9	
•		_

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-5 (20'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	733.13 0.00 288.33 0.00	
Dry weight of sample (g):	418.58	
Sample volume (cm³):	277.52	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	6.3	
Volumetric Moisture Content (% vol):	9.4	
Dry bulk density (g/cm <sup>3</sup> ):	1.51	
Wet bulk density (g/cm <sup>3</sup> ):	1.60	
Calculated Porosity (% vol):	43.1	
Percent Saturation:	21.9	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-6 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

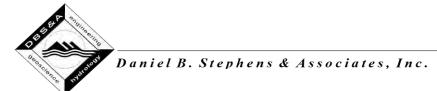
	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g):	826.85 0.00 284.35	
Tare weight, other (g):	0.00	
Dry weight of sample (g): Sample volume (cm³): Assumed particle density (g/cm³):	507.52 290.82 2.65	
Gravimetric Moisture Content (% g/g):	6.9	
Volumetric Moisture Content (% vol):	12.0	
Dry bulk density (g/cm <sup>3</sup> ):	1.75	
Wet bulk density (g/cm <sup>3</sup> ):	1.87	
Calculated Porosity (% vol):	34.1	
Percent Saturation:	35.2	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: TN-2 (20'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

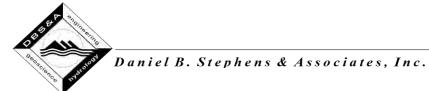
	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):     Tare weight, ring (g):     Tare weight, pan/plate (g):     Tare weight, other (g):     Dry weight of sample (g):     Sample volume (cm³):	577.54 0.00 284.28 0.00 276.75 212.09	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	6.0	
Volumetric Moisture Content (% vol):	7.8	
Dry bulk density (g/cm <sup>3</sup> ):	1.30	
Wet bulk density (g/cm <sup>3</sup> ):	1.38	
Calculated Porosity (% vol):	50.8	
Percent Saturation:	15.3	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: BS-1 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):  Tare weight, ring (g):  Tare weight, pan/plate (g):	730.69 0.00 268.40 0.00	
Tare weight, other (g):  Dry weight of sample (g):  Sample volume (cm³):  Assumed particle density (g/cm³):	426.30 291.88 2.65	
Gravimetric Moisture Content (% g/g):	8.4	
Volumetric Moisture Content (% vol):	12.3	
Dry bulk density (g/cm <sup>3</sup> ):	1.46	
Wet bulk density (g/cm <sup>3</sup> ):	1.58	
Calculated Porosity (% vol):	44.9	
Percent Saturation:	27.5	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: BS-6 (20'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

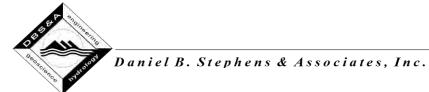
	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):	660.78 0.00 263.67 0.00 371.11 273.57 2.65	
Cravinastria Maiatura Cantant (0/ a/a)	7.0	
Gravimetric Moisture Content (% g/g):	7.0	
Volumetric Moisture Content (% vol):	9.5	
Dry bulk density (g/cm <sup>3</sup> ):	1.36	
Wet bulk density (g/cm <sup>3</sup> ):	1.45	
Calculated Porosity (% vol):	48.8	
Percent Saturation:	19.5	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: TS-1 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g):	837.27	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	269.17	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	526.79	
Sample volume (cm³):	287.39	
,		
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	7.8	
Volumetric Moisture Content (% vol):	14.4	
Dry bulk density (g/cm <sup>3</sup> ):	1.83	
Wet bulk density (g/cm <sup>3</sup> ):	1.98	
Calculated Porosity (% vol):	30.8	
Percent Saturation:	46.6	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: TS-2 (15'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

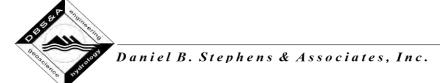
	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g):	765.98	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	268.91	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	456.41	
Sample volume (cm³):	285.11	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Assumed particle density (grown).	2.00	
Gravimetric Moisture Content (% g/g):	8.9	
( 3 3 /	14.3	
Volumetric Moisture Content (% vol):	14.3	
Dry bulk density (g/cm <sup>3</sup> ):	1.60	
Wet bulk density (g/cm <sup>3</sup> ):	1.74	
Calculated Porosity (% vol):	39.6	
Percent Saturation:	36.0	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: TS-3 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):  Dry weight of sample (g):	790.32 0.00 292.26 0.00 470.01	
Sample volume (cm <sup>3</sup> ):	292.17	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	6.0	
Volumetric Moisture Content (% vol):	9.6	
Dry bulk density (g/cm <sup>3</sup> ):	1.61	
Wet bulk density (g/cm <sup>3</sup> ):	1.70	
Calculated Porosity (% vol):	39.3	
Percent Saturation:	24.4	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: TS-4 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

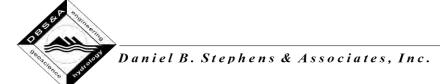
	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	794.64 0.00 284.24 0.00	
Dry weight of sample (g):	477.08	
Sample volume (cm³):	241.45	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	7.0	
Volumetric Moisture Content (% vol):	13.8	
Dry bulk density (g/cm <sup>3</sup> ):	1.98	
Wet bulk density (g/cm <sup>3</sup> ):	2.11	
Calculated Porosity (% vol):	25.4	
Percent Saturation:	54.2	
·		

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P1-1 (15'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

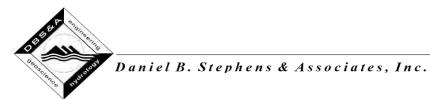
	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g):	686.24	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	297.38	
Tare weight, other (g):	0.00	
rare weight, ether (g).	0.00	
Dry weight of sample (g):	353.60	
Sample volume (cm³):	262.30	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
, , , , , , , , , , , , , , , , , , , ,		
Gravimetric Moisture Content (% g/g):	10.0	
Volumetric Moisture Content (% vol):	13.4	
Dry bulk density (g/cm <sup>3</sup> ):	1.35	
Wet bulk density (g/cm <sup>3</sup> ):	1.48	
Calculated Porosity (% vol):	49.1	
Percent Saturation:	27.4	
-		

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P1-1A (30'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

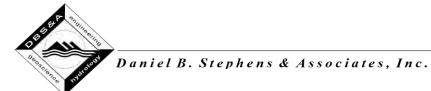
	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	553.07 0.00 269.55 0.00	
Dry weight of sample (g):	272.79	
Sample volume (cm³):	222.18	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	3.9	
Volumetric Moisture Content (% vol):	4.8	
Dry bulk density (g/cm <sup>3</sup> ):	1.23	
Wet bulk density (g/cm <sup>3</sup> ):	1.28	
Calculated Porosity (% vol):	53.7	
Percent Saturation:	9.0	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P1-2 (50'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g):	738.56 0.00 282.24 0.00 437.31 273.85	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	4.3	
Volumetric Moisture Content (% vol):	6.9	
Dry bulk density (g/cm <sup>3</sup> ):	1.60	
Wet bulk density (g/cm <sup>3</sup> ):	1.67	
Calculated Porosity (% vol):	39.7	
Percent Saturation:	17.5	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P2-1 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

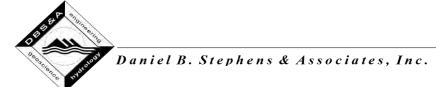
	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	862.56 0.00 269.31 0.00	
Dry weight of sample (g):	523.86	
Sample volume (cm³):	282.39	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	13.2	
Volumetric Moisture Content (% vol):	24.6	
Dry bulk density (g/cm <sup>3</sup> ):	1.86	
Wet bulk density (g/cm <sup>3</sup> ):	2.10	
Calculated Porosity (% vol):	30.0	
Percent Saturation:	81.9	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P2-1 (25'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

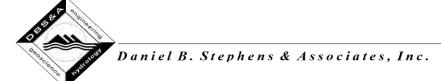
	As Received	Remolded
Test Date:	22-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):  Dry weight of sample (g):	739.39 0.00 209.29 0.00 459.48	
Sample volume (cm <sup>3</sup> ):	275.50	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	15.4	
Volumetric Moisture Content (% vol):	25.6	
Dry bulk density (g/cm <sup>3</sup> ):	1.67	
Wet bulk density (g/cm <sup>3</sup> ):	1.92	
Calculated Porosity (% vol):	37.1	
Percent Saturation:	69.2	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-1 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

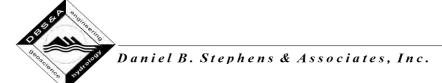
	As Received	Remolded
Test Date:	16-May-18	
Field weight* of sample (g):	789.58 0.00 208.68 0.00 541.45	
Sample volume (cm <sup>3</sup> ):	290.47	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	7.3	
Volumetric Moisture Content (% vol):	13.6	
Dry bulk density (g/cm <sup>3</sup> ):	1.86	
Wet bulk density (g/cm <sup>3</sup> ):	2.00	
Calculated Porosity (% vol):	29.7	
Percent Saturation:	45.8	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-1 (15'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

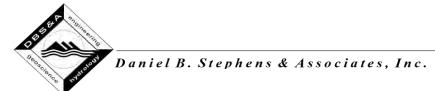
	As Received	Remolded
Test Date:	15-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	555.60 0.00 258.76 0.00	
Dry weight of sample (g): Sample volume (cm <sup>3</sup> ): Assumed particle density (g/cm <sup>3</sup> ):	271.23 290.68 2.65	
Gravimetric Moisture Content (% g/g):	9.4	
Volumetric Moisture Content (% vol):	8.8	
Dry bulk density (g/cm <sup>3</sup> ):	0.93	
Wet bulk density (g/cm <sup>3</sup> ):	1.02	
Calculated Porosity (% vol):	64.8	
Percent Saturation:	13.6	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-2 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):  Dry weight of sample (g):	792.24 0.00 298.95 0.00 462.96	
Sample volume (cm <sup>3</sup> ): Assumed particle density (g/cm <sup>3</sup> ):	273.96 2.65	
Gravimetric Moisture Content (% g/g):	6.6	
Volumetric Moisture Content (% vol):	11.1	
Dry bulk density (g/cm <sup>3</sup> ):	1.69	
Wet bulk density (g/cm <sup>3</sup> ):	1.80	
Calculated Porosity (% vol):	36.2	
Percent Saturation:	30.6	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-2 (20'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	15-May-18	
Field weight* of sample (g):	717.70	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	208.58	
Tare weight, other (g):	0.00	
3 9 7 7 (3)		
Dry weight of sample (g):	457.43	
Sample volume (cm <sup>3</sup> ):	274.45	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	11.3	
Volumetric Moisture Content (% vol):	18.8	
` ,		
Dry bulk density (g/cm <sup>3</sup> ):	1.67	
Wet bulk density (g/cm <sup>3</sup> ):	1.86	
Calculated Porosity (% vol):	37.1	
Percent Saturation:	50.8	
-		

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-3 (20'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	15-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	703.70 0.00 208.56 0.00	
Dry weight of sample (g):	457.99	
Sample volume (cm <sup>3</sup> ):	270.93	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	8.1	
Volumetric Moisture Content (% vol):	13.7	
Dry bulk density (g/cm <sup>3</sup> ):	1.69	
Wet bulk density (g/cm <sup>3</sup> ):	1.83	
Calculated Porosity (% vol):	36.2	
Percent Saturation:	37.9	
	•	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-3 (40'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

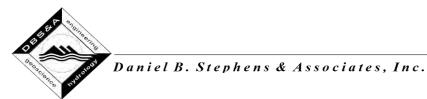
	As Received	Remolded
Test Date:	16-May-18	
Field weight* of sample (g):	813.73 0.00 213.53 0.00 523.50	
Assumed particle density (g/cm <sup>3</sup> ):	291.74 2.65	
Gravimetric Moisture Content (% g/g):	14.7	
Volumetric Moisture Content (% vol):	26.3	
Dry bulk density (g/cm <sup>3</sup> ):	1.79	
Wet bulk density (g/cm <sup>3</sup> ):	2.06	
Calculated Porosity (% vol):	32.3	
Percent Saturation:	81.4	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-4 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

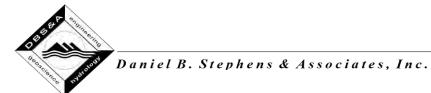
Field weight* of sample (g): 706.80 Tare weight, ring (g): 0.00 Tare weight, pan/plate (g): 213.41 Tare weight, other (g): 0.00  Dry weight of sample (g): 451.37 Sample volume (cm³): 292.80 Assumed particle density (g/cm³): 2.65  Gravimetric Moisture Content (% g/g): 9.3  Volumetric Moisture Content (% vol): 14.4 Dry bulk density (g/cm³): 1.54 Wet bulk density (g/cm³): 1.69 Calculated Porosity (% vol): 41.8		As Received	Remolded
Tare weight, ring (g): 0.00 Tare weight, pan/plate (g): 213.41 Tare weight, other (g): 0.00  Dry weight of sample (g): 451.37 Sample volume (cm³): 292.80 Assumed particle density (g/cm³): 2.65  Gravimetric Moisture Content (% g/g): 9.3  Volumetric Moisture Content (% vol): 14.4 Dry bulk density (g/cm³): 1.54 Wet bulk density (g/cm³): 1.69 Calculated Porosity (% vol): 41.8	Test Date:	15-May-18	
Volumetric Moisture Content (% vol): 14.4  Dry bulk density (g/cm³): 1.54  Wet bulk density (g/cm³): 1.69  Calculated Porosity (% vol): 41.8	Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):  Dry weight of sample (g): Sample volume (cm <sup>3</sup> ):	0.00 213.41 0.00 451.37 292.80	
i GitGiil Qaluialitii. 14.3	Volumetric Moisture Content (% vol):  Dry bulk density (g/cm³):  Wet bulk density (g/cm³):	14.4 1.54 1.69	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-4 (30'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

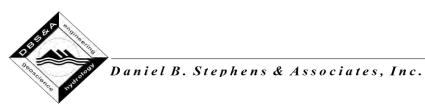
	As Received	Remolded
Test Date:	15-May-18	
Field weight* of sample (g):	757.20 0.00 293.36 0.00 437.63 286.94	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	6.0	
Volumetric Moisture Content (% vol):	9.1	
Dry bulk density (g/cm <sup>3</sup> ):	1.53	
Wet bulk density (g/cm <sup>3</sup> ):	1.62	
Calculated Porosity (% vol):	42.4	
Percent Saturation:	21.5	

Laboratory analysis by: E. Bastien
Data entered by: C. Krous
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-4 (40'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

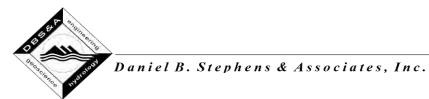
	As Received	Remolded
Test Date:	15-May-18	
Field weight* of sample (g): Tare weight, ring (g):	798.70 0.00	
Tare weight, pan/plate (g): Tare weight, other (g):	213.76 0.00	
Dry weight of sample (g):  Sample volume (cm <sup>3</sup> ):  Assumed particle density (g/cm <sup>3</sup> ):	546.30 291.43 2.65	
Assumed particle density (grown).	2.00	
Gravimetric Moisture Content (% g/g):	7.1	
Volumetric Moisture Content (% vol):	13.3	
Dry bulk density (g/cm <sup>3</sup> ):	1.87	
Wet bulk density (g/cm <sup>3</sup> ):	2.01	
Calculated Porosity (% vol):	29.3	
Percent Saturation:	45.3	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-5 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g):	867.36 0.00 292.86	
Tare weight, other (g):	0.00	
Dry weight of sample (g): Sample volume (cm³): Assumed particle density (g/cm³):	530.27 285.93 2.65	
Gravimetric Moisture Content (% g/g):	8.3	
Volumetric Moisture Content (% vol):	15.5	
Dry bulk density (g/cm <sup>3</sup> ):	1.85	
Wet bulk density (g/cm <sup>3</sup> ):	2.01	
Calculated Porosity (% vol):	30.0	
Percent Saturation:	51.5	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-6 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

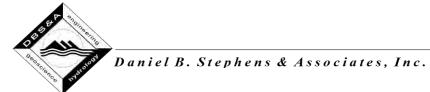
	As Received	Remolded
Test Date:	22-May-18	
Field weight* of sample (g):	660.32 0.00 263.20 0.00 378.94 232.31	
Assumed particle density (g/cm³):	2.65	
Gravimetric Moisture Content (% g/g):	4.8	
Volumetric Moisture Content (% vol):	7.8	
Dry bulk density (g/cm <sup>3</sup> ):	1.63	
Wet bulk density (g/cm <sup>3</sup> ):	1.71	
Calculated Porosity (% vol):	38.4	
Percent Saturation:	20.4	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-6 (20'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

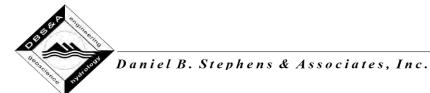
	As Received	Remolded
Test Date:	15-May-18	
Field weight* of sample (g):  Tare weight, ring (g):  Tare weight, pan/plate (g):  Tare weight, other (g):	764.00 0.00 212.68 0.00	
Dry weight of sample (g): Sample volume (cm³):	504.36	
Assumed particle density (g/cm <sup>3</sup> ):	291.86 2.65	
Gravimetric Moisture Content (% g/g):	9.3	
( 33,		
Volumetric Moisture Content (% vol):	16.1	
Dry bulk density (g/cm <sup>3</sup> ):	1.73	
Wet bulk density (g/cm <sup>3</sup> ):	1.89	
Calculated Porosity (% vol):	34.8	
Percent Saturation:	46.2	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-6 (50'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

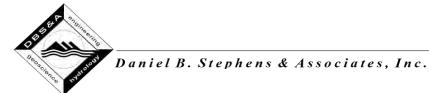
	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	758.56 0.00 210.96 0.00	
Dry weight of sample (g):	516.43	
Sample volume (cm³):	291.09	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	6.0	
Volumetric Moisture Content (% vol):	10.7	
Dry bulk density (g/cm <sup>3</sup> ):	1.77	
Wet bulk density (g/cm <sup>3</sup> ):	1.88	
Calculated Porosity (% vol):	33.1	
Percent Saturation:	32.4	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-5 (20'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

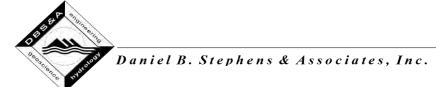
	As Received	Remolded
Test Date:	16-May-18	
Field weight* of sample (g):     Tare weight, ring (g):     Tare weight, pan/plate (g):     Tare weight, other (g):     Dry weight of sample (g):     Sample volume (cm³): Assumed particle density (g/cm³):	710.57 0.00 210.11 0.00 466.53 268.31 2.65	
Gravimetric Moisture Content (% g/g):  Volumetric Moisture Content (% vol):  Dry bulk density (g/cm³):  Wet bulk density (g/cm³):	7.3 12.6 1.74 1.87	
Calculated Porosity (% vol):	34.4	
Percent Saturation:	36.8	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-6 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):	795.13 0.00 286.81 0.00 462.06 291.36 2.65	
Gravimetric Moisture Content (% g/g):	10.0	
Volumetric Moisture Content (% vol):	15.9	
Dry bulk density (g/cm <sup>3</sup> ):	1.59	
Wet bulk density (g/cm <sup>3</sup> ):	1.74	
Calculated Porosity (% vol):	40.2	
Percent Saturation:	39.5	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-7 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

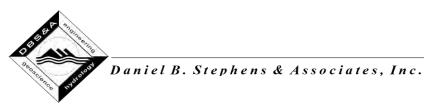
	As Received	Remolded
Test Date:	16-May-18	
Field weight* of sample (g):  Tare weight, ring (g):  Tare weight, pan/plate (g):  Tare weight, other (g):	638.50 0.00 207.42 0.00	
Dry weight of sample (g):	392.69	
Sample volume (cm <sup>3</sup> ):	263.40	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	9.8	
Volumetric Moisture Content (% vol):	14.6	
Dry bulk density (g/cm <sup>3</sup> ):	1.49	
Wet bulk density (g/cm <sup>3</sup> ):	1.64	
Calculated Porosity (% vol):	43.7	
Percent Saturation:	33.3	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-7 (25'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):	832.52 0.00 288.58 0.00 512.00 290.35 2.65	
Gravimetric Moisture Content (% g/g):	6.2	
Volumetric Moisture Content (% vol):	11.0	
Dry bulk density (g/cm <sup>3</sup> ):	1.76	
Wet bulk density (g/cm <sup>3</sup> ):	1.87	
Calculated Porosity (% vol):	33.5	
Percent Saturation:	32.9	
-		

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-8 (15'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	803.98 0.00 297.95 0.00	
Dry weight of sample (g):	447.92	
Sample volume (cm <sup>3</sup> ):	276.60	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	13.0	
Volumetric Moisture Content (% vol):	21.0	
Dry bulk density (g/cm <sup>3</sup> ):	1.62	
Wet bulk density (g/cm <sup>3</sup> ):	1.83	
Calculated Porosity (% vol):	38.9	
Percent Saturation:	54.0	
	<del></del>	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-9 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

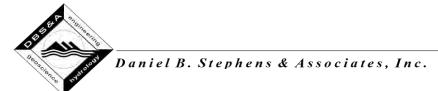
	As Received	Remolded
Test Date:	23-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	792.93 0.00 267.28 0.00	
Dry weight of sample (g):	503.41	
Sample volume (cm³):	269.21	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	4.4	
Volumetric Moisture Content (% vol):	8.3	
Dry bulk density (g/cm <sup>3</sup> ):	1.87	
Wet bulk density (g/cm <sup>3</sup> ):	1.95	
Calculated Porosity (% vol):	29.4	
Percent Saturation:	28.1	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-9 (35'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

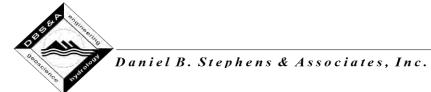
	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):     Tare weight, ring (g):     Tare weight, pan/plate (g):     Tare weight, other (g):     Dry weight of sample (g):     Sample volume (cm³):  Assumed particle density (g/cm³):	820.17 0.00 284.68 0.00 471.98 284.05 2.65	
Gravimetric Moisture Content (% g/g):  Volumetric Moisture Content (% vol):  Dry bulk density (g/cm³):  Wet bulk density (g/cm³):  Calculated Porosity (% vol):	13.5 22.4 1.66 1.89 37.3	
Percent Saturation:	59.9	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: BW-1 (30'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Field weight* of sample (g):	23-May-18 714.17 0.00	
, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):  Dry weight of sample (g): Sample volume (cm³): Assumed particle density (g/cm³):	284.25 0.00 393.38 281.54 2.65	
Gravimetric Moisture Content (% g/g):  Volumetric Moisture Content (% vol):  Dry bulk density (g/cm³):  Wet bulk density (g/cm³):  Calculated Porosity (% vol):  Percent Saturation:	9.3 13.0 1.40 1.53 47.3 27.5	

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

### Comments:

\* Weight including tares

NA = Not analyzed



### Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: BW-2 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g): Tare weight, ring (g): Tare weight, pan/plate (g): Tare weight, other (g):	751.25 0.00 283.91 0.00	
Dry weight of sample (g):	441.31	
Sample volume (cm³):	290.92	
Assumed particle density (g/cm <sup>3</sup> ):	2.65	
Gravimetric Moisture Content (% g/g):	5.9	
Volumetric Moisture Content (% vol):	8.9	
Dry bulk density (g/cm <sup>3</sup> ):	1.52	
Wet bulk density (g/cm <sup>3</sup> ):	1.61	
Calculated Porosity (% vol):	42.8	
Percent Saturation:	20.9	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

#### Comments:

\* Weight including tares

NA = Not analyzed

--- = This sample was not remolded



## Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: BW-3 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	
Field weight* of sample (g):     Tare weight, ring (g):     Tare weight, pan/plate (g):     Tare weight, other (g):     Dry weight of sample (g):     Sample volume (cm³): Assumed particle density (g/cm³):	756.43 0.00 268.23 0.00 470.38 290.70 2.65	
Gravimetric Moisture Content (% g/g):  Volumetric Moisture Content (% vol):  Dry bulk density (g/cm³):	3.8 6.1 1.62	
Wet bulk density (g/cm <sup>3</sup> ): Calculated Porosity (% vol):	1.68 38.9	
Percent Saturation:	15.7	

Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

#### Comments:

\* Weight including tares

NA = Not analyzed

--- = This sample was not remolded

**Particle Size Analysis** 



## **Summary of Particle Size Characteristics**

 Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	_
SA-GM 1B	NA	NA	NA	NA	NA	WS	NA	NA	(Est)
SA-GM 1T	NA	NA	NA	NA	NA	WS	NA	NA	(Est)
SA-GM 2B	NA	NA	0.071	NA	NA	WS	NA	NA	(Est)
SA-GM 2T	NA	NA	NA	NA	NA	WS	NA	NA	(Est)
SA-GM 3B	NA	0.18	0.25	NA	NA	WS	NA	NA	(Est)
SA-GM 3T	NA	0.18	0.37	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
SA-GM 4B	NA	0.11	0.13	NA	NA	WS	NA	NA	(Est)
SA-GM 5B	NA	0.21	0.28	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
SA-GM 5T	0.16	0.38	0.43	2.7	1.3	WS	NA	Sand	
SA-GM 6B	NA	NA	NA	NA	NA	WS	NA	NA	(Est)
SA-GM 6T	NA	NA	NA	NA	NA	WS	NA	NA	(Est)

d<sub>50</sub> = Median particle diameter

 $C_u = \frac{d}{dx}$ 

DS = Dry sieve

<sup>†</sup> Greater than 10% of sample is coarse material

Est = Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

- u<sub>10</sub>

 $= \frac{(d_{30})^2}{(d_{10})(d_{60})}$ 

WS = Wet sieve

= Hydrometer



### **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	
SA-GM 7B	NA	0.11	0.13	NA	NA	WS	NA	NA	(Est)
SA-GM 8B	NA	0.12	0.16	NA	NA	WS	NA	NA	(Est)
SA-GM 8T	NA	0.37	0.52	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
L1-1 (10'A)	2.2E-05	0.046	0.061	2773	33	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
L1-2 (20'B)	2.8E-05	0.0092	0.015	536	12	WS/H	Classification by ASTM 2487 requires Atterberg test	Silty Clay Loam	(Est)
L1-3 (5'A)	6.4E-45	0.066	0.088	1.4E+43	2.1E+42	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
L1-5 (20'B)	0.0011	0.074	0.093	85	17	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
L2-1 (5'A)	0.00040	0.045	0.060	150	9.4	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
L2-1 (15'A)	0.00024	0.056	0.065	271	11	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
L2-2 (5'A)	0.00019	0.067	0.085	447	60	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
L2-3 (5'A)	0.00094	0.076	0.089	95	26	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)

d<sub>50</sub> = Median particle diameter

 $C_u = \frac{d_{60}}{d_{10}}$ 

DS = Dry sieve

= Hydrometer

WS = Wet sieve

<sup>†</sup> Greater than 10% of sample is coarse material



### **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	
L2-4 (10'B)	3.9E-05	0.045	0.057	1462	65	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
L2-5 (5'A)	4.4E-05	0.0022	0.0047	107	0.50	WS/H	Classification by ASTM 2487 requires Atterberg test	Silty Clay	(Est)
L2-6 (5'A)	0.00031	0.013	0.030	97	0.43	WS/H	Lean clay (CL)	Clay Loam	(Est)
L2-7 (10'A)	1.9E-09	0.057	0.075	3.9E+07	4.4E+06	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
T/O-1 (20'A)	0.00030	0.0088	0.016	53	0.75	WS/H	Classification by ASTM 2487 requires Atterberg test	Silty Clay Loam	(Est)
T/O-1 (45'B)	5.1E-05	0.070	0.099	1941	51	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Clay Loam	(Est)
T/O-2 (5'A)	0.0025	0.010	0.022	8.8	0.15	WS/H	Classification by ASTM 2487 requires Atterberg test	Silt Loam	
T/O-3 (40'A)	0.00083	0.078	0.10	120	20	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
T/O-3 (70'B)	0.00032	0.034	0.045	141	8.4	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
T/O-4 (20'B)	0.00059	0.034	0.050	85	4.1	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
T/O-5 (10'B)	0.0011	0.028	0.039	35	2.3	WS/H	Classification by ASTM 2487 requires Atterberg test	Silt Loam	(Est)
									_

d<sub>50</sub> = Median particle diameter

 $C_{u} = \frac{d_{60}}{d_{10}}$ 

DS = Dry sieve

WS = Wet sieve

H = Hydrometer

 $=\frac{(d_{30})^2}{(d_{30})(d_{30})}$ 

<sup>†</sup> Greater than 10% of sample is coarse material



## **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	_
T/O-6 (5'A)	0.00066	0.043	0.054	82	9.1	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
TN-1 (5'A)	0.00074	0.077	0.097	131	17	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
TN-2 (20'A)	0.00077	0.079	0.10	130	18	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
BS-1 (10'A)	0.00029	0.052	0.076	262	4.4	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Clay Loam	(Est)
BS-2 (15'A)	0.0039	0.061	0.082	21	0.61	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	
BS-6 (20'A)	0.00018	0.054	0.062	344	43	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
TS-1 (20'A)	0.0010	0.035	0.048	48	2.0	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
TS-2 (10'A)	0.0019	0.087	0.12	63	3.0	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	
TS-3 (10'A)	0.00086	0.043	0.051	59	3.9	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
TS-4 (5'A)	0.0011	0.11	0.13	118	20	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P1-1 (5'A)	0.0012	0.13	0.17	142	23	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam <sup>†</sup>	(Est)
d <sub>50</sub> = Median particle diameter	C -	<u>d<sub>60</sub></u>		DS = Dry siev	ve .	<sup>†</sup> Greater tha	an 10% of sample is coarse material		-

Est = Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

= Hydrometer

WS = Wet sieve



### **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	d <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	_
P1-2 (30'B)	0.0010	0.11	0.16	160	21	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam <sup>†</sup>	(Est)
P2-1 (25'A)	0.00071	0.087	0.12	169	11	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P2-2 (5'B)	0.00078	0.089	0.11	141	28	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P3-1 (5'A)	NA	0.23	0.33	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
P3-2 (15'B)	NA	0.20	0.25	NA	NA	WS	NA	NA	(Est)
P3-2 (35'B)	NA	0.15	0.19	NA	NA	WS	NA	NA	(Est)
P3-3 (5'A)	NA	0.15	0.19	NA	NA	WS	NA	NA	(Est)
P3-3 (40'B)	NA	0.085	0.099	NA	NA	WS	NA	NA	(Est)
P3-4 (20'A)	0.11	0.25	0.29	2.6	0.91	WS	NA	Sand	
P3-4 (30'A)	0.10	0.19	0.22	2.2	0.89	WS	NA	Sand	
P3-4 (40'A)	0.0029	0.072	0.087	30	7.7	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	

d<sub>50</sub> = Median particle diameter

 $C_{u} = \frac{d_{60}}{d_{10}}$ 

DS = Dry sieve

H = Hydrometer

 $\frac{d_{30})^2}{\sqrt{d_{30}}}$  WS = Wet sieve

<sup>†</sup> Greater than 10% of sample is coarse material



## **Summary of Particle Size Characteristics (Continued)**

Sample Number	d <sub>10</sub> (mm)	<b>d</b> <sub>50</sub> (mm)	d <sub>60</sub> (mm)	$C_{u}$	$C_c$	Method	ASTM Classification	USDA Classification	
P3-5 (10'A)	0.020	0.099	0.12	6.0	2.2	WS/H	Classification by ASTM 2487 requires Atterberg test	Loamy Sand	
P3-6 (20'A)	NA	0.20	0.24	NA	NA	WS	NA	NA	(Est)
P3-6 (50'A)	NA	0.23	0.30	NA	NA	WS	NA	NA	(Est)
P4-5 (20'A)	NA	0.30	0.39	NA	NA	WS	NA	NA <sup>†</sup>	(Est)
P4-6 (10'A)	0.0012	0.072	0.084	70	23	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P4-7 (5'A)	NA	0.077	0.095	NA	NA	WS	NA	NA	(Est)
P4-7 (25'B)	0.0052	0.28	0.34	65	9.6	WS/H	Classification by ASTM 2487 requires Atterberg test	Loamy Sand	
P4-8 (15'B)	0.0011	0.085	0.13	118	5.1	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
P4-9 (35'B)	6.7E-06	0.061	0.087	1.3E+04	1160	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam <sup>†</sup>	(Est)
BW-1 (20'A)	0.0012	0.047	0.083	69	1.2	WS/H	Classification by ASTM 2487 requires Atterberg test	Loam	(Est)
BW-2 (10'A)	0.00035	0.062	0.084	240	18	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)
BW-3 (5'A)	0.0011	0.080	0.099	90	23	WS/H	Classification by ASTM 2487 requires Atterberg test	Sandy Loam	(Est)

d<sub>50</sub> = Median particle diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_{1} = \frac{(d_{30})^{2}}{(d_{30})^{2}}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

<sup>†</sup> Greater than 10% of sample is coarse material

Est = Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter



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### Percent Gravel, Sand, Silt and Clay\*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
SA-GM 1B	0.0	15.0	85.0	**
SA-GM 1T	0.1	34.3	65.6	**
SA-GM 2B	0.0	39.4	60.6	**
SA-GM 2T	0.0	24.4	75.6	**
SA-GM 3B	0.0	69.0	31.0	**
SA-GM 3T	15.1	48.0	36.9	**
SA-GM 4B	0.0	64.2	35.8	**
SA-GM 5B	14.6	61.8	23.6	**
SA-GM 5T	0.1	94.9	5.1	**
SA-GM 6B	0.0	20.4	79.6	**
SA-GM 6T	0.0	17.6	82.4	**
SA-GM 7B	0.0	62.6	37.4	**
SA-GM 8B	0.0	61.1	38.9	**
SA-GM 8T	13.4	70.7	15.8	**
L1-1 (10'A)	0.0	33.2	43.1	23.7
L1-2 (20'B)	0.1	2.3	68.1	29.5

<sup>\*</sup>USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

<sup>\*\*</sup>Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.

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### Percent Gravel, Sand, Silt and Clay\* (Continued)

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
L1-3 (5'A)	0.0	46.5	40.8	12.7
L1-5 (20'B)	0.0	49.7	37.7	12.6
L2-1 (5'A)	0.0	32.5	49.0	18.5
L2-1 (15'A)	0.0	31.5	50.5	18.0
L2-2 (5'A)	0.0	46.3	37.5	16.2
L2-3 (5'A)	0.0	51.2	36.8	12.1
L2-4 (10'B)	0.0	28.8	50.0	21.2
L2-5 (5'A)	0.0	2.8	48.6	48.6
L2-6 (5'A)	0.0	14.8	55.2	29.9
L2-7 (10'A)	0.0	40.1	48.2	11.7
T/O-1 (20'A)	0.2	3.2	66.0	30.6
T/O-1 (45'B)	0.0	47.9	31.0	21.1
T/O-2 (5'A)	0.0	23.0	71.5	5.5
T/O-3 (40'A)	0.0	51.5	34.4	14.1
T/O-3 (70'B)	0.5	8.7	73.8	17.1
T/O-4 (20'B)	0.0	24.8	57.7	17.5

<sup>\*</sup>USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

<sup>\*\*</sup>Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.



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### Percent Gravel, Sand, Silt and Clay\* (Continued)

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
T/O-5 (10'B)	0.0	10.1	75.3	14.6
T/O-6 (5'A)	0.0	24.3	59.7	16.0
TN-1 (5'A)	0.4	50.9	33.3	15.4
TN-2 (20'A)	0.0	51.9	34.4	13.8
BS-1 (10'A)	0.0	40.8	36.1	23.0
BS-2 (15'A)	0.0	43.0	51.6	5.3
BS-6 (20'A)	0.0	26.3	55.8	17.9
TS-1 (20'A)	0.0	18.2	65.1	16.7
TS-2 (10'A)	0.0	53.9	35.3	10.8
TS-3 (10'A)	0.0	16.1	68.6	15.2
TS-4 (5'A)	0.7	63.1	22.7	13.5
P1-1 (5'A)	18.8	49.8	20.8	10.6
P1-2 (30'B)	20.3	43.0	24.9	11.8
P2-1 (25'A)	0.3	54.0	30.7	15.1
P2-2 (5'B)	5.1	53.2	27.1	14.6
P3-1 (5'A)	19.7	64.9	15.3	**
P3-2 (15'B)	0.0	78.8	21.2	**

<sup>\*</sup>USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

<sup>\*\*</sup>Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm. 97



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# Percent Gravel, Sand, Silt and Clay\* (Continued)

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)	
P3-2 (35'B)	1.1	68.2	30.7		**
P3-3 (5'A)	0.3	67.7	31.9		**
P3-3 (40'B)	1.4	56.3	42.3		**
P3-4 (20'A)	0.0	92.7	7.3		**
P3-4 (30'A)	0.0	92.3	7.7		**
P3-4 (40'A)	0.0	48.1	44.2	7.7	
P3-5 (10'A)	0.0	68.6	27.8	3.6	
P3-6 (20'A)	0.0	85.2	14.8		**
P3-6 (50'A)	7.2	76.4	16.4		**
P4-5 (20'A)	24.9	61.0	14.1		**
P4-6 (10'A)	0.0	48.0	41.0	11.0	
P4-7 (5'A)	7.2	43.9	49.0		**
P4-7 (25'B)	0.0	77.0	17.5	5.5	
P4-8 (15'B)	0.5	51.9	35.5	12.1	
P4-9 (35'B)	15.7	26.6	46.4	11.4	
BW-1 (20'A)	0.0	45.4	34.9	19.7	
BW-2 (10'A)	0.0	44.1	38.1	17.8	
BW-3 (5'A)	0.0	53.1	35.9	11.0	_

<sup>\*</sup>USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

<sup>\*\*</sup>Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.



PO Number: 233001076-DBS

#### Particle Size Analysis Wet Sieve Data (#10 Split)

Calculated Weight of Sieve Sample (g): 83.95

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 402.69Job Number:DB18.1151.00Weight Passing #10 (g): 402.69

Sample Number: SA-GM 1B Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 83.95

Test Date: 23-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		·			-	
	3"	75	0.00	0.00	402.69	100.00
	2"	50	0.00	0.00	402.69	100.00
	1.5"	38.1	0.00	0.00	402.69	100.00
	1"	25	0.00	0.00	402.69	100.00
	3/4"	19.0	0.00	0.00	402.69	100.00
	3/8"	9.5	0.00	0.00	402.69	100.00
	4	4.75	0.00	0.00	402.69	100.00
	10	2.00	0.00	0.00	402.69	100.00
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	0.08	0.08	83.87	99.90
	40	0.425	0.32	0.40	83.55	99.52
	60	0.250	0.27	0.67	83.28	99.20
	140	0.106	4.87	5.54	78.41	93.40
	200	0.075	7.02	12.56	71.39	85.04
	dry pan		1.72	14.28	69.67	
	wet pan			69.67	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): NA  $d_{16}$  (mm): NA  $d_{60}$  (mm): NA  $d_{30}$  (mm): NA  $d_{84}$  (mm): NA

Median Particle Diameter--d<sub>50</sub> (mm): NA

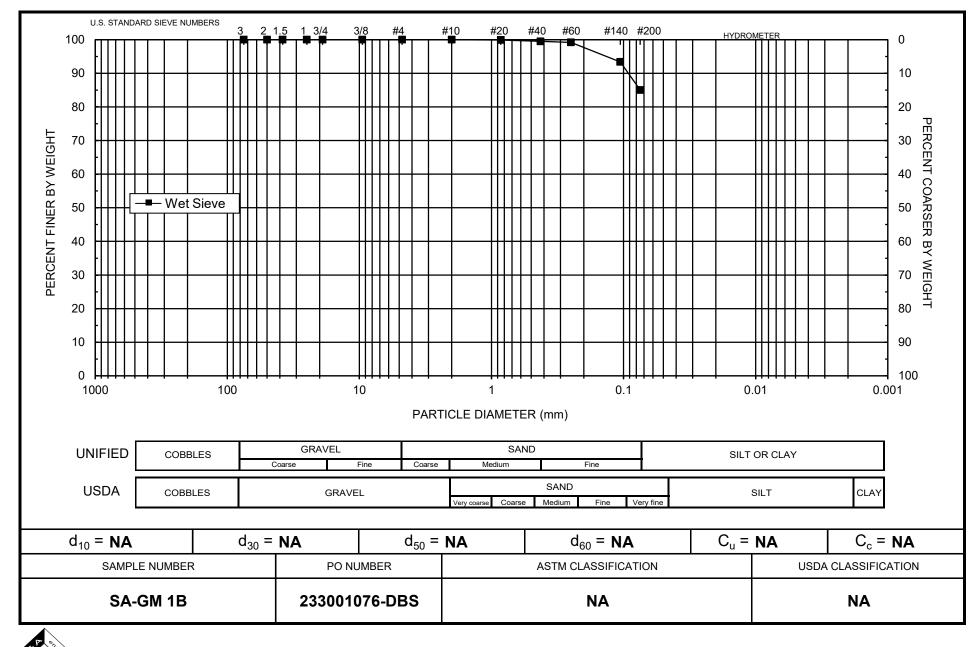
Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 394.50Job Number:DB18.1151.00Weight Passing #10 (g): 393.94

Sample Number: SA-GM 1T Weight Retained #10 (g): 0.56
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 55.40

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 55.48

Test Date: 23-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		, ,				
	3"	75	0.00	0.00	394.50	100.00
	2"	50	0.00	0.00	394.50	100.00
	1.5"	38.1	0.00	0.00	394.50	100.00
	1"	25	0.00	0.00	394.50	100.00
	3/4"	19.0	0.00	0.00	394.50	100.00
	3/8"	9.5	0.00	0.00	394.50	100.00
	4	4.75	0.23	0.23	394.27	99.94
	10	2.00	0.33	0.56	393.94	99.86
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	1.93	2.01	53.47	96.38
	40	0.425	1.51	3.52	51.96	93.66
	60	0.250	1.32	4.84	50.64	91.28
	140	0.106	7.96	12.80	42.68	76.93
	200	0.075	6.29	19.09	36.39	65.59
	dry pan		1.81	20.90	34.58	
	wet pan			34.58	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): NA  $d_{60}$  (mm): NA  $d_{60}$  (mm): NA  $d_{84}$  (mm): 0.16

Median Particle Diameter--d<sub>50</sub> (mm): NA

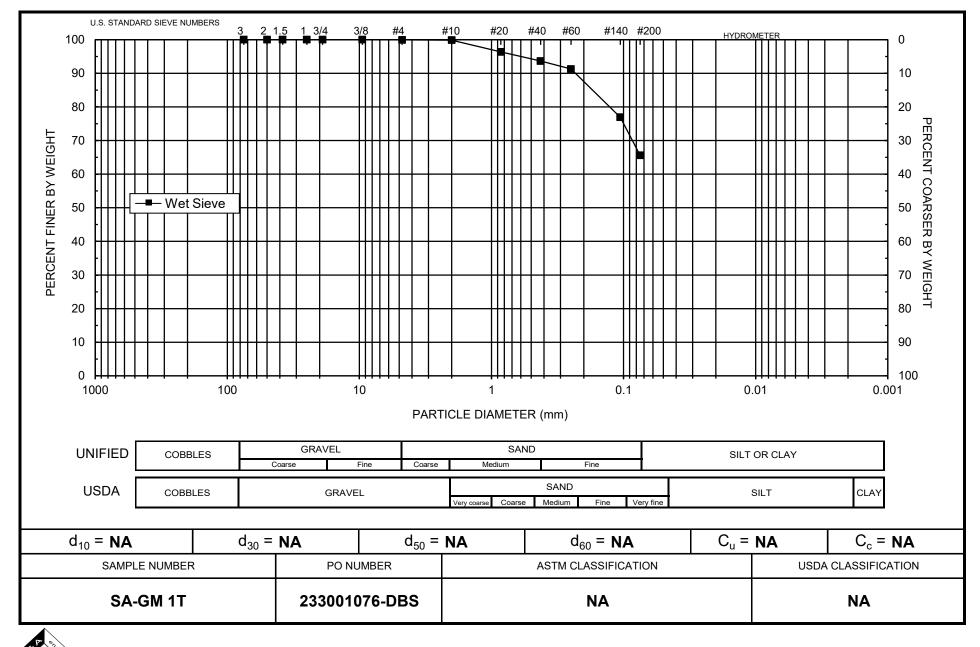
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter--[ $(d_{16}+d_{50}+d_{84})/3$ ] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 632.00Job Number:DB18.1151.00Weight Passing #10 (g): 632.00

Sample Number: SA-GM 2B Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 53.48

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 53.48

Test Date: 25-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						_
	3"	75	0.00	0.00	632.00	100.00
	2"	50	0.00	0.00	632.00	100.00
	1.5"	38.1	0.00	0.00	632.00	100.00
	1"	25	0.00	0.00	632.00	100.00
	3/4"	19.0	0.00	0.00	632.00	100.00
	3/8"	9.5	0.00	0.00	632.00	100.00
	4	4.75	0.00	0.00	632.00	100.00
	10	2.00	0.00	0.00	632.00	100.00
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	0.14	0.14	53.34	99.74
	40	0.425	1.32	1.46	52.02	97.27
	60	0.250	5.06	6.52	46.96	87.81
	140	0.106	12.46	18.98	34.50	64.51
	200	0.075	2.11	21.09	32.39	60.56
	dry pan		0.21	21.30	32.18	
	wet pan			32.18	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): NA  $d_{16}$  (mm): NA  $d_{60}$  (mm): 0.071  $d_{30}$  (mm): NA  $d_{84}$  (mm): 0.22

Median Particle Diameter--d<sub>50</sub> (mm): NA

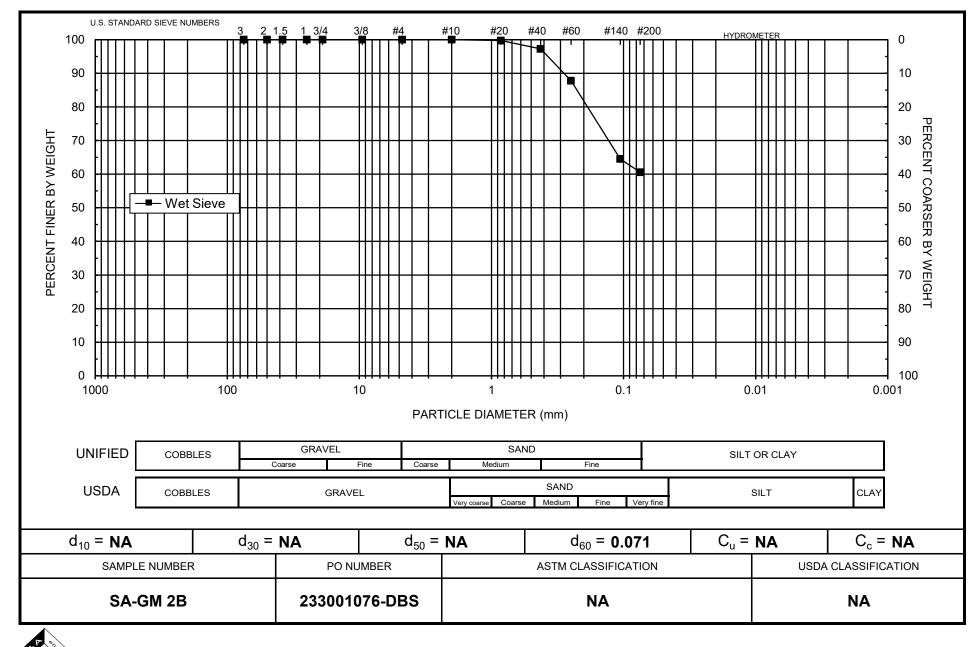
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





#### **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 544.47

Job Number: DB18.1151.00 Weight Passing #10 (g): 544.47 Sample Number: SA-GM 2T Weight Retained #10 (g): 0.00 Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 60.16

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 60.16

Test Date: 24-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	544.47	100.00
	2"	50	0.00	0.00	544.47	100.00
	1.5"	38.1	0.00	0.00	544.47	100.00
	1"	25	0.00	0.00	544.47	100.00
	3/4"	19.0	0.00	0.00	544.47	100.00
	3/8"	9.5	0.00	0.00	544.47	100.00
	4	4.75	0.00	0.00	544.47	100.00
	10	2.00	0.00	0.00	544.47	100.00
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	0.13	0.13	60.03	99.78
	40	0.425	0.36	0.49	59.67	99.19
	60	0.250	1.16	1.65	58.51	97.26
	140	0.106	8.90	10.55	49.61	82.46
	200	0.075	4.11	14.66	45.50	75.63
	dry pan		0.38	15.04	45.12	
	wet pan			45.12	0.00	

d<sub>10</sub> (mm): NA d<sub>50</sub> (mm): NA d<sub>16</sub> (mm): NA d<sub>60</sub> (mm): NA d<sub>30</sub> (mm): NA d<sub>84</sub> (mm): 0.12

Median Particle Diameter -- d<sub>50</sub> (mm): NA

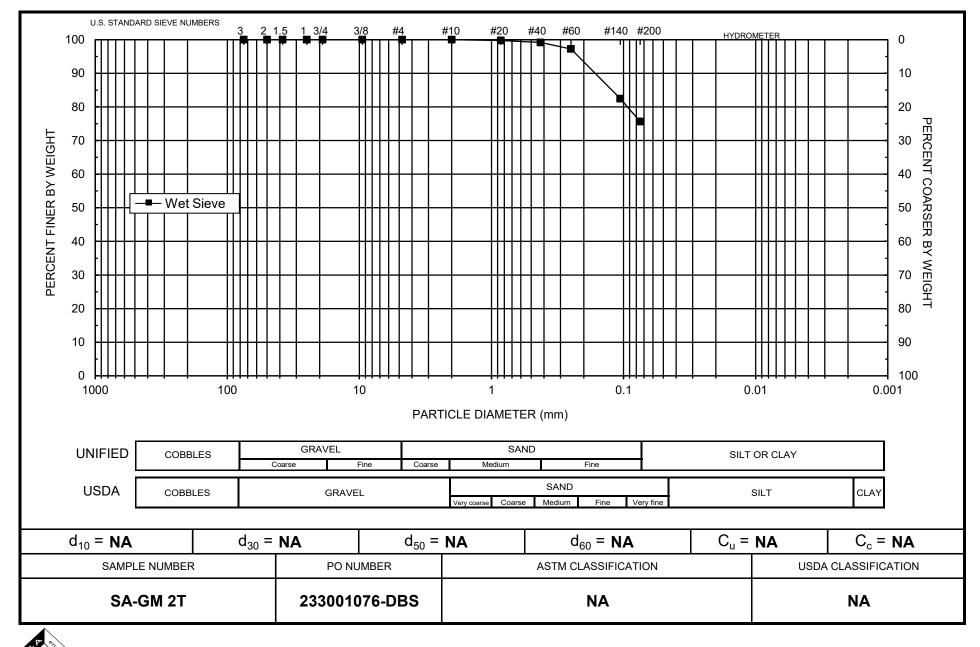
Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): NA

Coefficient of Curvature, Cc--[(d<sub>30</sub>)<sup>2</sup>/(d<sub>10</sub>\*d<sub>60</sub>)] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 509.48Job Number:DB18.1151.00Weight Passing #10 (g): 509.48

Sample Number: SA-GM 3B Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 90.13

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 90.13

Test Date: 23-May-18 Shape: Rounded

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
Traction	Nullibei	(11111)	Netaineu	Netaineu	rassing	70 F assiriy
+10						
	3"	75	0.00	0.00	509.48	100.00
	2"	50	0.00	0.00	509.48	100.00
	1.5"	38.1	0.00	0.00	509.48	100.00
	1"	25	0.00	0.00	509.48	100.00
	3/4"	19.0	0.00	0.00	509.48	100.00
	3/8"	9.5	0.00	0.00	509.48	100.00
	4	4.75	0.00	0.00	509.48	100.00
	10	2.00	0.00	0.00	509.48	100.00
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	0.24	0.24	89.89	99.73
	40	0.425	8.88	9.12	81.01	89.88
	60	0.250	26.63	35.75	54.38	60.34
	140	0.106	22.88	58.63	31.50	34.95
	200	0.075	3.56	62.19	27.94	31.00
	dry pan		0.70	62.89	27.24	
	wet pan			27.24	0.00	

Median Particle Diameter -- d<sub>50</sub> (mm): 0.18

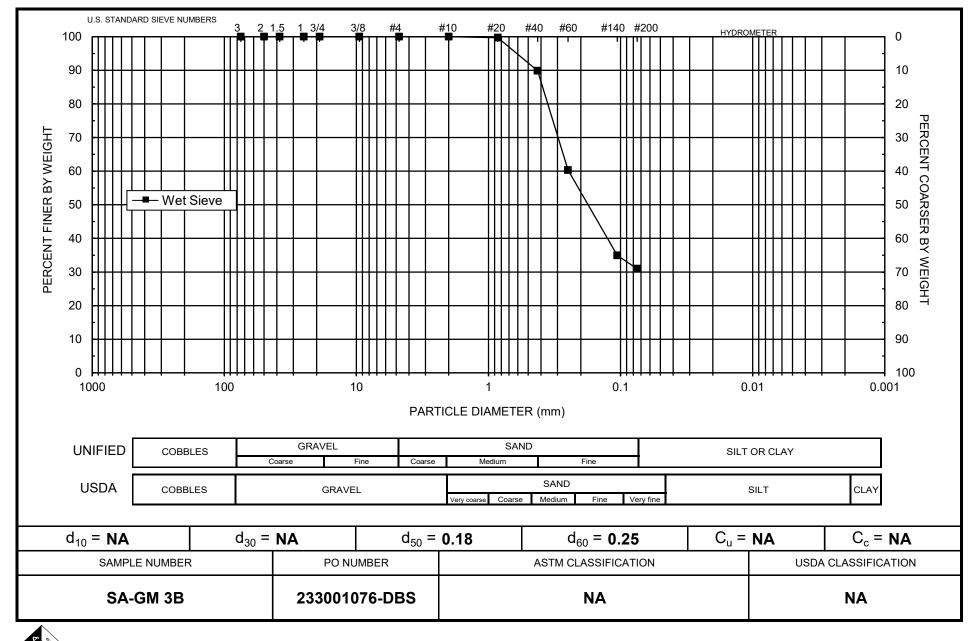
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 787.33Job Number:DB18.1151.00Weight Passing #10 (g): 628.52

Sample Number: SA-GM 3T Weight Retained #10 (g): 158.81

Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 61.15

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 76.60

Test Date: 23-May-18 Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
Traction	Number	(11111)	Netaineu	rtetaineu	rassing	70 F assiriy
+10						
	3"	75	0.00	0.00	787.33	100.00
	2"	50	0.00	0.00	787.33	100.00
	1.5"	38.1	78.11	78.11	709.22	90.08
	1"	25	28.97	107.08	680.25	86.40
	3/4"	19.0	0.00	107.08	680.25	86.40
	3/8"	9.5	0.00	107.08	680.25	86.40
	4	4.75	11.81	118.89	668.44	84.90
	10	2.00	39.92	158.81	628.52	79.83
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	7.14	22.59	54.01	70.51
	40	0.425	6.48	29.07	47.53	62.05
	60	0.250	5.62	34.69	41.91	54.71
	140	0.106	10.17	44.86	31.74	41.44
	200	0.075	3.47	48.33	28.27	36.91
	dry pan		0.58	48.91	27.69	
	wet pan			27.69	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ NA & d_{50} \ (mm): \ 0.18 \\ d_{16} \ (mm): \ NA & d_{60} \ (mm): \ 0.37 \\ d_{30} \ (mm): \ NA & d_{84} \ (mm): \ 4.1 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.18

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

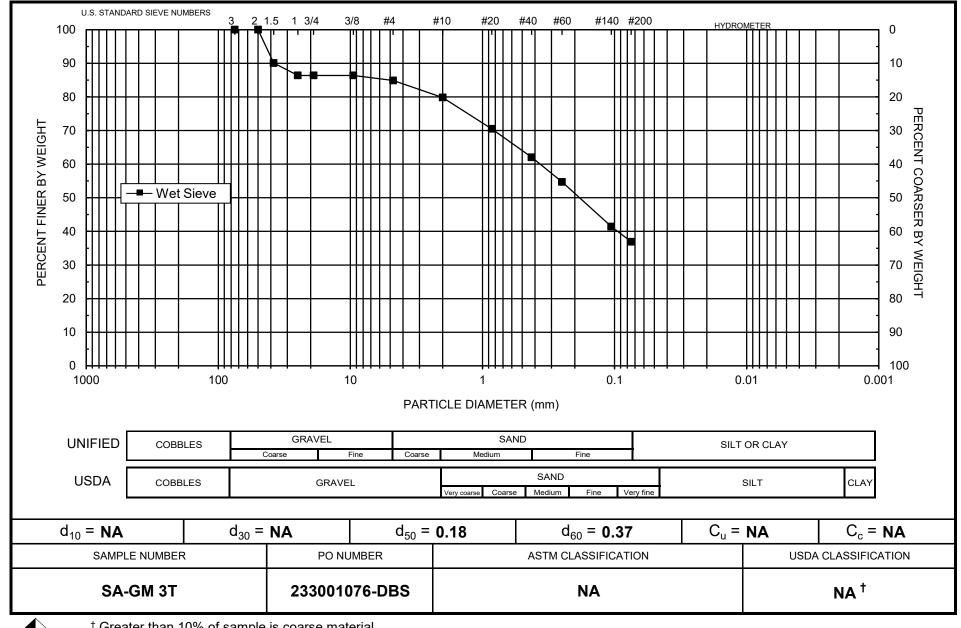
Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA <sup>†</sup>

<sup>†</sup> Greater than 10% of sample is coarse material



<sup>†</sup> Greater than 10% of sample is coarse material

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and ASTM classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

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#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 587.80Job Number:DB18.1151.00Weight Passing #10 (g): 587.80

Sample Number: SA-GM 4B Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 66.17

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 66.17

Test Date: 23-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	587.80	100.00
	2"	50	0.00	0.00	587.80	100.00
	1.5"	38.1	0.00	0.00	587.80	100.00
	1"	25	0.00	0.00	587.80	100.00
	3/4"	19.0	0.00	0.00	587.80	100.00
	3/8"	9.5	0.00	0.00	587.80	100.00
	4	4.75	0.00	0.00	587.80	100.00
	10	2.00	0.00	0.00	587.80	100.00
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	0.04	0.04	66.13	99.94
	40	0.425	0.31	0.35	65.82	99.47
	60	0.250	4.84	5.19	60.98	92.16
	140	0.106	29.07	34.26	31.91	48.22
	200	0.075	8.20	42.46	23.71	35.83
	dry pan		1.24	43.70	22.47	
	wet pan			22.47	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): 0.11  $d_{16}$  (mm): NA  $d_{60}$  (mm): 0.13  $d_{30}$  (mm): NA  $d_{84}$  (mm): 0.21

Median Particle Diameter -- d<sub>50</sub> (mm): 0.11

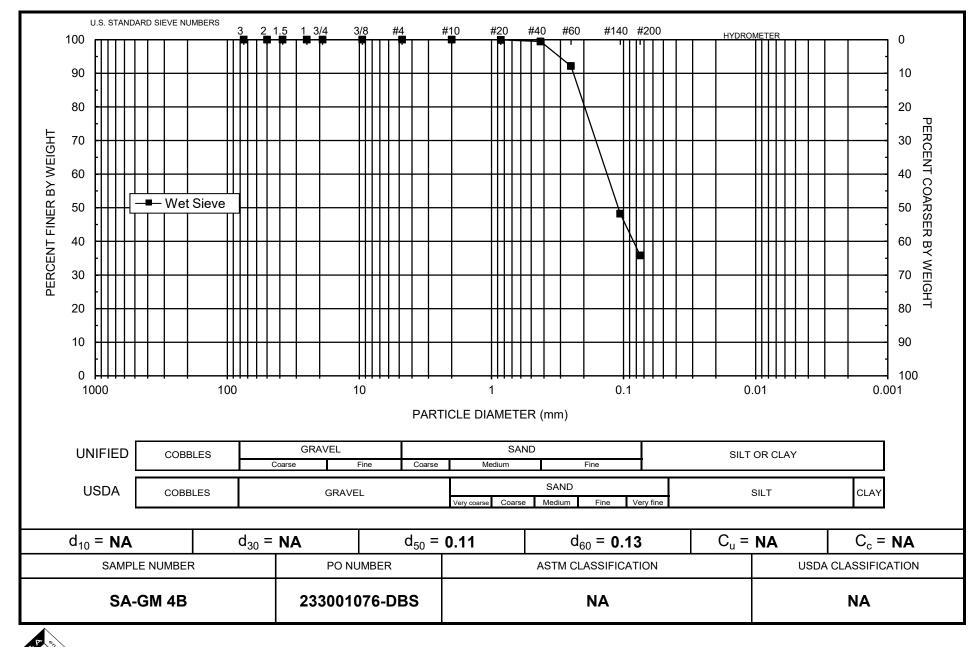
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 556.89Job Number:DB18.1151.00Weight Passing #10 (g): 456.92

Sample Number: SA-GM 5B Weight Retained #10 (g): 99.97
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS Weight Retained #10 (g): 99.97
Wt. of -10 Sieve Sample (g): 65.29
Calculated Weight of Sieve Sample (g): 79.57

Test Date: 23-May-18 Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10					-	
	3"	75	0.00	0.00	556.89	100.00
	2"	50	0.00	0.00	556.89	100.00
	1.5"	38.1	0.00	0.00	556.89	100.00
	1"	25	47.83	47.83	509.06	91.41
	3/4"	19.0	0.00	47.83	509.06	91.41
	3/8"	9.5	14.63	62.46	494.43	88.78
	4	4.75	18.74	81.20	475.69	85.42
	10	2.00	18.77	99.97	456.92	82.05
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	1.73	16.01	63.56	79.87
	40	0.425	4.81	20.82	58.75	73.83
	60	0.250	14.48	35.30	44.27	55.63
	140	0.106	20.87	56.17	23.40	29.41
	200	0.075	4.63	60.80	18.77	23.59
	dry pan		0.71	61.51	18.06	
	wet pan			18.06	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): 0.21  $d_{16}$  (mm): NA  $d_{60}$  (mm): 0.28  $d_{30}$  (mm): 0.11  $d_{84}$  (mm): 3.3

Median Particle Diameter -- d<sub>50</sub> (mm): 0.21

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

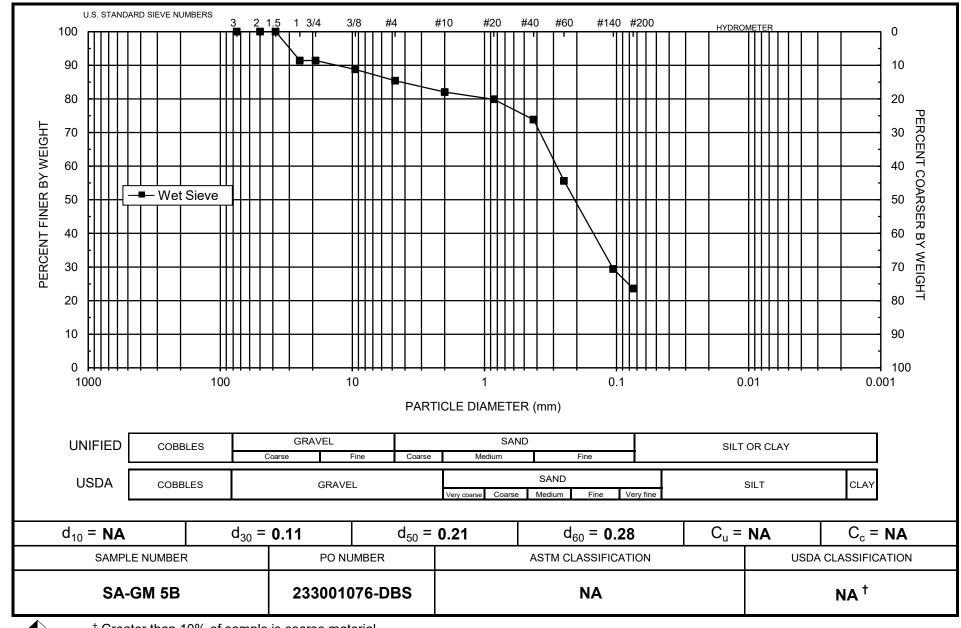
Coefficient of Curvature, Cc--[(d $_{30}$ ) $^2$ /(d $_{10}$ \*d $_{60}$ )] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA <sup>†</sup>

<sup>†</sup> Greater than 10% of sample is coarse material



 $^{\dagger}$  Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.



#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 1308.27

Job Number: DB18.1151.00 Weight Passing #10 (g): 1305.54 Sample Number: SA-GM 5T Weight Retained #10 (g): 2.73

Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 62.18

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 62.31

Test Date: 4-Jun-18 Shape: Rounded

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		·			-	
	3"	75	0.00	0.00	1308.27	100.00
	2"	50	0.00	0.00	1308.27	100.00
	1.5"	38.1	0.00	0.00	1308.27	100.00
	1"	25	0.00	0.00	1308.27	100.00
	3/4"	19.0	0.00	0.00	1308.27	100.00
	3/8"	9.5	0.00	0.00	1308.27	100.00
	4	4.75	0.68	0.68	1307.59	99.95
	10	2.00	2.05	2.73	1305.54	99.79
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	2.91	3.04	59.27	95.12
	40	0.425	22.18	25.22	37.09	59.52
	60	0.250	27.66	52.88	9.43	15.13
	140	0.106	6.06	58.94	3.37	5.41
	200	0.075	0.20	59.14	3.17	5.09
	dry pan		0.02	59.16	3.15	
	wet pan			3.15	0.00	

 $d_{10}$  (mm): 0.16  $d_{50}$  (mm): 0.38  $d_{16}$  (mm): 0.25  $d_{60}$  (mm): 0.43  $d_{30}$  (mm): 0.30  $d_{84}$  (mm): 0.68

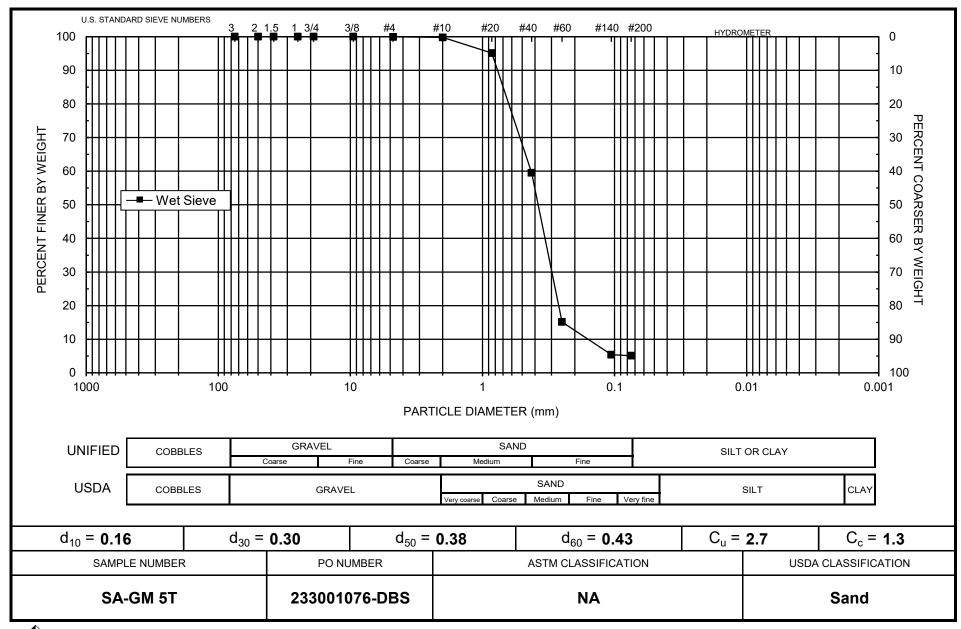
Median Particle Diameter--d<sub>50</sub> (mm): 0.38

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 2.7

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 1.3

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.44

ASTM Soil Classification: NA USDA Soil Classification: Sand







#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 641.27

Job Number:DB18.1151.00Weight Passing #10 (g): 641.27Sample Number:SA-GM 6BWeight Retained #10 (g): 0.00Project Name:St. Anthony Geotech InvestigationWt. of -10 Sieve Sample (g): 53.75

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 53.75

Test Date: 25-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing_
+10						
	3"	75	0.00	0.00	641.27	100.00
	2"	50	0.00	0.00	641.27	100.00
	1.5"	38.1	0.00	0.00	641.27	100.00
	1"	25	0.00	0.00	641.27	100.00
	3/4"	19.0	0.00	0.00	641.27	100.00
	3/8"	9.5	0.00	0.00	641.27	100.00
	4	4.75	0.00	0.00	641.27	100.00
	10	2.00	0.00	0.00	641.27	100.00
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	0.02	0.02	53.73	99.96
	40	0.425	0.05	0.07	53.68	99.87
	60	0.250	0.34	0.41	53.34	99.24
	140	0.106	6.26	6.67	47.08	87.59
	200	0.075	4.31	10.98	42.77	79.57
	dry pan		0.92	11.90	41.85	
	wet pan			41.85	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): NA  $d_{16}$  (mm): NA  $d_{60}$  (mm): NA  $d_{30}$  (mm): NA  $d_{84}$  (mm): 0.091

Median Particle Diameter--d<sub>50</sub> (mm): NA

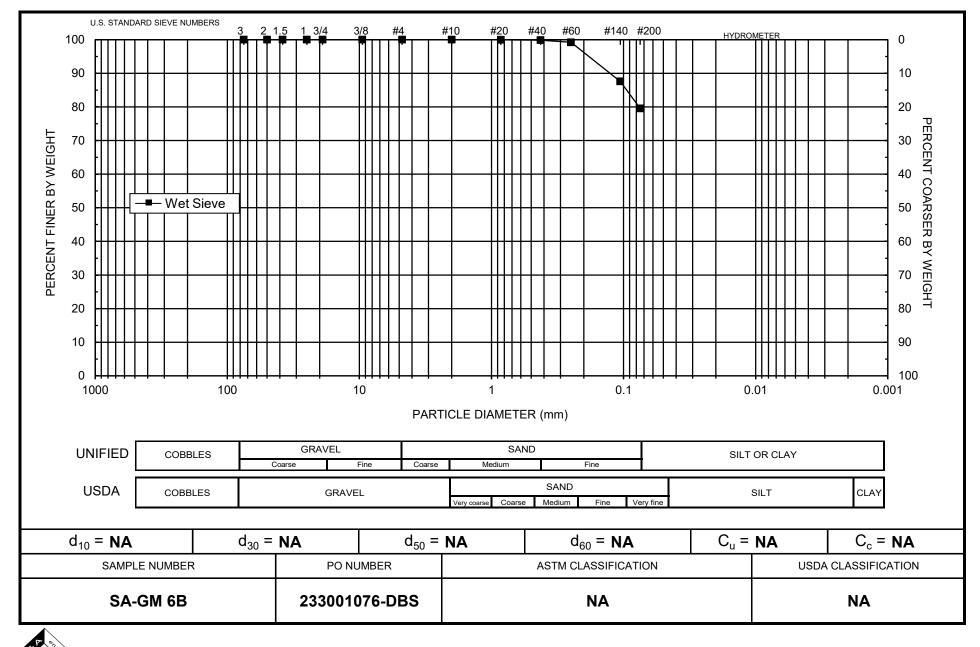
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter--[ $(d_{16}+d_{50}+d_{84})/3$ ] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 508.84Job Number:DB18.1151.00Weight Passing #10 (g): 508.84

Sample Number: SA-GM 6T Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 60.17

Test Date: 23-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	508.84	100.00
	2"	50	0.00	0.00	508.84	100.00
	1.5"	38.1	0.00	0.00	508.84	100.00
	1"	25	0.00	0.00	508.84	100.00
	3/4"	19.0	0.00	0.00	508.84	100.00
	3/8"	9.5	0.00	0.00	508.84	100.00
	4	4.75	0.00	0.00	508.84	100.00
	10	2.00	0.00	0.00	508.84	100.00
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	0.55	0.55	59.62	99.09
	40	0.425	0.62	1.17	59.00	98.06
	60	0.250	0.79	1.96	58.21	96.74
	140	0.106	4.78	6.74	53.43	88.80
	200	0.075	3.85	10.59	49.58	82.40
	dry pan		1.07	11.66	48.51	
	wet pan			48.51	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): NA  $d_{16}$  (mm): NA  $d_{60}$  (mm): NA  $d_{30}$  (mm): NA  $d_{84}$  (mm): 0.082

Median Particle Diameter--d<sub>50</sub> (mm): NA

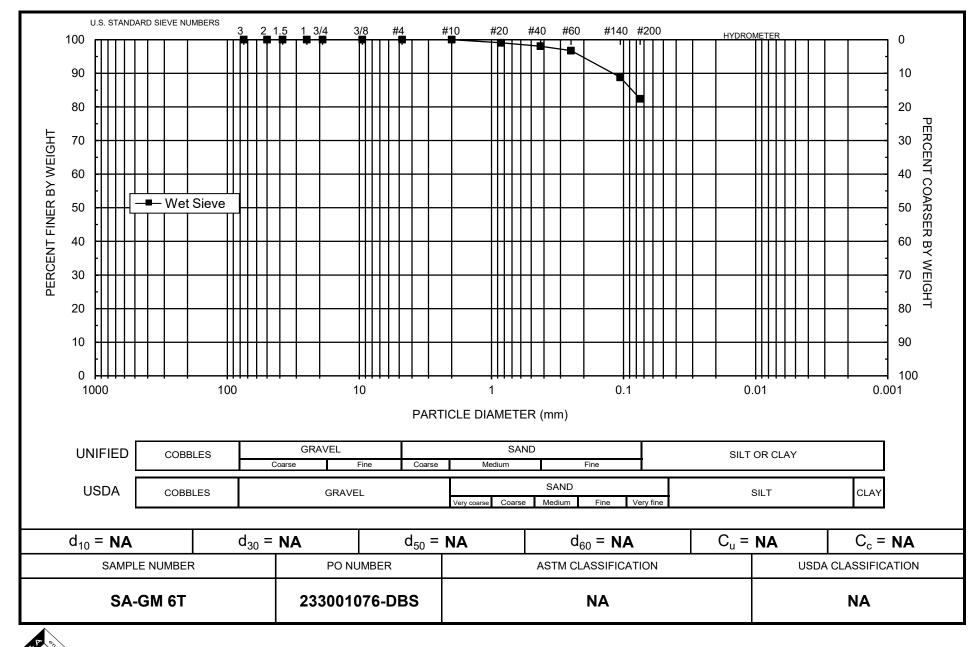
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter--[ $(d_{16}+d_{50}+d_{84})/3$ ] (mm): NA

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





#### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 916.23Job Number:DB18.1151.00Weight Passing #10 (g): 916.23

Sample Number: SA-GM 7B Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 54.29

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 54.29

Test Date: 25-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	916.23	100.00
	2"	50	0.00	0.00	916.23	100.00
	1.5"	38.1	0.00	0.00	916.23	100.00
	1"	25	0.00	0.00	916.23	100.00
	3/4"	19.0	0.00	0.00	916.23	100.00
	3/8"	9.5	0.00	0.00	916.23	100.00
	4	4.75	0.00	0.00	916.23	100.00
	10	2.00	0.00	0.00	916.23	100.00
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	0.00	0.00	54.29	100.00
	40	0.425	0.33	0.33	53.96	99.39
	60	0.250	4.51	4.84	49.45	91.08
	140	0.106	22.71	27.55	26.74	49.25
	200	0.075	6.44	33.99	20.30	37.39
	dry pan		1.21	35.20	19.09	
	wet pan			19.09	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ NA & d_{50} \ (mm): \ 0.11 \\ d_{16} \ (mm): \ NA & d_{60} \ (mm): \ 0.13 \\ d_{30} \ (mm): \ NA & d_{84} \ (mm): \ 0.22 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.11

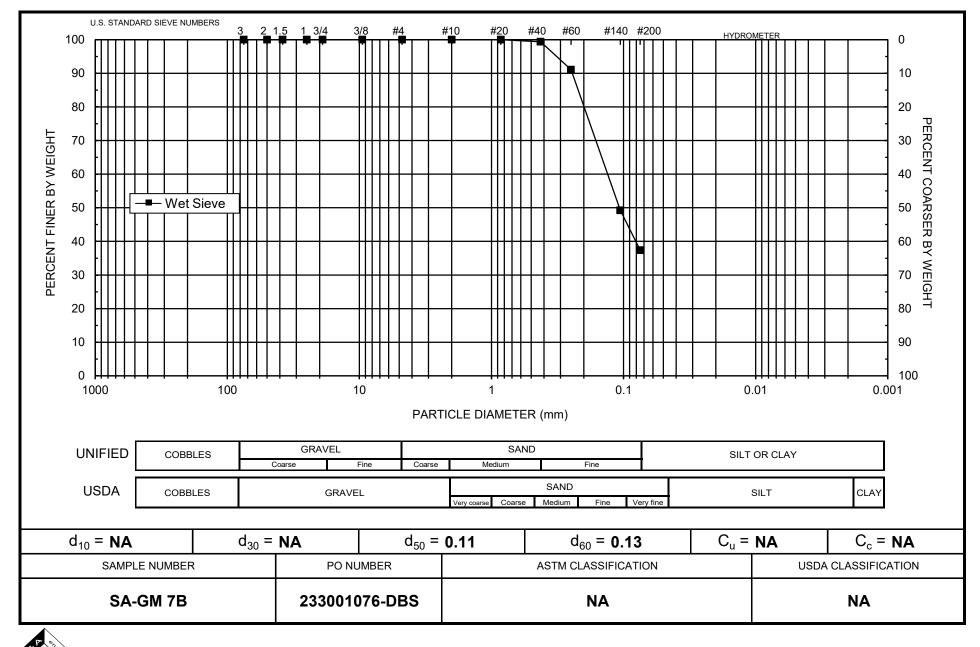
Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): NA

Coefficient of Curvature, Cc--[(d<sub>30</sub>)<sup>2</sup>/(d<sub>10</sub>\*d<sub>60</sub>)] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc

Initial Dry Weight of Sample (g): 1050.54

Job Number: DB18.1151.00

Weight Passing #10 (g): 1050.54

Sample Number: SA-GM 8B Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 60.03

Test Date: 25-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	1050.54	100.00
	2"	50	0.00	0.00	1050.54	100.00
	1.5"	38.1	0.00	0.00	1050.54	100.00
	1"	25	0.00	0.00	1050.54	100.00
	3/4"	19.0	0.00	0.00	1050.54	100.00
	3/8"	9.5	0.00	0.00	1050.54	100.00
	4	4.75	0.00	0.00	1050.54	100.00
	10	2.00	0.00	0.00	1050.54	100.00
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	0.10	0.10	59.93	99.83
	40	0.425	2.29	2.39	57.64	96.02
	60	0.250	11.11	13.50	46.53	77.51
	140	0.106	19.19	32.69	27.34	45.54
	200	0.075	3.97	36.66	23.37	38.93
	dry pan		1.27	37.93	22.10	
	wet pan			22.10	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ NA & d_{50} \ (mm): \ 0.12 \\ d_{16} \ (mm): \ NA & d_{60} \ (mm): \ 0.16 \\ d_{30} \ (mm): \ NA & d_{84} \ (mm): \ 0.30 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.12

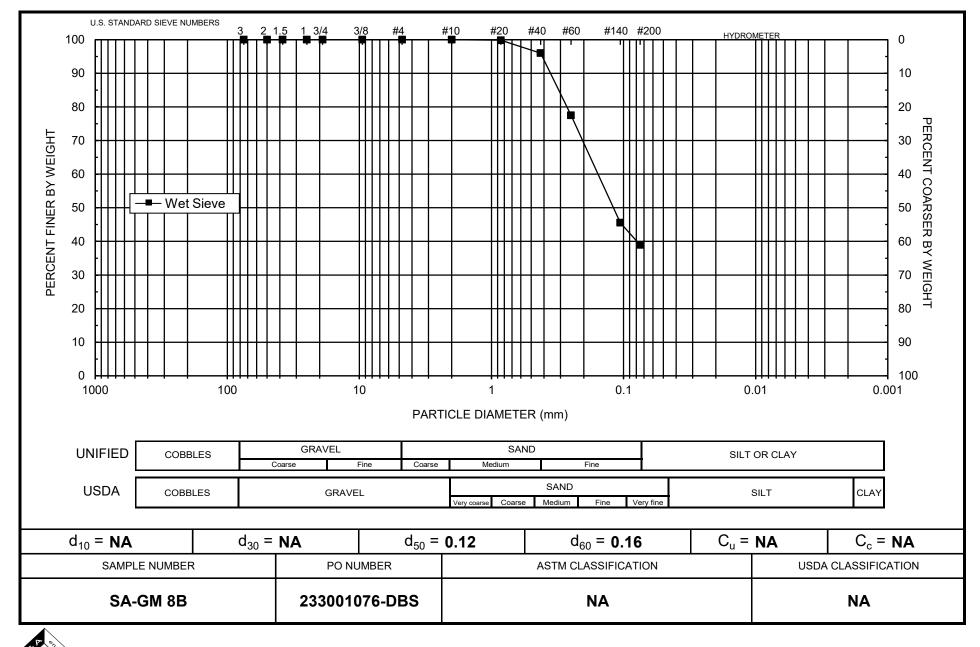
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Initial Dry Weight of Sample (g): 1380.92

Weight Passing #10 (g): 1136.29

Sample Number: SA-GM 8T Weight Retained #10 (g): 1136.29

Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 57.64

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 70.05

Test Date: 24-May-18 Shape: Rounded

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
	Number	(111111)	rtetained	Retained	i assiriy	70 1 assing
+10						
	3"	75	0.00	0.00	1380.92	100.00
	2"	50	0.00	0.00	1380.92	100.00
	1.5"	38.1	0.00	0.00	1380.92	100.00
	1"	25	44.66	44.66	1336.26	96.77
	3/4"	19.0	46.71	91.37	1289.55	93.38
	3/8"	9.5	49.31	140.68	1240.24	89.81
	4	4.75	44.99	185.67	1195.25	86.55
	10	2.00	58.96	244.63	1136.29	82.28
-10			(Based on cald	culated sieve wt.	)	
	20	0.85	7.38	19.79	50.26	71.75
	40	0.425	11.45	31.24	38.81	55.40
	60	0.250	13.38	44.62	25.43	36.30
	140	0.106	12.32	56.94	13.11	18.72
	200	0.075	2.01	58.95	11.10	15.85
	dry pan		0.13	59.08	10.97	2.00
	wet pan		3.10	10.97	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): 0.37  $d_{16}$  (mm): 0.076  $d_{60}$  (mm): 0.52  $d_{30}$  (mm): 0.18  $d_{84}$  (mm): 2.8

Median Particle Diameter -- d<sub>50</sub> (mm): 0.37

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

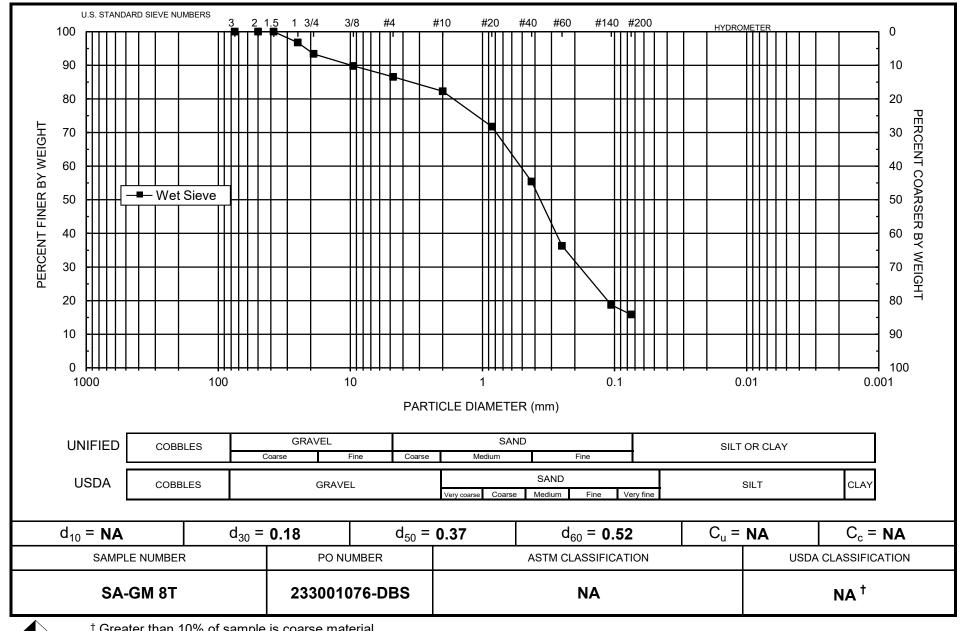
Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 1.1

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA <sup>†</sup>

<sup>†</sup> Greater than 10% of sample is coarse material



<sup>†</sup> Greater than 10% of sample is coarse material

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and ASTM classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

Daniel B. Stephens & Associates, Inc.



# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 272.52

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 272.52

 Sample Number:
 L1-1 (10'A)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 56.68
PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 56.68

Test Date: 17-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		, ,			<u> </u>	<u> </u>
	3"	75	0.00	0.00	272.52	100.00
	2"	50	0.00	0.00	272.52	100.00
	1.5"	38.1	0.00	0.00	272.52	100.00
	1"	25	0.00	0.00	272.52	100.00
	3/4"	19.0	0.00	0.00	272.52	100.00
	3/8"	9.5	0.00	0.00	272.52	100.00
	4	4.75	0.00	0.00	272.52	100.00
	10	2.00	0.00	0.00	272.52	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.08	0.08	56.60	99.86
	40	0.425	0.16	0.24	56.44	99.58
	60	0.250	0.49	0.73	55.95	98.71
	140	0.106	10.80	11.53	45.15	79.66
	200	0.075	7.28	18.81	37.87	66.81
	dry pan		0.83	19.64	37.04	
	wet pan			37.04	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 2.2 E-05 & d_{50} \ (mm): \ 0.046 \\ d_{16} \ (mm): \ 0.00016 & d_{60} \ (mm): \ 0.061 \\ d_{30} \ (mm): \ 0.0067 & d_{84} \ (mm): \ 0.13 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.046

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 2773

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 33

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.059

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L1-1 (10'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Total Sample Wt. (g): 56.68

Test Date: 9:00

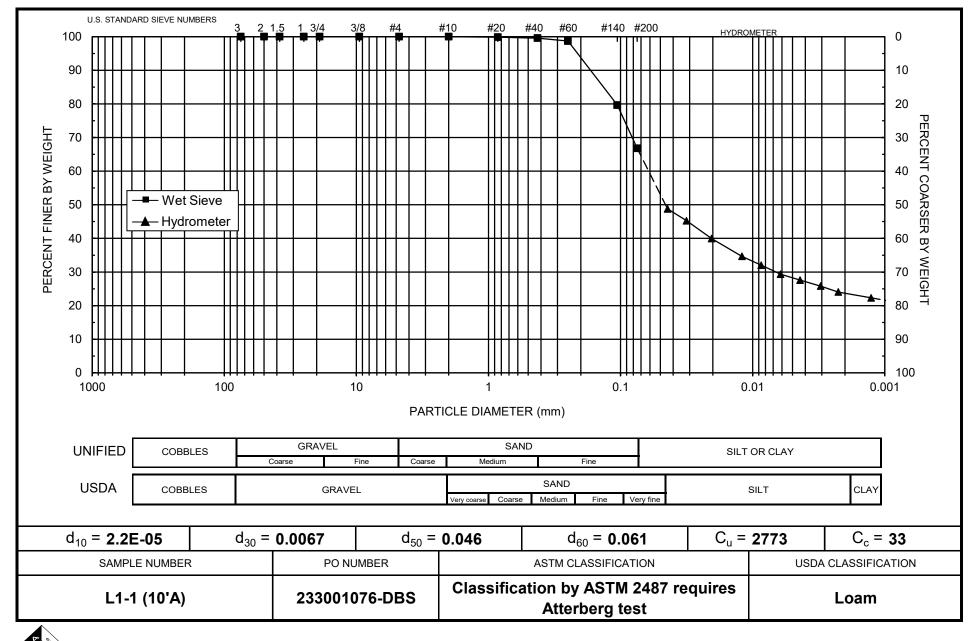
Total Sample Wt. (g): 272.52

Wt. Passing #10 (g): 272.52

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
	_								
15-May-18	1	21.6	33.0	5.4	27.6	10.9	0.04409	48.8	48.8
	2	21.6	31.0	5.4	25.6	11.2	0.03164	45.2	45.2
	5	21.6	28.0	5.4	22.6	11.7	0.02045	39.9	39.9
	15	21.6	25.0	5.4	19.6	12.2	0.01205	34.7	34.7
	30	21.6	23.5	5.4	18.1	12.4	0.00861	32.0	32.0
	60	21.5	22.0	5.4	16.6	12.7	0.00615	29.3	29.3
	120	21.5	21.0	5.4	15.6	12.9	0.00438	27.6	27.6
	250	21.5	20.0	5.4	14.6	13.0	0.00305	25.8	25.8
	468	21.5	19.0	5.4	13.6	13.2	0.00225	24.0	24.0
16-May-18	1484	21.6	18.0	5.4	12.6	13.3	0.00127	22.3	22.3

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 491.56

Weight Passing #10 (g): 489.94

Job Number: DB18.1151.00 Sample Number: L1-2 (20'B)

Weight Retained #10 (g): 1.62

Project Name: St. Anthony Geotech Investigation

Weight of Hydrometer Sample (g): 57.04

PO Number: 233001076-DBS

Calculated Weight of Sieve Sample (g): 57.23

Test Date: 17-May-18

Shape: Rounded

Hardness: Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		, ,			<u> </u>	<u> </u>
	3"	75	0.00	0.00	491.56	100.00
	2"	50	0.00	0.00	491.56	100.00
	1.5"	38.1	0.00	0.00	491.56	100.00
	1"	25	0.00	0.00	491.56	100.00
	3/4"	19.0	0.00	0.00	491.56	100.00
	3/8"	9.5	0.00	0.00	491.56	100.00
	4	4.75	0.63	0.63	490.93	99.87
	10	2.00	0.99	1.62	489.94	99.67
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.12	0.31	56.92	99.46
	40	0.425	0.12	0.43	56.80	99.25
	60	0.250	0.09	0.52	56.71	99.09
	140	0.106	0.42	0.94	56.29	98.36
	200	0.075	0.46	1.40	55.83	97.56
	dry pan		0.12	1.52	55.71	
	wet pan			55.71	0.00	

 $d_{10}$  (mm): 2.8E-05  $d_{50}$  (mm): 0.0092  $d_{16}$  (mm): 0.00010  $d_{60}$  (mm): 0.015  $d_{30}$  (mm): 0.0022  $d_{84}$  (mm): 0.044

Median Particle Diameter -- d<sub>50</sub> (mm): 0.0092

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 536

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 12

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.018

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Silty Clay Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L1-2 (20'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Total Sample Wt. (g): 57.04

Total Sample Wt. (g): 491.56

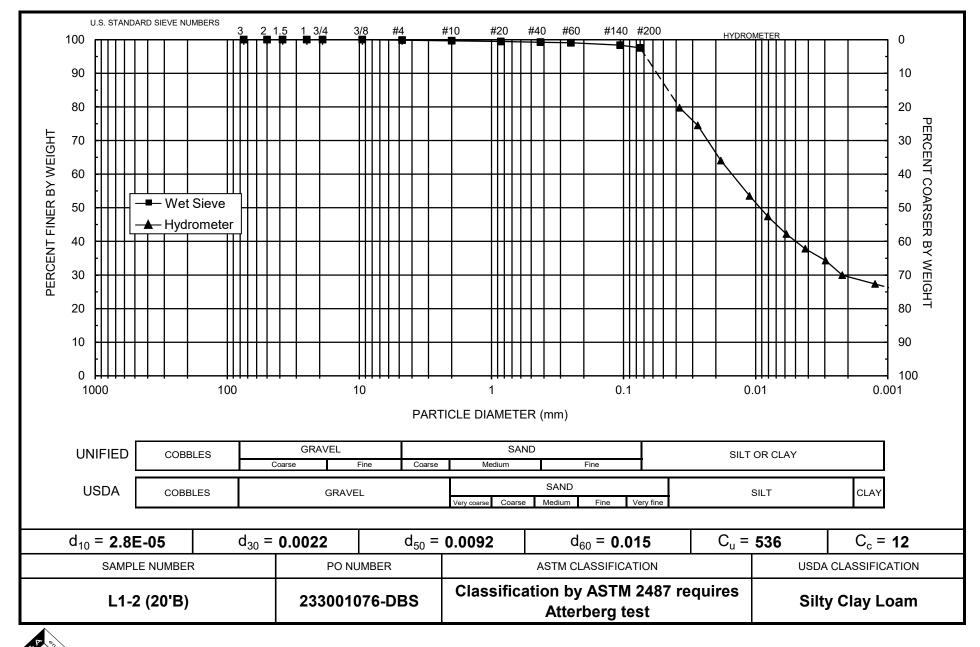
Start Time: 9:06

Wt. Passing #10 (g): 489.94

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
15-May-18	1	21.6	51.0	5.4	45.6	7.9	0.03765	80.0	79.8
	2	21.6	48.0	5.4	42.6	8.4	0.02743	74.8	74.5
	5	21.6	42.0	5.4	36.6	9.4	0.01833	64.2	64.0
	15	21.6	36.0	5.4	30.6	10.4	0.01112	53.7	53.5
	30	21.6	32.5	5.4	27.1	11.0	0.00808	47.6	47.4
	60	21.5	29.5	5.4	24.1	11.5	0.00585	42.3	42.2
	120	21.5	27.0	5.4	21.6	11.9	0.00421	37.9	37.8
	250	21.5	25.0	5.4	19.6	12.2	0.00296	34.4	34.3
	463	21.5	22.5	5.4	17.1	12.6	0.00221	30.0	29.9
16-May-18	1480	21.6	21.0	5.4	15.6	12.9	0.00125	27.4	27.3

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





### **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 434.95

Job Number: DB18.1151.00 Weight Passing #10 (g): 434.90 Sample Number: L1-3 (5'A) Weight Retained #10 (g): 0.05

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 59.96 PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 59.97

Test Date: 17-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		,				<u> </u>
	3"	75	0.00	0.00	434.95	100.00
	2"	50	0.00	0.00	434.95	100.00
	1.5"	38.1	0.00	0.00	434.95	100.00
	1"	25	0.00	0.00	434.95	100.00
	3/4"	19.0	0.00	0.00	434.95	100.00
	3/8"	9.5	0.00	0.00	434.95	100.00
	4	4.75	0.00	0.00	434.95	100.00
	10	2.00	0.05	0.05	434.90	99.99
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.32	0.33	59.64	99.45
	40	0.425	0.65	0.98	58.99	98.37
	60	0.250	1.65	2.63	57.34	95.62
	140	0.106	16.58	19.21	40.76	67.97
	200	0.075	8.65	27.86	32.11	53.55
	dry pan		1.00	28.86	31.11	
	wet pan			31.11	0.00	

d<sub>10</sub> (mm): 6.4E-45 d<sub>50</sub> (mm): 0.066 d<sub>16</sub> (mm): 0.0031 d<sub>60</sub> (mm): 0.088 d<sub>30</sub> (mm): 0.034 d<sub>84</sub> (mm): 0.17

Median Particle Diameter -- d<sub>50</sub> (mm): 0.066

Coefficient of Curvature,  $Cc - [(d_{30})^2/(d_{10}*d_{60})]$  (mm): 2.1E+42

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.080

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 1.4E+43 and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L1-3 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Start Time: 9:12

Initial Wt. (g): 59.96

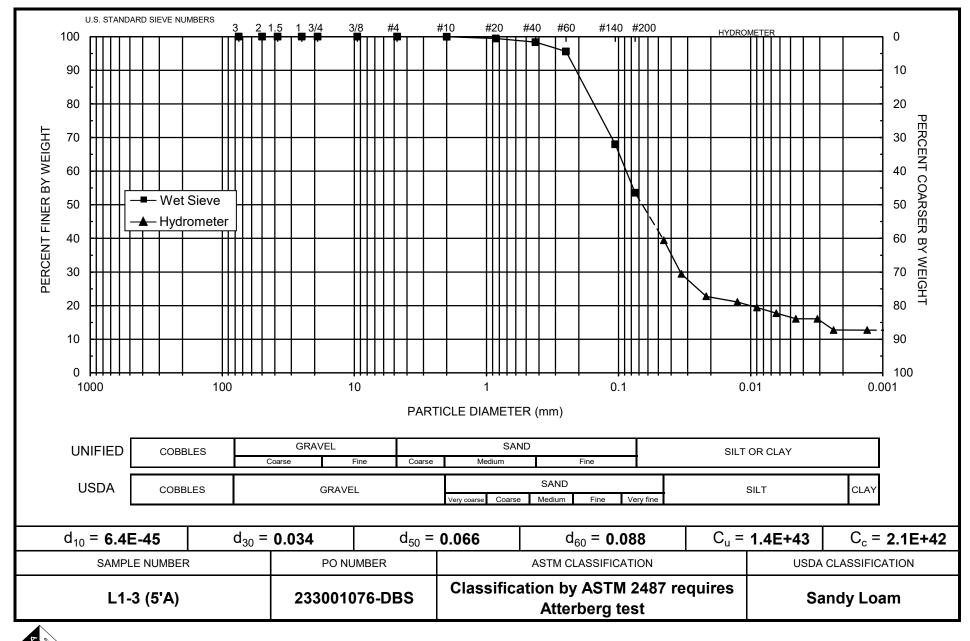
Total Sample Wt. (g): 434.95

Wt. Passing #10 (g): 434.90

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
•									_
15-May-18	1	21.6	29.0	5.4	23.6	11.5	0.04540	39.4	39.4
	2	21.6	23.0	5.4	17.6	12.5	0.03344	29.4	29.4
	5	21.6	19.0	5.4	13.6	13.2	0.02170	22.7	22.7
	15	21.6	18.0	5.4	12.6	13.3	0.01260	21.1	21.1
	30	21.7	17.0	5.4	11.6	13.5	0.00896	19.4	19.4
	60	21.5	16.0	5.4	10.6	13.7	0.00639	17.7	17.7
	120	21.5	15.0	5.4	9.6	13.8	0.00454	16.1	16.1
	254	21.5	15.0	5.4	9.6	13.8	0.00312	16.1	16.1
	458	21.5	13.0	5.4	7.6	14.2	0.00235	12.7	12.7
16-May-18	1475	21.6	13.0	5.4	7.6	14.2	0.00131	12.7	12.7

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





### **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 419.21

Weight Passing #10 (g): 419.21

Job Number: DB18.1151.00

Sample Number: L1-5 (20'B)

Weight Retained #10 (g): 0.00 Weight of Hydrometer Sample (g): 55.07

Project Name: St. Anthony Geotech Investigation

Calculated Weight of Sieve Sample (g): 55.07

PO Number: 233001076-DBS

Test Date: 24-May-18

Shape: Angular

Hardness: Hard and durable

Test	Sieve	Diameter	Wt.	Cum Wt.	Wt.	
Fraction	Number	(mm)	Retained	Retained	Passing	% Passing
+10						_
	3"	75	0.00	0.00	419.21	100.00
	2"	50	0.00	0.00	419.21	100.00
	1.5"	38.1	0.00	0.00	419.21	100.00
	1"	25	0.00	0.00	419.21	100.00
	3/4"	19.0	0.00	0.00	419.21	100.00
	3/8"	9.5	0.00	0.00	419.21	100.00
	4	4.75	0.00	0.00	419.21	100.00
	10	2.00	0.00	0.00	419.21	100.00
-10			(Based on calc	ulated sieve wt.)		
	20	0.85	0.02	0.02	55.05	99.96
	40	0.425	0.05	0.07	55.00	99.87
	60	0.250	0.41	0.48	54.59	99.13
	140	0.106	18.28	18.76	36.31	65.93
	200	0.075	8.60	27.36	27.71	50.32
	dry pan		0.80	28.16	26.91	
	wet pan			26.91	0.00	

d<sub>10</sub> (mm): 0.0011 d<sub>50</sub> (mm): 0.074 d<sub>16</sub> (mm): 0.0045 d<sub>60</sub> (mm): 0.093 d<sub>30</sub> (mm): 0.042 d<sub>84</sub> (mm): 0.17

Median Particle Diameter -- d<sub>50</sub> (mm): 0.074

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 85

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 17

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.083

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L1-5 (20'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 18-May-18 Initial Wt. (g): 55.07

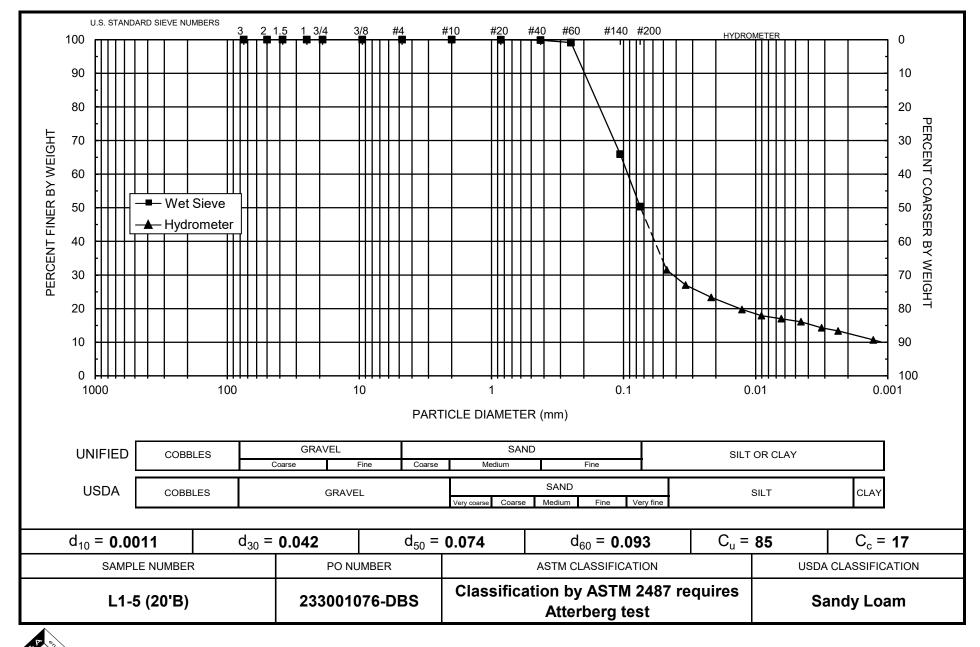
Test Date: 18-May-18 Total Sample Wt. (g): 419.21

Start Time: 9:30 Wt. Passing #10 (g): 419.21

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
18-May-18	1	21.6	23.5	6.1	17.4	12.4	0.04714	31.5	31.5
	2	21.6	21.0	6.1	14.9	12.9	0.03388	27.0	27.0
	5	21.6	19.0	6.1	12.9	13.2	0.02170	23.4	23.4
	15	21.6	17.0	6.1	10.9	13.5	0.01268	19.7	19.7
	30	21.6	16.0	6.1	9.9	13.7	0.00902	17.9	17.9
	60	21.6	15.5	6.1	9.4	13.8	0.00640	17.0	17.0
	120	21.6	15.0	6.1	8.9	13.8	0.00454	16.1	16.1
	250	21.6	14.0	6.1	7.9	14.0	0.00316	14.3	14.3
	446	21.6	13.5	6.1	7.4	14.1	0.00237	13.4	13.4
19-May-18	1544	21.7	12.0	6.1	5.9	14.3	0.00129	10.7	10.7

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 507.75

Job Number: DB18.1151.00 Weight Passing #10 (g): 507.75
Sample Number: L2-1 (5'A) Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 65.87

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 65.87

Test Date: 17-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	507.75	100.00
	2"	50	0.00	0.00	507.75	100.00
	1.5"	38.1	0.00	0.00	507.75	100.00
	1"	25	0.00	0.00	507.75	100.00
	3/4"	19.0	0.00	0.00	507.75	100.00
	3/8"	9.5	0.00	0.00	507.75	100.00
	4	4.75	0.00	0.00	507.75	100.00
	10	2.00	0.00	0.00	507.75	100.00
-10			(Based on calc	ulated sieve wt.)	)	
	20	0.85	0.52	0.52	65.35	99.21
	40	0.425	0.54	1.06	64.81	98.39
	60	0.250	0.84	1.90	63.97	97.12
	140	0.106	10.50	12.40	53.47	81.18
	200	0.075	9.01	21.41	44.46	67.50
	dry pan		1.73	23.14	42.73	
	wet pan			42.73	0.00	

 $\begin{array}{lll} d_{10} \, (mm) \!\!: \!\! 0.00040 & d_{50} \, (mm) \!\!: \!\! 0.045 \\ d_{16} \, (mm) \!\!: \!\! 0.0013 & d_{60} \, (mm) \!\!: \!\! 0.060 \\ d_{30} \, (mm) \!\!: \!\! 0.015 & d_{84} \, (mm) \!\!: \!\! 0.12 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.045

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 150

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 9.4

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.055

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L2-1 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Total Sample Wt. (g): 65.87

Total Sample Wt. (g): 507.75

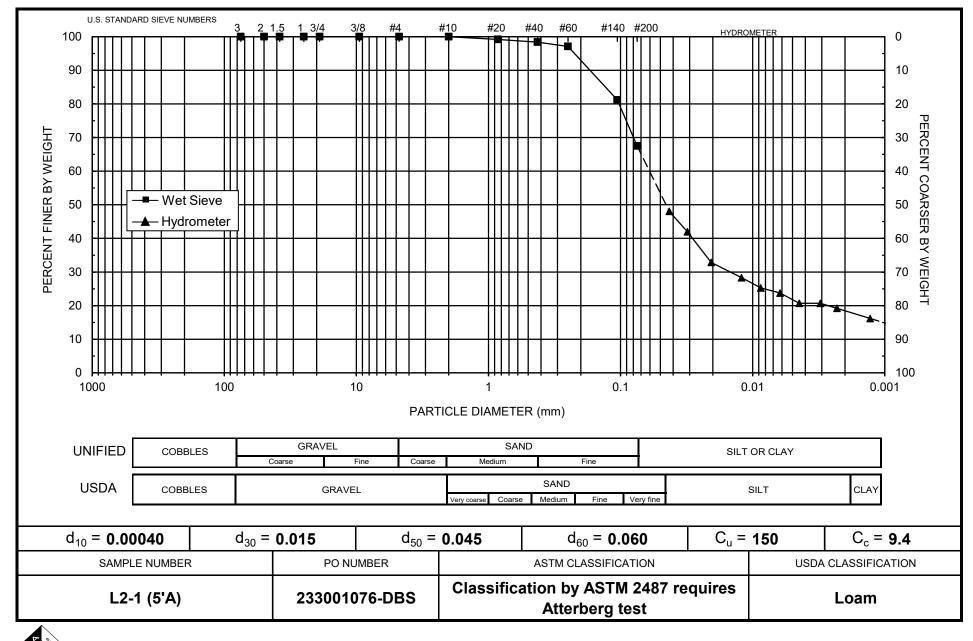
Start Time: 9:18

Wt. Passing #10 (g): 507.75

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
15-May-18	1	21.6	37.0	5.4	31.6	10.2	0.04274	48.0	48.0
	2	21.6	33.0	5.4	27.6	10.9	0.03118	42.0	42.0
	5	21.6	27.0	5.4	21.6	11.9	0.02059	32.9	32.9
	15	21.6	24.0	5.4	18.6	12.4	0.01213	28.3	28.3
	30	21.7	22.0	5.4	16.6	12.7	0.00868	25.3	25.3
	60	21.5	21.0	5.4	15.6	12.9	0.00619	23.7	23.7
	120	21.4	19.0	5.4	13.6	13.2	0.00444	20.7	20.7
	250	21.5	19.0	5.4	13.6	13.2	0.00307	20.7	20.7
	453	21.5	18.0	5.4	12.6	13.3	0.00230	19.2	19.2
16-May-18	1472	21.6	16.0	5.4	10.6	13.7	0.00129	16.2	16.2

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 371.36

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 371.36

 Sample Number:
 L2-1 (15'A)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 52.42
PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 52.42

Test Date: 29-Jun-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	371.36	100.00
	2"	50	0.00	0.00	371.36	100.00
	1.5"	38.1	0.00	0.00	371.36	100.00
	1"	25	0.00	0.00	371.36	100.00
	3/4"	19.0	0.00	0.00	371.36	100.00
	3/8"	9.5	0.00	0.00	371.36	100.00
	4	4.75	0.00	0.00	371.36	100.00
	10	2.00	0.00	0.00	371.36	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.11	0.11	52.31	99.79
	40	0.425	0.19	0.30	52.12	99.43
	60	0.250	0.42	0.72	51.70	98.63
	140	0.106	8.56	9.28	43.14	82.30
	200	0.075	7.21	16.49	35.93	68.54
	dry pan		0.42	16.91	35.51	
	wet pan			35.51	0.00	

 $\begin{array}{lll} d_{10} \, (mm) \!\!: \!\! 0.00024 & d_{50} \, (mm) \!\!: \!\! 0.056 \\ d_{16} \, (mm) \!\!: \!\! 0.0012 & d_{60} \, (mm) \!\!: \!\! 0.065 \\ d_{30} \, (mm) \!\!: \!\! 0.013 & d_{84} \, (mm) \!\!: \!\! 0.12 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.056

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 271

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 11

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.059

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L2-1 (15'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 27-Jun-18

Total Sample Wt. (g): 52.42

Test Date: 9:00

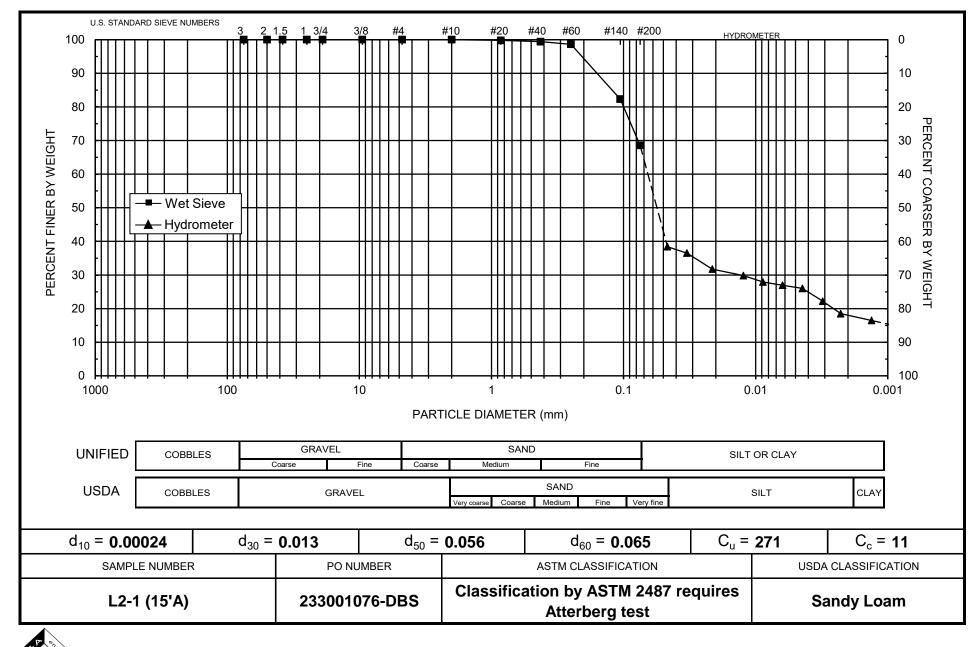
Total Sample Wt. (g): 371.36

Wt. Passing #10 (g): 371.36

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
27-Jun-18	1	21.6	25.5	5.4	20.1	12.1	0.04651	38.4	38.4
	2	21.6	24.5	5.4	19.1	12.3	0.03311	36.5	36.5
	5	21.6	22.0	5.4	16.6	12.7	0.02129	31.7	31.7
	15	21.5	21.0	5.4	15.6	12.9	0.01238	29.8	29.8
	30	21.5	20.0	5.4	14.6	13.0	0.00881	27.9	27.9
	60	21.4	19.5	5.4	14.1	13.1	0.00626	27.0	27.0
	120	21.6	19.0	5.4	13.6	13.2	0.00443	26.0	26.0
	250	21.6	17.0	5.4	11.6	13.5	0.00311	22.2	22.2
	470	22.5	15.0	5.3	9.7	13.8	0.00227	18.5	18.5
28-Jun-18	1429	21.4	14.0	5.4	8.6	14.0	0.00133	16.5	16.5

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 483.31

Job Number: DB18.1151.00 Weight Passing #10 (g): 483.31 Sample Number: L2-2 (5'A) Weight Retained #10 (g): 0.00

Weight of Hydrometer Sample (g): 63.94 Project Name: St. Anthony Geotech Investigation PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 63.94

Test Date: 17-May-18 Shape: Angular

Hardness: Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		,				
	3"	75	0.00	0.00	483.31	100.00
	2"	50	0.00	0.00	483.31	100.00
	1.5"	38.1	0.00	0.00	483.31	100.00
	1"	25	0.00	0.00	483.31	100.00
	3/4"	19.0	0.00	0.00	483.31	100.00
	3/8"	9.5	0.00	0.00	483.31	100.00
	4	4.75	0.00	0.00	483.31	100.00
	10	2.00	0.00	0.00	483.31	100.00
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.09	0.09	63.85	99.86
	40	0.425	0.12	0.21	63.73	99.67
	60	0.250	0.73	0.94	63.00	98.53
	140	0.106	17.65	18.59	45.35	70.93
	200	0.075	11.02	29.61	34.33	53.69
	dry pan		1.32	30.93	33.01	
	wet pan			33.01	0.00	

d<sub>10</sub> (mm): 0.00019 d<sub>50</sub> (mm): 0.067 d<sub>16</sub> (mm): 0.0018 d<sub>60</sub> (mm): 0.085 d<sub>30</sub> (mm): 0.031 d<sub>84</sub> (mm): 0.16

Median Particle Diameter -- d<sub>50</sub> (mm): 0.067

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 447

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 60

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.076

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L2-2 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Start Time: 9:24

Initial Wt. (g): 63.94

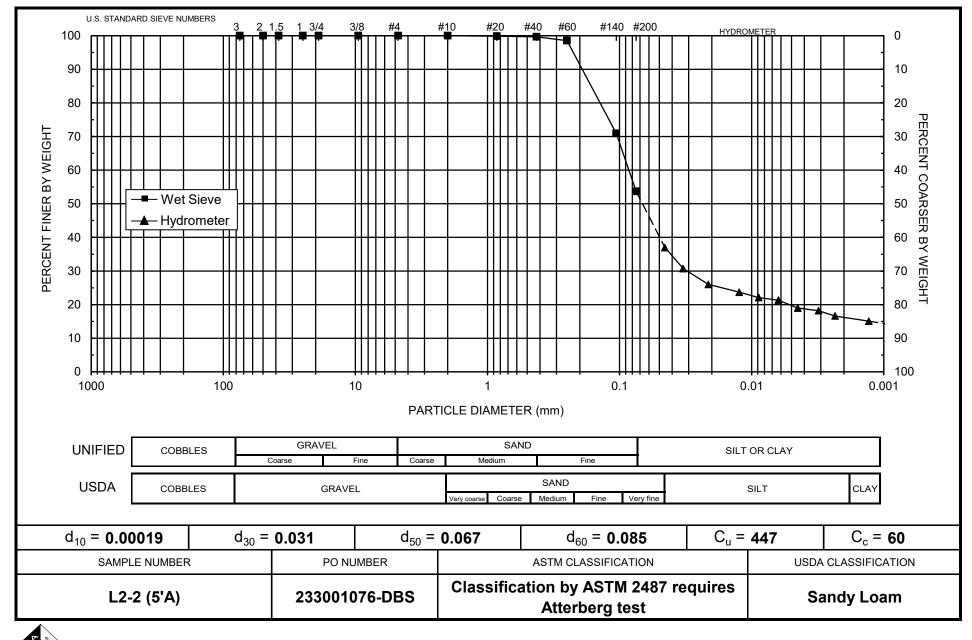
Total Sample Wt. (g): 483.31

Wt. Passing #10 (g): 483.31

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
15-May-18	1	21.6	29.0	5.4	23.6	11.5	0.04540	37.0	37.0
	2	21.6	25.0	5.4	19.6	12.2	0.03300	30.7	30.7
	5	21.6	22.0	5.4	16.6	12.7	0.02129	26.0	26.0
	15	21.6	20.5	5.4	15.1	12.9	0.01241	23.7	23.7
	30	21.5	19.5	5.4	14.1	13.1	0.00884	22.1	22.1
	60	21.5	19.0	5.4	13.6	13.2	0.00627	21.3	21.3
	120	21.5	17.5	5.4	12.1	13.4	0.00448	19.0	19.0
	250	21.5	17.0	5.4	11.6	13.5	0.00311	18.2	18.2
	448	21.5	16.0	5.4	10.6	13.7	0.00234	16.6	16.6
16-May-18	1468	21.6	15.0	5.4	9.6	13.8	0.00130	15.1	15.1

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 469.13

Job Number: DB18.1151.00

Sample Number: L2-3 (5'A)

Project Name: St. Anthony Geotech Investigation

Weight Passing #10 (g): 469.13

Weight Retained #10 (g): 0.00

Weight of Hydrometer Sample (g): 60.77

Project Name. St. Anthony Geolech investigation weight of Aydrometer Sample (g). 60.77

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 60.77

Test Date: 17-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						_
	3"	75	0.00	0.00	469.13	100.00
	2"	50	0.00	0.00	469.13	100.00
	1.5"	38.1	0.00	0.00	469.13	100.00
	1"	25	0.00	0.00	469.13	100.00
	3/4"	19.0	0.00	0.00	469.13	100.00
	3/8"	9.5	0.00	0.00	469.13	100.00
	4	4.75	0.00	0.00	469.13	100.00
	10	2.00	0.00	0.00	469.13	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.55	0.55	60.22	99.09
	40	0.425	0.62	1.17	59.60	98.07
	60	0.250	1.90	3.07	57.70	94.95
	140	0.106	13.92	16.99	43.78	72.04
	200	0.075	14.10	31.09	29.68	48.84
	dry pan		1.31	32.40	28.37	
	wet pan			28.37	0.00	

 $\begin{array}{lll} d_{10} \, (mm) \!\!: \!\! 0.00094 & d_{50} \, (mm) \!\!: \!\! 0.076 \\ d_{16} \, (mm) \!\!: \!\! 0.0097 & d_{60} \, (mm) \!\!: \!\! 0.089 \\ d_{30} \, (mm) \!\!: \!\! 0.047 & d_{84} \, (mm) \!\!: \!\! 0.17 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.076

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 95

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 26

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.085

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L2-3 (5'A) Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Start Time: 9:30

Initial Wt. (g): 60.77

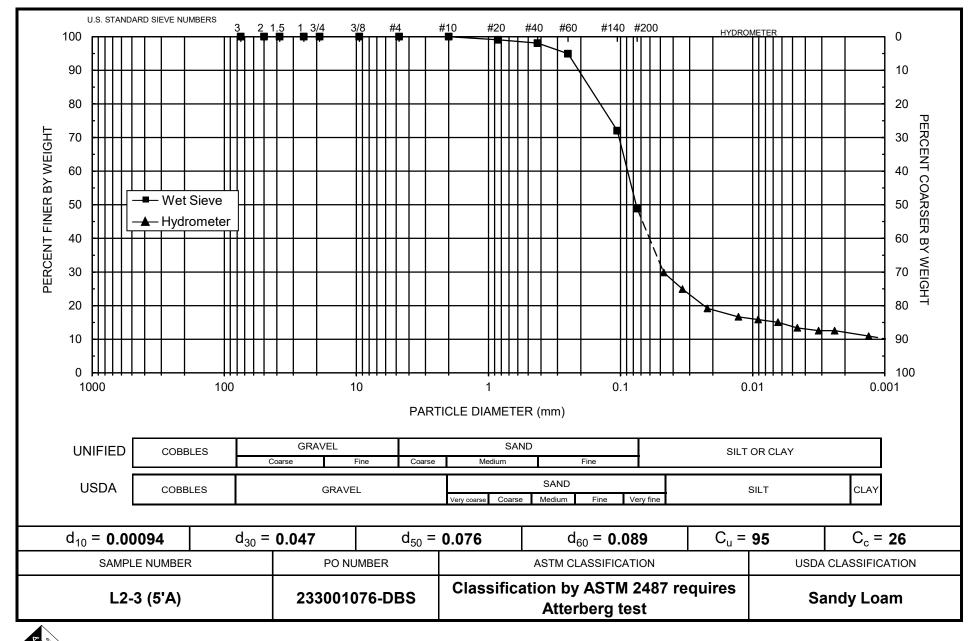
Total Sample Wt. (g): 469.13

Wt. Passing #10 (g): 469.13

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
15-May-18	1	21.6	23.5	5.4	18.1	12.4	0.04714	29.9	29.9
	2	21.6	20.5	5.4	15.1	12.9	0.03398	24.9	24.9
	5	21.6	17.0	5.4	11.6	13.5	0.02196	19.2	19.2
	15	21.5	15.5	5.4	10.1	13.8	0.01281	16.7	16.7
	30	21.5	15.0	5.4	9.6	13.8	0.00909	15.8	15.8
	60	21.6	14.5	5.4	9.1	13.9	0.00644	15.0	15.0
	120	21.4	13.5	5.4	8.1	14.1	0.00459	13.4	13.4
	253	21.5	13.0	5.4	7.6	14.2	0.00317	12.6	12.6
	443	21.5	13.0	5.4	7.6	14.2	0.00239	12.6	12.6
16-May-18	1463	21.6	12.0	5.4	6.6	14.3	0.00132	10.9	10.9

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 333.87

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 333.87

 Sample Number:
 L2-4 (10'B)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 58.28
PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 58.28

Test Date: 17-May-18 Shape: Angular

Hardness: Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing_
+10						
	3"	75	0.00	0.00	333.87	100.00
	2"	50	0.00	0.00	333.87	100.00
	1.5"	38.1	0.00	0.00	333.87	100.00
	1"	25	0.00	0.00	333.87	100.00
	3/4"	19.0	0.00	0.00	333.87	100.00
	3/8"	9.5	0.00	0.00	333.87	100.00
	4	4.75	0.00	0.00	333.87	100.00
	10	2.00	0.00	0.00	333.87	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.38	0.38	57.90	99.35
	40	0.425	0.54	0.92	57.36	98.42
	60	0.250	0.84	1.76	56.52	96.98
	140	0.106	7.17	8.93	49.35	84.68
	200	0.075	7.86	16.79	41.49	71.19
	dry pan		1.12	17.91	40.37	
	wet pan			40.37	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 3.9E-05 & d_{50} \ (mm): \ 0.045 \\ d_{16} \ (mm): \ 0.00032 & d_{60} \ (mm): \ 0.057 \\ d_{30} \ (mm): \ 0.012 & d_{84} \ (mm): \ 0.10 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.045

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 1462

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 65

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.048

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L2-4 (10'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Total Sample Wt. (g): 58.28

Total Sample Wt. (g): 333.87

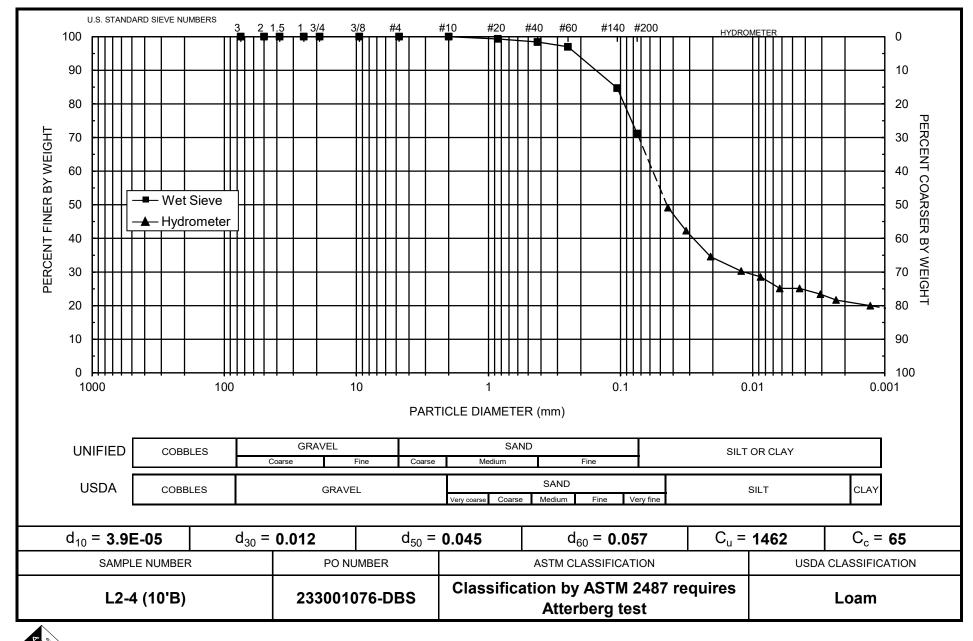
Start Time: 9:36

Wt. Passing #10 (g): 333.87

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
	_								
15-May-18	1	21.6	34.0	5.4	28.6	10.7	0.04376	49.1	49.1
	2	21.6	30.0	5.4	24.6	11.4	0.03187	42.3	42.3
	5	21.6	25.5	5.4	20.1	12.1	0.02080	34.6	34.6
	15	21.6	23.0	5.4	17.6	12.5	0.01221	30.3	30.3
	30	21.5	22.0	5.4	16.6	12.7	0.00870	28.5	28.5
	60	21.5	20.0	5.4	14.6	13.0	0.00623	25.1	25.1
	120	21.4	20.0	5.4	14.6	13.0	0.00441	25.1	25.1
	250	21.5	19.0	5.4	13.6	13.2	0.00307	23.4	23.4
	438	21.5	18.0	5.4	12.6	13.3	0.00234	21.7	21.7
16-May-18	1458	21.6	17.0	5.4	11.6	13.5	0.00129	20.0	20.0

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 485.58

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 485.58

 Sample Number:
 L2-5 (5'A)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Weight of Hydrometer Sample (g): 59.33

Calculated Weight of Sieve Sample (g): 59.33

Test Date: 17-May-18 Shape: Angular

Hardness: Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	485.58	100.00
	2"	50	0.00	0.00	485.58	100.00
	1.5"	38.1	0.00	0.00	485.58	100.00
	1"	25	0.00	0.00	485.58	100.00
	3/4"	19.0	0.00	0.00	485.58	100.00
	3/8"	9.5	0.00	0.00	485.58	100.00
	4	4.75	0.00	0.00	485.58	100.00
	10	2.00	0.00	0.00	485.58	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.00	0.00	59.33	100.00
	40	0.425	0.00	0.00	59.33	100.00
	60	0.250	0.04	0.04	59.29	99.93
	140	0.106	0.89	0.93	58.40	98.43
	200	0.075	0.75	1.68	57.65	97.17
	dry pan		0.16	1.84	57.49	
	wet pan			57.49	0.00	

 $d_{10}$  (mm): 4.4E-05  $d_{50}$  (mm): 0.0022  $d_{16}$  (mm): 8.0E-05  $d_{60}$  (mm): 0.0047  $d_{30}$  (mm): 0.00032  $d_{84}$  (mm): 0.023

Median Particle Diameter--d<sub>50</sub> (mm): 0.0022

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 107

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 0.50

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.0084

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Silty Clay



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L2-5 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Start Time: 9:42

Initial Wt. (g): 59.33

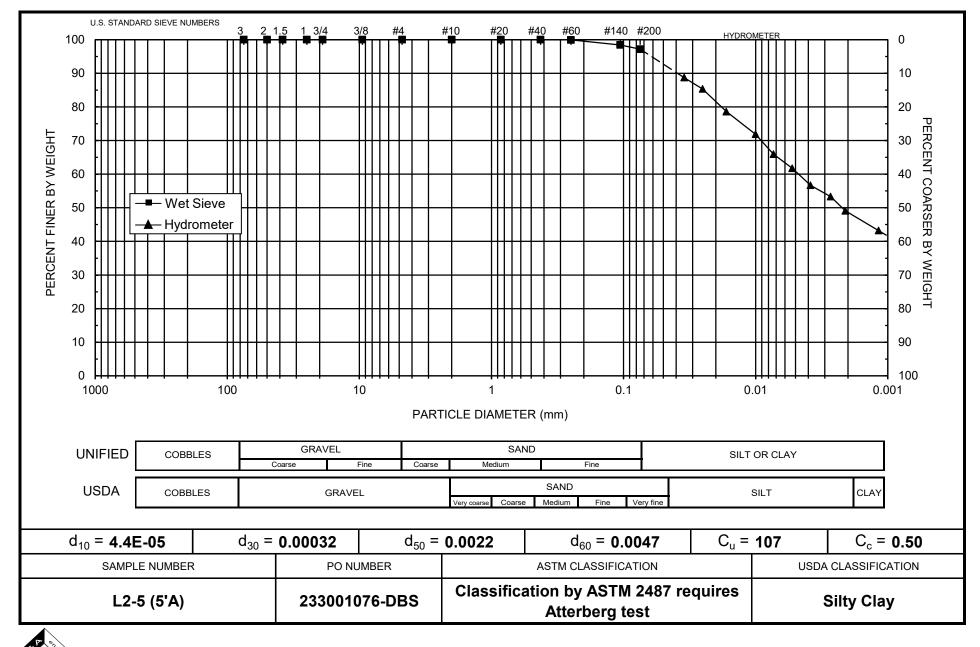
Total Sample Wt. (g): 485.58

Wt. Passing #10 (g): 485.58

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
	_								
15-May-18	1	21.7	58.0	5.4	52.6	6.8	0.03478	88.7	88.7
	2	21.6	56.0	5.4	50.6	7.1	0.02521	85.4	85.4
	5	21.6	52.0	5.4	46.6	7.8	0.01666	78.6	78.6
	15	21.6	48.0	5.4	42.6	8.4	0.01002	71.9	71.9
	30	21.5	44.5	5.4	39.1	9.0	0.00733	66.0	66.0
	60	21.6	42.0	5.4	36.6	9.4	0.00529	61.8	61.8
	120	21.5	39.0	5.4	33.6	9.9	0.00384	56.7	56.7
	250	21.5	37.0	5.4	31.6	10.2	0.00271	53.3	53.3
	433	21.5	34.5	5.4	29.1	10.6	0.00210	49.1	49.1
16-May-18	1454	21.6	31.0	5.4	25.6	11.2	0.00117	43.2	43.2

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial I

Initial Dry Weight of Sample (g): 230.60

Job Number: DB18.1151.00

Weight Passing #10 (g): 230.60 Weight Retained #10 (g): 0.00

Sample Number: L2-6 (5'A)

Weight of Hydrometer Sample (g): 54.02

Project Name: St. Anthony Geotech Investigation

Calculated Weight of Sieve Sample (g): 54.02

PO Number: 233001076-DBS

Test Date: 24-May-18

Shape: Rounded

Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	230.60	100.00
	2"	50	0.00	0.00	230.60	100.00
	1.5"	38.1	0.00	0.00	230.60	100.00
	1"	25	0.00	0.00	230.60	100.00
	3/4"	19.0	0.00	0.00	230.60	100.00
	3/8"	9.5	0.00	0.00	230.60	100.00
	4	4.75	0.00	0.00	230.60	100.00
	10	2.00	0.00	0.00	230.60	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.00	0.00	54.02	100.00
	40	0.425	0.03	0.03	53.99	99.94
	60	0.250	0.17	0.20	53.82	99.63
	140	0.106	3.57	3.77	50.25	93.02
	200	0.075	4.24	8.01	46.01	85.17
	dry pan		0.65	8.66	45.36	
	wet pan			45.36	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00031 & d_{50} \ (mm): \ 0.013 \\ d_{16} \ (mm): \ 0.00054 & d_{60} \ (mm): \ 0.030 \\ d_{30} \ (mm): \ 0.0020 & d_{84} \ (mm): \ 0.072 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.013

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 97

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 0.43

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.029

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

Classification of fines: CL

ASTM Soil Classification: Lean clay (CL) USDA Soil Classification: Clay Loam



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L2-6 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 18-May-18

Start Time: 9:36

Initial Wt. (g): 54.02

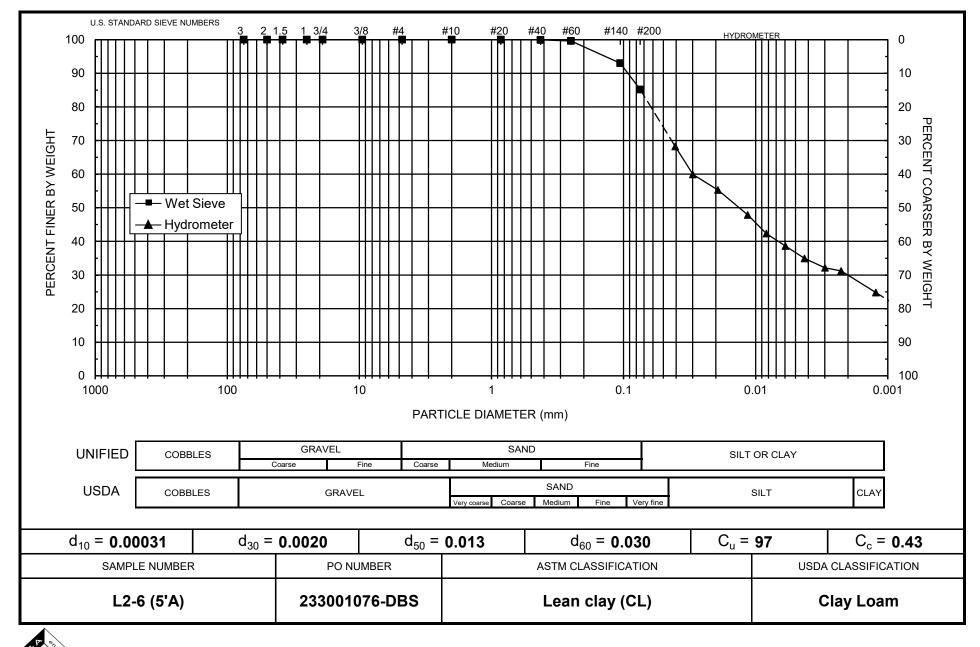
Total Sample Wt. (g): 230.60

Wt. Passing #10 (g): 230.60

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
18-May-18	1	21.6	43.0	6.1	36.9	9.3	0.04064	68.2	68.2
	2	21.6	38.5	6.1	32.4	10.0	0.02986	59.9	59.9
	5	21.6	36.0	6.1	29.9	10.4	0.01927	55.3	55.3
	15	21.6	32.0	6.1	25.9	11.1	0.01147	47.9	47.9
	30	21.6	29.0	6.1	22.9	11.5	0.00829	42.3	42.3
	60	21.6	27.0	6.1	20.9	11.9	0.00594	38.6	38.6
	120	21.6	25.0	6.1	18.9	12.2	0.00426	34.9	34.9
	250	21.6	23.5	6.1	17.4	12.4	0.00298	32.1	32.1
	441	21.6	23.0	6.1	16.9	12.5	0.00225	31.2	31.2
19-May-18	1539	21.7	19.5	6.1	13.4	13.1	0.00123	24.8	24.8

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





### **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 458.29

Job Number: DB18.1151.00 Weight Passing #10 (g): 458.15 Sample Number: L2-7 (10'A) Weight Retained #10 (g): 0.14

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 59.02 PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 59.04

Test Date: 30-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	458.29	100.00
	2"	50	0.00	0.00	458.29	100.00
	1.5"	38.1	0.00	0.00	458.29	100.00
	1"	25	0.00	0.00	458.29	100.00
	3/4"	19.0	0.00	0.00	458.29	100.00
	3/8"	9.5	0.00	0.00	458.29	100.00
	4	4.75	0.00	0.00	458.29	100.00
	10	2.00	0.14	0.14	458.15	99.97
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.10	0.12	58.92	99.80
	40	0.425	0.14	0.26	58.78	99.56
	60	0.250	0.47	0.73	58.31	98.77
	140	0.106	12.39	13.12	45.92	77.78
	200	0.075	10.54	23.66	35.38	59.93
	dry pan		0.75	24.41	34.63	
	wet pan			34.63	0.00	

d<sub>10</sub> (mm): 1.9E-09 d<sub>50</sub> (mm): 0.057 d<sub>16</sub> (mm): 0.0067 d<sub>60</sub> (mm): 0.075 d<sub>30</sub> (mm): 0.025 d<sub>84</sub> (mm): 0.14

Median Particle Diameter -- d<sub>50</sub> (mm): 0.057

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 3.9E+07

Coefficient of Curvature,  $Cc - [(d_{30})^2/(d_{10}*d_{60})]$  (mm): 4.4E+06

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.068

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: L2-7 (10'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation

Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 23-May-18 Initial Wt. (g): 59.02

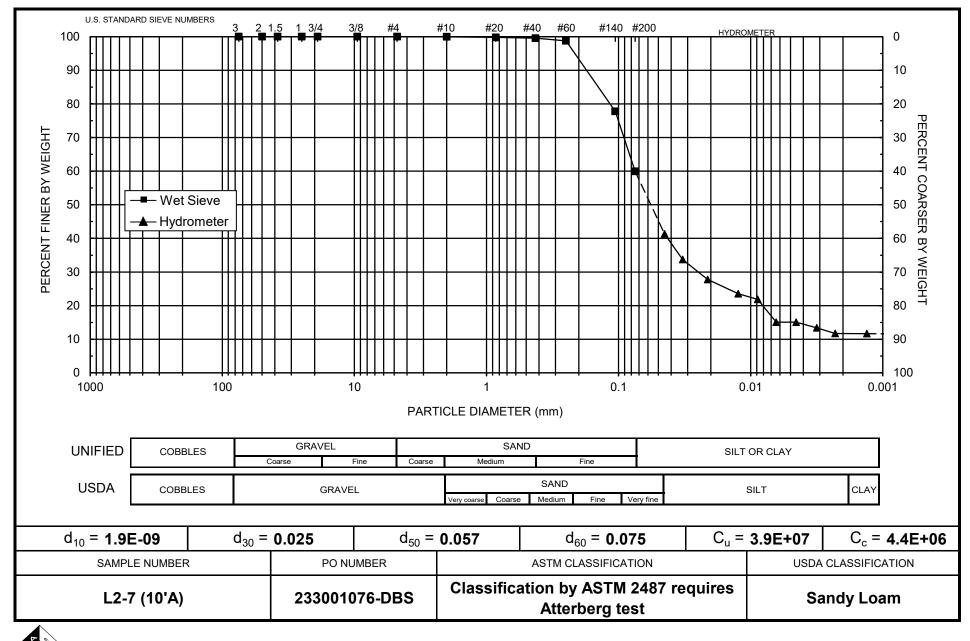
Total Sample Wt. (g): 458.29

Test Date: 23-May-18 Total Sample Wt. (g): 458.29
Start Time: 9:00 Wt. Passing #10 (g): 458.15

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
23-May-18	1	21.8	30.5	6.1	24.4	11.3	0.04481	41.3	41.3
	2	21.8	26.0	6.1	19.9	12.0	0.03270	33.7	33.7
	5	21.8	22.5	6.1	16.4	12.6	0.02117	27.8	27.8
	15	21.8	20.0	6.1	13.9	13.0	0.01242	23.6	23.5
	30	21.8	19.0	6.1	12.9	13.2	0.00884	21.9	21.9
	60	21.8	15.0	6.1	8.9	13.8	0.00640	15.1	15.1
	120	21.8	15.0	6.1	8.9	13.8	0.00453	15.1	15.1
	250	21.8	14.0	6.1	7.9	14.0	0.00315	13.4	13.4
	480	21.9	13.0	6.1	6.9	14.2	0.00229	11.7	11.7
24-May-18	1455	21.7	13.0	6.1	6.9	14.2	0.00132	11.7	11.7

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 451.54

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 449.76

 Sample Number:
 T/O-1 (20'A)
 Weight Retained #10 (g): 1.78

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Weight of Hydrometer Sample (g): 54.86

Calculated Weight of Sieve Sample (g): 55.08

Test Date: 17-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	451.54	100.00
	2"	50	0.00	0.00	451.54	100.00
	1.5"	38.1	0.00	0.00	451.54	100.00
	1"	25	0.00	0.00	451.54	100.00
	3/4"	19.0	0.00	0.00	451.54	100.00
	3/8"	9.5	0.00	0.00	451.54	100.00
	4	4.75	1.11	1.11	450.43	99.75
	10	2.00	0.67	1.78	449.76	99.61
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.24	0.46	54.62	99.17
	40	0.425	0.21	0.67	54.41	98.79
	60	0.250	0.15	0.82	54.26	98.52
	140	0.106	0.37	1.19	53.89	97.84
	200	0.075	0.72	1.91	53.17	96.54
	dry pan		0.25	2.16	52.92	
	wet pan			52.92	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00030 & d_{50} \ (mm): \ 0.0088 \\ d_{16} \ (mm): \ 0.00052 & d_{60} \ (mm): \ 0.016 \\ d_{30} \ (mm): \ 0.0019 & d_{84} \ (mm): \ 0.043 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.0088

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 53

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 0.75

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.017

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Silty Clay Loam

Laboratory analysis by: Z. Calhoun

Data entered by: J. Hines

Checked by: J. Hines



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: T/O-1 (20'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Total Sample Wt. (g): 54.86

Total Sample Wt. (g): 451.54

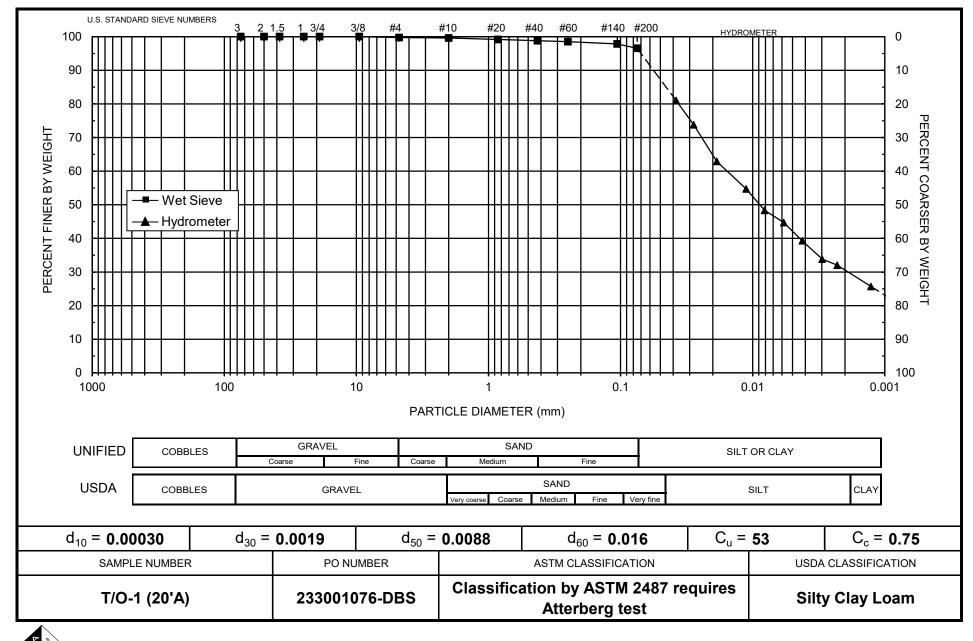
Start Time: 9:48

Wt. Passing #10 (g): 449.76

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
15-May-18	1	21.7	50.0	5.4	44.6	8.1	0.03799	81.4	81.0
	2	21.7	46.0	5.4	40.6	8.8	0.02793	74.1	73.8
	5	21.5	40.0	5.4	34.6	9.7	0.01867	63.1	62.9
	15	21.5	35.5	5.4	30.1	10.5	0.01118	54.9	54.7
	30	21.5	32.0	5.4	26.6	11.1	0.00812	48.5	48.4
	60	21.6	30.0	5.4	24.6	11.4	0.00582	44.9	44.7
	120	21.5	27.0	5.4	21.6	11.9	0.00421	39.4	39.3
	250	21.5	24.0	5.4	18.6	12.4	0.00298	34.0	33.8
	428	21.5	23.0	5.4	17.6	12.5	0.00229	32.1	32.0
16-May-18	1449	21.6	19.5	5.4	14.1	13.1	0.00127	25.8	25.7

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 440.68

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 440.68

 Sample Number:
 T/O-1 (45'B)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 53.68
PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 53.68

Test Date: 17-May-18 Shape: Angular Hardness: Soft

Test	Sieve	Diameter	Wt.	Cum Wt.	Wt.	0/ Dessing
Fraction	Number	(mm)	Retained	Retained	Passing	% Passing
+10						
	3"	75	0.00	0.00	440.68	100.00
	2"	50	0.00	0.00	440.68	100.00
	1.5"	38.1	0.00	0.00	440.68	100.00
	1"	25	0.00	0.00	440.68	100.00
	3/4"	19.0	0.00	0.00	440.68	100.00
	3/8"	9.5	0.00	0.00	440.68	100.00
	4	4.75	0.00	0.00	440.68	100.00
	10	2.00	0.00	0.00	440.68	100.00
-10			(Based on calcu	ulated sieve wt.	)	
	20	0.85	0.27	0.27	53.41	99.50
	40	0.425	0.29	0.56	53.12	98.96
	60	0.250	0.79	1.35	52.33	97.49
	140	0.106	19.08	20.43	33.25	61.94
	200	0.075	5.28	25.71	27.97	52.11
	dry pan		0.45	26.16	27.52	
	wet pan			27.52	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 5.1E-05 & d_{50} \ (mm): \ 0.070 \\ d_{16} \ (mm): \ 0.00037 & d_{60} \ (mm): \ 0.099 \\ d_{30} \ (mm): \ 0.016 & d_{84} \ (mm): \ 0.18 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.070

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 1941

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 51

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.083

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Clay Loam



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: T/O-1 (45'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 15-May-18

Start Time: 9:54

Initial Wt. (g): 53.68

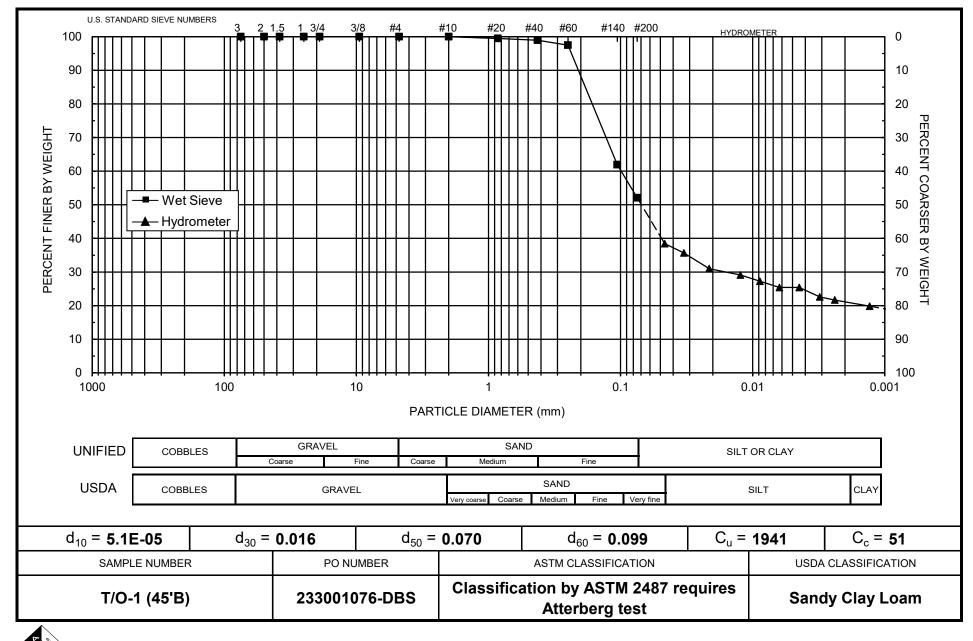
Total Sample Wt. (g): 440.68

Wt. Passing #10 (g): 440.68

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
	_								
15-May-18	1	21.6	26.0	5.4	20.6	12.0	0.04636	38.5	38.5
	2	21.6	24.5	5.4	19.1	12.3	0.03311	35.7	35.7
	5	21.5	22.0	5.4	16.6	12.7	0.02131	31.0	31.0
	15	21.5	21.0	5.4	15.6	12.9	0.01238	29.1	29.1
	30	21.5	20.0	5.4	14.6	13.0	0.00881	27.3	27.3
	60	21.5	19.0	5.4	13.6	13.2	0.00627	25.4	25.4
	120	21.5	19.0	5.4	13.6	13.2	0.00444	25.4	25.4
	250	21.4	17.5	5.4	12.1	13.4	0.00310	22.6	22.6
	423	21.5	17.0	5.4	11.6	13.5	0.00239	21.7	21.7
16-May-18	1444	21.6	16.0	5.4	10.6	13.7	0.00130	19.8	19.8

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 502.66

Job Number: DB18.1151.00 Weight Passing #10 (g): 501.78
Sample Number: T/O-2 (5'A) Weight Retained #10 (g): 0.88
Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 52.20

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 52.20
PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 52.29

Test Date: 23-May-18 Shape: Angular

Hardness: Hard and durable

Test	Sieve	Diameter	Wt.	Cum Wt.	Wt.	
Fraction	Number	(mm)	Retained	Retained	Passing	% Passing
+10						
	3"	75	0.00	0.00	502.66	100.00
	2"	50	0.00	0.00	502.66	100.00
	1.5"	38.1	0.00	0.00	502.66	100.00
	1"	25	0.00	0.00	502.66	100.00
	3/4"	19.0	0.00	0.00	502.66	100.00
	3/8"	9.5	0.00	0.00	502.66	100.00
	4	4.75	0.00	0.00	502.66	100.00
	10	2.00	0.88	0.88	501.78	99.82
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	2.09	2.18	50.11	95.83
	40	0.425	4.57	6.75	45.54	87.09
	60	0.250	2.38	9.13	43.16	82.54
	140	0.106	2.23	11.36	40.93	78.27
	200	0.075	0.66	12.02	40.27	77.01
	dry pan		0.31	12.33	39.96	
	wet pan			39.96	0.00	

 $d_{10}$  (mm): 0.0025  $d_{50}$  (mm): 0.010  $d_{16}$  (mm): 0.0026  $d_{60}$  (mm): 0.022  $d_{30}$  (mm): 0.0029  $d_{84}$  (mm): 0.30

Median Particle Diameter --  $d_{50}$  (mm): 0.010 Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): 8.8 Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 0.15 Mean Particle Diameter --[ $(d_{16}+d_{50}+d_{84})/3$ ] (mm): 0.10

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Silt Loam

Laboratory analysis by: Z. Calhoun/M. Garcia
Data entered by: M. Garcia
Checked by: J. Hines

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# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: T/O-2 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

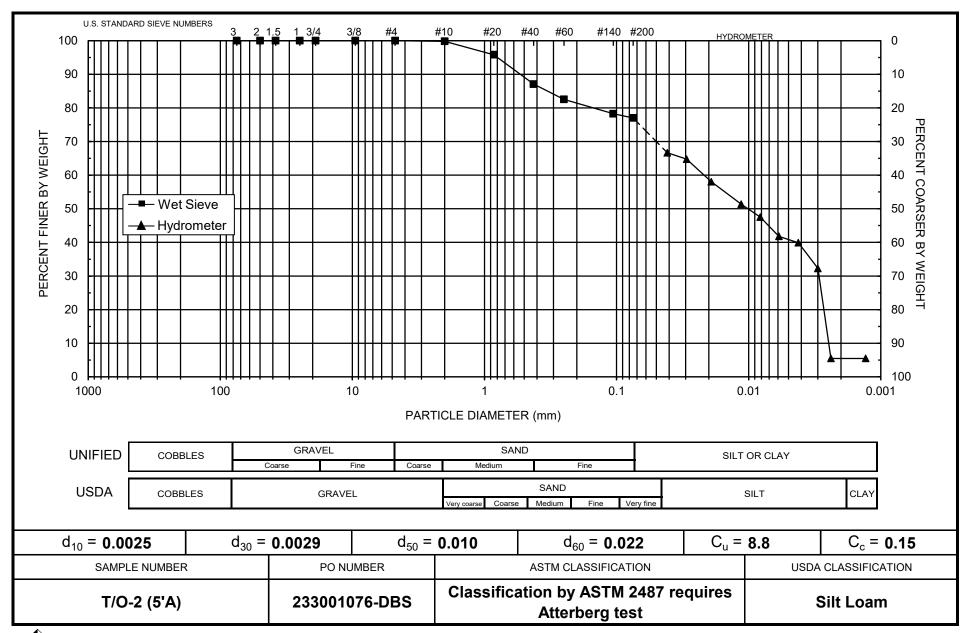
 Test Date:
 18-May-18
 Total Sample Wt. (g):
 502.66

 Start Time:
 9:06
 Wt. Passing #10 (g):
 501.78

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
40.14		0.4.0	44.6		0.4.0		0.0440=	22.2	00 =
18-May-18	1	21.6	41.0	6.1	34.9	9.6	0.04135	66.8	66.7
	2	21.6	40.0	6.1	33.9	9.7	0.02949	64.9	64.8
	5	21.6	36.5	6.1	30.4	10.3	0.01919	58.2	58.1
	15	21.6	33.0	6.1	26.9	10.9	0.01138	51.5	51.4
	30	21.6	31.0	6.1	24.9	11.2	0.00817	47.6	47.5
	60	21.6	28.0	6.1	21.9	11.7	0.00590	41.9	41.8
	120	21.6	27.0	6.1	20.9	11.9	0.00420	40.0	39.9
	250	21.6	23.0	6.1	16.9	12.5	0.00299	32.3	32.2
	466	21.6	9.0	6.1	2.9	14.8	0.00238	5.5	5.5
19-May-18	1565	21.7	9.0	6.1	2.9	14.8	0.00130	5.5	5.5

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





Daniel B. Stephens & Associates, Inc.



# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 403.81

Job Number: DB18.1151.00 Weight Passing #10 (g): 403.64
Sample Number: T/O-3 (40'A) Weight Retained #10 (g): 0.17
Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 53.27

Test Date: 24-May-18 Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	403.81	100.00
	2"	50	0.00	0.00	403.81	100.00
	1.5"	38.1	0.00	0.00	403.81	100.00
	1"	25	0.00	0.00	403.81	100.00
	3/4"	19.0	0.00	0.00	403.81	100.00
	3/8"	9.5	0.00	0.00	403.81	100.00
	4	4.75	0.15	0.15	403.66	99.96
	10	2.00	0.02	0.17	403.64	99.96
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.14	0.16	53.13	99.70
	40	0.425	0.22	0.38	52.91	99.28
	60	0.250	0.83	1.21	52.08	97.72
	140	0.106	19.16	20.37	32.92	61.77
	200	0.075	7.09	27.46	25.83	48.47
	dry pan		0.50	27.96	25.33	
	wet pan			25.33	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00083 & d_{50} \ (mm): \ 0.078 \\ d_{16} \ (mm): \ 0.0036 & d_{60} \ (mm): \ 0.10 \\ d_{30} \ (mm): \ 0.041 & d_{84} \ (mm): \ 0.18 \\ \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.078

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 120

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 20

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.087

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: Z. Calhoun/M. Garcia

Data entered by: M. Garcia Checked by: J. Hines



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: T/O-3 (40'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

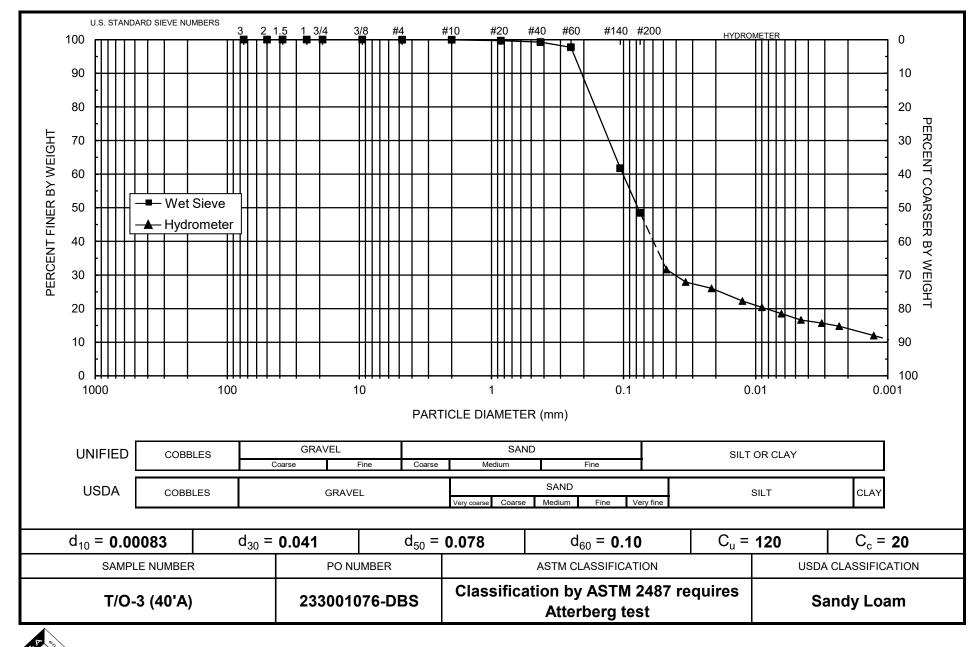
Test Date: 18-May-18 Total Sample Wt. (g): 53.27

Test Date: 9:12 Wt. Passing #10 (g): 403.64

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
18-May-18	1	21.6	23.0	6.1	16.9	12.5	0.04729	31.7	31.6
	2	21.6	21.0	6.1	14.9	12.9	0.03388	27.9	27.9
	5	21.6	20.0	6.1	13.9	13.0	0.02156	26.0	26.0
	15	21.6	18.0	6.1	11.9	13.3	0.01260	22.3	22.3
	30	21.6	17.0	6.1	10.9	13.5	0.00897	20.4	20.4
	60	21.6	16.0	6.1	9.9	13.7	0.00638	18.5	18.5
	120	21.6	15.0	6.1	8.9	13.8	0.00454	16.6	16.6
	250	21.6	14.5	6.1	8.4	13.9	0.00315	15.7	15.7
	462	21.6	14.0	6.1	7.9	14.0	0.00233	14.8	14.7
19-May-18	1560	21.7	12.5	6.1	6.4	14.3	0.00128	12.0	12.0

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 563.72

Job Number: DB18.1151.00

Weight Passing #10 (g): 558.38

Sample Number: T/O-3 (70'B)

Weight Retained #10 (g): 5.34

Project Name: St. Anthony Geotech Investigation

Weight of Hydrometer Sample (g): 49.58

Test Date: 22-May-18 Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10					-	
	3"	75	0.00	0.00	563.72	100.00
	2"	50	0.00	0.00	563.72	100.00
	1.5"	38.1	0.00	0.00	563.72	100.00
	1"	25	0.00	0.00	563.72	100.00
	3/4"	19.0	0.00	0.00	563.72	100.00
	3/8"	9.5	0.00	0.00	563.72	100.00
	4	4.75	2.62	2.62	561.10	99.54
	10	2.00	2.72	5.34	558.38	99.05
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.13	0.60	49.45	98.79
	40	0.425	0.16	0.76	49.29	98.47
	60	0.250	0.12	0.88	49.17	98.23
	140	0.106	1.05	1.93	48.12	96.14
	200	0.075	2.63	4.56	45.49	90.88
	dry pan		0.53	5.09	44.96	
	wet pan			44.96	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00032 & d_{50} \ (mm): \ 0.034 \\ d_{16} \ (mm): \ 0.0015 & d_{60} \ (mm): \ 0.045 \\ d_{30} \ (mm): \ 0.011 & d_{84} \ (mm): \ 0.067 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.034

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 141

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 8.4

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.034

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: T/O-3 (70'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation

Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 17-May-18 Initial Wt. (g): 49.58

Total Sample Wt. (g): 563.72

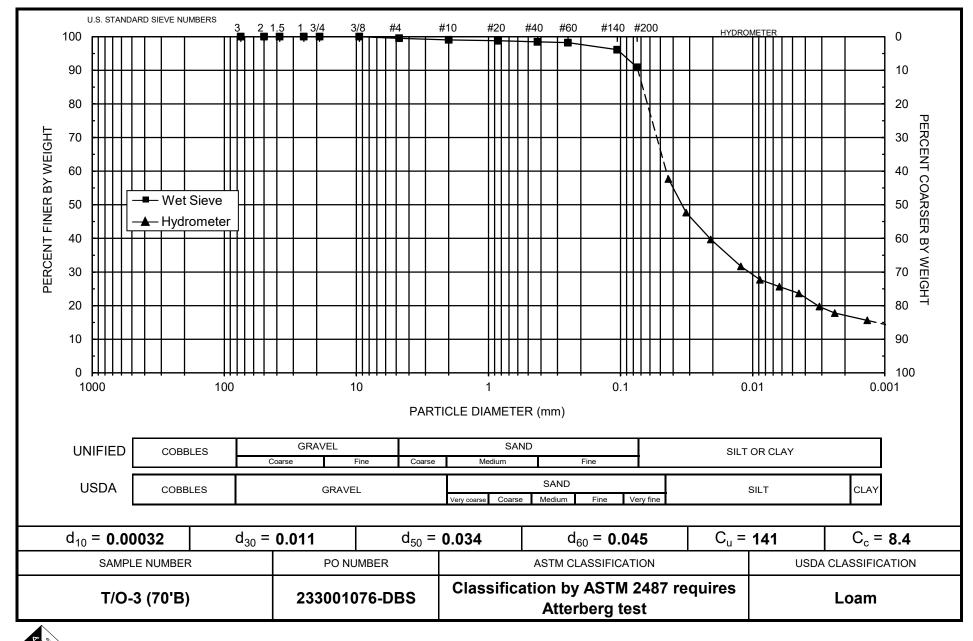
Start Time: 9:48

Wt. Passing #10 (g): 558.38

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
17-May-18	1	21.6	35.0	6.1	28.9	10.6	0.04342	58.2	57.7
	2	21.6	30.0	6.1	23.9	11.4	0.03187	48.1	47.7
	5	21.6	26.0	6.1	19.9	12.0	0.02073	40.1	39.7
	15	21.6	22.0	6.1	15.9	12.7	0.01229	32.0	31.7
	30	21.6	20.0	6.1	13.9	13.0	0.00880	28.0	27.7
	60	21.5	19.0	6.2	12.8	13.2	0.00627	25.9	25.6
	120	21.5	18.0	6.2	11.8	13.3	0.00446	23.9	23.6
	250	21.6	16.0	6.1	9.9	13.7	0.00313	19.9	19.7
	431	21.8	15.0	6.1	8.9	13.8	0.00239	18.0	17.8
18-May-18	1364	21.4	14.0	6.2	7.8	14.0	0.00136	15.8	15.6

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 454.63

 Job Number: DB18.1151.00
 Weight Passing #10 (g): 454.63

 Sample Number: T/O-4 (20'B)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 53.65

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 53.65

Test Date: 24-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	454.63	100.00
	2"	50	0.00	0.00	454.63	100.00
	1.5"	38.1	0.00	0.00	454.63	100.00
	1"	25	0.00	0.00	454.63	100.00
	3/4"	19.0	0.00	0.00	454.63	100.00
	3/8"	9.5	0.00	0.00	454.63	100.00
	4	4.75	0.00	0.00	454.63	100.00
	10	2.00	0.00	0.00	454.63	100.00
-10			(Based on calcu	ulated sieve wt.)		
	20	0.85	0.12	0.12	53.53	99.78
	40	0.425	0.13	0.25	53.40	99.53
	60	0.250	0.36	0.61	53.04	98.86
	140	0.106	8.30	8.91	44.74	83.39
	200	0.075	4.41	13.32	40.33	75.17
	dry pan		0.53	13.85	39.80	
	wet pan			39.80	0.00	

 $\begin{array}{lll} d_{10} \, (mm) \!\!: \!\! 0.00059 & d_{50} \, (mm) \!\!: \!\! 0.034 \\ d_{16} \, (mm) \!\!: \!\! 0.0016 & d_{60} \, (mm) \!\!: \!\! 0.050 \\ d_{30} \, (mm) \!\!: \!\! 0.011 & d_{84} \, (mm) \!\!: \!\! 0.11 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.034

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 85

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 4.1

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.049

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam

Laboratory analysis by: Z. Calhoun/M. Garcia

Data entered by: M. Garcia Checked by: J. Hines



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: T/O-4 (20'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 18-May-18 Initial Wt. (g): 53.65

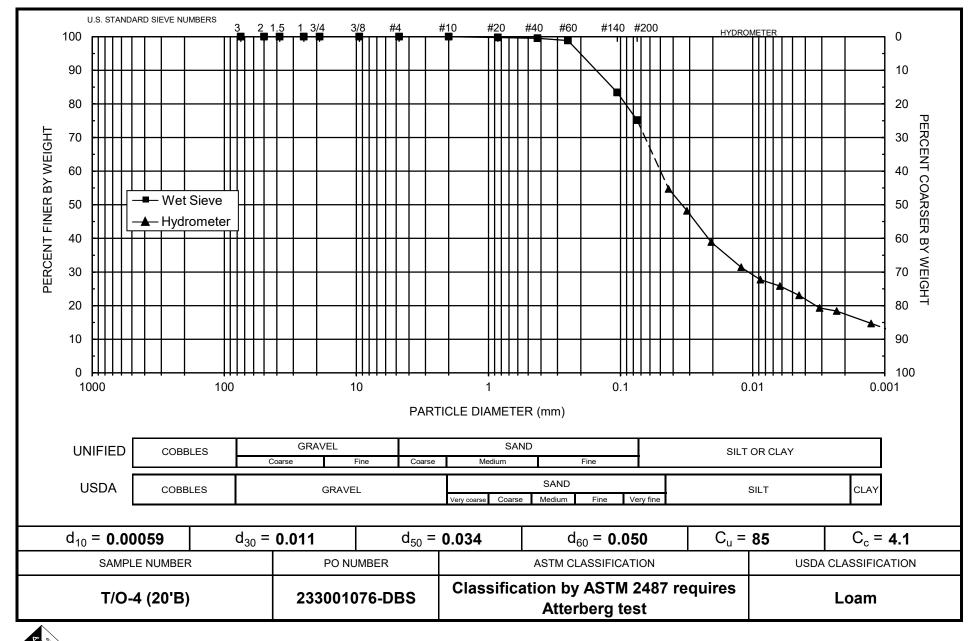
Test Date: 18-May-18 Total Sample Wt. (g): 454.63

Start Time: 9:18 Wt. Passing #10 (g): 454.63

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
18-May-18	1	21.6	35.5	6.1	29.4	10.5	0.04325	54.7	54.7
	2	21.6	32.0	6.1	25.9	11.1	0.03141	48.2	48.2
	5	21.6	27.0	6.1	20.9	11.9	0.02059	38.9	38.9
	15	21.6	23.0	6.1	16.9	12.5	0.01221	31.4	31.4
	30	21.6	21.0	6.1	14.9	12.9	0.00875	27.7	27.7
	60	21.6	20.0	6.1	13.9	13.0	0.00622	25.8	25.8
	120	21.6	18.5	6.1	12.4	13.3	0.00444	23.0	23.0
	250	21.6	16.5	6.1	10.4	13.6	0.00312	19.3	19.3
	457	21.6	16.0	6.1	9.9	13.7	0.00231	18.4	18.4
19-May-18	1555	21.7	14.0	6.1	7.9	14.0	0.00127	14.7	14.7

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 402.66

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 402.55

 Sample Number:
 T/O-5 (10'B)
 Weight Retained #10 (g): 0.11

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Weight of Hydrometer Sample (g): 52.88

Calculated Weight of Sieve Sample (g): 52.89

Test Date: 24-May-18 Shape: Angular

Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		, ,				
	3"	75	0.00	0.00	402.66	100.00
	2"	50	0.00	0.00	402.66	100.00
	1.5"	38.1	0.00	0.00	402.66	100.00
	1"	25	0.00	0.00	402.66	100.00
	3/4"	19.0	0.00	0.00	402.66	100.00
	3/8"	9.5	0.00	0.00	402.66	100.00
	4	4.75	0.00	0.00	402.66	100.00
	10	2.00	0.11	0.11	402.55	99.97
-10			(Based on calcı	ulated sieve wt.	)	
	20	0.85	0.37	0.38	52.51	99.27
	40	0.425	0.27	0.65	52.24	98.76
	60	0.250	0.24	0.89	52.00	98.31
	140	0.106	1.60	2.49	50.40	95.28
	200	0.075	2.85	5.34	47.55	89.90
	dry pan		0.66	6.00	46.89	
	wet pan			46.89	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.0011 & d_{50} \ (mm): \ 0.028 \\ d_{16} \ (mm): \ 0.0025 & d_{60} \ (mm): \ 0.039 \\ d_{30} \ (mm): \ 0.0100 & d_{84} \ (mm): \ 0.066 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.028

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): 35

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 2.3

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.032

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Silt Loam

Laboratory analysis by: Z. Calhoun/M. Garcia

Data entered by: M. Garcia Checked by: J. Hines



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: T/O-5 (10'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 18-May-18

Total Sample Wt. (g): 52.88

Total Sample Wt. (g): 402.66

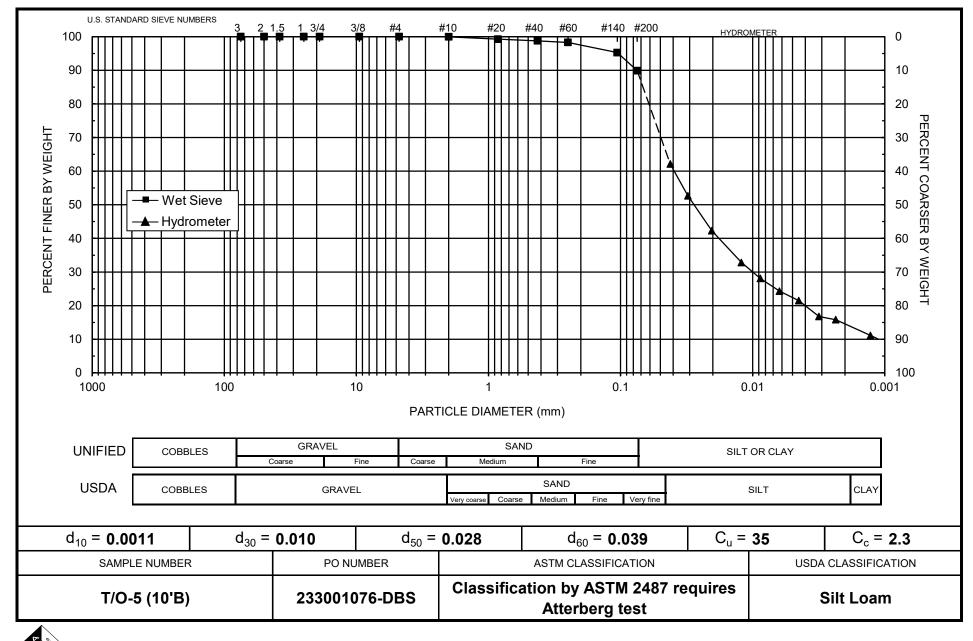
Start Time: 9:24

Wt. Passing #10 (g): 402.55

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
18-May-18	1	21.6	39.0	6.1	32.9	9.9	0.04205	62.1	62.1
	2	21.6	34.0	6.1	27.9	10.7	0.03094	52.7	52.7
	5	21.6	28.5	6.1	22.4	11.6	0.02038	42.3	42.3
	15	21.6	23.5	6.1	17.4	12.4	0.01217	32.8	32.8
	30	21.6	21.0	6.1	14.9	12.9	0.00875	28.1	28.1
	60	21.6	19.0	6.1	12.9	13.2	0.00626	24.3	24.3
	120	21.6	17.5	6.1	11.4	13.4	0.00447	21.5	21.5
	250	21.6	15.0	6.1	8.9	13.8	0.00314	16.8	16.8
	451	21.6	14.5	6.1	8.4	13.9	0.00235	15.8	15.8
19-May-18	1549	21.7	12.0	6.1	5.9	14.3	0.00128	11.1	11.1

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 507.52

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 507.52

 Sample Number:
 T/O-6 (5'A)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 49.32

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 49.32

Test Date: 18-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						_
	3"	75	0.00	0.00	507.52	100.00
	2"	50	0.00	0.00	507.52	100.00
	1.5"	38.1	0.00	0.00	507.52	100.00
	1"	25	0.00	0.00	507.52	100.00
	3/4"	19.0	0.00	0.00	507.52	100.00
	3/8"	9.5	0.00	0.00	507.52	100.00
	4	4.75	0.00	0.00	507.52	100.00
	10	2.00	0.00	0.00	507.52	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.95	0.95	48.37	98.07
	40	0.425	0.44	1.39	47.93	97.18
	60	0.250	0.38	1.77	47.55	96.41
	140	0.106	5.12	6.89	42.43	86.03
	200	0.075	5.08	11.97	37.35	75.73
	dry pan		0.69	12.66	36.66	
	wet pan			36.66	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00066 & d_{50} \ (mm): \ 0.043 \\ d_{16} \ (mm): \ 0.0020 & d_{60} \ (mm): \ 0.054 \\ d_{30} \ (mm): \ 0.018 & d_{84} \ (mm): \ 0.099 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.043

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 82

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 9.1

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.048

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: T/O-6 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18

Start Time: 9:42

Initial Wt. (g): 49.32

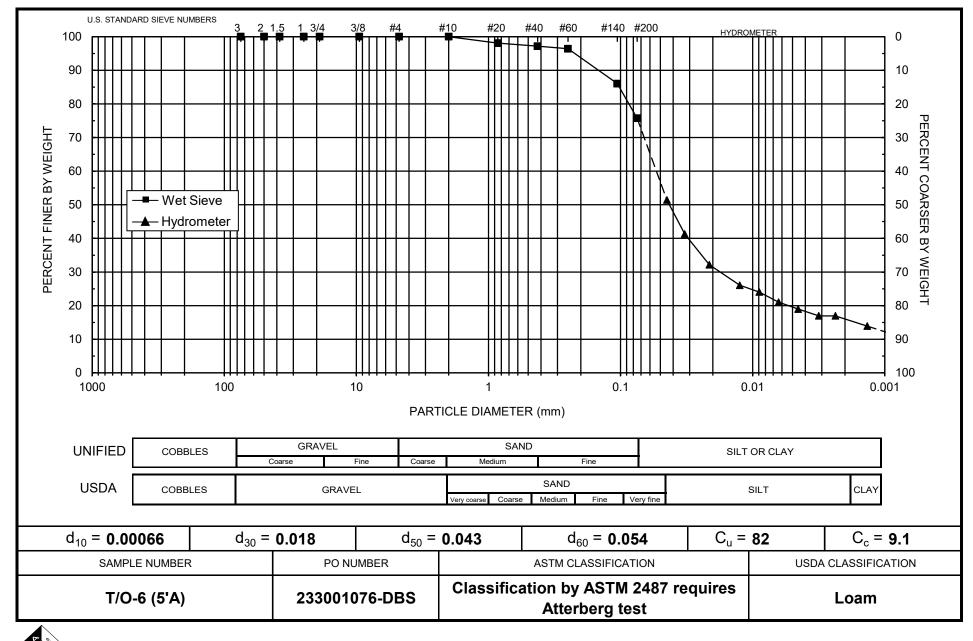
Total Sample Wt. (g): 507.52

Wt. Passing #10 (g): 507.52

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
16-May-18	1	21.6	31.5	6.1	25.4	11.1	0.04459	51.4	51.4
	2	21.6	26.5	6.1	20.4	12.0	0.03267	41.3	41.3
	5	21.6	22.0	6.1	15.9	12.7	0.02129	32.2	32.2
	15	21.6	19.0	6.1	12.9	13.2	0.01253	26.1	26.1
	30	21.6	18.0	6.1	11.9	13.3	0.00891	24.0	24.0
	60	21.6	16.5	6.1	10.4	13.6	0.00636	21.0	21.0
	120	21.6	15.5	6.1	9.4	13.8	0.00452	19.0	19.0
	250	21.6	14.5	6.1	8.4	13.9	0.00315	17.0	17.0
	445	21.6	14.5	6.1	8.4	13.9	0.00236	17.0	17.0
17-May-18	1377	21.6	13.0	6.1	6.9	14.2	0.00136	13.9	13.9

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc

Initial Dry Weight of Sample (g): 489.48

Job Number: DB18.1151.00

Weight Passing #10 (g): 485.66

Sample Number: TN-1 (5'A)

Weight Retained #10 (g): 3.82

Project Name: St. Anthony Geotech Investigation

Weight of Hydrometer Sample (g): 60.67

PO Number: 233001076-DBS

Calculated Weight of Sieve Sample (g): 61.15

Test Date: 23-May-18

Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						<u> </u>
	3"	75	0.00	0.00	489.48	100.00
	2"	50	0.00	0.00	489.48	100.00
	1.5"	38.1	0.00	0.00	489.48	100.00
	1"	25	0.00	0.00	489.48	100.00
	3/4"	19.0	0.00	0.00	489.48	100.00
	3/8"	9.5	0.00	0.00	489.48	100.00
	4	4.75	1.81	1.81	487.67	99.63
	10	2.00	2.01	3.82	485.66	99.22
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.49	0.97	60.18	98.42
	40	0.425	0.42	1.39	59.76	97.73
	60	0.250	1.04	2.43	58.72	96.03
	140	0.106	19.80	22.23	38.92	63.65
	200	0.075	9.15	31.38	29.77	48.69
	dry pan		1.39	32.77	28.38	
	wet pan			28.38	0.00	

d<sub>10</sub> (mm): 0.00074 d<sub>50</sub> (mm): 0.077 d<sub>16</sub> (mm): 0.0022 d<sub>60</sub> (mm): 0.097 d<sub>30</sub> (mm): 0.035 d<sub>84</sub> (mm): 0.18

Median Particle Diameter -- d<sub>50</sub> (mm): 0.077

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 131

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 17

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.086

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: Z. Calhoun/M. Garcia

Data entered by: M. Garcia Checked by: J. Hines



## **Particle Size Analysis Hydrometer Data**

Type of Water Used: DISTILLED Job Name: Stantec Consulting Services Inc

Reaction with H<sub>2</sub>O<sub>2</sub>: NA Job Number: DB18.1151.00

Sample Number: TN-1 (5'A) Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

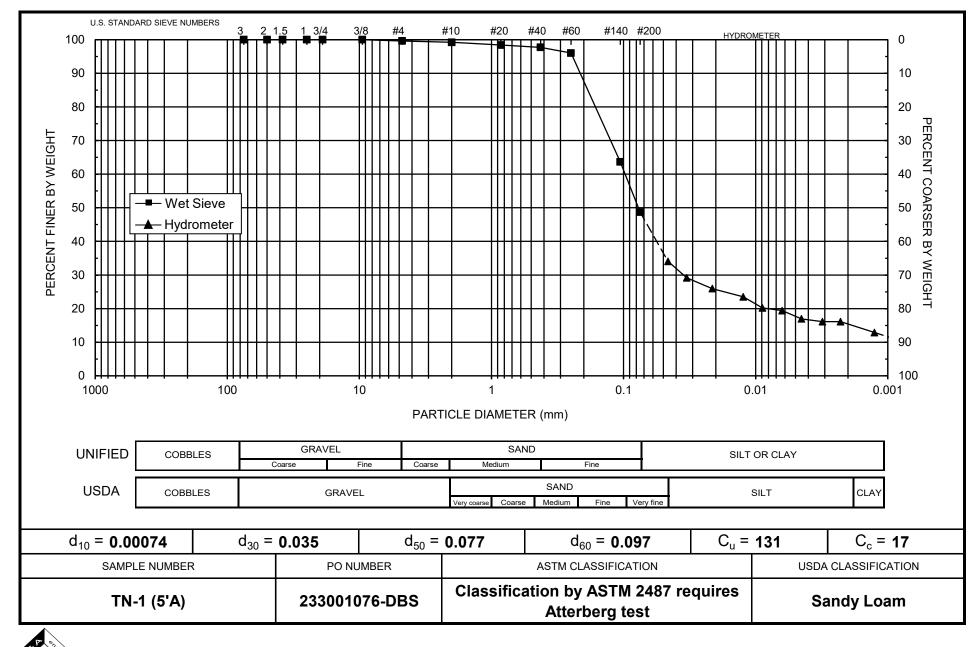
PO Number: 233001076-DBS

Initial Wt. (g): 60.67 Test Date: 18-May-18 Total Sample Wt. (g): 489.48 Start Time: 9:00 Wt. Passing #10 (g): 485.66

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
	_								
18-May-18	1	21.5	27.0	6.2	20.8	11.9	0.04609	34.3	34.1
	2	21.5	24.0	6.2	17.8	12.4	0.03326	29.4	29.2
	5	21.6	22.0	6.1	15.9	12.7	0.02129	26.1	25.9
	15	21.6	20.5	6.1	14.4	12.9	0.01241	23.7	23.5
	30	21.6	18.5	6.1	12.4	13.3	0.00889	20.4	20.2
	60	21.6	18.0	6.1	11.9	13.3	0.00630	19.5	19.4
	120	21.6	16.5	6.1	10.4	13.6	0.00450	17.1	16.9
	250	21.6	16.0	6.1	9.9	13.7	0.00313	16.3	16.1
	471	21.6	16.0	6.1	9.9	13.7	0.00228	16.3	16.1
19-May-18	1570	21.7	14.0	6.1	7.9	14.0	0.00126	13.0	12.9

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 276.75

Job Number: DB18.1151.00 Weight Passing #10 (g): 276.75
Sample Number: TN-2 (20'A) Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 68.55

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 68.55

Test Date: 18-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		,				<u> </u>
. •	3"	75	0.00	0.00	276.75	100.00
	2"	50	0.00	0.00	276.75	100.00
	1.5"	38.1	0.00	0.00	276.75	100.00
	1"	25	0.00	0.00	276.75	100.00
	3/4"	19.0	0.00	0.00	276.75	100.00
	3/8"	9.5	0.00	0.00	276.75	100.00
	4	4.75	0.00	0.00	276.75	100.00
	10	2.00	0.00	0.00	276.75	100.00
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.22	0.22	68.33	99.68
	40	0.425	0.29	0.51	68.04	99.26
	60	0.250	1.08	1.59	66.96	97.68
	140	0.106	24.88	26.47	42.08	61.39
	200	0.075	9.08	35.55	33.00	48.14
	dry pan		0.99	36.54	32.01	
	wet pan			32.01	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00077 & d_{50} \ (mm): \ 0.079 \\ d_{16} \ (mm): \ 0.0036 & d_{60} \ (mm): \ 0.10 \\ d_{30} \ (mm): \ 0.037 & d_{84} \ (mm): \ 0.18 \\ \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.079 Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 130

Coefficient of Curvature,  $Cc - [(d_{30})^2/(d_{10}*d_{60})]$  (mm): 18

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.088

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: TN-2 (20'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18

Total Sample Wt. (g): 68.55

Test Date: 9:36

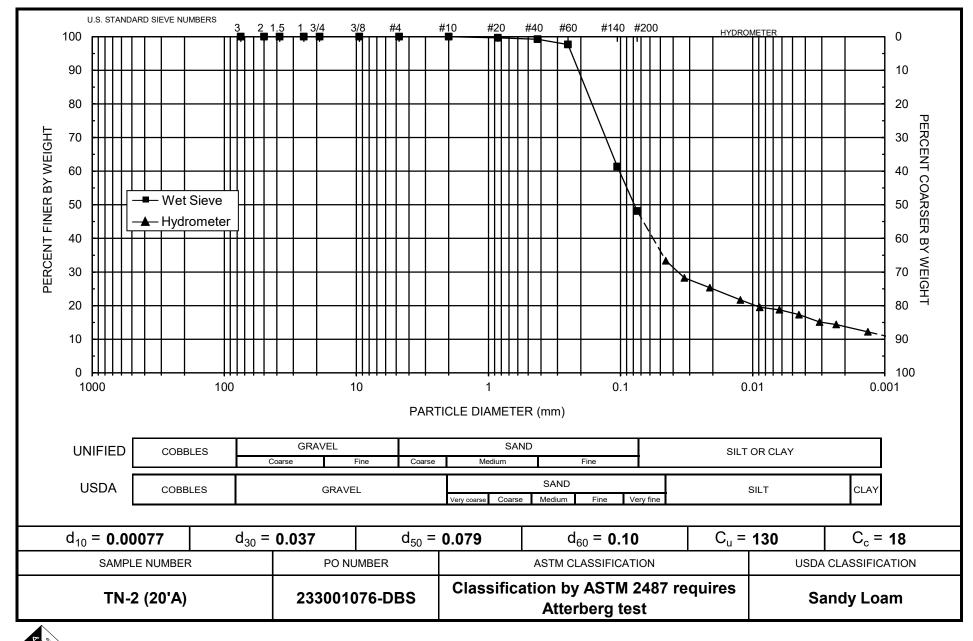
Total Sample Wt. (g): 276.75

Wt. Passing #10 (g): 276.75

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
16-May-18	1	21.6	29.0	6.1	22.9	11.5	0.04540	33.3	33.3
	2	21.6	25.5	6.1	19.4	12.1	0.03289	28.2	28.2
	5	21.6	23.5	6.1	17.4	12.4	0.02108	25.3	25.3
	15	21.6	21.0	6.1	14.9	12.9	0.01237	21.7	21.7
	30	21.6	19.5	6.1	13.4	13.1	0.00883	19.5	19.5
	60	21.6	19.0	6.1	12.9	13.2	0.00626	18.8	18.8
	120	21.6	18.0	6.1	11.9	13.3	0.00446	17.3	17.3
	250	21.6	16.5	6.1	10.4	13.6	0.00312	15.1	15.1
	450	21.6	16.0	6.1	9.9	13.7	0.00233	14.4	14.4
17-May-18	1383	21.6	14.5	6.1	8.4	13.9	0.00134	12.2	12.2

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





Test Date: 18-May-18

Daniel B. Stephens & Associates, Inc.

## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry

Initial Dry Weight of Sample (g): 426.30

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 426.30

 Sample Number:
 BS-1 (10'A)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation

Weight of Hydrometer Sample (g): 56.34

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 56.34

Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		· ,				
	3"	75	0.00	0.00	426.30	100.00
	2"	50	0.00	0.00	426.30	100.00
	1.5"	38.1	0.00	0.00	426.30	100.00
	1"	25	0.00	0.00	426.30	100.00
	3/4"	19.0	0.00	0.00	426.30	100.00
	3/8"	9.5	0.00	0.00	426.30	100.00
	4	4.75	0.00	0.00	426.30	100.00
	10	2.00	0.00	0.00	426.30	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.29	0.29	56.05	99.49
	40	0.425	0.26	0.55	55.79	99.02
	60	0.250	0.71	1.26	55.08	97.76
	140	0.106	13.36	14.62	41.72	74.05
	200	0.075	8.38	23.00	33.34	59.18
	dry pan		0.98	23.98	32.36	
	wet pan			32.36	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00029 & d_{50} \ (mm): \ 0.052 \\ d_{16} \ (mm): \ 0.00070 & d_{60} \ (mm): \ 0.076 \\ d_{30} \ (mm): \ 0.0098 & d_{84} \ (mm): \ 0.15 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.052

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 262

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 4.4

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.068

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Clay Loam



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: BS-1 (10'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18

Start Time: 9:00

Initial Wt. (g): 56.34

Total Sample Wt. (g): 426.30

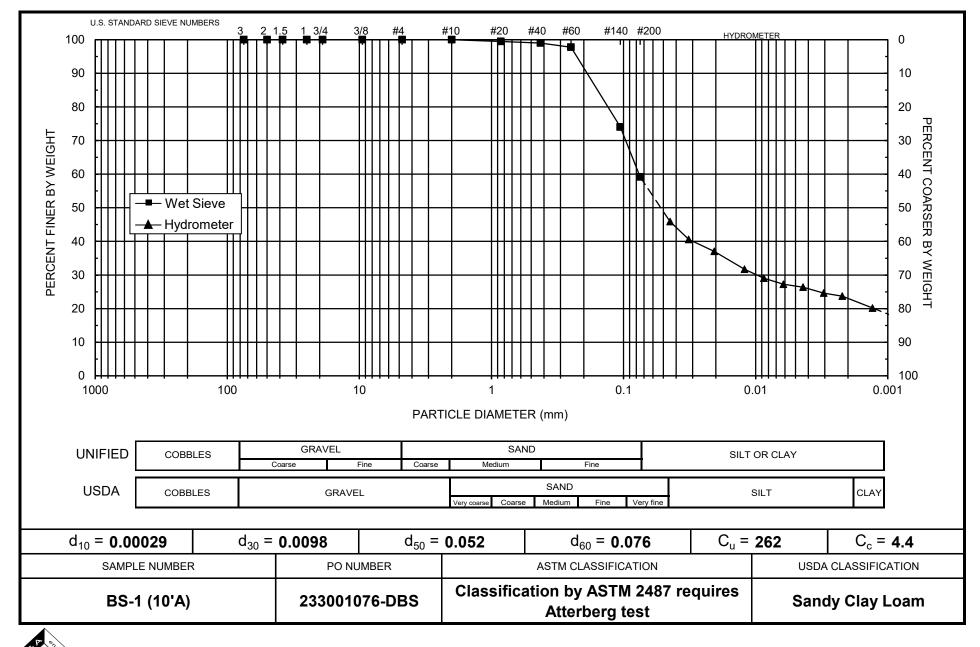
Wt. Passing #10 (g): 426.30

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
16-May-18	1	21.6	32.0	6.1	25.9	11.1	0.04442	45.9	45.9
	2	21.6	29.0	6.1	22.9	11.5	0.03210	40.6	40.6
	5	21.6	27.0	6.1	20.9	11.9	0.02059	37.0	37.0
	15	21.6	24.0	6.1	17.9	12.4	0.01213	31.7	31.7
	30	21.6	22.5	6.1	16.4	12.6	0.00866	29.0	29.0
	60	21.6	21.5	6.1	15.4	12.8	0.00617	27.3	27.3
	120	21.6	21.0	6.1	14.9	12.9	0.00437	26.4	26.4
	250	21.6	20.0	6.1	13.9	13.0	0.00305	24.6	24.6
	480	21.6	19.5	6.1	13.4	13.1	0.00221	23.7	23.7
17-May-18	1414	21.6	17.5	6.1	11.4	13.4	0.00130	20.2	20.2

#### Comments:

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 413.95

Weight Passing #10 (g): 413.95

Job Number: DB18.1151.00 Sample Number: BS-2 (15'A) Weight Retained #10 (g): 0.00

Weight of Hydrometer Sample (g): 53.66 Project Name: St. Anthony Geotech Investigation PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 53.66

Shape: Rounded Test Date: 18-May-18

Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	413.95	100.00
	2"	50	0.00	0.00	413.95	100.00
	1.5"	38.1	0.00	0.00	413.95	100.00
	1"	25	0.00	0.00	413.95	100.00
	3/4"	19.0	0.00	0.00	413.95	100.00
	3/8"	9.5	0.00	0.00	413.95	100.00
	4	4.75	0.00	0.00	413.95	100.00
	10	2.00	0.00	0.00	413.95	100.00
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	1.44	1.44	52.22	97.32
	40	0.425	1.17	2.61	51.05	95.14
	60	0.250	1.42	4.03	49.63	92.49
	140	0.106	12.29	16.32	37.34	69.59
	200	0.075	6.78	23.10	30.56	56.95
	dry pan		0.58	23.68	29.98	
	wet pan			29.98	0.00	

d<sub>10</sub> (mm): 0.0039 d<sub>50</sub> (mm): 0.061 d<sub>16</sub> (mm): 0.0048 d<sub>60</sub> (mm): 0.082 d<sub>30</sub> (mm): 0.014 d<sub>84</sub> (mm): 0.18

Median Particle Diameter -- d<sub>50</sub> (mm): 0.061 Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 21 Coefficient of Curvature,  $Cc - [(d_{30})^2/(d_{10}*d_{60})]$  (mm): 0.61 Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.082

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: E. Bastien Data entered by: M. Garcia Checked by: J. Hines



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: BS-2 (15'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18

Start Time: 9:06

Initial Wt. (g): 53.66

Total Sample Wt. (g): 413.95

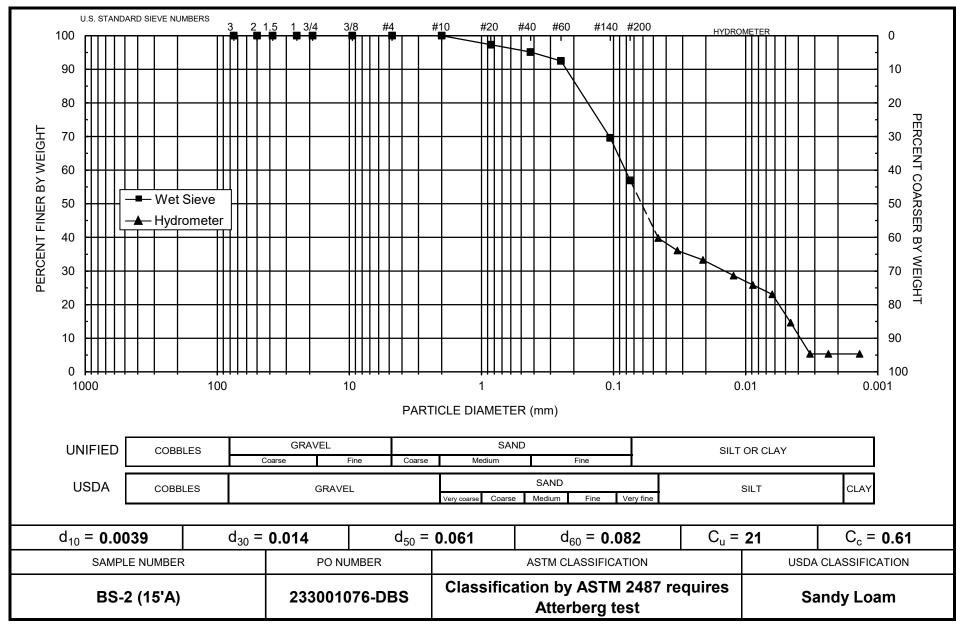
Wt. Passing #10 (g): 413.95

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
40.14		0.4.0	07.5		0.4.4	44.0	0.04500		
16-May-18	1	21.6	27.5	6.1	21.4	11.8	0.04588	39.8	39.8
	2	21.6	25.5	6.1	19.4	12.1	0.03289	36.1	36.1
	5	21.6	24.0	6.1	17.9	12.4	0.02101	33.3	33.3
	15	21.6	21.5	6.1	15.4	12.8	0.01233	28.6	28.6
	30	21.6	20.0	6.1	13.9	13.0	0.00880	25.8	25.8
	60	21.6	18.5	6.1	12.4	13.3	0.00628	23.0	23.0
	120	21.6	14.0	6.1	7.9	14.0	0.00456	14.6	14.6
	250	21.6	9.0	6.1	2.9	14.8	0.00325	5.3	5.3
	475	21.6	9.0	6.1	2.9	14.8	0.00236	5.3	5.3
17-May-18	1409	21.6	9.0	6.1	2.9	14.8	0.00137	5.3	5.3

#### Comments:

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device







# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 371.11

Job Number: DB18.1151.00 Weight Passing #10 (g): 371.11
Sample Number: BS-6 (20'A) Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 56.55

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 56.55

Test Date: 18-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	371.11	100.00
	2"	50	0.00	0.00	371.11	100.00
	1.5"	38.1	0.00	0.00	371.11	100.00
	1"	25	0.00	0.00	371.11	100.00
	3/4"	19.0	0.00	0.00	371.11	100.00
	3/8"	9.5	0.00	0.00	371.11	100.00
	4	4.75	0.00	0.00	371.11	100.00
	10	2.00	0.00	0.00	371.11	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.01	0.01	56.54	99.98
	40	0.425	0.02	0.03	56.52	99.95
	60	0.250	0.06	0.09	56.46	99.84
	140	0.106	6.93	7.02	49.53	87.59
	200	0.075	7.85	14.87	41.68	73.70
	dry pan		0.92	15.79	40.76	
	wet pan			40.76	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00018 & d_{50} \ (mm): \ 0.054 \\ d_{16} \ (mm): \ 0.0011 & d_{60} \ (mm): \ 0.062 \\ d_{30} \ (mm): \ 0.022 & d_{84} \ (mm): \ 0.097 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.054

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 344

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 43

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.051

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: E. Bastien
Data entered by: M. Garcia
Checked by: J. Hines



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: BS-6 (20'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18 Initial Wt. (g): 56.55

Test Date: 16-May-18 Total Sample Wt. (g): 371.11

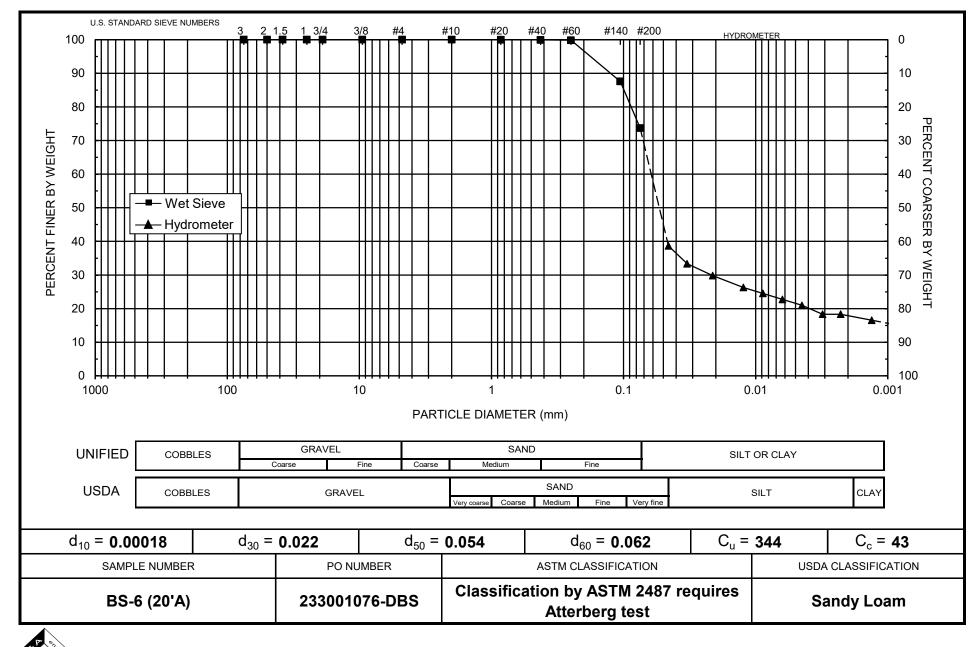
Start Time: 9:12 Wt. Passing #10 (g): 371.11

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
16-May-18	1	21.6	28.0	6.1	21.9	11.7	0.04572	38.7	38.7
	2	21.6	25.0	6.1	18.9	12.2	0.03300	33.4	33.4
	5	21.6	23.0	6.1	16.9	12.5	0.02115	29.8	29.8
	15	21.6	21.0	6.1	14.9	12.9	0.01237	26.3	26.3
	30	21.6	20.0	6.1	13.9	13.0	0.00880	24.5	24.5
	60	21.6	19.0	6.1	12.9	13.2	0.00626	22.7	22.7
	120	21.6	18.0	6.1	11.9	13.3	0.00446	21.0	21.0
	250	21.6	16.5	6.1	10.4	13.6	0.00312	18.3	18.3
	470	21.6	16.5	6.1	10.4	13.6	0.00227	18.3	18.3
17-May-18	1404	21.6	15.5	6.1	9.4	13.8	0.00132	16.6	16.6

#### Comments:

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 512.99

Weight Passing #10 (g): 510.37

Job Number: DB18.1151.00 Sample Number: TS-1 (20'A)

Weight Retained #10 (g): 2.62

Project Name: St. Anthony Geotech Investigation

Weight of Hydrometer Sample (g): 56.02

PO Number: 233001076-DBS

Calculated Weight of Sieve Sample (g): 56.31

Test Date: 24-May-18

Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10	Hambon	(11111)	rtotairiod	rtotamou	r dooning	70 1 decing
+10	3"	75	0.00	0.00	512.99	100.00
	2"	50	0.00	0.00	512.99	100.00
	1.5"	38.1	0.00	0.00	512.99	100.00
	1"	25	0.00	0.00	512.99	100.00
	3/4"	19.0	0.00	0.00	512.99	100.00
	3/8"	9.5	0.00	0.00	512.99	100.00
	4	4.75	0.00	0.00	512.99	100.00
	10	2.00	2.62	2.62	510.37	99.49
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.88	1.17	55.14	97.93
	40	0.425	0.47	1.64	54.67	97.09
	60	0.250	0.33	1.97	54.34	96.51
	140	0.106	1.86	3.83	52.48	93.20
	200	0.075	6.41	10.24	46.07	81.82
	dry pan		1.03	11.27	45.04	
	wet pan			45.04	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.0010 & d_{50} \ (mm): \ 0.035 \\ d_{16} \ (mm): \ 0.0019 & d_{60} \ (mm): \ 0.048 \\ d_{30} \ (mm): \ 0.0098 & d_{84} \ (mm): \ 0.080 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.035

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 48

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 2.0

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.039

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam

Laboratory analysis by: Z. Calhoun/M. Garcia

Data entered by: M. Garcia Checked by: J. Hines



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: TS-1 (20'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 18-May-18

Total Sample Wt. (g): 56.02

Test Date: 18-May-18

Total Sample Wt. (g): 512.99

Start Time: 9:48

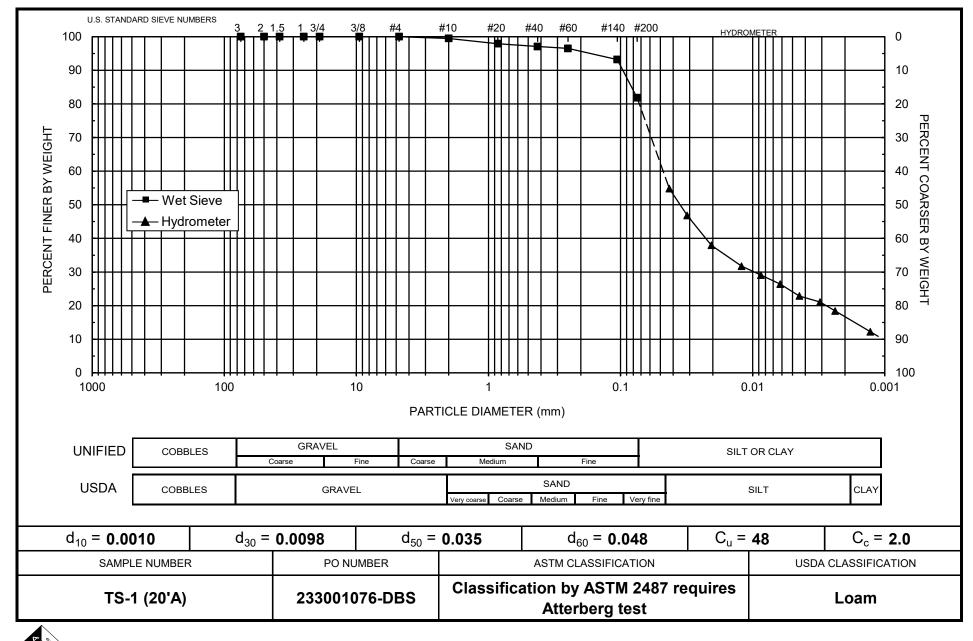
Wt. Passing #10 (g): 510.37

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
18-May-18	1	21.6	37.0	6.1	30.9	10.2	0.04274	55.1	54.8
	2	21.6	32.5	6.1	26.4	11.0	0.03129	47.1	46.8
	5	21.6	27.5	6.1	21.4	11.8	0.02052	38.1	37.9
	15	21.6	24.0	6.1	17.9	12.4	0.01213	31.9	31.7
	30	21.6	22.5	6.1	16.4	12.6	0.00866	29.2	29.1
	60	21.6	21.0	6.1	14.9	12.9	0.00618	26.5	26.4
	120	21.6	19.0	6.1	12.9	13.2	0.00443	23.0	22.8
	250	21.6	18.0	6.1	11.9	13.3	0.00309	21.2	21.1
	431	21.6	16.5	6.1	10.4	13.6	0.00237	18.5	18.4
19-May-18	1529	21.7	13.0	6.1	6.9	14.2	0.00128	12.3	12.2

#### Comments:

Laboratory analysis by: M. Zbrozek
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 343.53

Job Number: DB18.1151.00 Weight Passing #10 (g): 343.53 Sample Number: TS-2 (10'A) Weight Retained #10 (g): 0.00

Weight of Hydrometer Sample (g): 57.64 Project Name: St. Anthony Geotech Investigation PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 57.64

Test Date: 18-May-18

Shape: Rounded

Hardness: Hard and durable

Test Fraction	Sieve	Diameter	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Descina
Fraction	Number	(mm)	Netairieu	Retairieu	rassing	% Passing
+10						
	3"	75	0.00	0.00	343.53	100.00
	2"	50	0.00	0.00	343.53	100.00
	1.5"	38.1	0.00	0.00	343.53	100.00
	1"	25	0.00	0.00	343.53	100.00
	3/4"	19.0	0.00	0.00	343.53	100.00
	3/8"	9.5	0.00	0.00	343.53	100.00
	4	4.75	0.00	0.00	343.53	100.00
	10	2.00	0.00	0.00	343.53	100.00
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.88	0.88	56.76	98.47
	40	0.425	0.65	1.53	56.11	97.35
	60	0.250	1.09	2.62	55.02	95.45
	140	0.106	23.08	25.70	31.94	55.41
	200	0.075	5.36	31.06	26.58	46.11
	dry pan		0.22	31.28	26.36	
	wet pan			26.36	0.00	

d<sub>10</sub> (mm): 0.0019 d<sub>50</sub> (mm): 0.087 d<sub>16</sub> (mm): 0.0027 d<sub>60</sub> (mm): 0.12 d<sub>30</sub> (mm): 0.026 d<sub>84</sub> (mm): 0.20

Median Particle Diameter -- d<sub>50</sub> (mm): 0.087 Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 63 Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 3.0 Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.097

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: E. Bastien Data entered by: M. Garcia Checked by: J. Hines



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: TS-2 (10'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18

Start Time: 9:48

Initial Wt. (g): 57.64

Total Sample Wt. (g): 343.53

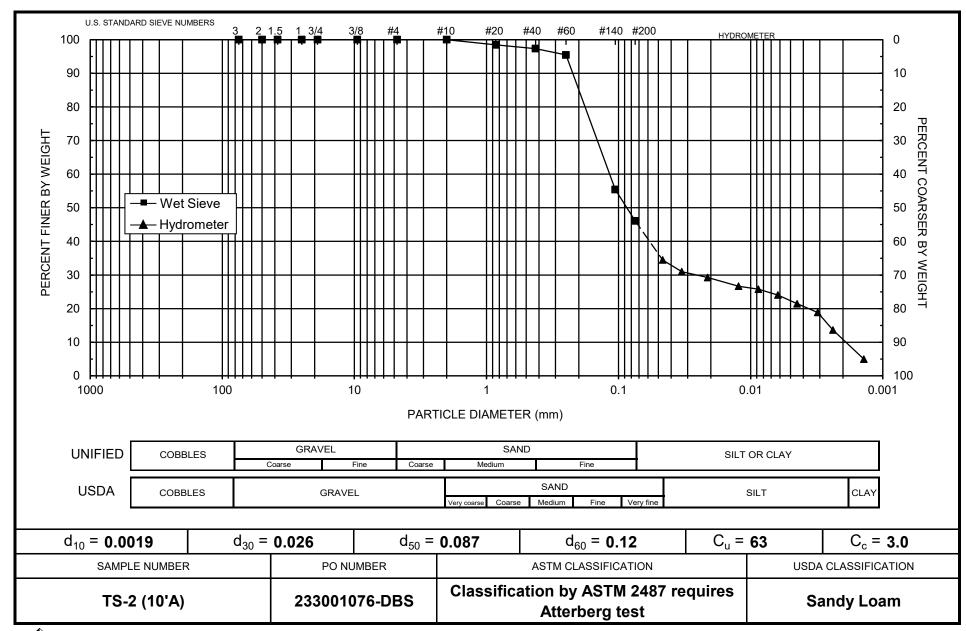
Wt. Passing #10 (g): 343.53

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
16-May-18	1	21.6	26.0	6.1	19.9	12.0	0.04636	34.5	34.5
	2	21.6	24.0	6.1	17.9	12.4	0.03322	31.0	31.0
	5	21.6	23.0	6.1	16.9	12.5	0.02115	29.3	29.3
	15	21.6	21.5	6.1	15.4	12.8	0.01233	26.6	26.6
	30	21.6	21.0	6.1	14.9	12.9	0.00875	25.8	25.8
	60	21.6	20.0	6.1	13.9	13.0	0.00622	24.0	24.0
	120	21.6	18.5	6.1	12.4	13.3	0.00444	21.4	21.4
	250	21.6	17.0	6.1	10.9	13.5	0.00311	18.8	18.8
	440	21.6	14.0	6.1	7.9	14.0	0.00238	13.6	13.6
17-May-18	1372	21.6	9.0	6.1	2.9	14.8	0.00139	5.0	5.0

#### Comments:

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device







# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 470.01

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 469.83

 Sample Number:
 TS-3 (10'A)
 Weight Retained #10 (g): 0.18

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 57.40

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 57.42

Test Date: 18-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		, ,				<u> </u>
	3"	75	0.00	0.00	470.01	100.00
	2"	50	0.00	0.00	470.01	100.00
	1.5"	38.1	0.00	0.00	470.01	100.00
	1"	25	0.00	0.00	470.01	100.00
	3/4"	19.0	0.00	0.00	470.01	100.00
	3/8"	9.5	0.00	0.00	470.01	100.00
	4	4.75	0.00	0.00	470.01	100.00
	10	2.00	0.18	0.18	469.83	99.96
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.40	0.42	57.00	99.27
	40	0.425	0.43	0.85	56.57	98.52
	60	0.250	0.30	1.15	56.27	97.99
	140	0.106	1.19	2.34	55.08	95.92
	200	0.075	6.92	9.26	48.16	83.87
	dry pan		1.73	10.99	46.43	
	wet pan			46.43	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00086 & d_{50} \ (mm): \ 0.043 \\ d_{16} \ (mm): \ 0.0023 & d_{60} \ (mm): \ 0.051 \\ d_{30} \ (mm): \ 0.013 & d_{84} \ (mm): \ 0.075 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.043

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 59

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 3.9

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.040

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam

Laboratory analysis by: E. Bastien/Z. Calhoun

Data entered by: M. Garcia Checked by: J. Hines



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: TS-3 (10'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18

Total Sample Wt. (g): 57.40

Total Sample Wt. (g): 470.01

Start Time: 9:54

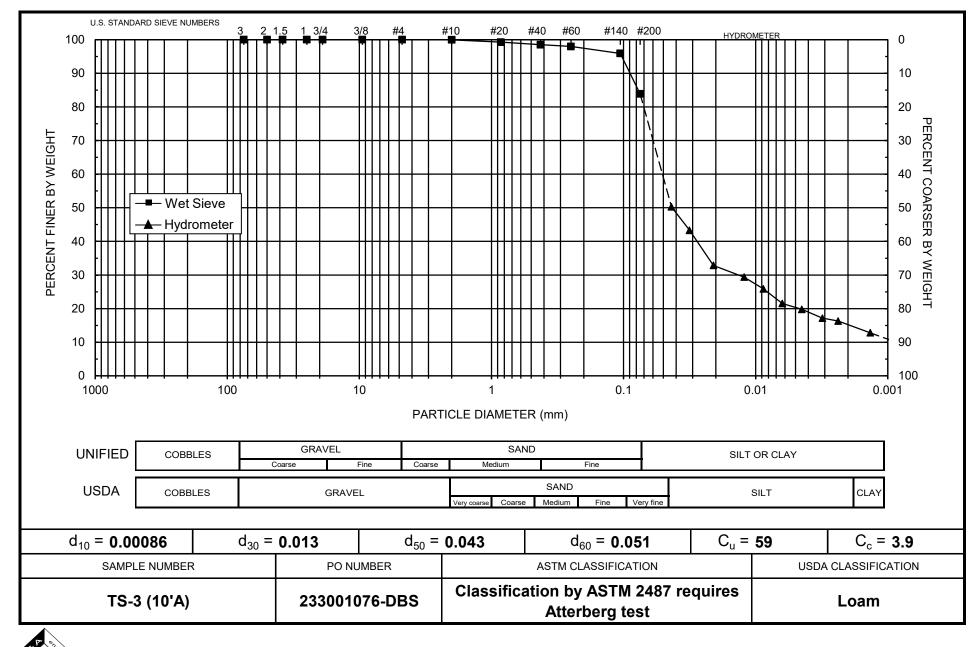
Wt. Passing #10 (g): 469.83

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
16-May-18	1	21.6	35.0	6.1	28.9	10.6	0.04342	50.3	50.3
	2	21.6	31.0	6.1	24.9	11.2	0.03164	43.3	43.3
	5	21.6	25.0	6.1	18.9	12.2	0.02087	32.9	32.8
	15	21.6	23.0	6.1	16.9	12.5	0.01221	29.4	29.4
	30	21.6	21.0	6.1	14.9	12.9	0.00875	25.9	25.9
	60	21.6	18.5	6.1	12.4	13.3	0.00628	21.5	21.5
	120	21.6	17.5	6.1	11.4	13.4	0.00447	19.8	19.8
	250	21.6	16.0	6.1	9.9	13.7	0.00313	17.2	17.2
	435	21.6	15.5	6.1	9.4	13.8	0.00238	16.3	16.3
17-May-18	1367	21.6	13.5	6.1	7.4	14.1	0.00136	12.8	12.8

#### Comments:

Laboratory analysis by: A. Bland
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device





# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 536.95

Job Number: DB18.1151.00 Weight Passing #10 (g): 522.77
Sample Number: TS-4 (5'A) Weight Retained #10 (g): 14.18
Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 52.41

PO Number: 233001076-DBS Weight of Sieve Sample (g): 53.83

Test Date: 24-May-18 Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10					_	
	3"	75	0.00	0.00	536.95	100.00
	2"	50	0.00	0.00	536.95	100.00
	1.5"	38.1	0.00	0.00	536.95	100.00
	1"	25	0.00	0.00	536.95	100.00
	3/4"	19.0	0.00	0.00	536.95	100.00
	3/8"	9.5	0.00	0.00	536.95	100.00
	4	4.75	3.53	3.53	533.42	99.34
	10	2.00	10.65	14.18	522.77	97.36
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.64	2.06	51.77	96.17
	40	0.425	0.53	2.59	51.24	95.19
	60	0.250	0.87	3.46	50.37	93.57
	140	0.106	24.08	27.54	26.29	48.84
	200	0.075	6.80	34.34	19.49	36.21
	dry pan		0.49	34.83	19.00	
	wet pan			19.00	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.0011 & d_{50} \ (mm): \ 0.11 \\ d_{16} \ (mm): \ 0.0038 & d_{60} \ (mm): \ 0.13 \\ d_{30} \ (mm): \ 0.054 & d_{84} \ (mm): \ 0.21 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.11

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): 118

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 20

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.11

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: Z. Calhoun/M. Garcia

Data entered by: M. Garcia Checked by: J. Hines



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: TS-4 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 18-May-18

Start Time: 9:54

Initial Wt. (g): 52.41

Total Sample Wt. (g): 536.95

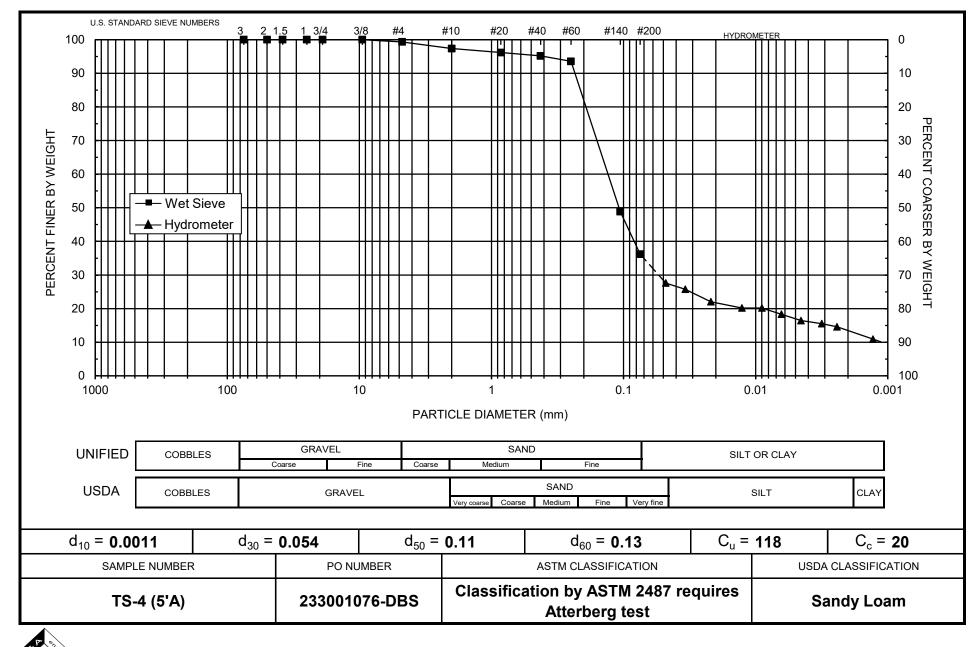
Wt. Passing #10 (g): 522.77

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
18-May-18	1	21.6	21.0	6.1	14.9	12.9	0.04791	28.4	27.6
	2	21.6	20.0	6.1	13.9	13.0	0.03409	26.4	25.7
	5	21.6	18.0	6.1	11.9	13.3	0.02183	22.6	22.0
	15	21.6	17.0	6.1	10.9	13.5	0.01268	20.7	20.2
	30	21.6	17.0	6.1	10.9	13.5	0.00897	20.7	20.2
	60	21.6	16.0	6.1	9.9	13.7	0.00638	18.8	18.3
	120	21.6	15.0	6.1	8.9	13.8	0.00454	16.9	16.5
	250	21.6	14.5	6.1	8.4	13.9	0.00315	16.0	15.5
	426	21.6	14.0	6.1	7.9	14.0	0.00242	15.0	14.6
19-May-18	1524	21.7	12.0	6.1	5.9	14.3	0.00129	11.2	10.9

#### Comments:

Laboratory analysis by: M. Zbrozek
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc

Initial Dry Weight of Sample (g): 323.18

Job Number: DB18.1151.00

Test Date: 21-May-18

Weight Passing #10 (g): 254.78

Sample Number: P1-1 (5'A)

Weight Retained #10 (g): 68.40

Project Name: St. Anthony Geotech Investigation

Weight of Hydrometer Sample (g): 68.64 Calculated Weight of Sieve Sample (g): 87.07

PO Number: 233001076-DBS

Shape: Angular

Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		()	7 (3 (3.11 ) 3 (3.11			70 : 2.55g
10	3"	75	0.00	0.00	323.18	100.00
	2"	50	0.00	0.00	323.18	100.00
	1.5"	38.1	0.00	0.00	323.18	100.00
	1"	25	0.00	0.00	323.18	100.00
	3/4"	19.0	15.05	15.05	308.13	95.34
	3/8"	9.5	35.95	51.00	272.18	84.22
	4	4.75	9.84	60.84	262.34	81.17
	10	2.00	7.56	68.40	254.78	78.84
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	1.63	20.06	67.01	76.96
	40	0.425	0.95	21.01	66.06	75.87
	60	0.250	1.17	22.18	64.89	74.53
	140	0.106	27.03	49.21	37.86	43.48
	200	0.075	10.55	59.76	27.31	31.37
	dry pan		0.88	60.64	26.43	
	wet pan			26.43	0.00	

 $d_{10}$  (mm): 0.0012  $d_{50}$  (mm): 0.13  $d_{16}$  (mm): 0.013  $d_{60}$  (mm): 0.17  $d_{30}$  (mm): 0.069  $d_{84}$  (mm): 9.0

Median Particle Diameter -- d<sub>50</sub> (mm): 0.13

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): 142

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 23

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 3.0

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam †

<sup>†</sup> Greater than 10% of sample is coarse material

Laboratory analysis by: M. Garcia Data entered by: M. Garcia Checked by: J. Hines



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P1-1 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

 Test Date:
 17-May-18
 Total Sample Wt. (g):
 323.18

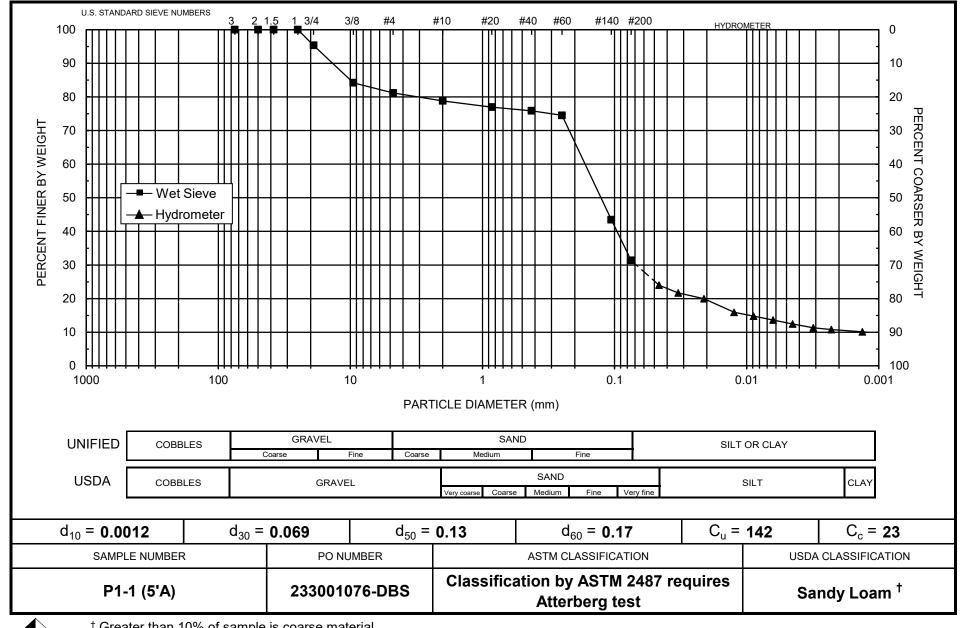
 Start Time:
 9:00
 Wt. Passing #10 (g):
 254.78

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
17-May-18	1	21.7	27.0	6.1	20.9	11.9	0.04598	30.4	24.0
	2	21.7	25.0	6.1	18.9	12.2	0.03296	27.5	21.7
	5	21.7	23.5	6.1	17.4	12.4	0.02106	25.3	20.0
	15	21.6	20.0	6.1	13.9	13.0	0.01245	20.2	15.9
	30	21.6	19.0	6.1	12.9	13.2	0.00886	18.7	14.8
	60	21.6	18.0	6.1	11.9	13.3	0.00630	17.3	13.6
	120	21.5	17.0	6.2	10.8	13.5	0.00449	15.8	12.4
	250	21.6	16.0	6.2	9.8	13.7	0.00313	14.3	11.3
	471	21.7	15.5	6.1	9.4	13.8	0.00228	13.7	10.8
18-May-18	1404	21.4	15.0	6.2	8.8	13.8	0.00133	12.8	10.1

#### Comments:

Laboratory analysis by: M. Zbrozek
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device



<sup>†</sup> Greater than 10% of sample is coarse material

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and ASTM classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

Daniel B. Stephens & Associates, Inc.



## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 268.32

Weight Passing #10 (g): 210.98

Job Number: DB18.1151.00 Sample Number: P1-2 (30'B)

Weight Retained #10 (g): 57.34

Project Name: St. Anthony Geotech Investigation

Weight of Hydrometer Sample (g): 57.55

PO Number: 233001076-DBS

Calculated Weight of Sieve Sample (g): 73.19

Test Date: 21-May-18

Shape: Rounded

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	268.32	100.00
	2"	50	0.00	0.00	268.32	100.00
	1.5"	38.1	0.00	0.00	268.32	100.00
	1"	25	0.00	0.00	268.32	100.00
	3/4"	19.0	31.23	31.23	237.09	88.36
	3/8"	9.5	17.38	48.61	219.71	81.88
	4	4.75	5.97	54.58	213.74	79.66
	10	2.00	2.76	57.34	210.98	78.63
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	1.55	17.19	56.00	76.51
	40	0.425	1.00	18.19	55.00	75.15
	60	0.250	1.18	19.37	53.82	73.53
	140	0.106	18.74	38.11	35.08	47.93
	200	0.075	8.23	46.34	26.85	36.68
	dry pan		0.54	46.88	26.31	
	wet pan			26.31	0.00	

 $d_{10}$  (mm): 0.0010  $d_{50}$  (mm): 0.11  $d_{16}$  (mm): 0.0071  $d_{60}$  (mm): 0.16  $d_{30}$  (mm): 0.058  $d_{84}$  (mm): 12

Median Particle Diameter -- d<sub>50</sub> (mm): 0.11

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 160

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 21

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 4.0

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam †

<sup>†</sup> Greater than 10% of sample is coarse material

Laboratory analysis by: M. Garcia
Data entered by: M. Garcia
Checked by: J. Hines



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P1-2 (30'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 17-May-18

Start Time: 9:06

Initial Wt. (g): 57.55

Total Sample Wt. (g): 268.32

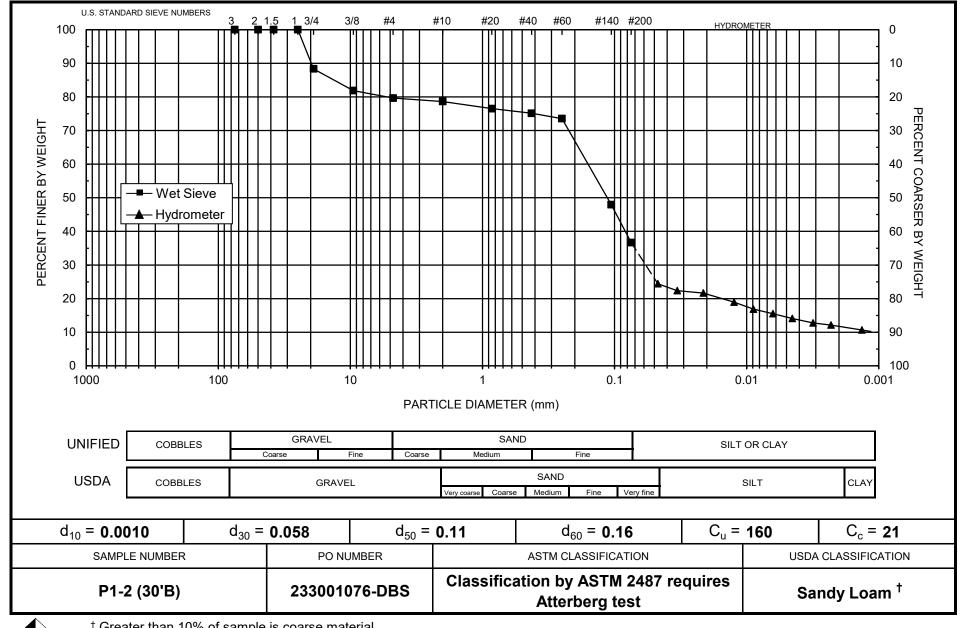
Wt. Passing #10 (g): 210.98

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
	_								
17-May-18	1	21.7	24.0	6.1	17.9	12.4	0.04696	31.1	24.4
	2	21.7	22.5	6.1	16.4	12.6	0.03353	28.4	22.4
	5	21.6	22.0	6.1	15.9	12.7	0.02129	27.6	21.7
	15	21.6	20.0	6.1	13.9	13.0	0.01245	24.1	18.9
	30	21.6	18.5	6.1	12.4	13.3	0.00889	21.5	16.9
	60	21.6	17.5	6.1	11.4	13.4	0.00632	19.7	15.5
	120	21.5	16.5	6.2	10.3	13.6	0.00451	17.9	14.1
	250	21.6	15.5	6.2	9.3	13.8	0.00314	16.2	12.8
	466	21.7	15.0	6.1	8.9	13.8	0.00230	15.4	12.1
18-May-18	1399	21.4	14.0	6.2	7.8	14.0	0.00134	13.6	10.7

#### Comments:

Laboratory analysis by: M. Zbrozek
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device



<sup>†</sup> Greater than 10% of sample is coarse material

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and ASTM classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

Daniel B. Stephens & Associates, Inc.



# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 487.96

Job Number: DB18.1151.00 Weight Passing #10 (g): 485.94 Sample Number: P2-1 (25'A) Weight Retained #10 (g): 2.02

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 59.29

PO Number: 233001076-DBS Weight of Sieve Sample (g): 59.29

Calculated Weight of Sieve Sample (g): 59.54

Test Date: 21-May-18 Shape: Rounded

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10	T CATTLE CT	(11111)	rtotairiou	rtotamou	r deening	70 1 dooning
+10	3"	75	0.00	0.00	487.96	100.00
	2"	50	0.00	0.00	487.96	100.00
	1.5"	38.1	0.00	0.00	487.96	100.00
	1"	25	0.00	0.00	487.96	100.00
	3/4"	19.0	0.00	0.00	487.96	100.00
	3/8"	9.5	0.00	0.00	487.96	100.00
	4	4.75	1.27	1.27	486.69	99.74
	10	2.00	0.75	2.02	485.94	99.59
-10			(Based on calcu	ulated sieve wt.	)	
	20	0.85	` 1.48	1.73	57.81	97.10
	40	0.425	1.24	2.97	56.57	95.02
	60	0.250	1.60	4.57	54.97	92.33
	140	0.106	22.04	26.61	32.93	55.31
	200	0.075	5.68	32.29	27.25	45.77
	dry pan		0.42	32.71	26.83	
	wet pan			26.83	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00071 & d_{50} \ (mm): \ 0.087 \\ d_{16} \ (mm): \ 0.0025 & d_{60} \ (mm): \ 0.12 \\ d_{30} \ (mm): \ 0.030 & d_{84} \ (mm): \ 0.21 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.087

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 169

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 11

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.100

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: M. Garcia Data entered by: M. Garcia Checked by: J. Hines



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P2-1 (25'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 17-May-18

Total Sample Wt. (g): 59.29

Test Date: 9:12

Total Sample Wt. (g): 487.96

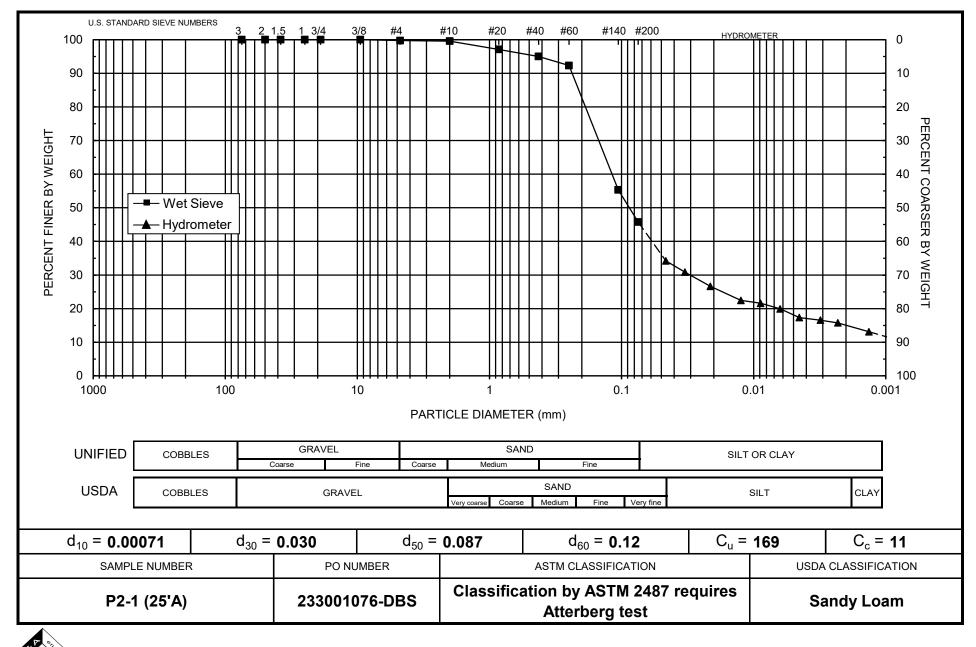
Wt. Passing #10 (g): 485.94

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
17-May-18	1	21.6	26.5	6.1	20.4	12.0	0.04620	34.3	34.2
	2	21.6	24.5	6.1	18.4	12.3	0.03311	31.0	30.8
	5	21.6	22.0	6.1	15.9	12.7	0.02129	26.7	26.6
	15	21.6	19.5	6.1	13.4	13.1	0.01249	22.5	22.4
	30	21.6	19.0	6.1	12.9	13.2	0.00886	21.7	21.6
	60	21.6	18.0	6.1	11.9	13.3	0.00630	20.0	19.9
	120	21.5	16.5	6.2	10.3	13.6	0.00451	17.4	17.3
	250	21.6	16.0	6.1	9.9	13.7	0.00313	16.6	16.6
	461	21.7	15.5	6.1	9.4	13.8	0.00231	15.8	15.8
18-May-18	1394	21.4	14.0	6.2	7.8	14.0	0.00134	13.2	13.1

#### Comments:

Laboratory analysis by: M. Zbrozek
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 509.13

Weight Passing #10 (g): 474.49

Job Number: DB18.1151.00 Sample Number: P2-2 (5'B) Weight Retained #10 (g): 34.64

Weight of Hydrometer Sample (g): 72.59 Project Name: St. Anthony Geotech Investigation PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 77.89

Test Date: 21-May-18 Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	509.13	100.00
	2"	50	0.00	0.00	509.13	100.00
	1.5"	38.1	0.00	0.00	509.13	100.00
	1"	25	0.00	0.00	509.13	100.00
	3/4"	19.0	0.00	0.00	509.13	100.00
	3/8"	9.5	18.36	18.36	490.77	96.39
	4	4.75	7.79	26.15	482.98	94.86
	10	2.00	8.49	34.64	474.49	93.20
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	1.21	6.51	71.38	91.64
	40	0.425	0.60	7.11	70.78	90.87
	60	0.250	0.63	7.74	70.15	90.06
	140	0.106	24.65	32.39	45.50	58.42
	200	0.075	13.04	45.43	32.46	41.67
	dry pan		0.72	46.15	31.74	
	wet pan			31.74	0.00	

d<sub>10</sub> (mm): 0.00078 d<sub>50</sub> (mm): 0.089 d<sub>16</sub> (mm): 0.0027 d<sub>60</sub> (mm): 0.11 d<sub>30</sub> (mm): 0.049 d<sub>84</sub> (mm): 0.21

Median Particle Diameter -- d<sub>50</sub> (mm): 0.089 Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 141

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 28

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.10

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: M. Garcia Data entered by: M. Garcia Checked by: J. Hines



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P2-2 (5'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 17-May-18

Start Time: 9:18

Initial Wt. (g): 72.59

Total Sample Wt. (g): 509.13

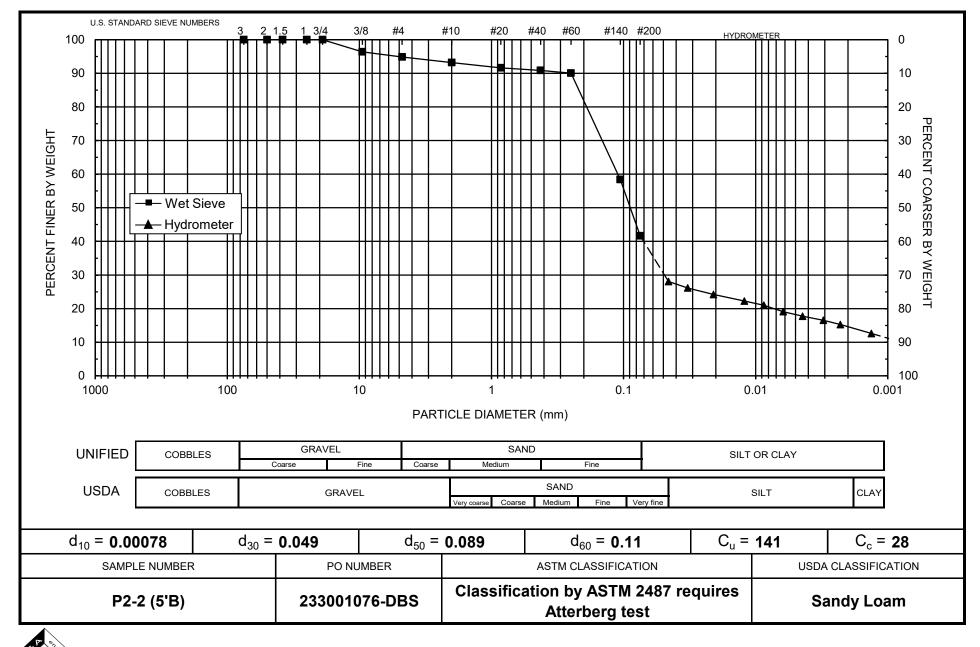
Wt. Passing #10 (g): 474.49

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
17-May-18	1	21.6	28.0	6.1	21.9	11.7	0.04572	30.1	28.1
	2	21.6	26.5	6.1	20.4	12.0	0.03267	28.0	26.1
	5	21.6	25.0	6.1	18.9	12.2	0.02087	26.0	24.2
	15	21.6	23.5	6.2	17.3	12.4	0.01218	23.9	22.3
	30	21.6	22.5	6.1	16.4	12.6	0.00866	22.5	21.0
	60	21.6	21.0	6.1	14.9	12.9	0.00618	20.5	19.1
	120	21.5	20.0	6.2	13.8	13.0	0.00441	19.0	17.7
	250	21.6	19.0	6.1	12.9	13.2	0.00307	17.7	16.5
	456	21.7	18.0	6.1	11.9	13.3	0.00228	16.4	15.3
18-May-18	1389	21.4	16.0	6.2	9.8	13.7	0.00133	13.5	12.6

#### Comments:

Laboratory analysis by: M. Zbrozek
Data entered by: M. Garcia
Checked by: J. Hines

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc

Initial Dry Weight of Sample (g): 541.45

Job Number: DB18.1151.00 Weight Passing #10 (g): 418.25 Sample Number: P3-1 (5'A) Weight Retained #10 (g): 123.20 Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 57.93

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 74.99

Test Date: 23-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		, ,			<u> </u>	<u> </u>
	3"	75	0.00	0.00	541.45	100.00
	2"	50	0.00	0.00	541.45	100.00
	1.5"	38.1	0.00	0.00	541.45	100.00
	1"	25	0.00	0.00	541.45	100.00
	3/4"	19.0	39.21	39.21	502.24	92.76
	3/8"	9.5	34.72	73.93	467.52	86.35
	4	4.75	32.76	106.69	434.76	80.30
	10	2.00	16.51	123.20	418.25	77.25
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	3.93	20.99	54.00	72.01
	40	0.425	4.22	25.21	49.78	66.38
	60	0.250	9.70	34.91	40.08	53.44
	140	0.106	24.22	59.13	15.86	21.15
	200	0.075	4.35	63.48	11.51	15.35
	dry pan		0.84	64.32	10.67	
	wet pan			10.67	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ NA & d_{50} \ (mm): \ 0.23 \\ d_{16} \ (mm): \ 0.078 & d_{60} \ (mm): \ 0.33 \\ d_{30} \ (mm): \ 0.13 & d_{84} \ (mm): \ 7.3 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.23

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

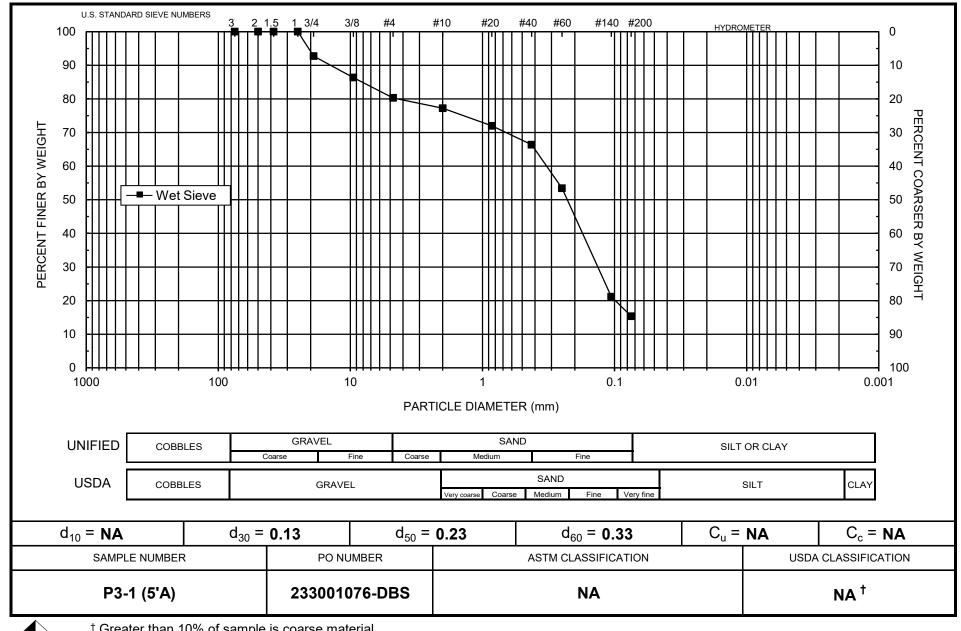
Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 2.5

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA <sup>†</sup>

<sup>†</sup> Greater than 10% of sample is coarse material

Laboratory analysis by: Z. Calhoun Data entered by: M. Garcia Checked by: J. Hines



<sup>†</sup> Greater than 10% of sample is coarse material

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and ASTM classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

Daniel B. Stephens & Associates, Inc.



## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 410.00Job Number:DB18.1151.00Weight Passing #10 (g): 410.00

Sample Number: P3-2 (15'B) Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 58.51

PO Number: 233001076-DBS

Calculated Weight of Sieve Sample (g): 58.51

Test Date: 23-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	410.00	100.00
	2"	50	0.00	0.00	410.00	100.00
	1.5"	38.1	0.00	0.00	410.00	100.00
	1"	25	0.00	0.00	410.00	100.00
	3/4"	19.0	0.00	0.00	410.00	100.00
	3/8"	9.5	0.00	0.00	410.00	100.00
	4	4.75	0.00	0.00	410.00	100.00
	10	2.00	0.00	0.00	410.00	100.00
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	0.89	0.89	57.62	98.48
	40	0.425	4.90	5.79	52.72	90.10
	60	0.250	17.46	23.25	35.26	60.26
	140	0.106	21.30	44.55	13.96	23.86
	200	0.075	1.58	46.13	12.38	21.16
	dry pan		0.24	46.37	12.14	
	wet pan			12.14	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): 0.20  $d_{16}$  (mm): NA  $d_{60}$  (mm): 0.25  $d_{30}$  (mm): 0.12  $d_{84}$  (mm): 0.38

Median Particle Diameter -- d<sub>50</sub> (mm): 0.20

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

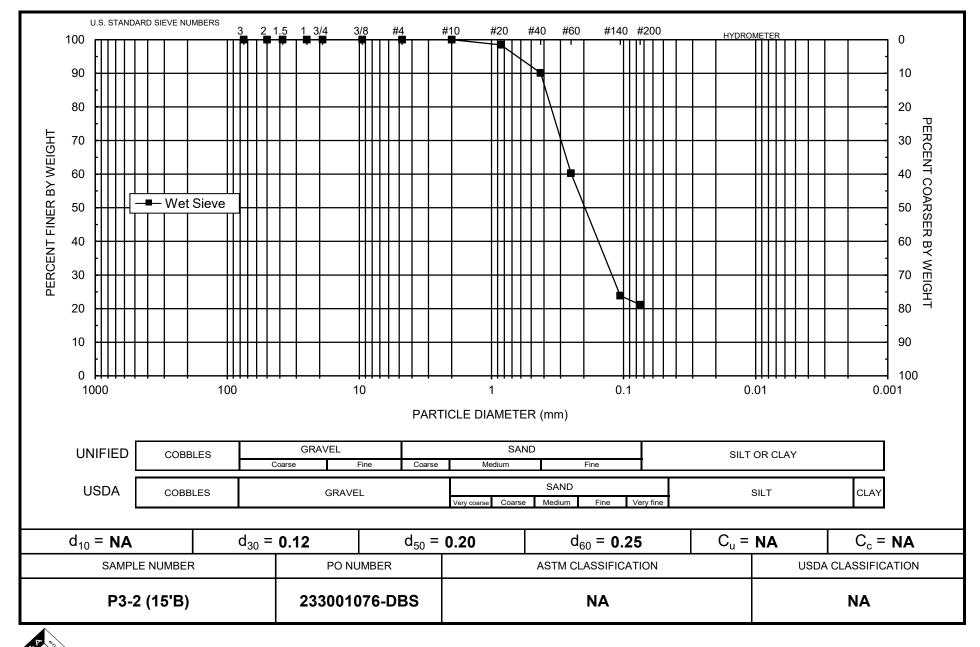
Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA

Laboratory analysis by: Z. Calhoun

Data entered by: M. Garcia

Checked by: J. Hines





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Initial Dry Weight of Sample (g): 426.94

Weight Passing #10 (g): 422.32

Sample Number: P3-2 (35'B)

Project Name: St. Anthony Geotech Investigation

Weight Retained #10 (g): 4.62

Wt. of -10 Sieve Sample (g): 58.70

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 59.34

Test Date: 23-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						_
	3"	75	0.00	0.00	426.94	100.00
	2"	50	0.00	0.00	426.94	100.00
	1.5"	38.1	0.00	0.00	426.94	100.00
	1"	25	0.00	0.00	426.94	100.00
	3/4"	19.0	0.00	0.00	426.94	100.00
	3/8"	9.5	4.62	4.62	422.32	98.92
	4	4.75	0.00	4.62	422.32	98.92
	10	2.00	0.00	4.62	422.32	98.92
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	1.10	1.74	57.60	97.06
	40	0.425	2.97	4.71	54.63	92.06
	60	0.250	11.98	16.69	42.65	71.87
	140	0.106	22.65	39.34	20.00	33.70
	200	0.075	1.76	41.10	18.24	30.74
	dry pan		0.27	41.37	17.97	
	wet pan			17.97	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ NA & d_{50} \ (mm): \ 0.15 \\ d_{16} \ (mm): \ NA & d_{60} \ (mm): \ 0.19 \\ d_{30} \ (mm): \ NA & d_{84} \ (mm): \ 0.34 \\ \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.15

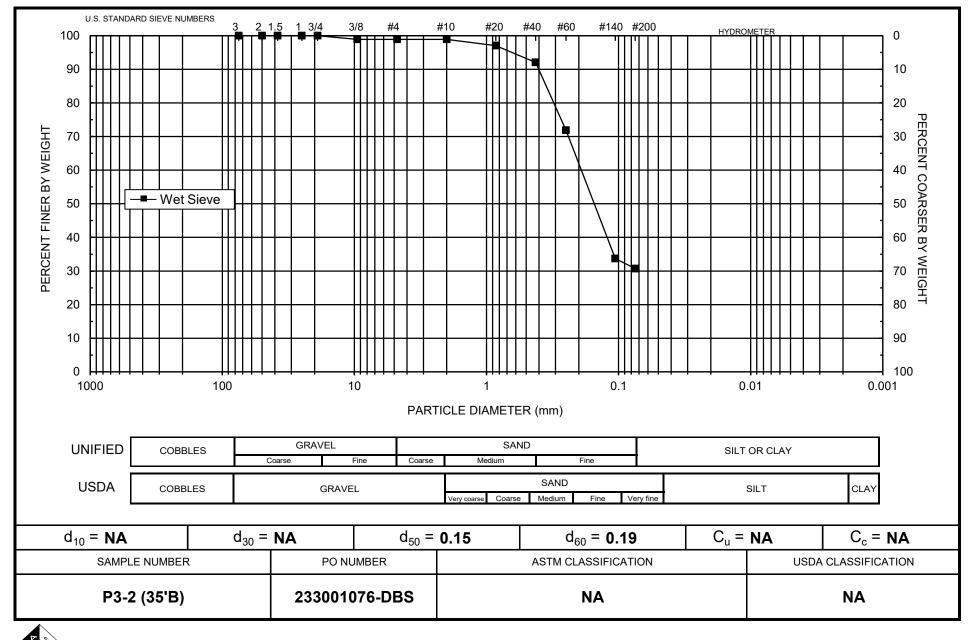
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 492.77

Job Number: DB18.1151.00 Weight Passing #10 (g): 489.86 Sample Number: P3-3 (5'A) Weight Retained #10 (g): 2.91 Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 65.64

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 66.03

Test Date: 23-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
Fraction	Number	(111111)	Retailled	Netairieu	rassing	70 Fassing
+10						
	3"	75	0.00	0.00	492.77	100.00
	2"	50	0.00	0.00	492.77	100.00
	1.5"	38.1	0.00	0.00	492.77	100.00
	1"	25	0.00	0.00	492.77	100.00
	3/4"	19.0	0.00	0.00	492.77	100.00
	3/8"	9.5	0.00	0.00	492.77	100.00
	4	4.75	1.58	1.58	491.19	99.68
	10	2.00	1.33	2.91	489.86	99.41
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	0.69	1.08	64.95	98.36
	40	0.425	3.51	4.59	61.44	93.05
	60	0.250	13.49	18.08	47.95	72.62
	140	0.106	24.20	42.28	23.75	35.97
	200	0.075	2.66	44.94	21.09	31.94
	dry pan		0.39	45.33	20.70	
	wet pan			20.70	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ NA & d_{50} \ (mm): \ 0.15 \\ d_{16} \ (mm): \ NA & d_{60} \ (mm): \ 0.19 \\ d_{30} \ (mm): \ NA & d_{84} \ (mm): \ 0.34 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.15

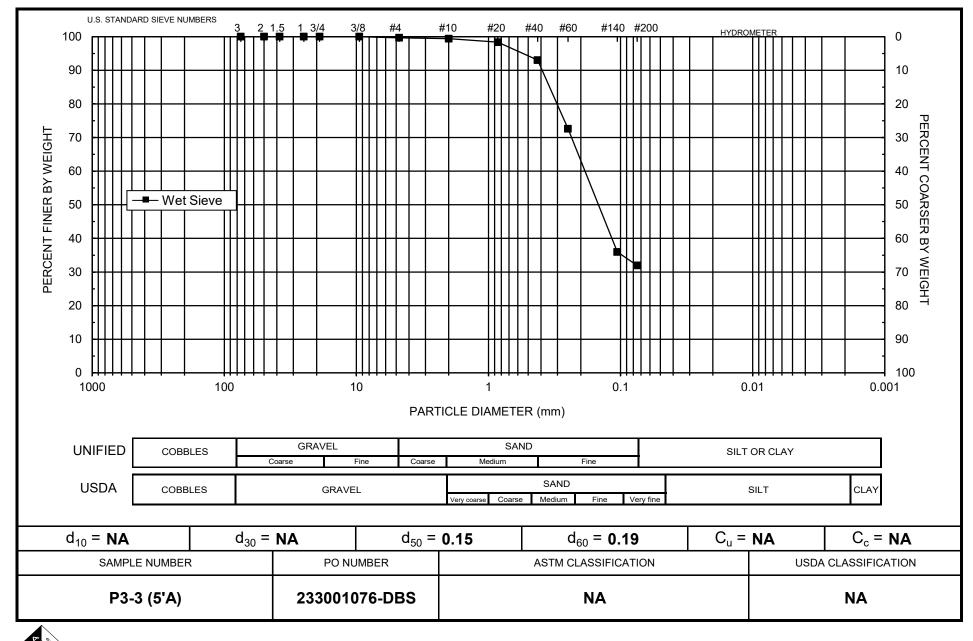
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 501.86Job Number:DB18.1151.00Weight Passing #10 (g): 478.89Sample Number:P3-3 (40'B)Weight Retained #10 (g): 22.97

Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Weight Retained #16 (g): 52.67

Wt. of -10 Sieve Sample (g): 53.69

Calculated Weight of Sieve Sample (g): 56.27

Test Date: 23-May-18 Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		, ,			<u> </u>	<u> </u>
	3"	75	0.00	0.00	501.86	100.00
	2"	50	0.00	0.00	501.86	100.00
	1.5"	38.1	0.00	0.00	501.86	100.00
	1"	25	0.00	0.00	501.86	100.00
	3/4"	19.0	0.00	0.00	501.86	100.00
	3/8"	9.5	0.00	0.00	501.86	100.00
	4	4.75	7.07	7.07	494.79	98.59
	10	2.00	15.90	22.97	478.89	95.42
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	1.13	3.71	52.56	93.41
	40	0.425	0.97	4.68	51.59	91.69
	60	0.250	1.37	6.05	50.22	89.26
	140	0.106	14.16	20.21	36.06	64.09
	200	0.075	12.28	32.49	23.78	42.26
	dry pan		1.47	33.96	22.31	
	wet pan			22.31	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): 0.085  $d_{16}$  (mm): NA  $d_{60}$  (mm): 0.099  $d_{30}$  (mm): NA  $d_{84}$  (mm): 0.21

Median Particle Diameter -- d<sub>50</sub> (mm): 0.085

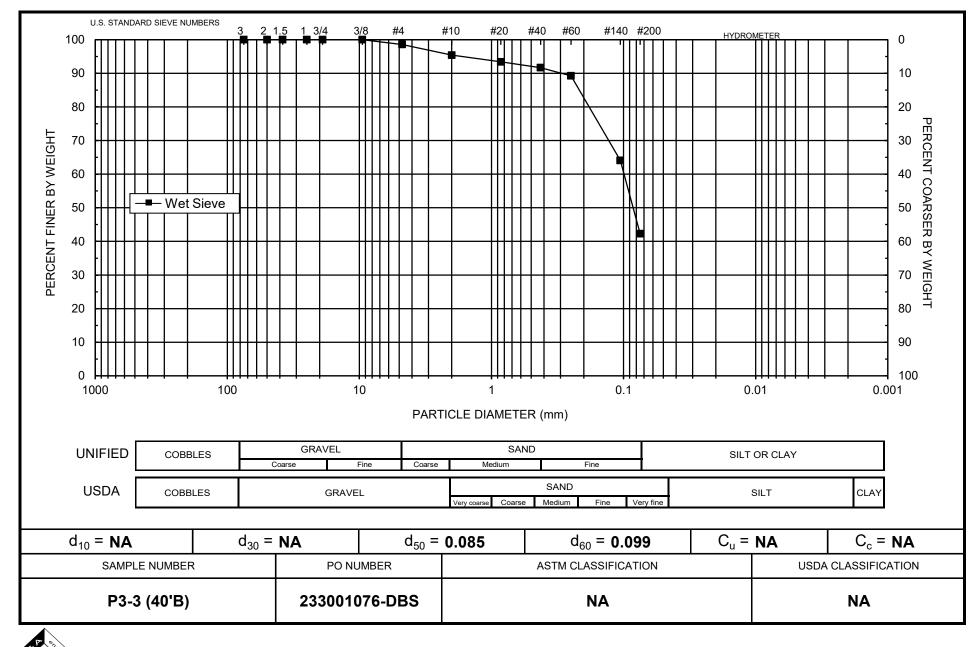
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





## **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 489.96 Job Number: DB18.1151.00 Weight Passing #10 (g): 489.74

Sample Number: P3-4 (20'A) Weight Retained #10 (g): 0.22 Wt. of -10 Sieve Sample (g): 64.28 Project Name: St. Anthony Geotech Investigation PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 64.31

Shape: Rounded Test Date: 23-May-18

Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	489.96	100.00
	2"	50	0.00	0.00	489.96	100.00
	1.5"	38.1	0.00	0.00	489.96	100.00
	1"	25	0.00	0.00	489.96	100.00
	3/4"	19.0	0.00	0.00	489.96	100.00
	3/8"	9.5	0.00	0.00	489.96	100.00
	4	4.75	0.19	0.19	489.77	99.96
	10	2.00	0.03	0.22	489.74	99.96
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	0.69	0.72	63.59	98.88
	40	0.425	3.81	4.53	59.78	92.96
	60	0.250	28.17	32.70	31.61	49.15
	140	0.106	26.15	58.85	5.46	8.49
	200	0.075	0.78	59.63	4.68	7.28
	dry pan		0.18	59.81	4.50	
	wet pan			4.50	0.00	

d<sub>10</sub> (mm): 0.11 d<sub>50</sub> (mm): 0.25 d<sub>16</sub> (mm): 0.12 d<sub>60</sub> (mm): 0.29 d<sub>30</sub> (mm): 0.17 d<sub>84</sub> (mm): 0.38

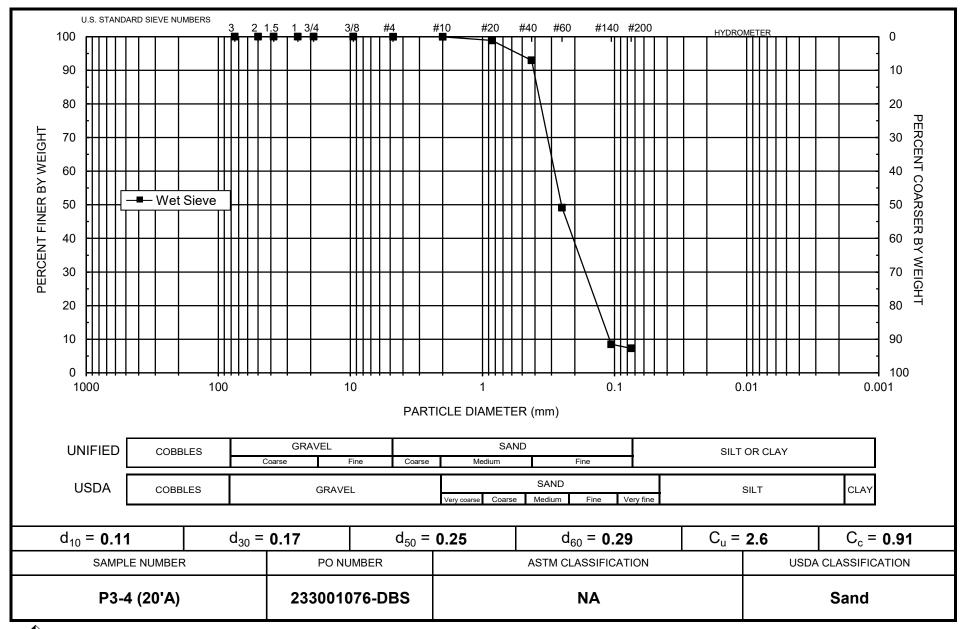
Median Particle Diameter -- d<sub>50</sub> (mm): 0.25

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 2.6

Coefficient of Curvature,  $Cc - [(d_{30})^2/(d_{10}*d_{60})]$  (mm): 0.91

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.25

ASTM Soil Classification: NA USDA Soil Classification: Sand







PO Number: 233001076-DBS

## **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 437.63 Job Number: DB18.1151.00 Weight Passing #10 (g): 437.63

Sample Number: P3-4 (30'A) Weight Retained #10 (g): 0.00 Wt. of -10 Sieve Sample (g): 76.13 Project Name: St. Anthony Geotech Investigation

Test Date: 23-May-18 Shape: Angular

Hardness: Soft

Calculated Weight of Sieve Sample (g): 76.13

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		()				
	3"	75	0.00	0.00	437.63	100.00
	2"	50	0.00	0.00	437.63	100.00
	1.5"	38.1	0.00	0.00	437.63	100.00
	1"	25	0.00	0.00	437.63	100.00
	3/4"	19.0	0.00	0.00	437.63	100.00
	3/8"	9.5	0.00	0.00	437.63	100.00
	4	4.75	0.00	0.00	437.63	100.00
	10	2.00	0.00	0.00	437.63	100.00
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	0.90	0.90	75.23	98.82
	40	0.425	3.21	4.11	72.02	94.60
	60	0.250	19.75	23.86	52.27	68.66
	140	0.106	44.38	68.24	7.89	10.36
	200	0.075	2.00	70.24	5.89	7.74
	dry pan		0.12	70.36	5.77	
	wet pan			5.77	0.00	

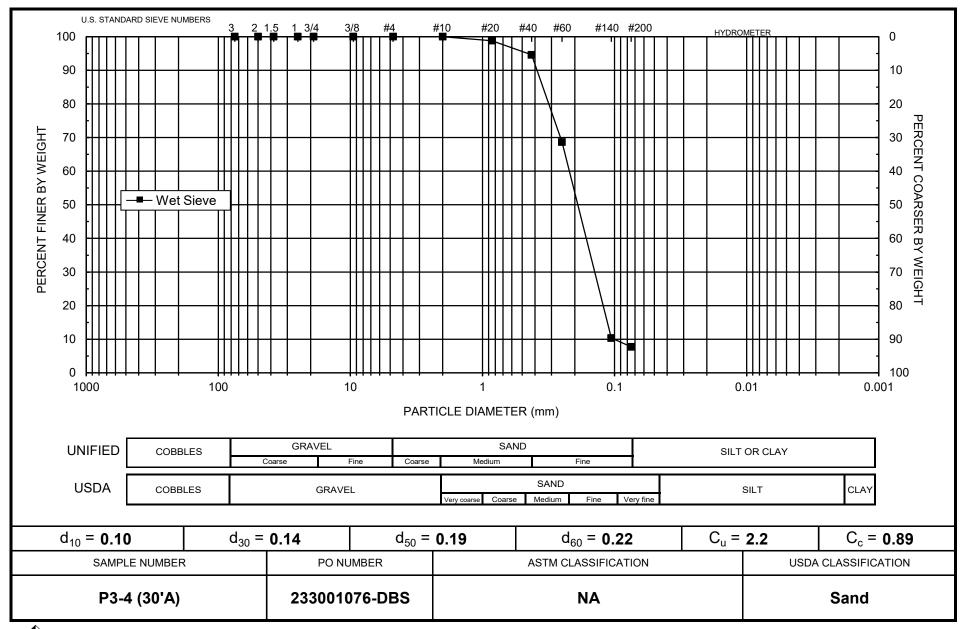
 $d_{10}$  (mm): 0.10 d<sub>50</sub> (mm): 0.19 d<sub>16</sub> (mm): 0.12 d<sub>60</sub> (mm): 0.22 d<sub>30</sub> (mm): 0.14 d<sub>84</sub> (mm): 0.34

Median Particle Diameter -- d<sub>50</sub> (mm): 0.19

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 2.2 Coefficient of Curvature,  $Cc - [(d_{30})^2/(d_{10}*d_{60})]$  (mm): 0.89

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.22

ASTM Soil Classification: NA USDA Soil Classification: Sand







### **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 546.30

Job Number: DB18.1151.00 Weight Passing #10 (g): 546.30 Sample Number: P3-4 (40'A) Weight Retained #10 (g): 0.00

Weight of Hydrometer Sample (g): 54.62 Project Name: St. Anthony Geotech Investigation PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 54.62

Test Date: 24-May-18 Shape: Angular

Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		,				
	3"	75	0.00	0.00	546.30	100.00
	2"	50	0.00	0.00	546.30	100.00
	1.5"	38.1	0.00	0.00	546.30	100.00
	1"	25	0.00	0.00	546.30	100.00
	3/4"	19.0	0.00	0.00	546.30	100.00
	3/8"	9.5	0.00	0.00	546.30	100.00
	4	4.75	0.00	0.00	546.30	100.00
	10	2.00	0.00	0.00	546.30	100.00
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.03	0.03	54.59	99.95
	40	0.425	0.07	0.10	54.52	99.82
	60	0.250	0.14	0.24	54.38	99.56
	140	0.106	16.01	16.25	38.37	70.25
	200	0.075	10.01	26.26	28.36	51.92
	dry pan		1.23	27.49	27.13	
	wet pan			27.13	0.00	

d<sub>10</sub> (mm): 0.0029 d<sub>50</sub> (mm): 0.072 d<sub>16</sub> (mm): 0.0099 d<sub>60</sub> (mm): 0.087 d<sub>30</sub> (mm): 0.044 d<sub>84</sub> (mm): 0.16

Median Particle Diameter -- d<sub>50</sub> (mm): 0.072 Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 30 Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 7.7 Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.081

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P3-4 (40'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 18-May-18 Initial Wt. (g): 54.62

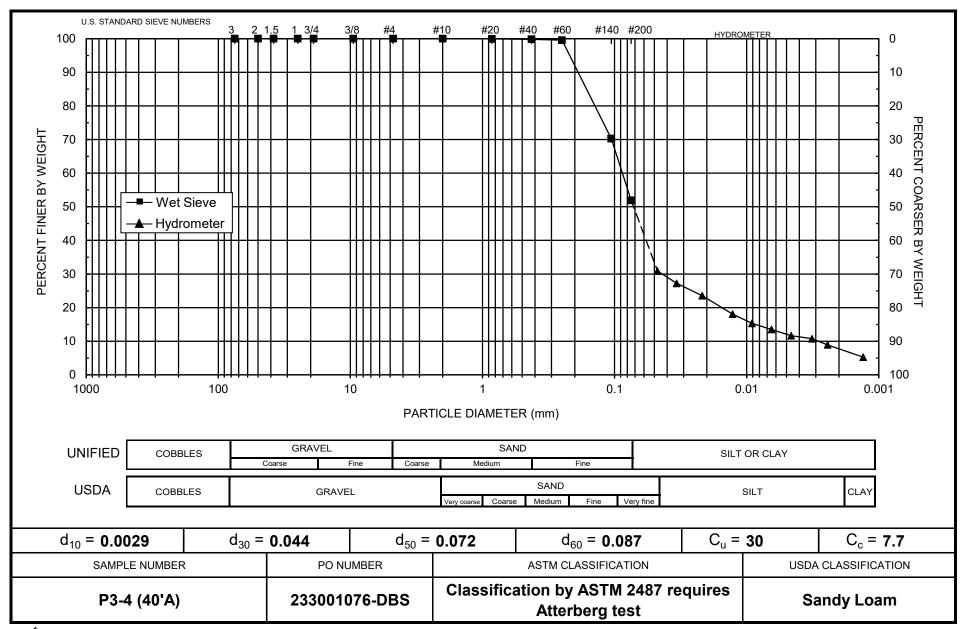
Test Date: 18-May-18 Total Sample Wt. (g): 546.30

Start Time: 9:42 Wt. Passing #10 (g): 546.30

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
18-May-18	1	21.6	23.0	6.1	16.9	12.5	0.04729	30.9	30.9
	2	21.6	21.0	6.1	14.9	12.9	0.03388	27.2	27.2
	5	21.6	19.0	6.1	12.9	13.2	0.02170	23.5	23.5
	15	21.6	16.0	6.1	9.9	13.7	0.01276	18.1	18.1
	30	21.6	14.5	6.1	8.4	13.9	0.00910	15.3	15.3
	60	21.6	13.5	6.1	7.4	14.1	0.00647	13.5	13.5
	120	21.6	12.5	6.1	6.4	14.3	0.00460	11.6	11.6
	250	21.6	12.0	6.1	5.9	14.3	0.00320	10.7	10.7
	436	21.6	11.0	6.1	4.9	14.5	0.00244	8.9	8.9
19-May-18	1534	21.7	9.0	6.1	2.9	14.8	0.00131	5.3	5.3

### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device







## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 530.27

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 530.27

 Sample Number:
 P3-5 (10'A)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 51.69
PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 51.69

Test Date: 21-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10					-	
	3"	75	0.00	0.00	530.27	100.00
	2"	50	0.00	0.00	530.27	100.00
	1.5"	38.1	0.00	0.00	530.27	100.00
	1"	25	0.00	0.00	530.27	100.00
	3/4"	19.0	0.00	0.00	530.27	100.00
	3/8"	9.5	0.00	0.00	530.27	100.00
	4	4.75	0.00	0.00	530.27	100.00
	10	2.00	0.00	0.00	530.27	100.00
-10			(Based on calcı	ulated sieve wt.)		
	20	0.85	0.24	0.24	51.45	99.54
	40	0.425	0.48	0.72	50.97	98.61
	60	0.250	0.74	1.46	50.23	97.18
	140	0.106	21.82	23.28	28.41	54.96
	200	0.075	12.18	35.46	16.23	31.40
	dry pan		1.16	36.62	15.07	
	wet pan			15.07	0.00	

 $d_{10}$  (mm): 0.020  $d_{50}$  (mm): 0.099  $d_{16}$  (mm): 0.040  $d_{60}$  (mm): 0.12  $d_{30}$  (mm): 0.072  $d_{84}$  (mm): 0.19

Median Particle Diameter--d<sub>50</sub> (mm): 0.099 Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 6.0

Coefficient of Curvature,  $Cc - [(d_{30})^2/(d_{10}*d_{60})]$  (mm): 2.2

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.11

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loamy Sand



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P3-5 (10'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 17-May-18

Total Sample Wt. (g): 51.69

Total Sample Wt. (g): 530.27

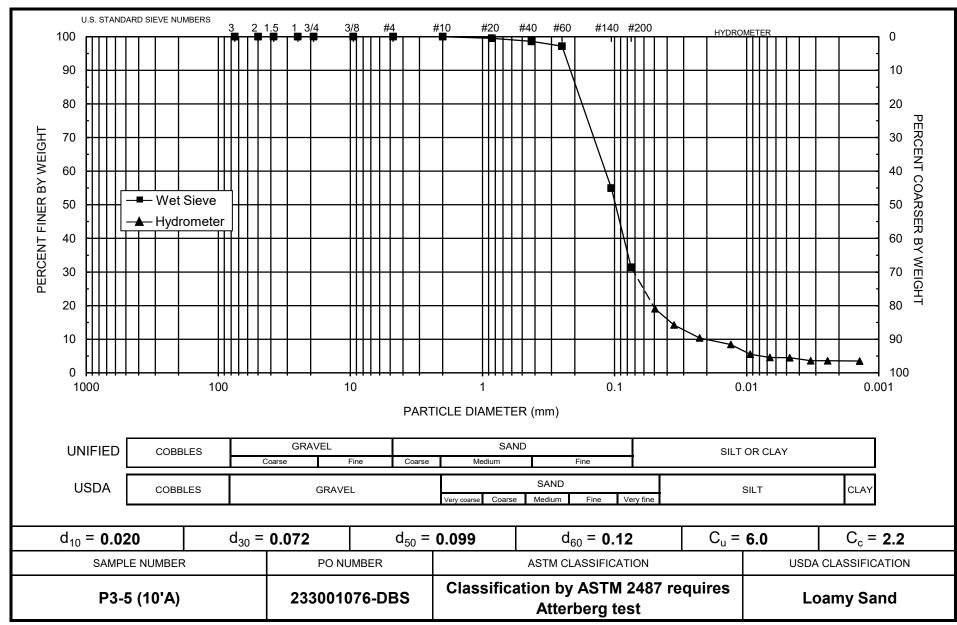
Start Time: 9:24

Wt. Passing #10 (g): 530.27

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
17-May-18	1	21.6	16.0	6.1	9.9	13.7	0.04941	19.1	19.1
	2	21.6	13.5	6.1	7.4	14.1	0.03546	14.2	14.2
	5	21.6	11.5	6.1	5.4	14.4	0.02269	10.4	10.4
	15	21.6	10.5	6.1	4.4	14.6	0.01317	8.4	8.4
	30	21.6	9.0	6.1	2.9	14.8	0.00939	5.5	5.5
	60	21.6	8.5	6.1	2.4	14.9	0.00666	4.6	4.6
	120	21.5	8.5	6.2	2.3	14.9	0.00472	4.5	4.5
	250	21.6	8.0	6.1	1.9	15.0	0.00327	3.6	3.6
	451	21.7	8.0	6.1	1.9	15.0	0.00243	3.6	3.6
18-May-18	1384	21.4	8.0	6.2	1.8	15.0	0.00139	3.5	3.5

### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device







### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 504.36Job Number:DB18.1151.00Weight Passing #10 (g): 504.12

Sample Number: P3-6 (20'A) Weight Retained #10 (g): 0.24
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 67.91

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 67.94

Test Date: 23-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	504.36	100.00
	2"	50	0.00	0.00	504.36	100.00
	1.5"	38.1	0.00	0.00	504.36	100.00
	1"	25	0.00	0.00	504.36	100.00
	3/4"	19.0	0.00	0.00	504.36	100.00
	3/8"	9.5	0.00	0.00	504.36	100.00
	4	4.75	0.00	0.00	504.36	100.00
	10	2.00	0.24	0.24	504.12	99.95
-10			(Based on calc	ulated sieve wt.	)	
	20	0.85	0.74	0.77	67.17	98.86
	40	0.425	4.63	5.40	62.54	92.05
	60	0.250	20.41	25.81	42.13	62.01
	140	0.106	30.53	56.34	11.60	17.07
	200	0.075	1.53	57.87	10.07	14.82
	dry pan		0.27	58.14	9.80	
	wet pan			9.80	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): 0.20  $d_{16}$  (mm): 0.090  $d_{60}$  (mm): 0.24  $d_{30}$  (mm): 0.14  $d_{84}$  (mm): 0.37

Median Particle Diameter -- d<sub>50</sub> (mm): 0.20

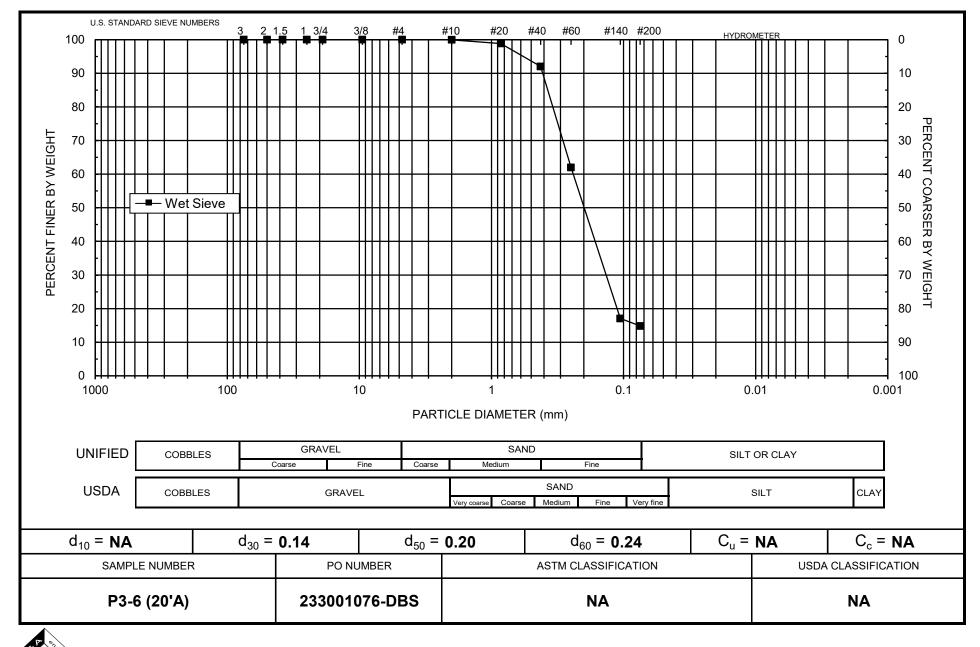
Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.22

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Weight Passing #10 (g): 478.59

Sample Number: P3-6 (50'A)

Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Weight Retained #10 (g): 37.84

Wt. of -10 Sieve Sample (g): 53.46

Calculated Weight of Sieve Sample (g): 57.69

Test Date: 23-May-18 Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10		, ,			<u> </u>	<u> </u>
	3"	75	0.00	0.00	516.43	100.00
	2"	50	0.00	0.00	516.43	100.00
	1.5"	38.1	0.00	0.00	516.43	100.00
	1"	25	24.39	24.39	492.04	95.28
	3/4"	19.0	0.00	24.39	492.04	95.28
	3/8"	9.5	11.43	35.82	480.61	93.06
	4	4.75	1.21	37.03	479.40	92.83
	10	2.00	0.81	37.84	478.59	92.67
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	3.87	8.10	49.59	85.96
	40	0.425	6.71	14.81	42.88	74.33
	60	0.250	12.35	27.16	30.53	52.92
	140	0.106	18.46	45.62	12.07	20.92
	200	0.075	2.61	48.23	9.46	16.40
	dry pan		0.22	48.45	9.24	
	wet pan			9.24	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ NA & d_{50} \ (mm): \ 0.23 \\ d_{16} \ (mm): \ 0.073 & d_{60} \ (mm): \ 0.30 \\ d_{30} \ (mm): \ 0.14 & d_{84} \ (mm): \ 0.76 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.23

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[(d<sub>30</sub>)<sup>2</sup>/(d<sub>10</sub>\*d<sub>60</sub>)] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.35

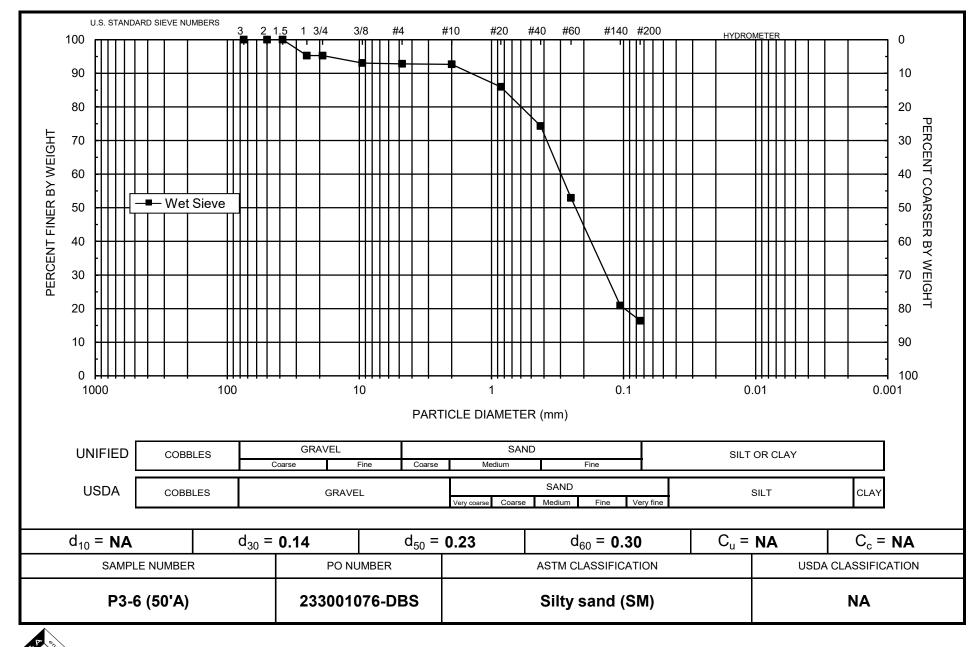
Classification of fines (visual method): ML

ASTM Soil Classification: Silty sand (SM)

USDA Soil Classification: NA

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter





## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 466.53Job Number:DB18.1151.00Weight Passing #10 (g): 348.80

Sample Number: P4-5 (20'A) Weight Retained #10 (g): 117.73

Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 79.83

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 106.77

Test Date: 23-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	466.53	100.00
	2"	50	0.00	0.00	466.53	100.00
	1.5"	38.1	0.00	0.00	466.53	100.00
	1"	25	30.38	30.38	436.15	93.49
	3/4"	19.0	73.43	103.81	362.72	77.75
	3/8"	9.5	11.00	114.81	351.72	75.39
	4	4.75	1.17	115.98	350.55	75.14
	10	2.00	1.75	117.73	348.80	74.76
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	4.15	31.09	75.68	70.88
	40	0.425	8.37	39.46	67.31	63.04
	60	0.250	21.50	60.96	45.81	42.90
	140	0.106	27.64	88.60	18.17	17.02
	200	0.075	3.11	91.71	15.06	14.10
	dry pan		0.44	92.15	14.62	
	wet pan			14.62	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): 0.30  $d_{16}$  (mm): 0.094  $d_{60}$  (mm): 0.39  $d_{30}$  (mm): 0.16  $d_{84}$  (mm): 21

Median Particle Diameter -- d<sub>50</sub> (mm): 0.30

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

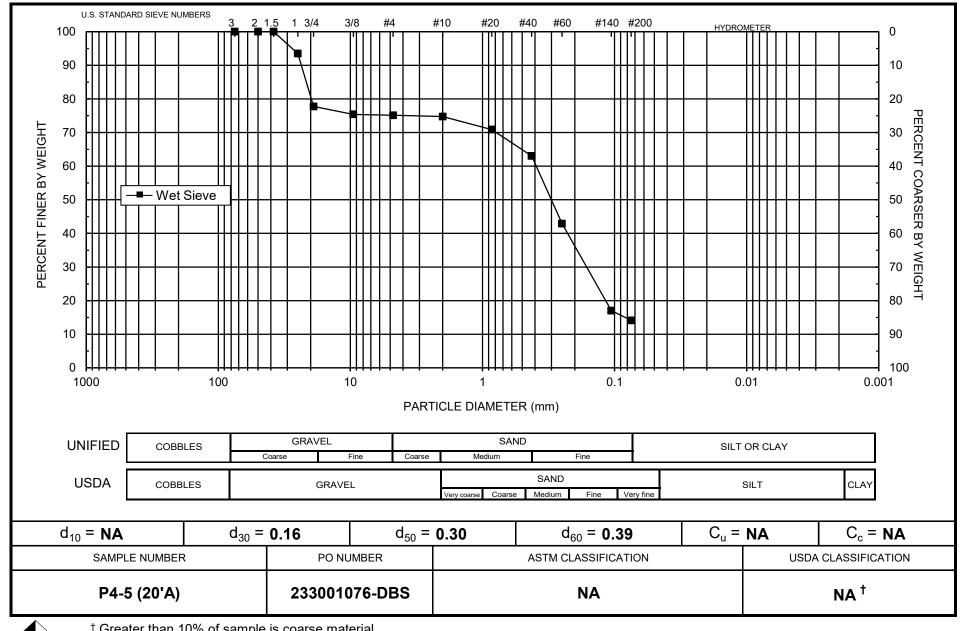
Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 7.1

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA <sup>†</sup>

<sup>†</sup> Greater than 10% of sample is coarse material



<sup>†</sup> Greater than 10% of sample is coarse material

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and ASTM classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

Daniel B. Stephens & Associates, Inc.



# Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 462.06

Job Number: DB18.1151.00 Weight Passing #10 (g): 462.06
Sample Number: P4-6 (10'A) Weight Retained #10 (g): 0.00
Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 51.81

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 51.81

Test Date: 21-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10					-	
	3"	75	0.00	0.00	462.06	100.00
	2"	50	0.00	0.00	462.06	100.00
	1.5"	38.1	0.00	0.00	462.06	100.00
	1"	25	0.00	0.00	462.06	100.00
	3/4"	19.0	0.00	0.00	462.06	100.00
	3/8"	9.5	0.00	0.00	462.06	100.00
	4	4.75	0.00	0.00	462.06	100.00
	10	2.00	0.00	0.00	462.06	100.00
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	2.10	2.10	49.71	95.95
	40	0.425	1.18	3.28	48.53	93.67
	60	0.250	0.88	4.16	47.65	91.97
	140	0.106	7.66	11.82	39.99	77.19
	200	0.075	13.05	24.87	26.94	52.00
	dry pan		0.98	25.85	25.96	
	wet pan			25.96	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.0012 & d_{50} \ (mm): \ 0.072 \\ d_{16} \ (mm): \ 0.0087 & d_{60} \ (mm): \ 0.084 \\ d_{30} \ (mm): \ 0.048 & d_{84} \ (mm): \ 0.16 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.072

Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): 70

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 23

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.080

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P4-6 (10'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 17-May-18

Total Sample Wt. (g): 51.81

Total Sample Wt. (g): 462.06

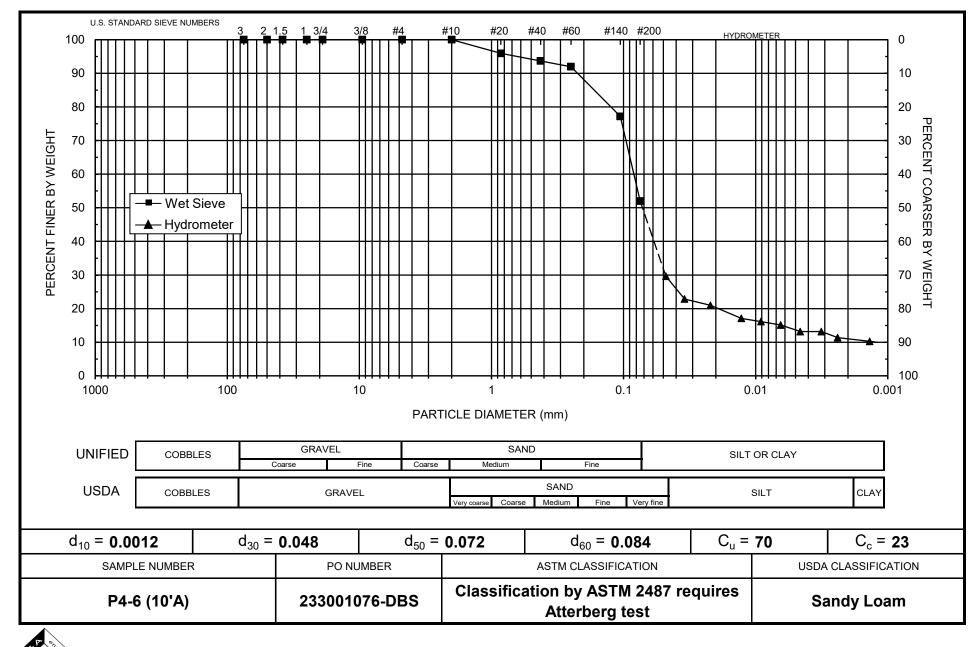
Start Time: 9:30

Wt. Passing #10 (g): 462.06

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
17-May-18	1	21.6	21.5	6.2	15.3	12.8	0.04778	29.6	29.6
	2	21.6	18.0	6.2	11.8	13.3	0.03454	22.9	22.9
	5	21.6	17.0	6.1	10.9	13.5	0.02196	21.0	21.0
	15	21.6	15.0	6.1	8.9	13.8	0.01283	17.1	17.1
	30	21.6	14.5	6.1	8.4	13.9	0.00910	16.1	16.1
	60	21.5	14.0	6.2	7.8	14.0	0.00646	15.1	15.1
	120	21.5	13.0	6.2	6.8	14.2	0.00460	13.2	13.2
	250	21.6	13.0	6.2	6.8	14.2	0.00318	13.2	13.2
	446	21.7	12.0	6.1	5.9	14.3	0.00239	11.3	11.3
18-May-18	1379	21.4	11.5	6.2	5.3	14.4	0.00137	10.2	10.2

### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name:Stantec Consulting Services IncInitial Dry Weight of Sample (g): 392.69Job Number:DB18.1151.00Weight Passing #10 (g): 363.52

Sample Number: P4-7 (5'A) Weight Retained #10 (g): 29.17
Project Name: St. Anthony Geotech Investigation Wt. of -10 Sieve Sample (g): 70.76

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 76.44

Test Date: 23-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10					-	
	3"	75	0.00	0.00	392.69	100.00
	2"	50	0.00	0.00	392.69	100.00
	1.5"	38.1	0.00	0.00	392.69	100.00
	1"	25	0.00	0.00	392.69	100.00
	3/4"	19.0	0.00	0.00	392.69	100.00
	3/8"	9.5	19.91	19.91	372.78	94.93
	4	4.75	8.24	28.15	364.54	92.83
	10	2.00	1.02	29.17	363.52	92.57
-10			(Based on calc	culated sieve wt.	)	
	20	0.85	2.09	7.77	68.67	89.84
	40	0.425	1.75	9.52	66.92	87.55
	60	0.250	4.75	14.27	62.17	81.33
	140	0.106	12.43	26.70	49.74	65.07
	200	0.075	12.32	39.02	37.42	48.95
	dry pan		1.84	40.86	35.58	
	wet pan			35.58	0.00	

 $d_{10}$  (mm): NA  $d_{50}$  (mm): 0.077  $d_{16}$  (mm): NA  $d_{60}$  (mm): 0.095  $d_{30}$  (mm): NA  $d_{84}$  (mm): 0.31

Median Particle Diameter--d<sub>50</sub> (mm): 0.077

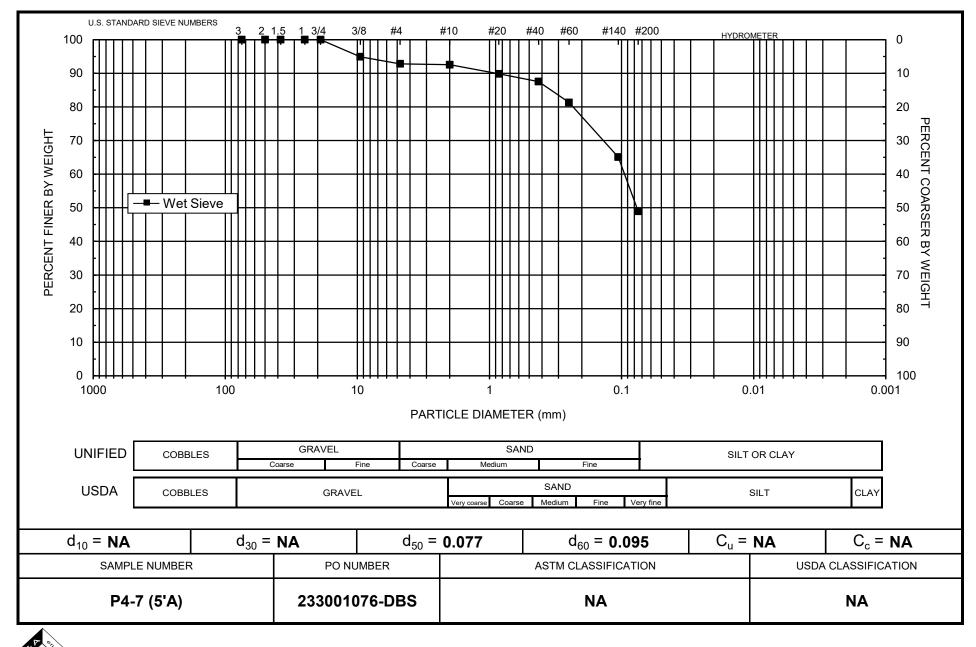
Uniformity Coefficient, Cu--[ $d_{60}/d_{10}$ ] (mm): NA

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): NA

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): NA

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

ASTM Soil Classification: NA USDA Soil Classification: NA





## **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 512.00

Job Number: DB18.1151.00 Weight Passing #10 (g): 512.00 Sample Number: P4-7 (25'B) Weight Retained #10 (g): 0.00

Weight of Hydrometer Sample (g): 63.98 Project Name: St. Anthony Geotech Investigation PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 63.98

Test Date: 21-May-18 Shape: Angular

Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	512.00	100.00
	2"	50	0.00	0.00	512.00	100.00
	1.5"	38.1	0.00	0.00	512.00	100.00
	1"	25	0.00	0.00	512.00	100.00
	3/4"	19.0	0.00	0.00	512.00	100.00
	3/8"	9.5	0.00	0.00	512.00	100.00
	4	4.75	0.00	0.00	512.00	100.00
	10	2.00	0.00	0.00	512.00	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	1.36	1.36	62.62	97.87
	40	0.425	15.92	17.28	46.70	72.99
	60	0.250	18.56	35.84	28.14	43.98
	140	0.106	12.11	47.95	16.03	25.05
	200	0.075	1.34	49.29	14.69	22.96
	dry pan		0.11	49.40	14.58	
	wet pan			14.58	0.00	

d<sub>10</sub> (mm): 0.0052 d<sub>50</sub> (mm): 0.28 d<sub>16</sub> (mm): 0.026 d<sub>60</sub> (mm): 0.34 d<sub>30</sub> (mm): 0.13 d<sub>84</sub> (mm): 0.58

Median Particle Diameter -- d<sub>50</sub> (mm): 0.28 Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 65 Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 9.6 Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.30

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loamy Sand

Laboratory analysis by: J. Hines/M. Garcia Data entered by: M. Garcia Checked by: J. Hines



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P4-7 (25'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 17-May-18

Total Sample Wt. (g): 63.98

Total Sample Wt. (g): 512.00

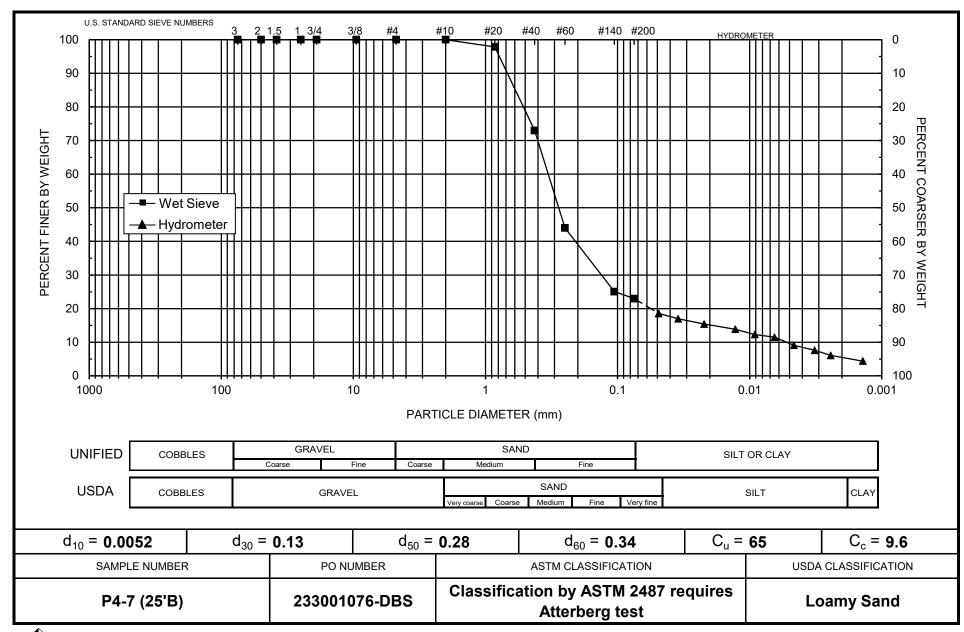
Start Time: 9:36

Wt. Passing #10 (g): 512.00

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
17-May-18	1	21.6	18.0	6.1	11.9	13.3	0.04882	18.5	18.5
	2	21.6	17.0	6.1	10.9	13.5	0.03473	17.0	17.0
	5	21.6	16.0	6.1	9.9	13.7	0.02210	15.4	15.4
	15	21.6	15.0	6.1	8.9	13.8	0.01283	13.8	13.8
	30	21.6	14.0	6.1	7.9	14.0	0.00913	12.3	12.3
	60	21.6	13.5	6.1	7.4	14.1	0.00647	11.5	11.5
	120	21.5	12.0	6.2	5.8	14.3	0.00463	9.1	9.1
	250	21.6	11.0	6.1	4.9	14.5	0.00322	7.6	7.6
	441	21.7	10.0	6.1	3.9	14.7	0.00243	6.1	6.1
18-May-18	1374	21.4	9.0	6.2	2.8	14.8	0.00139	4.4	4.4

### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device







## Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 447.92

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 441.77

 Sample Number:
 P4-8 (15'B)
 Weight Retained #10 (g): 6.15

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 53.46
PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 54.20

Test Date: 22-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	447.92	100.00
	2"	50	0.00	0.00	447.92	100.00
	1.5"	38.1	0.00	0.00	447.92	100.00
	1"	25	0.00	0.00	447.92	100.00
	3/4"	19.0	0.00	0.00	447.92	100.00
	3/8"	9.5	0.00	0.00	447.92	100.00
	4	4.75	2.23	2.23	445.69	99.50
	10	2.00	3.92	6.15	441.77	98.63
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	3.56	4.30	49.90	92.06
	40	0.425	3.26	7.56	46.64	86.04
	60	0.250	2.80	10.36	43.84	80.88
	140	0.106	14.27	24.63	29.57	54.55
	200	0.075	3.78	28.41	25.79	47.58
	dry pan		0.41	28.82	25.38	
	wet pan			25.38	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.0011 & d_{50} \ (mm): \ 0.085 \\ d_{16} \ (mm): \ 0.0061 & d_{60} \ (mm): \ 0.13 \\ d_{30} \ (mm): \ 0.027 & d_{84} \ (mm): \ 0.34 \\ \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.085

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 118

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 5.1

Mean Particle Diameter -- [ $(d_{16}+d_{50}+d_{84})/3$ ] (mm): 0.14

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: M. Garcia/Z. Calhoun

Data entered by: M. Garcia Checked by: J. Hines



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P4-8 (15'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 17-May-18

Start Time: 9:42

Initial Wt. (g): 53.46

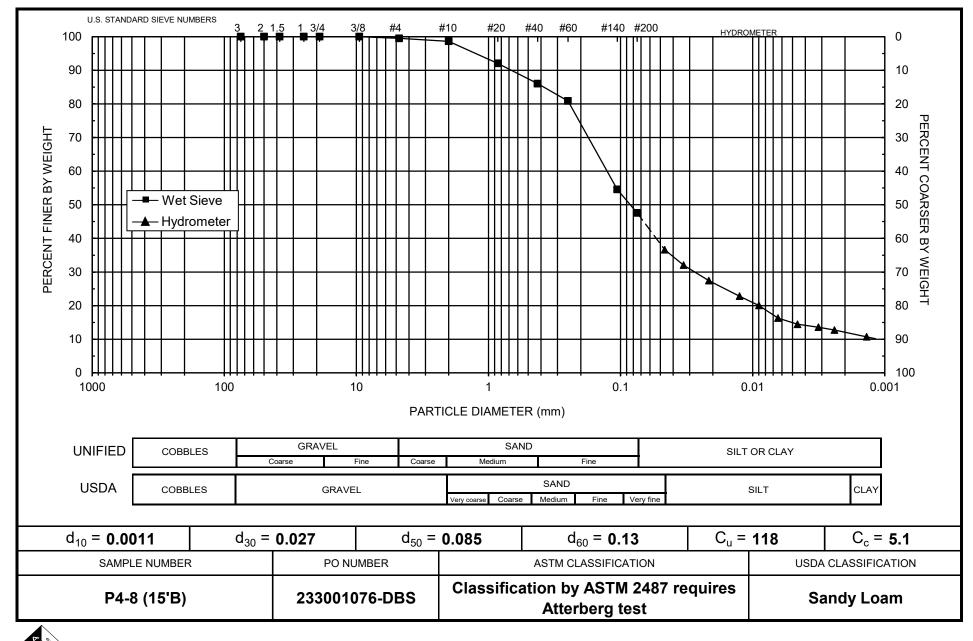
Total Sample Wt. (g): 447.92

Wt. Passing #10 (g): 441.77

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
17-May-18	1	21.6	26.0	6.1	19.9	12.0	0.04636	37.1	36.6
	2	21.6	23.5	6.1	17.4	12.4	0.03333	32.5	32.0
	5	21.6	21.0	6.1	14.9	12.9	0.02143	27.8	27.4
	15	21.6	18.5	6.1	12.4	13.3	0.01257	23.1	22.8
	30	21.6	17.0	6.1	10.9	13.5	0.00897	20.3	20.0
	60	21.5	15.0	6.2	8.8	13.8	0.00642	16.5	16.3
	120	21.5	14.0	6.2	7.8	14.0	0.00457	14.6	14.4
	250	21.6	13.5	6.1	7.4	14.1	0.00317	13.8	13.6
	436	21.8	13.0	6.1	6.9	14.2	0.00240	12.9	12.7
18-May-18	1369	21.4	12.0	6.2	5.8	14.3	0.00137	10.9	10.7

### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device





## **Particle Size Analysis** Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc

Initial Dry Weight of Sample (g): 471.98

Weight Passing #10 (g): 382.23

Job Number: DB18.1151.00 Sample Number: P4-9 (35'B)

Weight Retained #10 (g): 89.75

Project Name: St. Anthony Geotech Investigation

Weight of Hydrometer Sample (g): 52.47

PO Number: 233001076-DBS

Test Date: 21-May-18

Calculated Weight of Sieve Sample (g): 64.79

Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	471.98	100.00
	2"	50	0.00	0.00	471.98	100.00
	1.5"	38.1	0.00	0.00	471.98	100.00
	1"	25	0.00	0.00	471.98	100.00
	3/4"	19.0	19.43	19.43	452.55	95.88
	3/8"	9.5	37.71	57.14	414.84	87.89
	4	4.75	16.82	73.96	398.02	84.33
	10	2.00	15.79	89.75	382.23	80.98
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	2.15	14.47	50.32	77.67
	40	0.425	1.87	16.34	48.45	74.78
	60	0.250	2.63	18.97	45.82	70.72
	140	0.106	5.03	24.00	40.79	62.96
	200	0.075	3.36	27.36	37.43	57.77
	dry pan		0.79	28.15	36.64	
	wet pan			36.64	0.00	

d<sub>10</sub> (mm): 6.7E-06 d<sub>50</sub> (mm): 0.061 d<sub>16</sub> (mm): 0.0035

d<sub>30</sub> (mm): 0.026

d<sub>60</sub> (mm): 0.087

d<sub>84</sub> (mm): 4.4

Median Particle Diameter -- d<sub>50</sub> (mm): 0.061

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 1.3E+04

Coefficient of Curvature,  $Cc - [(d_{30})^2/(d_{10}*d_{60})]$  (mm): 1160

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 1.5

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam †

<sup>†</sup> Greater than 10% of sample is coarse material

Laboratory analysis by: M. Garcia/Z. Calhoun Data entered by: M. Garcia

Checked by: J. Hines



# Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: P4-9 (35'B)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 17-May-18

Start Time: 9:54

Initial Wt. (g): 52.47

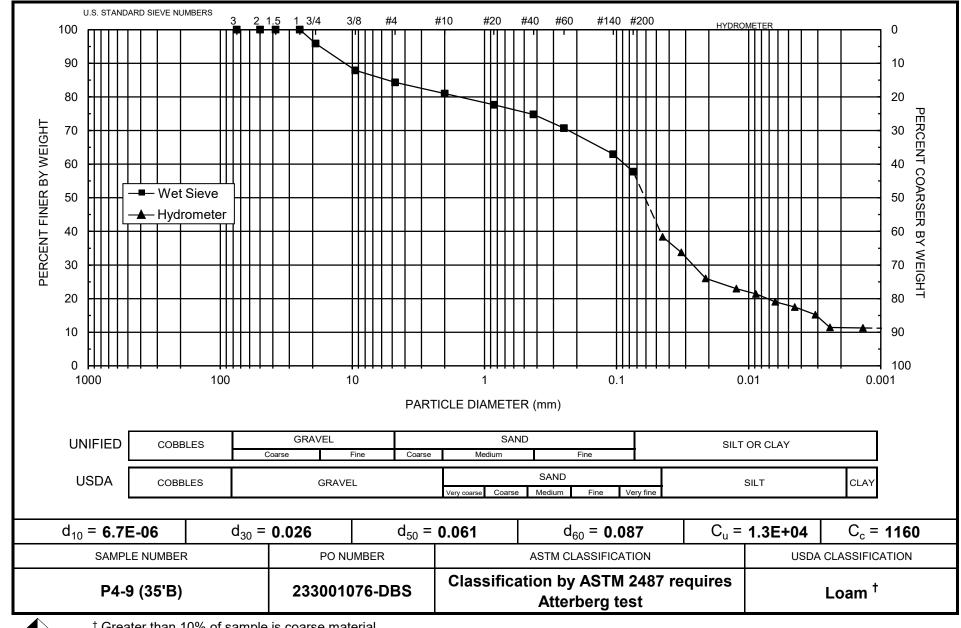
Total Sample Wt. (g): 471.98

Wt. Passing #10 (g): 382.23

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
	_								
17-May-18	1	21.6	31.0	6.1	24.9	11.2	0.04475	47.4	38.4
	2	21.6	28.0	6.1	21.9	11.7	0.03233	41.7	33.7
	5	21.6	23.0	6.1	16.9	12.5	0.02115	32.1	26.0
	15	21.6	21.0	6.1	14.9	12.9	0.01237	28.3	22.9
	30	21.6	20.0	6.1	13.9	13.0	0.00880	26.4	21.4
	60	21.5	18.5	6.2	12.3	13.3	0.00629	23.5	19.0
	120	21.5	17.5	6.2	11.3	13.4	0.00448	21.6	17.5
	250	21.6	16.0	6.1	9.9	13.7	0.00313	18.8	15.2
	426	21.8	13.5	6.1	7.4	14.1	0.00242	14.1	11.4
18-May-18	1359	21.4	13.5	6.2	7.3	14.1	0.00136	13.9	11.3

### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device



<sup>†</sup> Greater than 10% of sample is coarse material

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and ASTM classification are estimates, since extrapolation was required to obtain the d<sub>10</sub> diameter

Daniel B. Stephens & Associates, Inc.



### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 400.84

Job Number: DB18.1151.00 Weight Passing #10 (g): 400.84 Sample Number: BW-1 (20'A) Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 53.41

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 53.41

Test Date: 18-May-18 Shape: Rounded Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	400.84	100.00
	2"	50	0.00	0.00	400.84	100.00
	1.5"	38.1	0.00	0.00	400.84	100.00
	1"	25	0.00	0.00	400.84	100.00
	3/4"	19.0	0.00	0.00	400.84	100.00
	3/8"	9.5	0.00	0.00	400.84	100.00
	4	4.75	0.00	0.00	400.84	100.00
	10	2.00	0.00	0.00	400.84	100.00
-10			(Based on calcu	ulated sieve wt.)	)	
	20	0.85	0.12	0.12	53.29	99.78
	40	0.425	0.36	0.48	52.93	99.10
	60	0.250	1.22	1.70	51.71	96.82
	140	0.106	12.74	14.44	38.97	72.96
	200	0.075	9.80	24.24	29.17	54.62
	dry pan		2.09	26.33	27.08	
	wet pan			27.08	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.0012 & d_{50} \ (mm): \ 0.047 \\ d_{16} \ (mm): \ 0.0017 & d_{60} \ (mm): \ 0.083 \\ d_{30} \ (mm): \ 0.011 & d_{84} \ (mm): \ 0.16 \end{array}$ 

Median Particle Diameter -- d<sub>50</sub> (mm): 0.047

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 69

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}^*d_{60})$ ] (mm): 1.2

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.070

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Loam



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: BW-1 (20'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18

Start Time: 9:18

Initial Wt. (g): 53.41

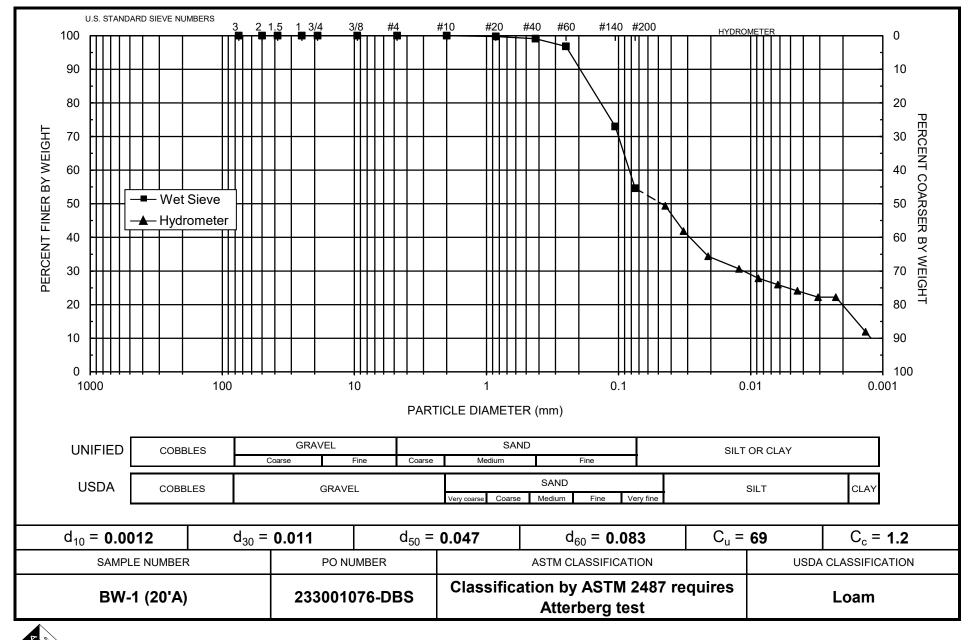
Total Sample Wt. (g): 400.84

Wt. Passing #10 (g): 400.84

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
40.14		0.4.0			00.4	44.0	0.04400	40.4	40.4
16-May-18	1	21.6	32.5	6.1	26.4	11.0	0.04426	49.4	49.4
	2	21.6	28.5	6.1	22.4	11.6	0.03222	41.9	41.9
	5	21.6	24.5	6.1	18.4	12.3	0.02094	34.4	34.4
	15	21.6	22.5	6.1	16.4	12.6	0.01225	30.6	30.6
	30	21.6	21.0	6.1	14.9	12.9	0.00875	27.8	27.8
	60	21.6	20.0	6.1	13.9	13.0	0.00622	26.0	26.0
	120	21.6	19.0	6.1	12.9	13.2	0.00443	24.1	24.1
	250	21.6	18.0	6.1	11.9	13.3	0.00309	22.2	22.2
	465	21.6	18.0	6.1	11.9	13.3	0.00226	22.2	22.2
17-May-18	1398	21.6	12.5	6.1	6.4	14.3	0.00135	11.9	11.9

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device



Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and ASTM classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

Daniel B. Stephens & Associates, Inc.



### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 441.31

Job Number: DB18.1151.00 Weight Passing #10 (g): 441.31 Sample Number: BW-2 (10'A) Weight Retained #10 (g): 0.00 Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 61.69

PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 61.69

Test Date: 18-May-18 Shape: Angular Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing_
+10						_
	3"	75	0.00	0.00	441.31	100.00
	2"	50	0.00	0.00	441.31	100.00
	1.5"	38.1	0.00	0.00	441.31	100.00
	1"	25	0.00	0.00	441.31	100.00
	3/4"	19.0	0.00	0.00	441.31	100.00
	3/8"	9.5	0.00	0.00	441.31	100.00
	4	4.75	0.00	0.00	441.31	100.00
	10	2.00	0.00	0.00	441.31	100.00
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.39	0.39	61.30	99.37
	40	0.425	0.38	0.77	60.92	98.75
	60	0.250	0.69	1.46	60.23	97.63
	140	0.106	17.78	19.24	42.45	68.81
	200	0.075	7.96	27.20	34.49	55.91
	dry pan		1.02	28.22	33.47	
	wet pan			33.47	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.00035 & d_{50} \ (mm): \ 0.062 \\ d_{16} \ (mm): \ 0.0013 & d_{60} \ (mm): \ 0.084 \\ d_{30} \ (mm): \ 0.023 & d_{84} \ (mm): \ 0.17 \end{array}$ 

Median Particle Diameter--d<sub>50</sub> (mm): 0.062

Uniformity Coefficient, Cu -- [d<sub>60</sub>/d<sub>10</sub>] (mm): 240

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 18

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.078

Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: BW-2 (10'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18

Total Sample Wt. (g): 61.69

Total Sample Wt. (g): 441.31

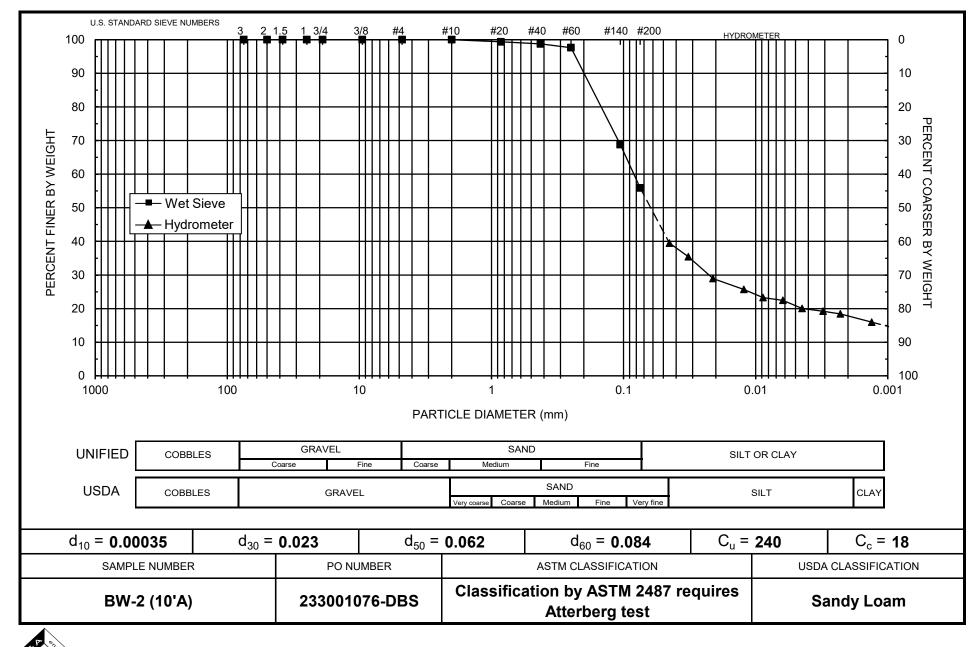
Start Time: 9:24

Wt. Passing #10 (g): 441.31

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
16-May-18	1	21.6	30.5	6.1	24.4	11.3	0.04491	39.5	39.5
	2	21.6	28.0	6.1	21.9	11.7	0.03233	35.4	35.4
	5	21.6	24.0	6.1	17.9	12.4	0.02101	29.0	29.0
	15	21.6	22.0	6.1	15.9	12.7	0.01229	25.7	25.7
	30	21.6	20.5	6.1	14.4	12.9	0.00877	23.3	23.3
	60	21.6	20.0	6.1	13.9	13.0	0.00622	22.5	22.5
	120	21.6	18.5	6.1	12.4	13.3	0.00444	20.0	20.0
	250	21.6	18.0	6.1	11.9	13.3	0.00309	19.2	19.2
	460	21.6	17.5	6.1	11.4	13.4	0.00228	18.4	18.4
17-May-18	1393	21.6	16.0	6.1	9.9	13.7	0.00132	16.0	16.0

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device



Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and ASTM classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

Daniel B. Stephens & Associates, Inc.



### Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc Initial Dry Weight of Sample (g): 470.38

 Job Number:
 DB18.1151.00
 Weight Passing #10 (g): 470.38

 Sample Number:
 BW-3 (5'A)
 Weight Retained #10 (g): 0.00

Project Name: St. Anthony Geotech Investigation Weight of Hydrometer Sample (g): 56.32
PO Number: 233001076-DBS Calculated Weight of Sieve Sample (g): 56.32

Test Date: 18-May-18 Shape: Angular

Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	470.38	100.00
	2"	50	0.00	0.00	470.38	100.00
	1.5"	38.1	0.00	0.00	470.38	100.00
	1"	25	0.00	0.00	470.38	100.00
	3/4"	19.0	0.00	0.00	470.38	100.00
	3/8"	9.5	0.00	0.00	470.38	100.00
	4	4.75	0.00	0.00	470.38	100.00
	10	2.00	0.00	0.00	470.38	100.00
-10			(Based on calcı	ulated sieve wt.)	)	
	20	0.85	0.41	0.41	55.91	99.27
	40	0.425	0.58	0.99	55.33	98.24
	60	0.250	1.26	2.25	54.07	96.00
	140	0.106	18.31	20.56	35.76	63.49
	200	0.075	9.35	29.91	26.41	46.89
	dry pan		1.59	31.50	24.82	
	wet pan			24.82	0.00	

 $\begin{array}{lll} d_{10} \ (mm): \ 0.0011 & d_{50} \ (mm): \ 0.080 \\ d_{16} \ (mm): \ 0.014 & d_{60} \ (mm): \ 0.099 \\ d_{30} \ (mm): \ 0.050 & d_{84} \ (mm): \ 0.18 \end{array}$ 

 $\textit{Median Particle Diameter--} d_{50} \; (mm) \text{: } \; 0.080$ 

Uniformity Coefficient, Cu--[d<sub>60</sub>/d<sub>10</sub>] (mm): 90

Coefficient of Curvature, Cc--[ $(d_{30})^2/(d_{10}*d_{60})$ ] (mm): 23

Mean Particle Diameter -- [(d<sub>16</sub>+d<sub>50</sub>+d<sub>84</sub>)/3] (mm): 0.091

Note: Reported values for d<sub>10</sub>, C<sub>u</sub>, C<sub>c</sub>, and soil classification are estimates, since extrapolation was required to

obtain the d<sub>10</sub> diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam



## Particle Size Analysis Hydrometer Data

Job Name: Stantec Consulting Services Inc Type of Water Used: DISTILLED

Job Number: DB18.1151.00 Reaction with H<sub>2</sub>O<sub>2</sub>: NA

Sample Number: BW-3 (5'A)

Dispersant\*: (NaPO<sub>3</sub>)<sub>6</sub>

Project Name: St. Anthony Geotech Investigation Assumed particle density: 2.65

PO Number: 233001076-DBS

Test Date: 16-May-18

Start Time: 9:30

Initial Wt. (g): 56.32

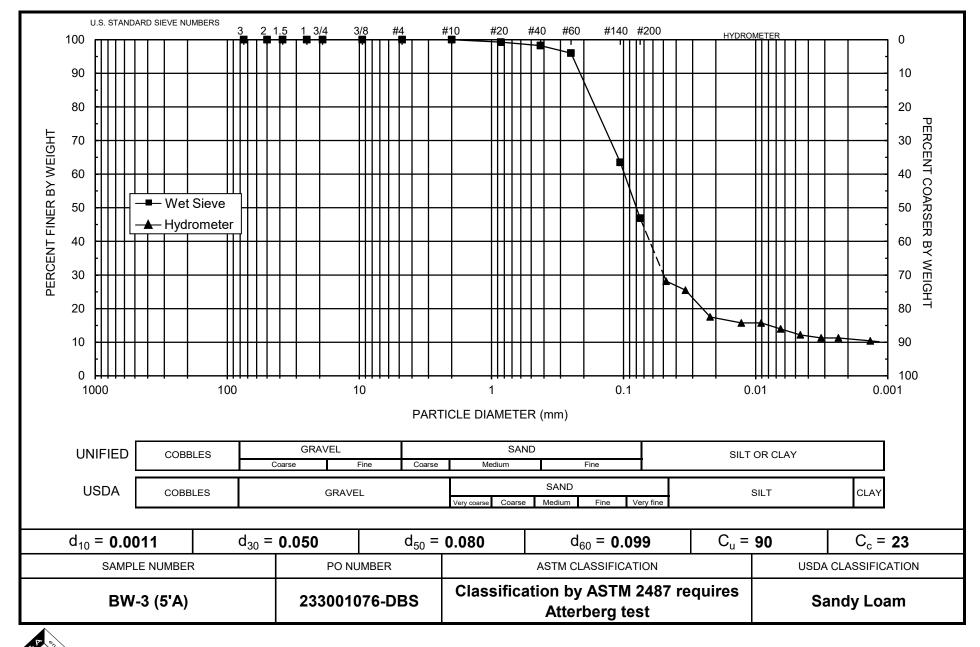
Total Sample Wt. (g): 470.38

Wt. Passing #10 (g): 470.38

	Time	Temp	R	$R_L$	$R_{corr}$	L	D	Р	
Date	(min)	(°C)	(g/L)	(g/L)	(g/L)	(cm)	(mm)	(%)	% Finer
16-May-18	1	21.6	22.0	6.1	15.9	12.7	0.04760	28.2	28.2
	2	21.6	20.5	6.1	14.4	12.9	0.03398	25.5	25.5
	5	21.6	16.0	6.1	9.9	13.7	0.02210	17.5	17.5
	15	21.6	15.0	6.1	8.9	13.8	0.01283	15.7	15.7
	30	21.6	15.0	6.1	8.9	13.8	0.00908	15.7	15.7
	60	21.6	14.0	6.1	7.9	14.0	0.00646	14.0	14.0
	120	21.6	13.0	6.1	6.9	14.2	0.00459	12.2	12.2
	250	21.6	12.5	6.1	6.4	14.3	0.00319	11.3	11.3
	455	21.6	12.5	6.1	6.4	14.3	0.00236	11.3	11.3
17-May-18	1388	21.6	12.0	6.1	5.9	14.3	0.00136	10.4	10.4

#### Comments:

<sup>\*</sup> Dispersion device: mechanically operated stirring device



Note: Reported values for  $d_{10}$ ,  $C_u$ ,  $C_c$ , and ASTM classification are estimates, since extrapolation was required to obtain the  $d_{10}$  diameter

Daniel B. Stephens & Associates, Inc.

Atterberg Limits/ Identification of Fines



## **Summary of Atterberg Tests**

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
L1-2 (20'A)	41	19	22	CL
L2-2 (5'B)				ML
L2-6 (5'A)	34	17	17	CL
T/O-1 (25'A)	30	16	14	CL
T/O-2 (10'A)	48	23	25	CL
T/O-3 (60'A)				ML
P1-1 (10'A)				ML
P1-2 (15'A)				ML
P2-2 (5'A)	39	15	24	CL
P3-1 (15'A)				ML
P3-3 (40'A)				ML
P3-4 (40'B)				ML
P3-5 (10'B)				ML
P3-6 (50'A)				ML
P4-8 (15'A)				ML

<sup>--- =</sup> Soil requires visual-manual classification due to non-plasticity



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L1-2 (20'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

#### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:	35	27	19
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	129.37	123.19	125.05
Weight of pan plus dry soil (g)	126.57	120.14	121.57
Weight of pan (g):	119.34	112.55	113.30
Gravimetric moisture content (% g/g):	38.73	40.18	42.08

Liquid Limit: 41

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	123.79	122.02
Weight of pan plus dry soil (g)	122.47	120.79
Weight of pan (g):	115.57	114.20
Gravimetric moisture content (% g/g):	19.13	18.66

Plastic Limit: 19

#### **Results**

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 41
Plastic Limit: 19
Plasticity Index: 22
Classification: CL

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-2 (5'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):			

Liquid Limit:

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):		

Plastic Limit: ---

### Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-2 (5'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Dark Grayish Brown (2.5Y 4/2)

Odor: None

Moisture Condition: Moist

HCI Reaction: None

#### **Preliminary Identification:**

Dry Strength: Low

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia Checked by: J. Hines



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-6 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:	33	26	21
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	126.79	125.83	128.90
Weight of pan plus dry soil (g)	123.84	122.43	125.45
Weight of pan (g):	114.42	112.27	115.70
Gravimetric moisture content (% g/g):	31.32	33.46	35.38

Liquid Limit: 34

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	125.68	122.40
Weight of pan plus dry soil (g)	124.31	120.96
Weight of pan (g):	116.56	112.62
Gravimetric moisture content (% g/g):	17.68	17.27

Plastic Limit: 17

#### **Results**

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 34
Plastic Limit: 17
Plasticity Index: 17
Classification: CL

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-1 (25'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

#### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:	35	26	20
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	131.02	130.17	133.23
Weight of pan plus dry soil (g)	127.58	126.82	129.76
Weight of pan (g):	115.76	115.62	118.66
Gravimetric moisture content (% g/g):	29.10	29.91	31.26

Liquid Limit: 30

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	125.77	125.95
Weight of pan plus dry soil (g)	124.55	124.61
Weight of pan (g):	116.80	116.23
Gravimetric moisture content (% g/g):	15.74	15.99

Plastic Limit: 16

#### **Results**

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 30
Plastic Limit: 16
Plasticity Index: 14
Classification: CL

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-2 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

#### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:	34	27	20
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	126.06	125.51	129.53
Weight of pan plus dry soil (g)	123.09	121.88	125.52
Weight of pan (g):	116.49	114.26	117.44
Gravimetric moisture content (% g/g):	45.00	47.64	49.63

Liquid Limit: 48

#### **Plastic Limit**

Trial 1	Trial 2
PL1	PL2
124.49	122.16
122.97	120.57
116.26	113.70
22.65	23.14
	PL1 124.49 122.97 116.26

Plastic Limit: 23

#### **Results**

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 48
Plastic Limit: 23
Plasticity Index: 25
Classification: CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/O-3 (60'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):			
Liquid Limit:			

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number: Weight of pan plus moist soil (g): Weight of pan plus dry soil (g) Weight of pan (g): Gravimetric moisture content (% g/g):		

#### Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: T/ 0-3 (60'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Dark Grayish Brown (2.5Y 4/2)

Odor: None

Moisture Condition: Moist

HCI Reaction: None

#### **Preliminary Identification:**

Dry Strength: Low

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia Checked by: J. Hines



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P1-1 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

#### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):			

Liquid Limit:

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):		

Plastic Limit: --

#### Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P1-1 (10'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Very Dark Grayish Brown (2.5Y 3/2)

Odor: None

Moisture Condition: Moist
HCl Reaction: None

#### **Preliminary Identification:**

Dry Strength: None

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia

Checked by: J. Hines



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P1-2 (15'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:			_
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):			
Liquid Limit:			

## **Plastic Limit**

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):		

Plastic Limit: --

#### Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P1-2 (15'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Dark Olive Brown (2.5Y 3/3)

Odor: None

Moisture Condition: Moist
HCl Reaction: None

#### **Preliminary Identification:**

Dry Strength: None

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia

Checked by: J. Hines



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P2-2 (5'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

#### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:	30	23	17
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	125.25	125.09	124.77
Weight of pan plus dry soil (g)	121.92	121.40	121.35
Weight of pan (g):	113.14	112.25	113.24
Gravimetric moisture content (% g/g):	37.93	40.33	42.17

Liquid Limit: 39

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	127.23	122.78
Weight of pan plus dry soil (g)	125.93	121.53
Weight of pan (g):	117.26	113.02
Gravimetric moisture content (% g/g):	14.99	14.69

Plastic Limit: 15

#### **Results**

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 39
Plastic Limit: 15
Plasticity Index: 24
Classification: CL

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-1 (15'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):			
Liquid Limit:			

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):		

Plastic Limit:

#### **Results**

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-1 (15'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Dark Olive Brown (2.5Y 3/3)

Odor: None

Moisture Condition: Moist

HCI Reaction: None

#### **Preliminary Identification:**

Dry Strength: Low

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia

Checked by: J. Hines



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-3 (40'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

#### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:			_
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):			
Liquid Limit:			

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):		

Plastic Limit: --

#### **Results**

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-3 (40'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Light Olive Brown (2.5Y 5/3)

Odor: None

Moisture Condition: Moist

HCl Reaction: Strong

#### **Preliminary Identification:**

Dry Strength: Low

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia

Checked by: J. Hines



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-4 (40'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:			_
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):			
Liquid Limit:			

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number: Weight of pan plus moist soil (g): Weight of pan plus dry soil (g) Weight of pan (g): Gravimetric moisture content (% g/g):		

#### Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-4 (40'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 25-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Very Dark Gray (2.5Y 3/1)

Odor: None

Moisture Condition: Moist

HCI Reaction: None

#### **Preliminary Identification:**

Dry Strength: Low

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia Checked by: J. Hines



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-5 (10'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):			
Liamid Lingite			
Liquid Limit:			

## Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):		

Plastic Limit:

Results

Percent of Sample Retained on #40 Sieve: See Sieve

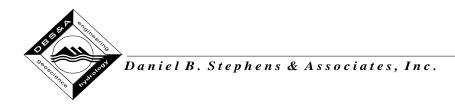
Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P3-5 (10'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Very Dark Grayish Brown (2.5Y 3/2)

Odor: None

Moisture Condition: Moist
HCl Reaction: None

#### **Preliminary Identification:**

Dry Strength: None

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia

Checked by: J. Hines



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-3 (10'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops:			_
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):			
Liquid Limit:			

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):		

Plastic Limit:

### Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-3 (10'B)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Grayish Brown (2.5 Y 5/2)

Odor: None

Moisture Condition: Moist

HCI Reaction: None

#### **Preliminary Identification:**

Dry Strength: Low

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia Checked by: J. Hines



### **Atterberg Limits**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-8 (15'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

### **Liquid Limit**

	Trial 1	Trial 2	Trial 3
Number of drops: Pan number: Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)  Weight of pan plus dry soil (g)  Weight of pan (g):  Gravimetric moisture content (% g/g):			
Gravimetric moisture content (78 g/g).			
Liquid Limit:			

#### **Plastic Limit**

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):		

Plastic Limit:

#### Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: --Plastic Limit: --Plasticity Index: ---

Classification (Visual Method): ML

#### Comments:

--- = Soil requires visual-manual classification due to non-plasticity

\* = 1-point method requested by client



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: P4-8 (15'A)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Test Date: 24-May-18

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

#### **Descriptive Information:**

Color of Moist Sample: Very Dark Grayish Brown (2.5Y 3/2)

Odor: None

Moisture Condition: Moist

HCI Reaction: None

#### **Preliminary Identification:**

Dry Strength: Low

Dilatency: Rapid

Toughness: Low

Plasticity: Non-plastic

#### **Identification of Inorganic Fine Grained Soils:**

Silt (ML)

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia Checked by: J. Hines

**Proctor Compaction** 



## **Summary of Proctor Compaction Tests**

	Measured		Oversize Corrected	
Sample Number	Optimum Moisture Content (% g/g)	Maximum Dry Bulk Density (g/cm <sup>3</sup> )	Optimum Moisture Content (% g/g)	Maximum Dry Bulk Density (g/cm³)
•		· ·	(10 919)	(9/ /
L1 Auger Cuttings (1 & 2)	14.6	1.81		
L2 Auger Cuttings (1 & 2)	14.1	1.81		
T/O Auger Cuttings (1 & 2) (T/O-1 & T/O-3,4)	14.5	1.83		
Topsoil North Cuttings (1 & 2)	12.6	1.89		
Borrow South Cuttings (1 & 2)	13.0	1.84		
Topsoil South Cuttings (1 & 2) (TS-2 & TS-3,4)	15.2	1.81	12.3	1.92
Borrow West Auger Cuttings (1 & 2)	12.7	1.87		
P1-2 Auger Cuttings	12.8	1.82		
P3 Auger Cuttings (1 & 2)	9.9	1.96	9.2	2.00
P4 Auger Cuttings (1 & 2)	11.1	1.94	9.0	2.05

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

NR = Not requested

NA = Not applicable



### **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc Split (3/4", 3/8", #4): #4

Job Number: DB18.1151.00 Mass of coarse material (g): 1706.10

Sample Number: L1 Auger Cuttings (1 & 2)

Mass of fines material (g): 42928.00

Project Name: St. Anthony Geotech Investigation Mold weight (g): 4226

Test Date: 17-May-18 Compaction Method: Standard A

Preparation Method: Dry

As Received Moisture Content (% g/g): NA

Type of Rammer: Mechanical

	Weight of	Weight of	Weight of			
	Mold and	Container and	Container and	Weight of	Dry Bulk	Moisture
	Compacted Soil	Wet Soil	Dry Soil	Container	Density	Content
Trial	(g)	(g)	(g)	(g)	(g/cm <sup>3</sup> )	(% g/g)
1	6030	1077.29	1000.09	289.63	1.73	10.87
2	6119	922.44	850.65	284.61	1.78	12.68
3	6185	1005.58	908.36	282.13	1.80	15.52
4	6138	1012.94	907.34	297.40	1.73	17.31
5	6088	942.07	835.56	269.59	1.66	18.82

Soil Fractions

Properties of Coarse Material

Coarse Fraction (% g/g): 3.8 Fines Fraction (% g/g): 96.2 Assumed particle density (g/cm³): 2.65 Assumed Initial Moisture Content (% g/g): 0.0

### Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk	Moisture
	Density of	Content of
	Composite	Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1		
2		
3		
4		
5		

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

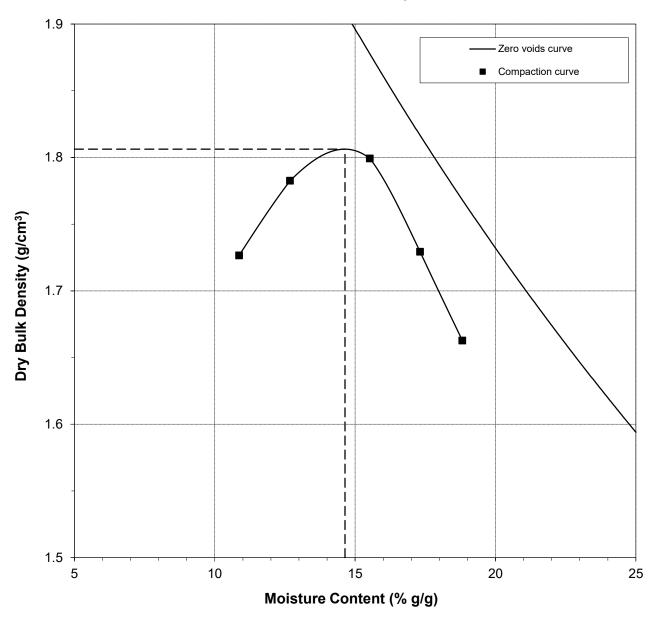


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: L1 Auger Cuttings (1 & 2)

	Measured	Corrected
Optimum Moisture Content (% g/g):	14.6	
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.81	

Test Date: 17-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



### **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc

Split (3/4", 3/8", #4): #4

Job Number: DB18.1151.00

Mass of coarse material (g): 892.80

Mass of fines material (g): 47420.00

Sample Number: L2 Auger Cuttings (1 & 2) Project Name: St. Anthony Geotech Investigation

Mold weight (g): 4226

PO Number: 233001076-DBS

Mold volume (cm<sup>3</sup>): 942.46

Test Date: 16-May-18

Compaction Method: Standard A

Preparation Method: Dry

As Received Moisture Content (% g/g): NA

Type of Rammer: Mechanical

	Weight of	Weight of	Weight of			
	Mold and	Container and	Container and	Weight of	Dry Bulk	Moisture
	Compacted Soil	Wet Soil	Dry Soil	Container	Density	Content
Trial	(g)	(g)	(g)	(g)	(g/cm <sup>3</sup> )	(% g/g)
1	6011	962.16	898.93	268.39	1.72	10.03
2	6116	1085.28	1000.85	290.42	1.79	11.88
3	6176	1062.87	968.24	298.44	1.81	14.13
4	6179	1009.32	906.58	284.54	1.78	16.52
5	6127	923.31	825.37	284.32	1.71	18.10

Soil Fractions

**Properties of Coarse Material** 

Coarse Fraction (% g/g): 1.8 Fines Fraction (% g/g): 98.2 Assumed particle density (g/cm<sup>3</sup>): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

### Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk	Moisture
	Density of	Content of
	Composite	Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1		
2		
3		
4		
5		

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

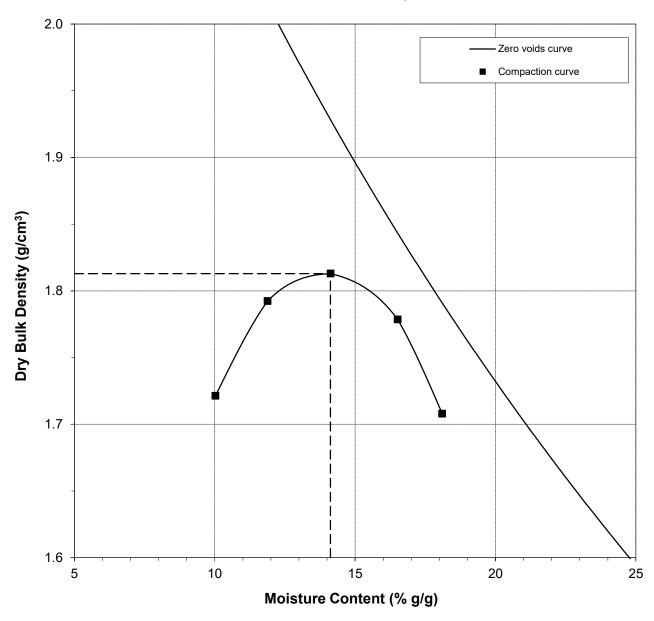


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: L2 Auger Cuttings (1 & 2)

	Measured	Corrected
Optimum Moisture Content (% g/g):	14.1	
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.81	

Test Date: 16-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



### **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc Split (3/4", 3/8", #4): #4

Job Number: DB18.1151.00 Mass of coarse material (g): 2357.50 Sample Number: T/O Auger Cuttings (1 & 2) (T/O-1 & T/O-M4s of fines material (g): 45348.00

Project Name:St. Anthony Geotech InvestigationMold weight (g): 4226PO Number:233001076-DBSMold volume (cm³): 942.46

Test Date: 16-May-18 Compaction Method: Standard A

Preparation Method: Dry

As Received Moisture Content (% g/g): NA

Type of Rammer: Mechanical

	Weight of	Weight of	Weight of			
	Mold and	Container and	Container and	Weight of	Dry Bulk	Moisture
	Compacted Soil	Wet Soil	Dry Soil	Container	Density	Content
Trial	(g)	(g)	(g)	(g)	(g/cm <sup>3</sup> )	(% g/g)
1	6014	997.05	925.87	269.45	1.71	10.84
2	6144	1095.35	1004.84	292.22	1.81	12.70
3	6204	1132.12	1022.57	282.88	1.83	14.81
4	6199	899.82	813.68	289.57	1.80	16.44
5	6139	938.80	831.19	269.92	1.70	19.17

Soil Fractions

Properties of Coarse Material

Coarse Fraction (% g/g): 4.9 Fines Fraction (% g/g): 95.1

Assumed particle density (g/cm<sup>3</sup>): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

### Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk	Moisture
	Density of	Content of
	Composite	Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1		
2		
3		
4		
5		

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

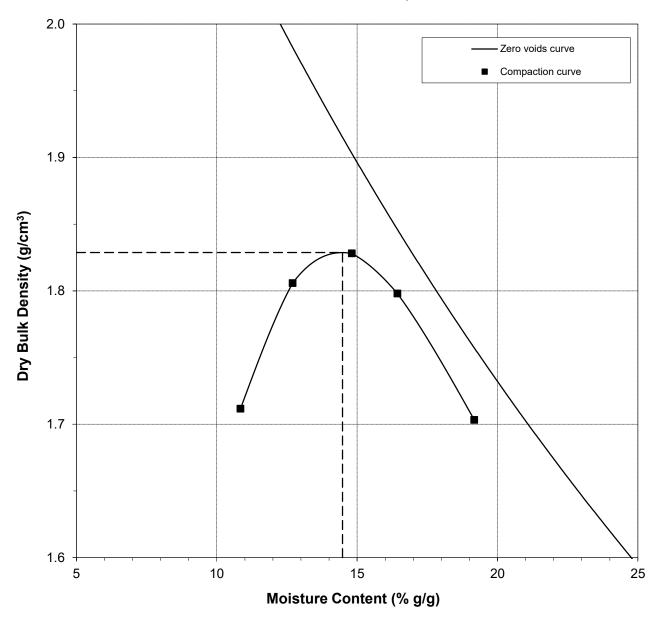


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: T/O Auger Cuttings (1 & 2) (T/O-1 & T/O-3,4)

	Measured	Corrected
Optimum Moisture Content (% g/g):	14.5	
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.83	

Test Date: 16-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



### **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Mass of coarse material (g): 591.00

Sample Number: Topsoil North Cuttings (1 & 2)

Mass of fines material (g): 34020.00

Project Name: St. Anthony Geotech Investigation Mold weight (g): 4226
PO Number: 233001076-DBS Mold volume (cm³): 942.46

Trainisci. 2000 for 6 BBC

Test Date: 17-May-18 Compaction Method: Standard A

Preparation Method: Dry

Split (3/4", 3/8", #4): #4

As Received Moisture Content (% g/g): NA

Type of Rammer: Mechanical

	Weight of Mold and Compacted Soil	Weight of Container and Wet Soil	Weight of Container and Dry Soil	Weight of Container	Dry Bulk Density	Moisture Content
Trial	(g)	(g)	(g)	(g)	(g/cm³)	(% g/g)
1	6064	996.39	937.78	268.08	1.79	8.75
2	6162	1063.65	988.83	291.63	1.86	10.73
3	6237	1016.08	933.26	289.17	1.89	12.86
4	6179	1055.57	954.88	269.83	1.81	14.70
5	6121	1195.75	1063.30	292.88	1.72	17.19

Soil Fractions

**Properties of Coarse Material** 

Coarse Fraction (% g/g): 1.7 Fines Fraction (% g/g): 98.3 Assumed particle density (g/cm<sup>3</sup>): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

### Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk	Moisture
	Density of	Content of
	Composite	Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1		
2		
3		
4		
5		

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

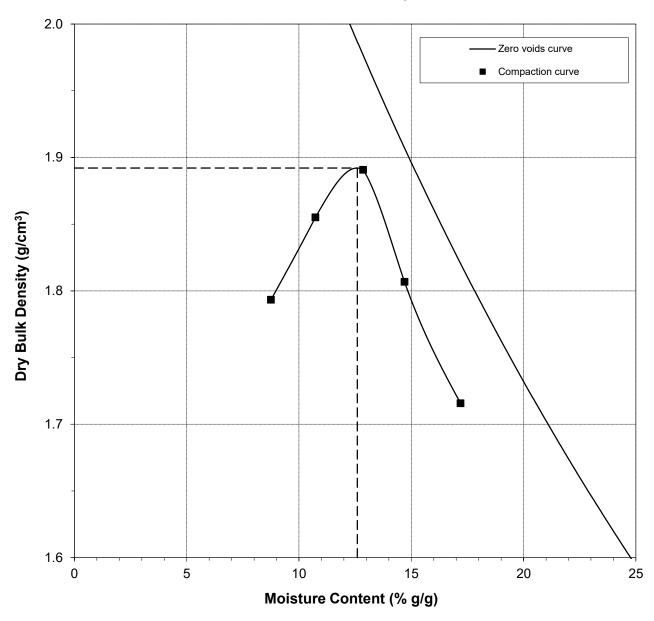


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: Topsoil North Cuttings (1 & 2)

	Measured	Corrected
Optimum Moisture Content (% g/g):	12.6	
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.89	

Test Date: 17-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



### **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc

1059.23

1147.62

Split (3/4", 3/8", #4): #4

Job Number: DB18.1151.00

Mass of coarse material (g): 337.52

Sample Number: Borrow South Cuttings (1 & 2)

Mass of fines material (g): 46770.00

Project Name: St. Anthony Geotech Investigation

Mold weight (g): 4226

PO Number: 233001076-DBS

Mold valuma (am<sup>3</sup>): 040.4

Mold volume (cm<sup>3</sup>): 942.46

Test Date: 23-May-18

As Received Moisture Content (% g/g): NA

Compaction Method: Standard A

Preparation Method: Dry

1.82

1.74

14.83

17.00

Type of Rammer: Mechanical

	Weight of Mold and Compacted Soil	Weight of Container and Wet Soil	Weight of Container and Dry Soil	Weight of Container	Dry Bulk Density	Moisture Content
Trial	(g)	(g)	(g)	(g)	(g/cm³)	(% g/g)
1	5947	979.08	925.82	286.94	1.69	8.34
2	6077	1068.89	996.06	293.36	1.78	10.36
3	6186	1143.03	1047.75	300.24	1.84	12.75

959.03

1022.92

Soil Fractions

6197

6143

**Properties of Coarse Material** 

Coarse Fraction (% g/g): 0.7 Fines Fraction (% g/g): 99.3

4

5

Assumed particle density (g/cm<sup>3</sup>): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

283.30

289.53

Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk	Moisture
	Density of	Content of
	Composite	Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1		
2		
3		
4		
5		

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

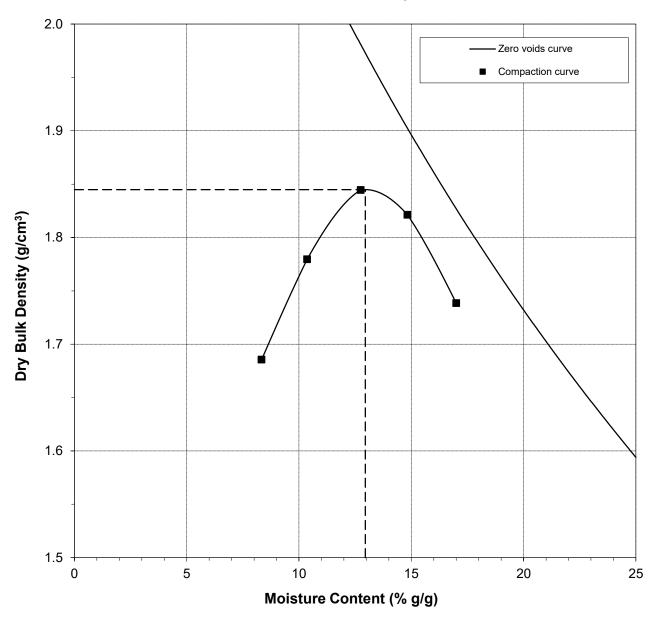


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: Borrow South Cuttings (1 & 2)

	Measured	Corrected
Optimum Moisture Content (% g/g):	13.0	
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.84	

Test Date: 23-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



### **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc Split (3/4", 3/8", #4): #4

Job Number: DB18.1151.00 Mass of coarse material (g): 5710.40 Sample Number: Topsoil South Cuttings (1 & 2) (TS-2 & TSMB,\$4) of fines material (g): 24015.18

Project Name: St. Anthony Geotech Investigation Mold weight (g): 4226
PO Number: 233001076-DBS Mold volume (cm³): 942.46

Test Date: 16-May-18 Compaction Method: Standard A

Preparation Method: Dry

As Received Moisture Content (% g/g): NA

Type of Rammer: Mechanical

	Weight of	Weight of	Weight of			
	Mold and Compacted Soil	Container and Wet Soil	Container and Dry Soil	Weight of Container	Dry Bulk Density	Moisture Content
	•		•		,	
Trial	(g)	(g)	(g)	(g)	(g/cm <sup>3</sup> )	(% g/g)
1	6038	1126.72	1054.15	296.93	1.75	9.58
2	6097	1085.79	1004.40	284.58	1.78	11.31
3	6160	1015.23	924.00	267.30	1.80	13.89
4	6181	994.82	892.02	289.75	1.77	17.07
5	6124	1073.18	954.74	296.46	1.71	17.99

Soil Fractions

**Properties of Coarse Material** 

Coarse Fraction (% g/g): 19.2 Fines Fraction (% g/g): 80.8 Assumed particle density (g/cm<sup>3</sup>): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

### Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk	Moisture
	Density of	Content of
	Composite	Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1	1.88	7.74
2	1.90	9.13
3	1.92	11.22
4	1.89	13.79
5	1.83	14.54

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

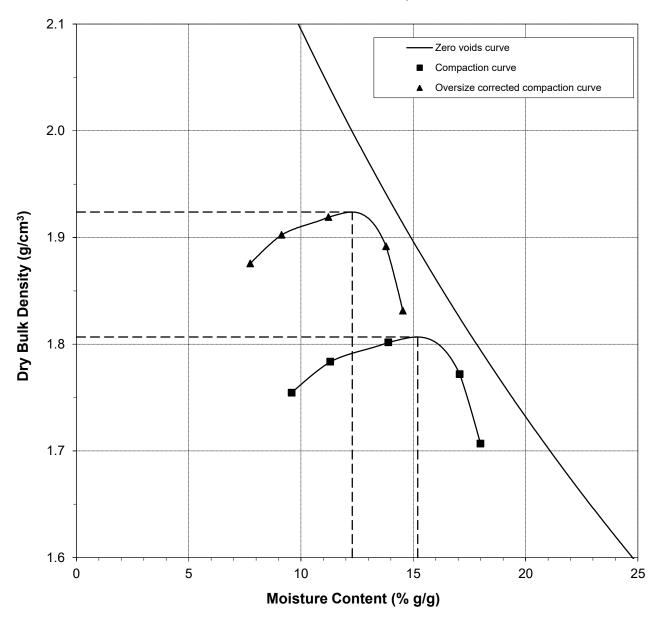


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: Topsoil South Cuttings (1 & 2) (TS-2 & TS-3,4)

	Measured	Corrected
Optimum Moisture Content (% g/g):	15.2	12.3
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.81	1.92

Test Date: 16-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



### **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc Split (3/4", 3/8", #4): #4

Job Number: DB18.1151.00 Mass of coarse material (g): 699.80 Mass of fines material (g): 44700.00 Sample Number: Borrow West Auger Cuttings (1 & 2)

Project Name: St. Anthony Geotech Investigation Mold weight (g): 4226

Mold volume (cm<sup>3</sup>): 942.46 PO Number: 233001076-DBS

Compaction Method: Standard A Test Date: 23-May-18

Preparation Method: Dry

Type of Rammer: Mechanical As Received Moisture Content (% g/g): NA

	Weight of Mold and Compacted Soil	Weight of Container and Wet Soil	Weight of Container and Dry Soil	Weight of Container	Dry Bulk Density	Moisture Content
Trial	(g)	(g)	(g)	(g)	(g/cm <sup>3</sup> )	(% g/g)
1	5996	993.18	936.74	268.32	1.73	8.44
2	6120	1052.40	976.47	267.86	1.82	10.72
3	6211	977.97	899.31	270.20	1.87	12.50
4	6203	1078.97	975.04	269.32	1.83	14.73
5	6129	1070.18	955.15	268.21	1.73	16.75

Soil Fractions

**Properties of Coarse Material** Assumed particle density (g/cm<sup>3</sup>): 2.65 Coarse Fraction (% g/g): 1.5

Fines Fraction (% g/g): 98.5 Assumed Initial Moisture Content (% g/g): 0.0

### Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk	Moisture
	Density of	Content of
	Composite	Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1		
2		
3		
4		
5		

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

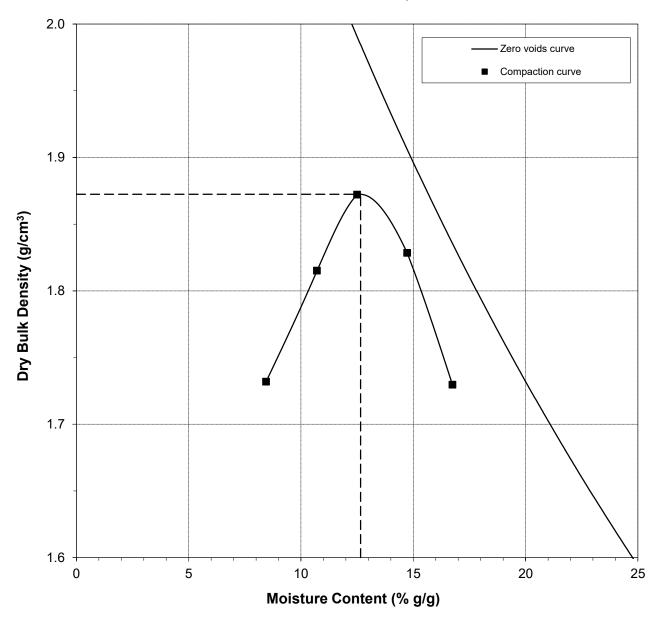


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: Borrow West Auger Cuttings (1 & 2)

	Measured	Corrected
Optimum Moisture Content (% g/g):	12.7	
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.87	

Test Date: 23-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



## **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc Split (3/4", 3/8", #4): #4

Job Number: DB18.1151.00 Mass of coarse material (g): 793.10
Sample Number: P1-2 Auger Cuttings Mass of fines material (g): 20670.00

Project Name: St. Anthony Geotech Investigation Mold weight (g): 4226

Test Date: 23-May-18 Compaction Method: Standard A

Preparation Method: Dry

As Received Moisture Content (% g/g): NA

Type of Rammer: Mechanical

	Weight of	Weight of	Weight of			
	Mold and	Container and	Container and	Weight of	Dry Bulk	Moisture
	Compacted Soil	Wet Soil	Dry Soil	Container	Density	Content
Trial	(g)	(g)	(g)	(g)	(g/cm <sup>3</sup> )	(% g/g)
1	5992	939.86	883.72	284.26	1.71	9.37
2	6096	1025.24	953.81	288.60	1.79	10.74
3	6166	959.37	880.64	269.61	1.82	12.88
4	6158	1079.80	974.79	284.78	1.78	15.22
5	6107	976.63	872.96	284.13	1.70	17.61

Soil Fractions

Properties of Coarse Material

Coarse Fraction (% g/g): 3.7 Fines Fraction (% g/g): 96.3 Assumed particle density (g/cm³): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

### Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk	Moisture
	Density of	Content of
	Composite	Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1		
2		
3		
4		
5		

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

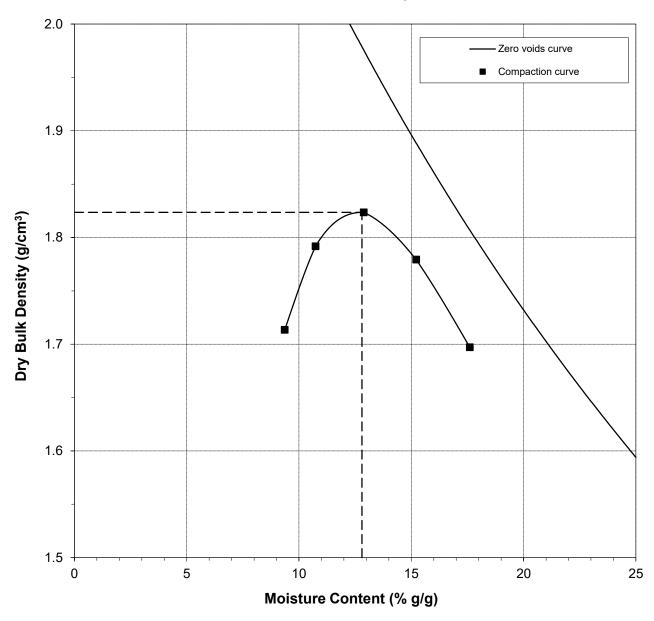


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: P1-2 Auger Cuttings

	Measured	Corrected
Optimum Moisture Content (% g/g):	12.8	
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.82	

Test Date: 23-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



### **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc Split (3/4", 3/8", #4): #4

Job Number: DB18.1151.00 Mass of coarse material (g): 2644.40 Sample Number: P3 Auger Cuttings (1 & 2) Mass of fines material (g): 36609.20

Project Name: St. Anthony Geotech Investigation Mold weight (g): 4226

Test Date: 17-May-18 Compaction Method: Standard A

Preparation Method: Dry

As Received Moisture Content (% g/g): NA

Type of Rammer: Mechanical

	Weight of Mold and Compacted Soil	Weight of Container and Wet Soil	Weight of Container and Dry Soil	Weight of Container	Dry Bulk Density	Moisture Content
Trial	(g)	(g)	(g)	(g)	(g/cm <sup>3</sup> )	(% g/g)
1	6095	968.15	927.41	298.44	1.86	6.48
2	6185	1116.67	1054.91	292.84	1.92	8.10
3	6258	1191.07	1109.22	283.88	1.96	9.92
4	6246	1167.22	1073.30	294.43	1.91	12.06
5	6182	1228.99	1112.04	286.79	1.82	14.17

Soil Fractions

**Properties of Coarse Material** 

Coarse Fraction (% g/g): 6.7 Fines Fraction (% g/g): 93.3 Assumed particle density (g/cm<sup>3</sup>): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

### Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk	Moisture
	Density of	Content of
	Composite	Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1	1.90	6.04
2	1.96	7.56
3	2.00	9.25
4	1.95	11.25
5	1.86	13.22

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

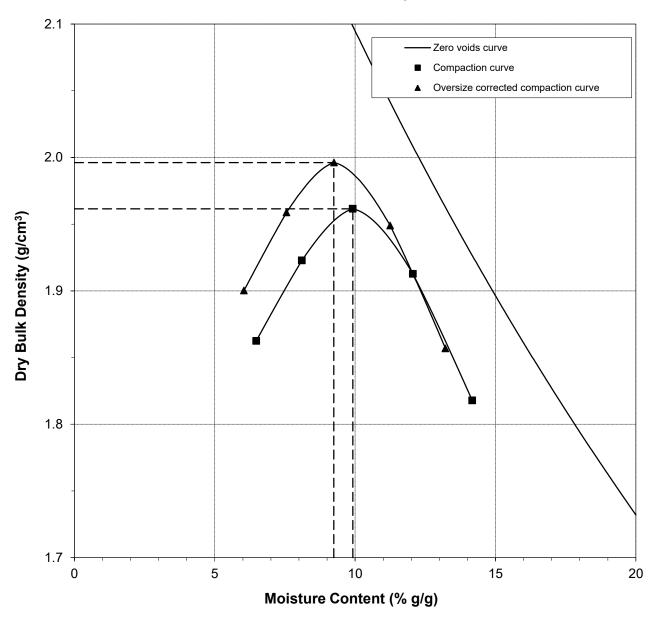


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: P3 Auger Cuttings (1 & 2)

	Measured	Corrected
Optimum Moisture Content (% g/g):	9.9	9.2
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.96	2.00

Test Date: 17-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



## **Proctor Compaction Data**

Job Name: Stantec Consulting Services Inc Split (3/4", 3/8", #4): #4

Job Number: DB18.1151.00 Mass of coarse material (g): 7810.70

Sample Number: P4 Auger Cuttings (1 & 2)

Mass of fines material (g): 32410.00

Project Name: St. Anthony Geotech Investigation Mold weight (g): 4226
PO Number: 233001076-DBS Mold volume (cm³): 942.46

Test Date: 23-May-18 Compaction Method: Standard A

Preparation Method: Dry

As Received Moisture Content (% g/g): NA

Type of Rammer: Mechanical

	Weight of Mold and	Weight of Container and	Weight of Container and	Weight of	Dry Bulk	Moisture
	Compacted Soil	Wet Soil	Dry Soil	Container	Density	Content
Trial	(g)	(g)	(g)	(g)	(g/cm <sup>3</sup> )	(% g/g)
1	6021	1062.03	1016.33	283.72	1.79	6.24
2	6138	1145.66	1078.20	269.57	1.87	8.34
3	6236	1004.05	935.64	269.39	1.93	10.27
4	6265	1028.30	946.86	282.76	1.93	12.26
5	6192	1002.37	912.55	284.64	1.82	14.30

Soil Fractions

Properties of Coarse Material

Coarse Fraction (% g/g): 19.4 Fines Fraction (% g/g): 80.6 Assumed particle density (g/cm<sup>3</sup>): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

### Oversize Corrected Values for Dry Bulk Density and Moisture Content

	Dry Bulk Density of Composite	Moisture Content of Composite
Trial	(g/cm <sup>3</sup> )	(% g/g)
1	1.91	5.03
2	1.98	6.72
3	2.04	8.27
4	2.03	9.88
5	1.94	11.53

<sup>--- =</sup> Oversize correction is unnecessary since coarse fraction < 5% of composite mass

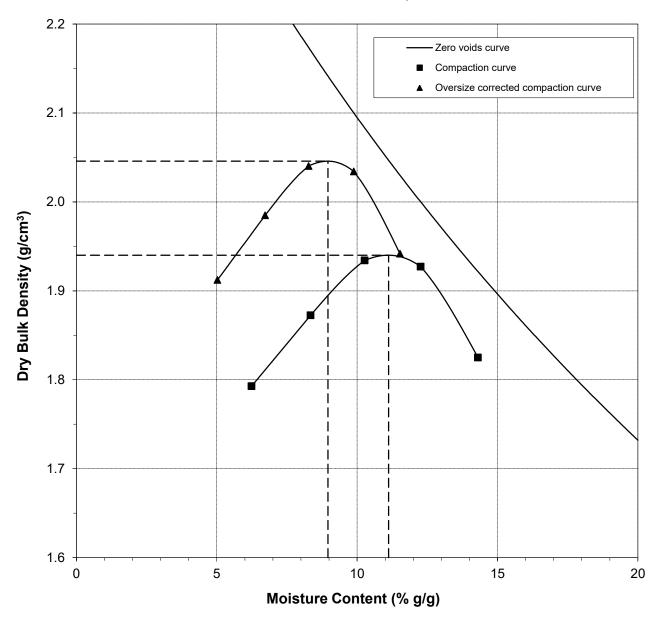


## **Proctor Compaction Data Points with Fitted Curve**

Sample Number: P4 Auger Cuttings (1 & 2)

	Measured	Corrected
Optimum Moisture Content (% g/g):	11.1	9.0
Maximum Dry Bulk Density (g/cm <sup>3</sup> ):	1.94	2.05

Test Date: 23-May-18



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

**Consolidated Undrained Testing** 

## **Summary of Consolidated Undrained (CU) Triaxial Shear Testing**

Sample Number	Effective Consolidation Stress (psi)	Effective Minor Stress at Failure (psi)	Effective Major Stress at Failure (psi)	Pore-Water Pressure at Failure (psi)	Total Minor Stress at Failure (psi)	Total Major Stress at Failure (psi)	% Strain at Failure* (%)
L2-1 (15'A) CU Stage 1 (6.0 psi)	6.0	2.5	8.4	75.0	77.6	83.4	2.12
L2-1 (15'A) CU Stage 2 (12.0 psi)	12.0	5.0	18.0	78.6	83.6	96.6	2.96
L2-1 (15'A) CU Stage 3 (24.0 psi)	24.0	9.6	35.8	86.1	95.6	121.9	7.73
L2-5 (5'B) CU Stage 1 (2.0 psi)	2.0	0.7	5.2	81.9	82.7	87.1	1.88
L2-5 (5'B) CU Stage 2 (4.0 psi)	4.0	2.0	9.4	82.5	84.6	91.9	0.97
L2-5 (5'B) CU Stage 3 (8.0 psi)	8.0	3.3	15.4	85.4	88.7	100.9	1.13
L2-6 (10'B) CU Stage 1 (3.5 psi)	3.5	2.1	3.5	83.0	85.1	86.4	0.69
L2-6 (10'B) CU Stage 2 (7.1 psi)	7.1	3.2	10.3	85.5	88.6	95.8	3.02
L2-6 (10'B) CU Stage 3 (14.0 psi)	14.0	6.0	22.4	89.7	95.7	112.1	11.74

<sup>\*</sup>Noted percent strain used as failure criterion.

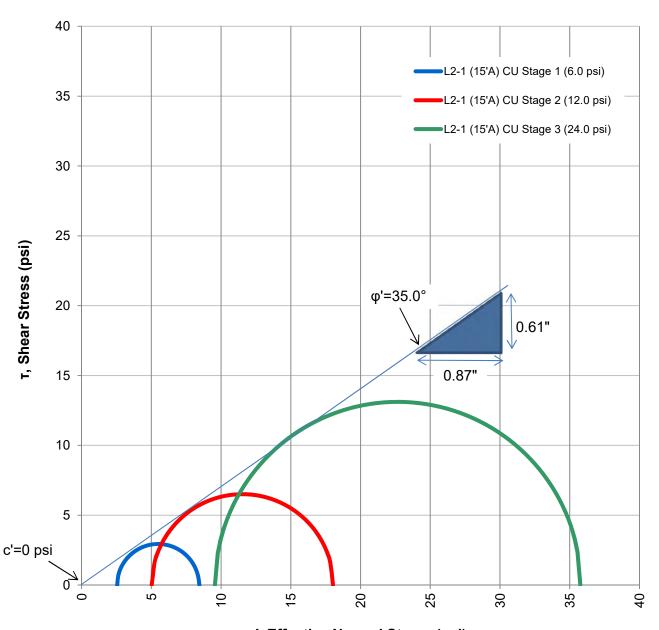
# Summary of Consolidated Undrained Estimated Effective Friction Angle and Cohesion

	c' Cohesion	φ' Friction Angle
Sample Number	(psi)	(°)
L2-1 (15'A) CU	0	35
L2-5 (5'B) CU	0.9	35.8
L2-6 (10'B) CU	0	32.3

<sup>&</sup>lt;sup>1</sup>The cohesion and friction angle provided represent one possible interpretation of a Mohr-Coulomb failure envelope. Qualified persons familiar with the material and the site should evaluate the test results independently prior to use in the intended application.

## Mohr's Circles: Effective

## L2-1 (15'A) CU



σ', Effective Normal Stress (psi)

# Estimated Effective Mohr-Coulomb Failure Parameters<sup>1</sup>:

cohesion (c')(psi) = 0 friction angle  $(\phi')(^\circ)$  = 35.0

<sup>&</sup>lt;sup>1</sup>The cohesion and friction angle provided represent one possible interpretation of a Mohr-Coulomb failure envelope. Qualified persons familiar with the material and the site should evaluate the test results independently prior to use in the intended application.

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-1 (15'A) CU

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### **Remolded or Initial Sample Properties**

Initial Mass (g): 389.62

Length (cm): 11.35

Diameter (cm): 4.89

Area (cm<sup>2</sup>): 18.80

Volume (cm<sup>3</sup>): 213.46

Dry Mass (g): 371.07

Dry Density (g/cm<sup>3</sup>): 1.74

Dry Unit Weight (lbf/ft<sup>3</sup>): 108.53

Equivalent Height of Solids (cm): 7.45

Water Content (%, g/g): 5.0

Water Content (%, vol): 8.7

Water Content Based On: ☐ Cuttings ☑ Whole Specimen

Porosity (%, vol): 34.4

Void Ratio (e): 0.524

Saturation (%): 25.3

### **Test and Sample Conditions**

Height to Diameter Ratio: 2.3

Largest Particle Dimension (approx.) (cm): 0.475

Diameter to Largest Particle Ratio (approx.): 10.30

Visual Description of Sample: Silt-Consolidated

USCS Classification: NA

Plastic Limit: NA

Liquid Limit: NA

Sample Preparation:  $\ oxdot$  In situ sample, extruded  $\ oxdot$  Remolded Sample

Trimming Procedure: NA

Split: NA

Percent Coarse Material (%): <5%

Particle Density (g/cm<sup>3</sup>): 2.65 ☑ Assumed ☐ Measured

B-Value Post Saturation: 0.99

Method for Specimen Saturation: ☐ Dry ☑ Wet

Laboratory analysis by: D. O'Dowd

Data entered by: C. Krous

Checked by: J. Hines



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-1 (15'A) CU

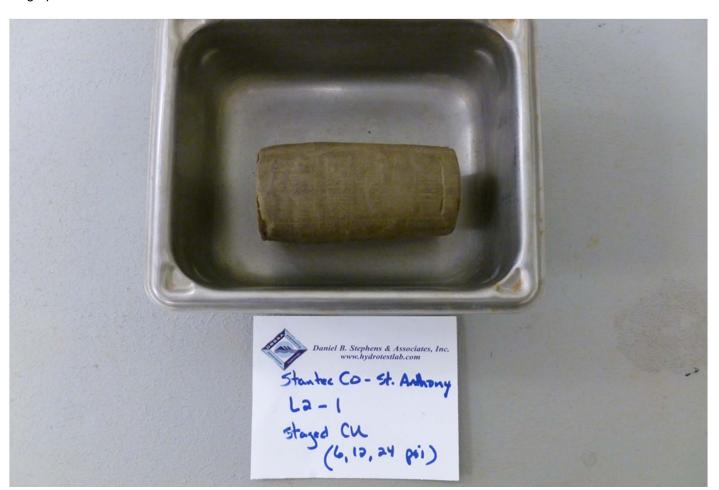
Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Remarks on Failure: Buldge failure.

General Notes: The entire sample was extruded and subjected to CU triaxial shear testing.

### Photograph of Failure



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 1 (6.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Stage 1

Date/Time Shear Initiated: 6/14/18 1240 Date/Time Shear Completed: 6/14/18 1255

#### **Consolidation Data**

Length (cm): 11.08

Diameter (cm): 4.89

Measured outflow (cm<sup>3</sup>): 5.04

Area (cm2): 18.80

Area Determined by Method: ☑ A ☐ B

Volume (cm<sup>3</sup>): 208.42

Dry Density (g/cm<sup>3</sup>): 1.78

Dry Unit Weight (lbf/ft<sup>3</sup>): 111.15

Equivalent Height of Solids (cm): 7.45

Porosity (%, vol): 32.8

Void Ratio (e): 0.488

Time to 50% Primary Consol. (t50) (min): 0.7

### **Shear Data**

Effective Consolidation Stress (psi): 5.98

Total Back Pressure (psi): 71.58

Failure Criterion: Peak

Deviator Stress at Failure (psi): 5.9

Effective Minor Stress at Failure (psi): 2.5

Effective Major Stress at Failure (psi): 8.4

Membrane Correction Required/Applied: ☐ Yes ☑ No

Axial Strain (ε) at Failure (%): 2.12

Strain Rate (%/hr): 8.5

### Test Notes:

Test was halted prior to reaching a maximum target of 3% strain, after a reduction in deviator stress was recorded. Failure was interpreted as the peak deviator stress achieved.

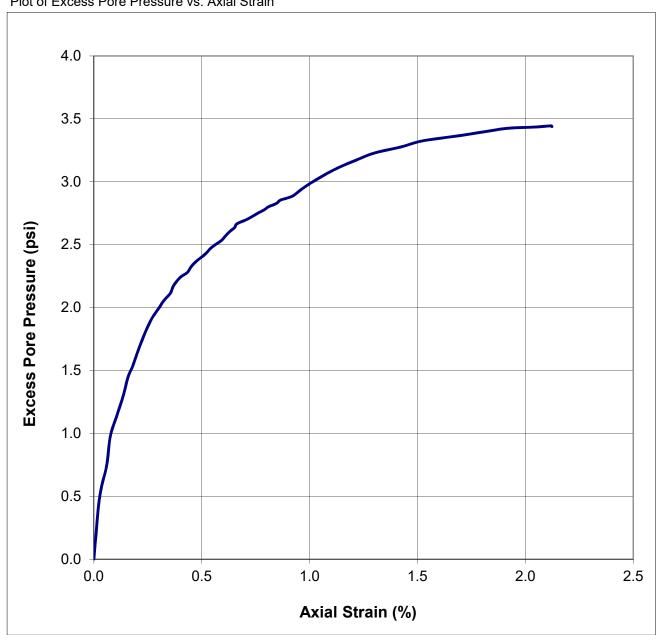
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 1 (6.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Plot of Excess Pore Pressure vs. Axial Strain



Job Name: Stantec Consulting Services Inc

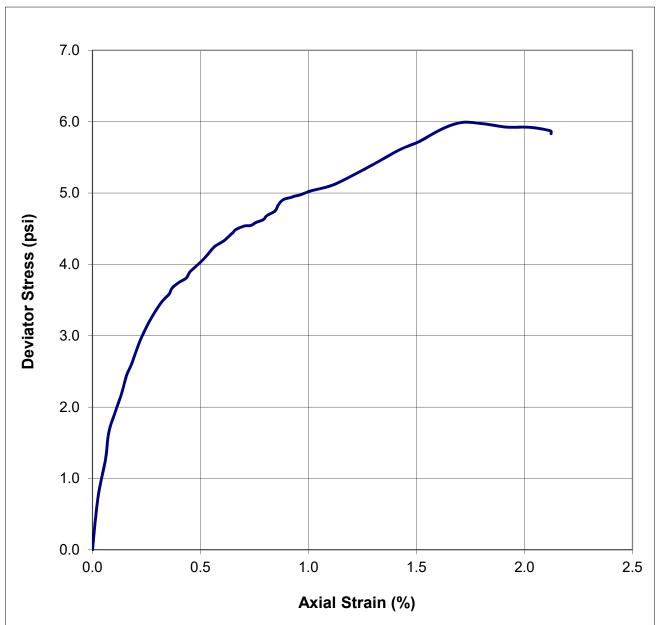
Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 1 (6.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Plot of Deviator Stress vs. Axial Strain



Job Name: Stantec Consulting Services Inc

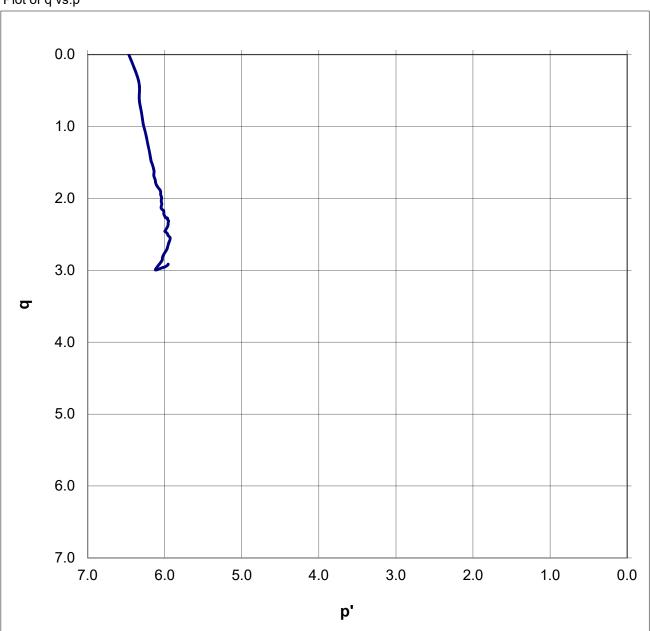
Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 1 (6.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS







Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 1 (6.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### **Raw Data**

Pore Pressure Strain Stress Stress Pore Pressure Strain Stress Str					Data			
(psi)		Axial	Effective Major	Effective Minor		Axial	Effective Major	Effective Minor
71.58         0.00         5.98         5.98           72.03         0.06         0.03         6.22         5.49           72.33         0.06         6.48         5.21           72.55         0.08         6.64         4.99           72.73         0.11         6.77         4.82           72.88         0.14         6.86         4.66           73.02         0.16         6.96         4.52           73.23         0.20         7.10         4.31           73.23         0.20         7.10         4.31           73.34         0.24         7.21         4.13           73.56         0.30         7.34         3.97           73.56         0.30         7.34         3.97           73.59         0.35         7.42         3.84           73.75         0.37         7.45         3.78           73.82         0.40         7.46         3.71           73.85         0.43         7.47         3.62           73.91         0.45         7.52         3.62           73.93         0.45         7.53         3.62           74.00         0.51         7.63								Stress
72.06 0.03 6.22 5.49 72.33 0.06 6.48 5.21 72.55 0.08 6.64 4.99 72.73 0.11 6.77 4.82 72.28 0.14 6.86 4.66 73.02 0.16 6.96 4.52 73.12 0.18 7.03 4.42 73.32 0.20 7.10 4.31 73.32 0.22 7.17 4.21 73.41 0.24 7.21 4.13 73.49 0.27 7.27 4.04 73.56 0.30 7.34 3.97 73.63 0.33 7.38 3.89 73.89 0.35 7.42 3.84 73.75 0.37 7.45 3.78 73.86 0.43 7.47 3.67 73.91 0.45 7.52 3.62 73.96 0.48 7.55 3.57 74.00 0.51 7.60 3.52 74.05 0.54 7.63 3.47 74.10 0.85 7.76 3.30 74.11 0.59 7.70 3.40 74.11 0.59 7.70 3.40 74.11 0.59 7.70 3.40 74.11 0.59 7.70 3.40 74.11 0.59 7.70 3.40 74.11 0.59 7.70 3.40 74.11 0.59 7.70 3.40 74.14 0.66 7.76 3.30 74.14 0.68 7.76 3.30 74.14 0.68 7.76 3.30 74.14 0.68 7.76 3.30 74.15 0.68 7.77 3.18 74.24 0.66 7.78 3.21 74.25 0.68 7.77 3.24 74.30 0.73 7.75 3.21 74.31 0.85 7.85 3.10 74.44 0.89 7.97 3.00 74.46 0.92 7.97 3.00 74.47 0.98 7.97 3.00 74.48 0.93 7.97 3.00 74.49 0.93 7.97 3.00 74.44 0.89 7.97 3.00 74.45 0.99 7.99 2.96 74.47 1.11 8.00 2.89 74.48 1.31 8.19 2.78 74.98 1.81 8.58 2.61 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.42 2.55					(psi)	(%)	(psi)	(psi)
72.33         0.06         6.48         5.21           72.73         0.11         6.77         4.82           72.73         0.14         6.86         4.66           73.02         0.16         6.96         4.52           73.12         0.18         7.03         4.42           73.23         0.20         7.10         4.31           73.341         0.24         7.21         4.13           73.49         0.27         7.27         4.04           73.56         0.30         7.34         3.97           73.68         0.30         7.34         3.99           73.89         0.35         7.42         3.84           73.75         0.37         7.45         3.78           73.86         0.40         7.46         3.77           73.86         0.43         7.47         3.67           73.96         0.48         7.55         3.57           74.00         0.51         7.50         3.34           74.05         0.54         7.63         3.47           74.06         0.54         7.63         3.47           74.10         0.50         7.68         3.44								
72.55								
72.73         0.11         6.77         4.82           72.88         0.14         6.86         4.66           73.02         0.16         6.96         4.52           73.23         0.20         7.10         4.31           73.23         0.22         7.17         4.21           73.41         0.24         7.21         4.13           73.46         0.27         7.27         4.04           73.56         0.30         7.34         3.97           73.63         0.33         7.38         3.89           73.89         0.35         7.42         3.84           73.75         0.37         7.45         3.78           73.80         0.35         7.42         3.84           73.75         0.37         7.45         3.78           73.82         0.40         7.46         3.71           73.86         0.43         7.55         3.67           74.05         0.45         7.52         3.62           73.96         0.48         7.55         3.57           74.05         0.54         7.63         3.47           74.11         0.59         7.76         3.24								
72.88 0.14 6.86 4.66 73.02 0.16 6.96 4.52 73.12 0.18 7.03 4.42 73.23 0.20 7.10 4.31 73.32 0.22 7.17 4.21 73.41 0.24 7.21 4.13 73.49 0.27 7.27 4.04 73.56 0.30 7.34 3.97 73.63 0.33 7.38 3.89 73.69 0.35 7.42 3.84 73.75 0.37 7.45 3.78 73.82 0.40 7.46 3.71 73.86 0.43 7.47 3.67 73.91 0.45 7.52 3.62 73.99 0.46 7.52 3.62 73.91 0.45 7.52 3.62 74.00 0.51 7.60 3.52 74.00 0.54 7.63 3.47 74.01 0.59 7.70 3.36 74.10 0.60 7.73 3.40 74.11 0.59 7.70 3.36 74.19 0.63 7.73 3.33 74.21 0.65 7.75 3.30 74.21 0.65 7.75 3.30 74.22 0.66 7.76 3.27 74.27 0.70 7.77 3.24 74.30 0.73 7.75 3.21 74.31 0.76 7.77 3.18 74.32 0.79 7.77 3.18 74.33 0.76 7.77 3.18 74.34 0.86 7.92 3.07 74.44 0.86 7.92 3.07 74.44 0.86 7.92 3.07 74.44 0.86 7.92 3.07 74.44 0.86 7.92 3.07 74.44 0.86 7.92 3.07 74.44 0.86 7.92 3.07 74.45 0.99 7.78 3.15 74.48 0.93 7.97 3.00 74.48 0.92 7.97 3.00 74.48 0.93 7.97 3.00 74.48 0.93 7.97 3.00 74.48 0.93 7.97 3.00 74.48 0.93 7.97 3.00 74.48 0.93 7.97 3.00 74.49 0.96 7.97 3.00 74.55 0.99 7.98 2.97 74.47 1.11 8.00 2.89 74.48 1.31 8.19 2.78 74.90 1.52 8.41 2.69 74.93 1.81 8.58 2.61 74.98 1.81 8.58 2.61 74.98 1.81 8.58 2.61 74.98 1.81 8.58 2.61 75.00 1.92 8.50 2.58 75.01 2.02 8.49 2.57								
73.02								
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73.23 0.20 7.10 4.31 7.323 0.20 7.17 4.21 7.341 0.24 7.21 4.13 7.341 0.24 7.21 4.13 7.341 0.24 7.21 4.13 7.341 0.24 7.349 0.27 7.27 4.04 7.356 0.30 7.34 3.97 7.356 0.30 7.34 3.97 7.363 0.33 7.38 3.89 7.369 0.35 7.42 3.84 7.375 0.37 7.45 3.78 7.362 0.40 7.46 3.71 7.366 0.43 7.47 3.67 7.391 0.45 7.52 3.62 7.396 0.48 7.55 3.57 7.40 0.51 7.60 3.52 7.40 0.51 7.60 3.52 7.40 0.51 7.60 3.52 7.40 0.55 7.70 3.40 7.41 0.59 7.70 3.40 7.41 0.59 7.70 3.40 7.41 0.60 0.56 7.68 3.44 7.41 0.59 7.70 3.40 7.41 0.60 0.56 7.68 3.44 7.41 0.59 7.70 3.40 7.41 0.63 7.73 3.33 7.42 0.66 7.75 3.30 7.42 0.66 7.76 3.27 7.42 0.66 7.76 3.27 7.42 0.66 7.76 3.27 7.43 0.0 7.3 7.75 3.21 7.43 0.0 7.3 7.75 3.21 7.43 0.0 7.3 7.75 3.21 7.43 0.0 7.3 7.75 3.21 7.43 0.0 7.3 7.75 3.21 7.43 0.0 0.73 7.75 3.21 7.43 0.0 0.73 7.75 3.21 7.44 0.86 7.97 7.78 3.15 7.44 0.86 7.97 7.79 3.06 7.77 3.18 7.44 0.86 7.97 7.78 3.15 7.44 0.88 7.99 7.99 3.00 7.99 7.78 3.15 7.44 0.89 7.99 7.99 3.00 7.45 0.99 7.99 3.00 7.45 0.99 7.99 7.99 7.99 7.99 7.99 7.99 7.99								
73.32 0.22 7.17 4.21 73.49 0.24 7.21 4.13 73.49 0.27 7.27 4.04 73.68 0.30 7.34 3.97 73.68 0.33 7.38 3.89 73.69 0.35 7.42 3.84 73.75 0.37 7.45 3.78 73.82 0.40 7.46 3.71 73.86 0.43 7.47 3.67 73.91 0.45 7.52 3.62 73.99 0.48 7.55 3.57 74.00 0.51 7.60 3.52 74.00 0.51 7.60 3.52 74.08 0.56 7.68 3.44 74.11 0.59 7.70 3.40 74.16 0.61 7.70 3.36 74.21 0.65 7.75 3.30 74.21 0.65 7.76 3.27 74.27 0.70 7.77 3.24 74.30 0.73 7.75 3.21 74.33 0.76 7.77 3.18 74.36 0.79 7.78 3.15 74.44 0.86 7.92 3.07 74.44 0.89 7.97 3.06 74.44 0.89 7.97 3.06 74.44 0.89 7.97 3.06 74.44 0.89 7.97 3.06 74.45 0.99 7.98 2.97 74.57 1.01 8.00 2.89 74.57 1.01 8.00 2.89 74.58 1.41 8.59 2.96 74.67 1.11 8.00 2.89 74.59 1.71 8.63 2.64 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.41 2.69 74.99 1.52 8.49 2.57 75.00 2.02 8.49 2.57								
73.41         0.24         7.21         4.13           73.49         0.27         7.27         4.04           73.56         0.30         7.34         3.97           73.69         0.35         7.42         3.84           73.75         0.37         7.45         3.78           73.86         0.43         7.47         3.67           73.91         0.45         7.52         3.62           73.96         0.48         7.55         3.57           74.00         0.51         7.60         3.52           74.05         0.54         7.63         3.47           74.08         0.56         7.68         3.44           74.11         0.59         7.70         3.40           74.12         0.63         7.73         3.33           74.21         0.65         7.75         3.30           74.22         0.70         7.76         3.27           74.23         0.76         7.75         3.30           74.24         0.66         7.76         3.21           74.30         0.73         7.75         3.21           74.33         0.76         7.77         3.18								
73.49         0.27         7.27         4.04           73.56         0.30         7.34         3.97           73.63         0.33         7.38         3.89           73.75         0.37         7.45         3.78           73.82         0.40         7.46         3.71           73.86         0.43         7.47         3.67           73.91         0.45         7.52         3.62           73.96         0.48         7.55         3.57           74.00         0.51         7.60         3.52           74.05         0.54         7.63         3.47           74.09         0.54         7.63         3.47           74.10         0.54         7.63         3.44           74.11         0.59         7.70         3.40           74.19         0.63         7.73         3.33           74.21         0.65         7.75         3.30           74.22         0.70         7.77         3.24           74.23         0.73         7.75         3.21           74.33         0.76         7.77         3.18           74.36         0.79         7.78         3.15								
73.56								
73.63								
73.69								
73.75         0.37         7.45         3.78           73.82         0.40         7.46         3.71           73.86         0.43         7.47         3.67           73.96         0.48         7.52         3.62           73.96         0.48         7.55         3.57           74.00         0.51         7.60         3.52           74.05         0.54         7.63         3.47           74.08         0.56         7.68         3.44           74.11         0.59         7.70         3.40           74.16         0.61         7.70         3.40           74.19         0.63         7.73         3.33           74.21         0.65         7.76         3.27           74.27         0.70         7.77         3.24           74.27         0.70         7.77         3.18           74.33         0.76         7.77         3.18           74.34         0.79         7.78         3.15           74.33         0.81         7.81         3.15           74.44         0.85         7.85         3.10           74.44         0.89         7.97         3.06								
73.82       0.40       7.46       3.71         73.86       0.43       7.47       3.67         73.91       0.45       7.52       3.62         73.96       0.48       7.55       3.57         74.00       0.51       7.60       3.52         74.05       0.54       7.63       3.47         74.08       0.56       7.68       3.44         74.11       0.59       7.70       3.36         74.16       0.61       7.70       3.36         74.19       0.63       7.75       3.30         74.21       0.65       7.75       3.30         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.04         74.44       0.89       7.97       3.04         74.44       0.89       7.97       3.04         74.45								
73.86       0.43       7.47       3.67         73.91       0.45       7.52       3.62         73.96       0.48       7.55       3.57         74.00       0.51       7.60       3.52         74.05       0.54       7.63       3.47         74.08       0.56       7.68       3.44         74.11       0.59       7.70       3.40         74.14       0.61       7.70       3.36         74.19       0.63       7.73       3.33         74.21       0.65       7.75       3.23         74.22       0.70       7.77       3.24         74.33       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.15         74.44       0.85       7.85       3.10         74.43       0.86       7.92       3.06         74.44       0.89       7.97       3.04         74.44       0.89       7.97       3.04         74.44       0.89       7.97       3.00         74.46								
73.91       0.45       7.52       3.62         73.96       0.48       7.55       3.57         74.00       0.51       7.60       3.52         74.05       0.54       7.63       3.47         74.08       0.56       7.68       3.44         74.11       0.59       7.70       3.40         74.16       0.61       7.70       3.36         74.19       0.63       7.75       3.33         74.21       0.65       7.75       3.30         74.24       0.66       7.76       3.27         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.34       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.44       0.89       7.97       3.06         74.55       0.99       7.97       3.00         74.55								
73.96         0.48         7.55         3.57           74.00         0.51         7.60         3.52           74.05         0.54         7.63         3.47           74.08         0.56         7.68         3.44           74.11         0.59         7.70         3.36           74.19         0.63         7.73         3.33           74.21         0.65         7.75         3.30           74.22         0.66         7.76         3.27           74.27         0.70         7.77         3.24           74.33         0.73         7.75         3.21           74.33         0.76         7.77         3.18           74.33         0.76         7.77         3.18           74.38         0.81         7.81         3.13           74.41         0.85         7.85         3.10           74.43         0.86         7.92         3.07           74.44         0.89         7.97         3.06           74.44         0.89         7.97         3.06           74.48         0.93         7.97         3.00           74.45         0.96         7.97         3.00								
74.00       0.51       7.60       3.52         74.05       0.54       7.63       3.47         74.08       0.56       7.68       3.44         74.11       0.59       7.70       3.40         74.16       0.61       7.70       3.36         74.19       0.63       7.73       3.33         74.21       0.65       7.75       3.30         74.24       0.66       7.76       3.27         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.43       0.81       7.81       3.13         74.44       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.04         74.48       0.93       7.97       3.02         74.55       0.99       7.98       2.97         74.57								
74.05       0.54       7.63       3.47         74.08       0.56       7.68       3.44         74.11       0.59       7.70       3.40         74.16       0.61       7.70       3.36         74.19       0.63       7.73       3.33         74.21       0.65       7.75       3.30         74.24       0.66       7.76       3.27         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.44       0.89       7.97       3.06         74.48       0.93       7.97       3.02         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.87       1.31       8.19       2.78         74.85								
74.08       0.56       7.68       3.44         74.11       0.59       7.70       3.40         74.16       0.61       7.70       3.36         74.19       0.63       7.73       3.33         74.21       0.65       7.75       3.30         74.24       0.66       7.76       3.27         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.44       0.89       7.97       3.04         74.48       0.93       7.97       3.02         74.45       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.57       1.01       7.99       2.96         74.81								
74.11       0.59       7.70       3.40         74.16       0.61       7.70       3.36         74.19       0.63       7.73       3.33         74.21       0.65       7.75       3.20         74.24       0.66       7.76       3.27         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.44       0.89       7.97       3.06         74.44       0.89       7.97       3.06         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.87       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90								
74.16       0.61       7.70       3.36         74.19       0.63       7.73       3.33         74.21       0.65       7.75       3.20         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.44       0.89       7.97       3.04         74.48       0.93       7.97       3.02         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.67       1.11       8.00       2.89         74.81       1.31       8.19       2.78         74.81       1.31       8.19       2.78         74.90       1.52       8.41       2.69         74.93								
74.19       0.63       7.73       3.33         74.21       0.65       7.75       3.30         74.24       0.66       7.76       3.27         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.46       0.92       7.97       3.04         74.48       0.93       7.97       3.02         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.87       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.82       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.98								
74.21       0.65       7.75       3.30         74.24       0.66       7.76       3.27         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.44       0.89       7.97       3.04         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.98								
74.24       0.66       7.76       3.27         74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.44       0.89       7.97       3.06         74.44       0.89       7.97       3.06         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.01       2.02       8.49       2.57         75.02								
74.27       0.70       7.77       3.24         74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.46       0.92       7.97       3.04         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.01								
74.30       0.73       7.75       3.21         74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.46       0.92       7.97       3.02         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01								
74.33       0.76       7.77       3.18         74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.46       0.92       7.97       3.04         74.48       0.93       7.97       3.00         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02								
74.36       0.79       7.78       3.15         74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.46       0.92       7.97       3.04         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.38       0.81       7.81       3.13         74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.46       0.92       7.97       3.04         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.81       1.31       8.19       2.78         74.82       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.41       0.85       7.85       3.10         74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.46       0.92       7.97       3.04         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.43       0.86       7.92       3.07         74.44       0.89       7.97       3.06         74.46       0.92       7.97       3.04         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.44       0.89       7.97       3.06         74.46       0.92       7.97       3.04         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.46       0.92       7.97       3.04         74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.48       0.93       7.97       3.02         74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.52       0.96       7.97       3.00         74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.55       0.99       7.98       2.97         74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.57       1.01       7.99       2.96         74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.67       1.11       8.00       2.89         74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.75       1.22       8.10       2.83         74.81       1.31       8.19       2.78         74.85       1.42       8.34       2.74         74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.81     1.31     8.19     2.78       74.85     1.42     8.34     2.74       74.90     1.52     8.41     2.69       74.93     1.61     8.55     2.66       74.95     1.71     8.63     2.64       74.98     1.81     8.58     2.61       75.00     1.92     8.50     2.58       75.01     2.02     8.49     2.57       75.02     2.12     8.42     2.55								
74.85     1.42     8.34     2.74       74.90     1.52     8.41     2.69       74.93     1.61     8.55     2.66       74.95     1.71     8.63     2.64       74.98     1.81     8.58     2.61       75.00     1.92     8.50     2.58       75.01     2.02     8.49     2.57       75.02     2.12     8.42     2.55								
74.90       1.52       8.41       2.69         74.93       1.61       8.55       2.66         74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.93     1.61     8.55     2.66       74.95     1.71     8.63     2.64       74.98     1.81     8.58     2.61       75.00     1.92     8.50     2.58       75.01     2.02     8.49     2.57       75.02     2.12     8.42     2.55								
74.95       1.71       8.63       2.64         74.98       1.81       8.58       2.61         75.00       1.92       8.50       2.58         75.01       2.02       8.49       2.57         75.02       2.12       8.42       2.55								
74.98     1.81     8.58     2.61       75.00     1.92     8.50     2.58       75.01     2.02     8.49     2.57       75.02     2.12     8.42     2.55								
75.00     1.92     8.50     2.58       75.01     2.02     8.49     2.57       75.02     2.12     8.42     2.55								
75.01     2.02     8.49     2.57       75.02     2.12     8.42     2.55								
75.02 2.12 8.42 2.55								
1.5.52								
	70.02	2.12	0.00	2.00				

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 2 (12.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Stage 2

Date/Time Shear Initiated: 6/14/18 1529 Date/Time Shear Completed: 6/14/18 1539

#### **Consolidation Data**

Length (cm): 11.17

Diameter (cm): 4.89

Measured outflow (cm<sup>3</sup>): 3.39

Area (cm<sup>2</sup>): 18.80

Area Determined by Method: ☑ A ☐ B

Volume (cm<sup>3</sup>): 210.07

Dry Density (g/cm<sup>3</sup>): 1.77

Dry Unit Weight (lbf/ft<sup>3</sup>): 110.28

Equivalent Height of Solids (cm): 7.45

Porosity (%, vol): 33.3

Void Ratio (e): 0.500

Time to 50% Primary Consol. (t50) (min): 0.97

### **Shear Data**

Effective Consolidation Stress (psi): 12.05

Total Back Pressure (psi): 71.48

Failure Criterion: Peak Deviator Stress at Failure (psi): 13.0

Effective Minor Stress at Failure (psi): 5.0

Lifective willor Stress at Fallure (psi). 3.0

Effective Major Stress at Failure (psi): 18.0

Membrane Correction Required/Applied: ☐ Yes ☑ No

Axial Strain (ε) at Failure (%): 2.96

Strain Rate (%/hr): 18.59

### Test Notes:

Test was halted after reaching a maximum target of 3% strain. Failure was interpreted as the peak deviator stress achieved.

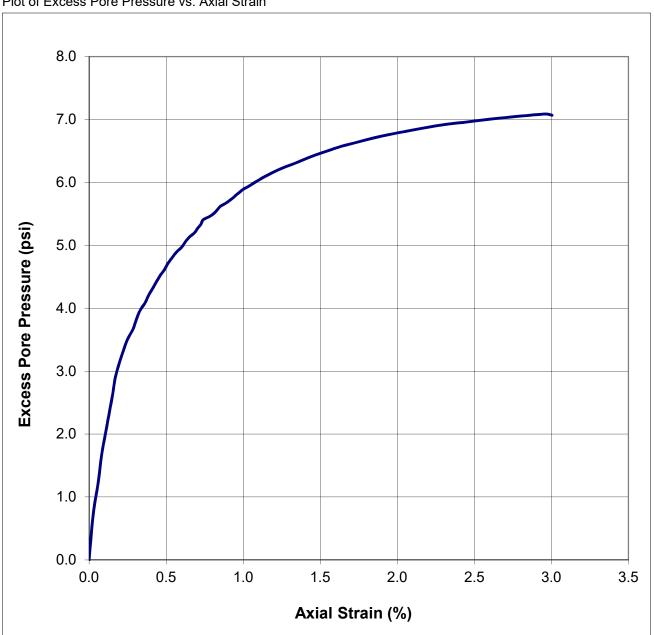
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 2 (12.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Excess Pore Pressure vs. Axial Strain



Job Name: Stantec Consulting Services Inc

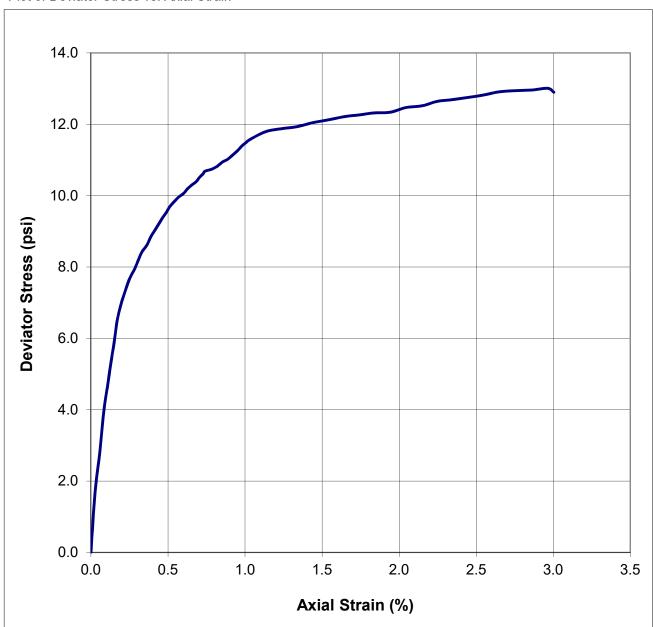
Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 2 (12.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Plot of Deviator Stress vs. Axial Strain



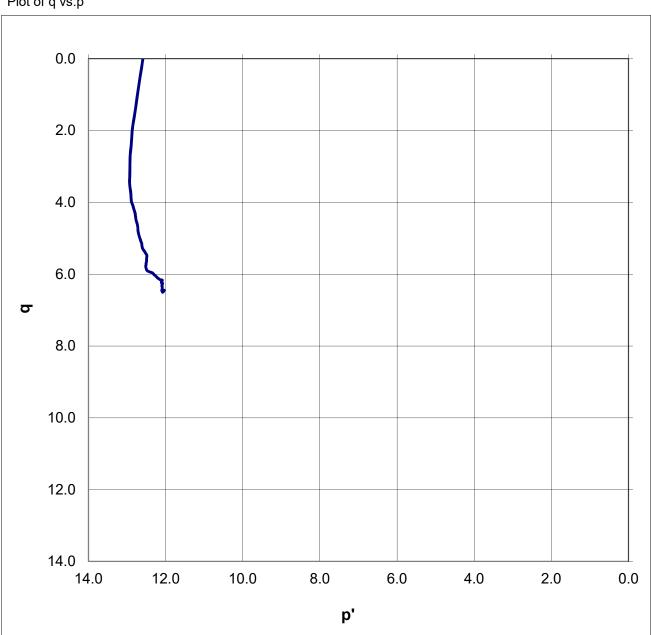
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 2 (12.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## Plot of q vs.p'



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 2 (12.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### **Raw Data**

Pore Pressure (psi) 71.48 72.21 72.71 73.15	<b>(%)</b> 0.00	Effective Major Stress (psi)	Effective Minor Stress	Pore Pressure	Axial Strain	Effective Major Stress	Effective Minor Stress
71.48 72.21 72.71 73.15	0.00	(nsi)					อแยรร
72.21 72.71 73.15	0.00	(POI)	(psi)	(psi)	(%)	(psi)	(psi)
72.71 73.15		12.05	12.05				
73.15	0.03	13.02	11.32				
	0.06	13.67	10.81				
72 F2	0.08	14.27	10.37				
73.53	0.11	14.71	9.98				
73.84	0.13	15.08	9.67				
74.13	0.15	15.38	9.39				
74.37	0.17	15.63	9.15				
74.60	0.19	15.87	8.92				
74.80	0.22	16.03	8.72				
74.98	0.25	16.18	8.53				
75.15	0.29	16.32	8.36				
75.31	0.31	16.41	8.20				
75.44	0.33	16.49	8.07				
75.57	0.36	16.56	7.94				
75.69	0.39	16.65	7.82				
75.80	0.41	16.73	7.71				
75.91	0.44	16.79	7.60				
76.01	0.46	16.87	7.49				
76.09	0.49 0.51	16.94 17.01	7.41				
76.20 76.29	0.54	17.06	7.32 7.23				
76.29 76.37	0.57	17.11	7.23 7.16				
76.45	0.60	17.15	7.08				
76.53	0.62	17.19	7.01				
76.61	0.65	17.19	6.94				
76.68	0.68	17.27	6.88				
76.75	0.71	17.32	6.80				
76.82	0.73	17.35	6.75				
76.88	0.74	17.36	6.68				
76.94	0.78	17.37	6.63				
76.99	0.81	17.39	6.58				
77.05	0.83	17.40	6.53				
77.10	0.85	17.42	6.48				
77.15	0.89	17.45	6.44				
77.19	0.91	17.50	6.40				
77.23	0.93	17.55	6.36				
77.28	0.96	17.59	6.31				
77.33	0.98	17.66	6.27				
77.38	1.00	17.71	6.23				
77.41	1.03	17.76	6.19				
77.56	1.13	17.84	6.05				
77.69	1.24	17.81	5.93				
77.78	1.34	17.77	5.83				
77.89	1.44	17.77	5.73				
77.97	1.54	17.77	5.65				
78.05	1.64	17.77	5.56				
78.12	1.74	17.76	5.50				
78.18	1.84	17.75	5.43				
78.24	1.94	17.71	5.38				
78.28	2.04	17.80	5.34				
78.33	2.15	17.80	5.28				
78.38	2.25	17.88	5.24				
78.41	2.34	17.89	5.20				
78.44	2.45	17.92	5.17				
78.47	2.54	17.95	5.14				
78.49	2.64	18.01	5.11				
78.52 78.55	2.75	18.02 18.01	5.08 5.05				
78.55 78.57	2.86 2.96	18.04	5.05 5.03				
78.55	3.00	17.94	5.04				

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 3 (24.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Stage 3

Date/Time Shear Initiated: 6/15/18 1339 Date/Time Shear Completed: 6/15/18 1447

#### **Consolidation Data**

Length (cm): 11.20

Diameter (cm): 4.89

Measured outflow (cm<sup>3</sup>): 2.78

Area (cm2): 18.80

Area Determined by Method: ☑ A ☐ B

Volume (cm<sup>3</sup>): 210.68

Dry Density (g/cm<sup>3</sup>): 1.76

Dry Unit Weight (lbf/ft<sup>3</sup>): 109.96

Equivalent Height of Solids (cm): 7.45

Porosity (%, vol): 33.5

Void Ratio (e): 0.505

Time to 50% Primary Consol. (t50) (min): 1.82

#### **Shear Data**

Effective Consolidation Stress (psi): 24.03

Total Back Pressure (psi): 71.59

Failure Criterion: Peak

Deviator Stress at Failure (psi): 26.2

Effective Minor Stress at Failure (psi): 9.6

Effective Major Stress at Failure (psi): 35.8

Membrane Correction Required/Applied: ☐ Yes ☑ No

Axial Strain (ε) at Failure (%): 7.73

Strain Rate (%/hr): 13.21

#### Test Notes:

Test was halted after reaching the target of 15% strain. Failure was interpreted as the peak deviator stress achieved.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

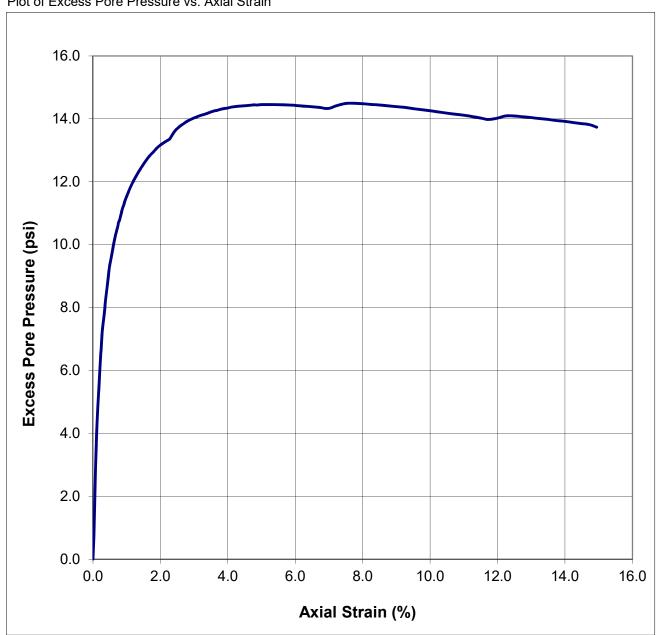
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 3 (24.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Excess Pore Pressure vs. Axial Strain



Job Name: Stantec Consulting Services Inc

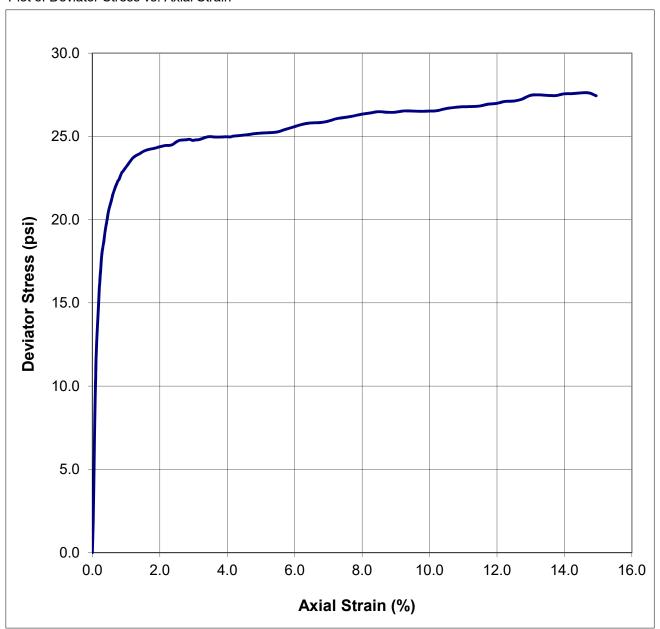
Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 3 (24.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Deviator Stress vs. Axial Strain



Job Name: Stantec Consulting Services Inc

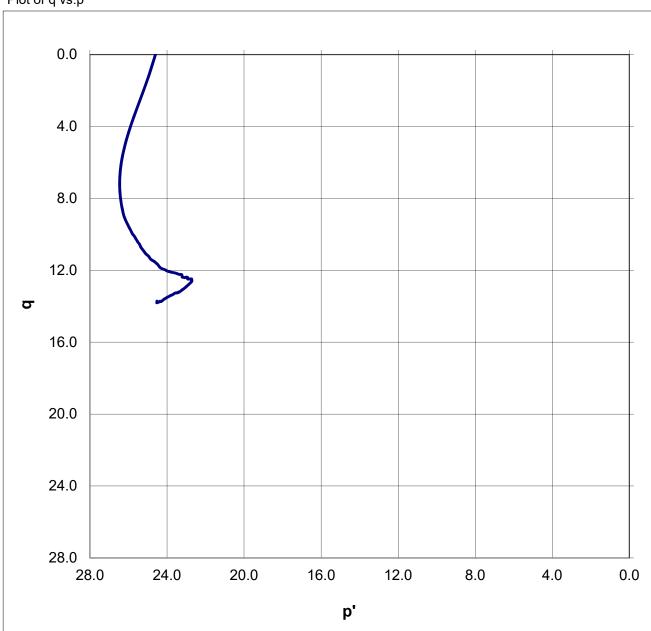
Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 3 (24.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS





Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-1 (15'A) CU Stage 3 (24.0 psi)

Project Name: St. Anthony Geotech Investigation

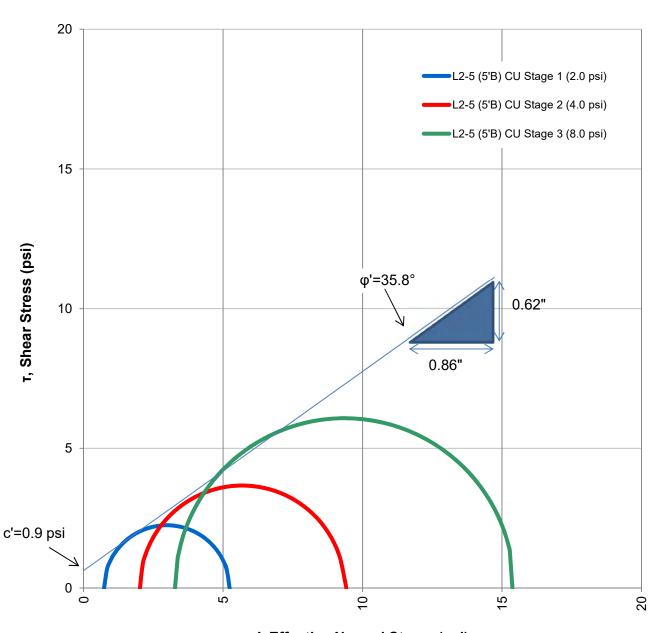
PO Number: 233001076-DBS

#### **Raw Data**

		Raw Data									
	Axial	_	Effective Minor		Axial	Effective Major	Effective Minor				
Pore Pressure	Strain	Stress	Stress	Pore Pressure	Strain	Stress	Stress				
(psi)	(%)	(psi)	(psi)	(psi)	(%)	(psi)	(psi)				
71.59	0.00	24.03	24.03	85.65	3.07	34.80	10.01				
72.57	0.03	25.83	23.06	85.69	3.17	34.77	9.96				
73.41	0.05	27.55	22.22	85.73	3.28	34.81	9.93				
74.26	0.07	29.27	21.36	85.76	3.38	34.84	9.89				
75.06	0.09	30.66	20.57	85.80	3.47	34.84	9.85				
75.74	0.11	31.70	19.88	85.84	3.57	34.78	9.81				
76.35	0.14	32.46	19.27	85.86	3.68	34.74	9.79				
76.87	0.17	33.03	18.75	85.89	3.78	34.72	9.76				
77.34	0.19	33.49	18.28	85.92	3.88	34.69	9.73				
77.76	0.21	33.84	17.85	85.93	3.98	34.69	9.71				
78.15	0.23	34.13	17.47	85.96	4.09	34.64	9.68				
78.52	0.26	34.39	17.09	85.98	4.18	34.67	9.66				
78.84	0.28	34.60	16.77	85.99	4.28	34.68	9.64				
79.15	0.31	34.76	16.46	86.00	4.38	34.67	9.63				
79.43	0.34	34.87	16.18	86.01	4.48	34.68	9.61				
79.69	0.36	34.97	15.92	86.02	4.57	34.69	9.60				
79.93	0.38	35.06	15.68	86.02	4.68	34.71	9.59				
80.15	0.41	35.13	15.45	86.04	4.78	34.72	9.57				
80.38	0.43	35.21	15.23	86.03	4.87	34.74	9.57				
80.58	0.46	35.24	15.02	86.04	4.97	34.75	9.56				
80.77	0.47	35.29	14.83	86.04	5.23	34.76	9.54				
80.94	0.50	35.34	14.66	86.04	5.47	34.78	9.53				
81.11	0.53	35.38	14.49	86.04	5.71	34.93	9.52				
81.28	0.56	35.41	14.31	86.02	5.97	35.08	9.52				
81.42	0.58	35.47	14.17	86.00	6.23	35.25	9.52				
81.56	0.60	35.52	14.03	85.98	6.47	35.33	9.52				
81.70	0.63	35.54	13.90	85.95	6.74	35.34	9.52				
81.83	0.65	35.56	13.76	85.92	6.98	35.43	9.53				
81.94	0.68	35.59	13.65	86.01	7.23	35.59	9.53				
82.07	0.71	35.61	13.52	86.08	7.49	35.69	9.55				
82.18	0.71	35.62	13.41	86.09	7.49	35.78	9.56				
					7.73 7.98		9.57				
82.29	0.76	35.61	13.29	86.07		35.90	9.59				
82.38	0.79	35.61	13.20	86.05	8.24	35.99					
82.49	0.81	35.62	13.09	86.04	8.49	36.09	9.60				
82.58	0.84	35.65	12.99	86.00	8.73	36.07	9.63				
82.67	0.86	35.66	12.90	85.98	8.99	36.09	9.64				
82.76	0.88	35.66	12.81	85.96	9.24	36.18	9.65				
82.84	0.91	35.64	12.73	85.92	9.49	36.20	9.68				
82.92	0.93	35.62	12.66	85.88	9.75	36.21	9.71				
83.00	0.95	35.61	12.57	85.85	10.00	36.24	9.72				
83.08	0.98	35.60	12.49	85.81	10.24	36.30	9.75				
83.34	1.08	35.60	12.22	85.78	10.49	36.44	9.77				
83.58	1.18	35.64	11.98	85.74	10.74	36.53	9.79				
83.79	1.29	35.59	11.76	85.71	10.98	36.58	9.81				
83.96	1.38	35.52	11.58	85.67	11.24	36.62	9.83				
84.13	1.49	35.47	11.40	85.62	11.49	36.68	9.85				
84.28	1.58	35.40	11.24	85.57	11.73	36.80	9.87				
84.42	1.68	35.31	11.09	85.61	11.98	36.89	9.92				
84.53	1.78	35.23	10.97	85.69	12.24	37.03	9.93				
84.65	1.88	35.15	10.84	85.69	12.48	37.07	9.95				
84.74	1.98	35.11	10.74	85.66	12.73	37.20	9.98				
84.82	2.09	35.06	10.65	85.64	12.98	37.46	10.00				
84.89	2.18	35.03	10.57	85.60	13.23	37.52	10.03				
84.96	2.28	34.95	10.49	85.58	13.48	37.51	10.05				
85.13	2.38	34.92	10.41	85.54	13.74	37.52	10.03				
85.25	2.47	34.98	10.33	85.51	13.74	37.64	10.09				
85.35	2.47	35.02	10.33	85.48	14.23	37.68	10.09				
85.43	2.57	34.99	10.27	85.44	14.23	37.06 37.75	10.12				
85.43 85.51	2.68 2.78	34.99 34.95	10.21	85.44 85.41	14.48	37.75 37.77	10.14				
85.56	2.78	34.95 34.92	10.16	85.41 85.33	14.73	37.77 37.67	10.16				
85.61	2.00	34.80	10.10	00.00	17.34	37.07	10.23				

## **Mohr's Circles: Effective**

## L2-5 (5'B) CU



 $\sigma$ ', Effective Normal Stress (psi)

# Estimated Effective Mohr-Coulomb Failure Parameters<sup>1</sup>:

cohesion (c')(psi) = 0.9 friction angle  $(\phi')(^{\circ})$  = 35.8

<sup>&</sup>lt;sup>1</sup>The cohesion and friction angle provided represent one possible interpretation of a Mohr-Coulomb failure envelope. Qualified persons familiar with the material and the site should evaluate the test results independently prior to use in the intended application.

Job Name: Stantec Consulting Services Inc.

Job Number: DB18.1151.00 Sample Number: L2-5 (5'B) CU

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### **Remolded or Initial Sample Properties**

Initial Mass (g): 410.32

Length (cm): 11.51

Diameter (cm): 4.91

Area (cm<sup>2</sup>): 18.97

Volume (cm<sup>3</sup>): 218.37

Dry Mass (g): 366.98

Dry Density (g/cm<sup>3</sup>): 1.68

Dry Unit Weight (lbf/ft<sup>3</sup>): 104.92

Equivalent Height of Solids (cm): 7.30

Water Content (%, g/g): 11.8

Water Content (%, vol): 19.8

Water Content Based On: ☐ Cuttings ☑ Whole Specimen

Porosity (%, vol): 36.6

Void Ratio (e): 0.577

Saturation (%): 54.3

### **Test and Sample Conditions**

Height to Diameter Ratio: 2.3

Largest Particle Dimension (approx.) (cm): 0.475

Diameter to Largest Particle Ratio (approx.): 10.35

Visual Description of Sample: Silt-Consolidated

USCS Classification: NA

Plastic Limit: NA

Liquid Limit: NA

Sample Preparation:  $\ oxdot$  In situ sample, extruded  $\ oxdot$  Remolded Sample

Trimming Procedure: NA

Split: NA

Percent Coarse Material (%): <5%

Particle Density (g/cm<sup>3</sup>): 2.65 ☑ Assumed ☐ Measured

B-Value Post Saturation: 0.97

Method for Specimen Saturation: ☐ Dry ☑ Wet

Laboratory analysis by: D. O'Dowd

Data entered by: C. Krous

Checked by: J. Hines



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-5 (5'B) CU

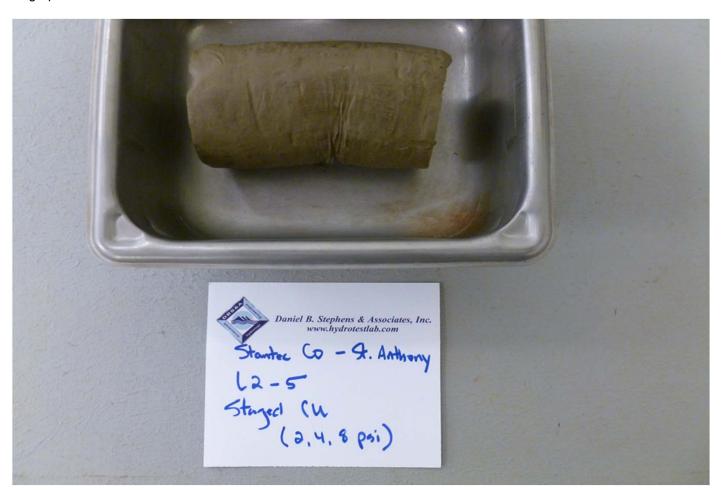
Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Remarks on Failure: Buldge failure.

General Notes: The entire sample was extruded and subjected to CU triaxial shear testing.

## Photograph of Failure



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 1 (2.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Stage 1

Date/Time Shear Initiated: 6/14/18 1205 Date/Time Shear Completed: 6/14/18 1210

#### **Consolidation Data**

Length (cm): 11.49

Diameter (cm): 4.91

Measured outflow (cm<sup>3</sup>): 0.513

Area (cm2): 18.97

Area Determined by Method: ☑ A ☐ B

Volume (cm<sup>3</sup>): 217.85

Dry Density (g/cm<sup>3</sup>): 1.68

Dry Unit Weight (lbf/ft<sup>3</sup>): 105.16

Equivalent Height of Solids (cm): 7.30

Porosity (%, vol): 36.4

Void Ratio (e): 0.573

Time to 50% Primary Consol. (t50) (min): 0.16

## **Shear Data**

Effective Consolidation Stress (psi): 1.97

Total Back Pressure (psi): 80.68

Failure Criterion: Peak

Deviator Stress at Failure (psi): 4.5

Effective Minor Stress at Failure (psi): 0.7

Effective Major Stress at Failure (psi): 5.2

Membrane Correction Required/Applied: ☐ Yes ☑ No

Axial Strain (ε) at Failure (%): 1.88

Strain Rate (%/hr): 37.08

#### Test Notes:

Test was halted after reaching a maximum target of 3% strain. Failure was interpreted as the peak deviator stress achieved.

Laboratory analysis by: D. O'Dowd

Data entered by: C. Krous

Checked by: J. Hines

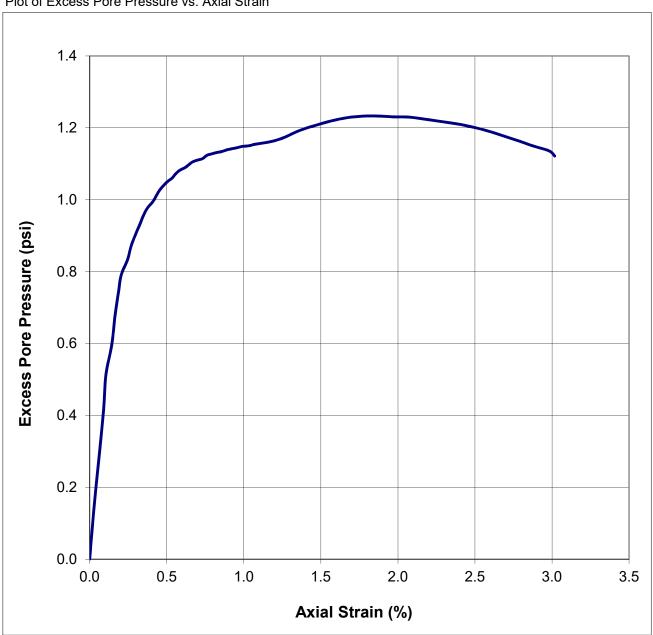
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 1 (2.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Excess Pore Pressure vs. Axial Strain



Job Name: Stantec Consulting Services Inc

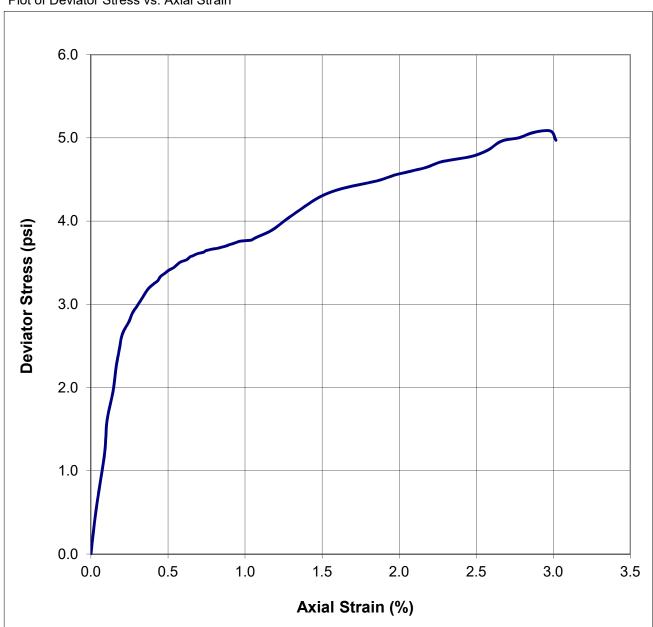
Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 1 (2.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Deviator Stress vs. Axial Strain



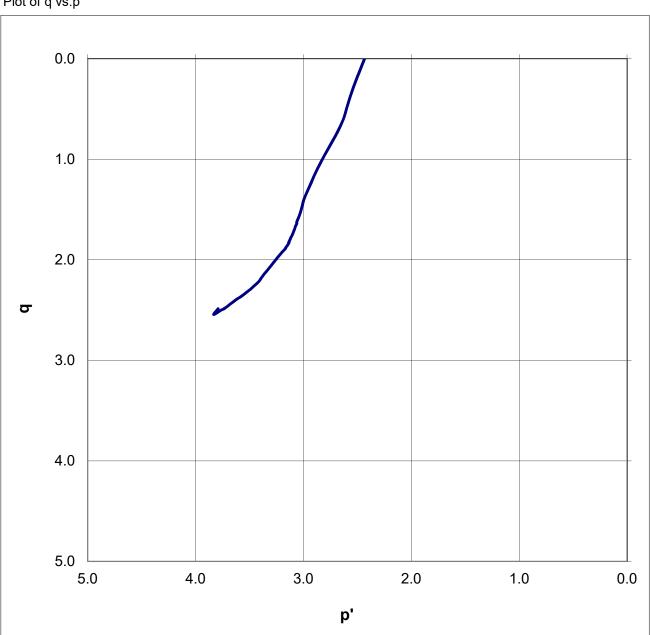
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 1 (2.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## Plot of q vs.p'



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 1 (2.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### **Raw Data**

Axial   Effective Major   Effective Minor   Strain   Stress   Stress   Pore Pressure   (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)
80.68       0.00       1.97       1.97         80.84       0.03       2.31       1.81         80.98       0.06       2.57       1.68         81.10       0.09       2.79       1.56         81.20       0.11       3.07       1.46	(%)	(psi)	(psi)
80.68     0.00     1.97     1.97       80.84     0.03     2.31     1.81       80.98     0.06     2.57     1.68       81.10     0.09     2.79     1.56       81.20     0.11     3.07     1.46			
80.98       0.06       2.57       1.68         81.10       0.09       2.79       1.56         81.20       0.11       3.07       1.46			
81.10     0.09     2.79     1.56       81.20     0.11     3.07     1.46			
81.20 0.11 3.07 1.46			
81 28 0 14 3 33 1 37 L			
81.36 0.16 3.54 1.30			
81.42 0.18 3.69 1.24			
81.47 0.20 3.82 1.18			
81.52 0.25 3.93 1.14			
81.56 0.27 3.99 1.10			
81.59 0.30 4.04 1.07			
81.62 0.33 4.09 1.04			
81.64 0.35 4.14 1.01			
81.66 0.37 4.19 0.99			
81.68 0.41 4.23 0.98			
81.70 0.43 4.24 0.96			
81.71 0.45 4.28 0.95			
81.72 0.48 4.30 0.93			
81.73 0.50 4.33 0.92 81.74 0.54 4.35 0.91			
81.74 0.54 4.35 0.91 81.75 0.55 4.37 0.90			
81.76 0.58 4.40 0.89			
81.77 0.62 4.42 0.88			
81.78 0.64 4.44 0.87			
81.79 0.66 4.45 0.87			
81.79 0.69 4.47 0.86			
81.80 0.73 4.48 0.86			
81.80 0.74 4.50 0.85			
81.81 0.76 4.50 0.84			
81.81 0.79 4.51 0.84			
81.81 0.82 4.51 0.84			
81.82 0.85 4.52 0.84			
81.82 0.87 4.53 0.83			
81.82 0.90 4.55 0.83			
81.83 0.93 4.56 0.83			
81.83 0.96 4.58 0.82			
81.83 0.99 4.58 0.82			
81.83 1.01 4.59 0.82			
81.83 1.04 4.59 0.82			
81.84 1.06 4.61 0.81			
81.85 1.17 4.70 0.81			
81.86 1.26 4.80 0.80			
81.88 1.36 4.92 0.78			
81.89 1.47 5.04 0.76			
81.90 1.57 5.11 0.75			
81.91 1.67 5.15 0.74 81.92 1.77 5.18 0.73			
81.92 1.88 5.23 0.74 81.91 1.97 5.29 0.74			
81.91 2.07 5.33 0.74 81.91 2.18 5.39 0.74			
81.90 2.27 5.46 0.75			
81.90 2.38 5.50 0.75			
81.89 2.48 5.54 0.76			
81.88 2.58 5.63 0.77			
81.86 2.67 5.75 0.78			
81.85 2.78 5.80 0.80			
81.83 2.87 5.88 0.81			
81.82 2.98 5.91 0.83			
81.81 3.02 5.81 0.84			

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 2 (4.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Stage 2

Date/Time Shear Initiated: 6/14/18 1446 Date/Time Shear Completed: 6/14/18 1501

#### **Consolidation Data**

Length (cm): 11.43

Diameter (cm): 4.91

Measured outflow (cm<sup>3</sup>): 1.608

Area (cm2): 18.97

Area Determined by Method: <a> A</a> <a> B</a>

Volume (cm<sup>3</sup>): 216.76

Dry Density (g/cm<sup>3</sup>): 1.69

Dry Unit Weight (lbf/ft<sup>3</sup>): 105.70

Equivalent Height of Solids (cm): 7.30

Porosity (%, vol): 36.1

Void Ratio (e): 0.565

Time to 50% Primary Consol. (t50) (min): 1.49

### **Shear Data**

Effective Consolidation Stress (psi): 4.01

Total Back Pressure (psi): 80.54

Failure Criterion: Peak

Deviator Stress at Failure (psi): 7.3

Effective Minor Stress at Failure (psi): 2.0

Effective Major Stress at Failure (psi): 9.4

Membrane Correction Required/Applied: ☐ Yes ☑ No

Axial Strain (ε) at Failure (%): 0.97

Strain Rate (%/hr): 12.11

#### Test Notes:

Test was halted after reaching a maximum target of 3% strain. Failure was interpreted as the peak deviator stress achieved.

> Laboratory analysis by: D. O'Dowd Data entered by: C. Krous Checked by: J. Hines

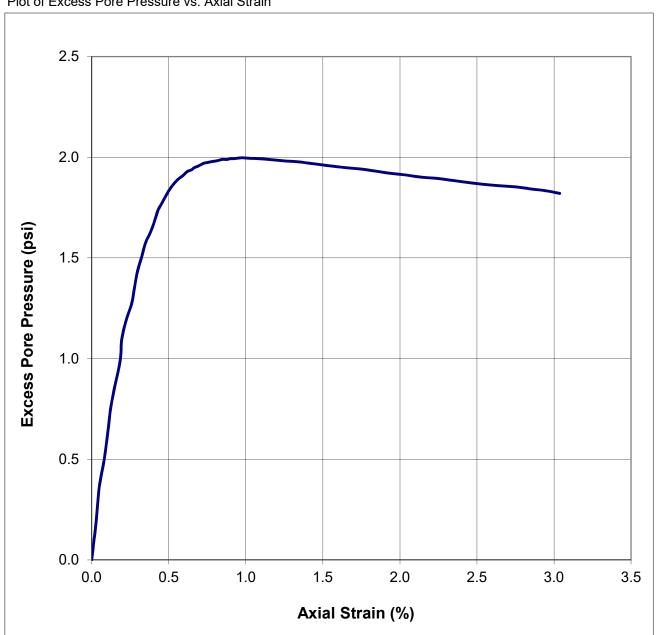
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 2 (4.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Excess Pore Pressure vs. Axial Strain



Job Name: Stantec Consulting Services Inc

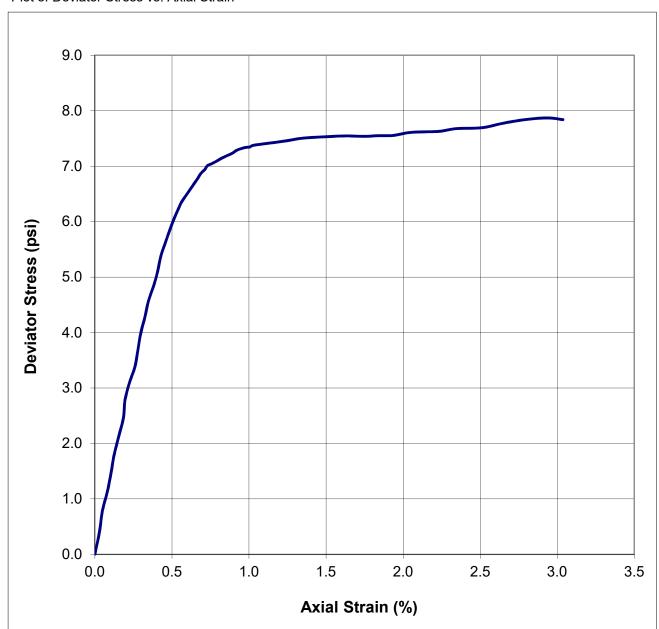
Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 2 (4.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Deviator Stress vs. Axial Strain



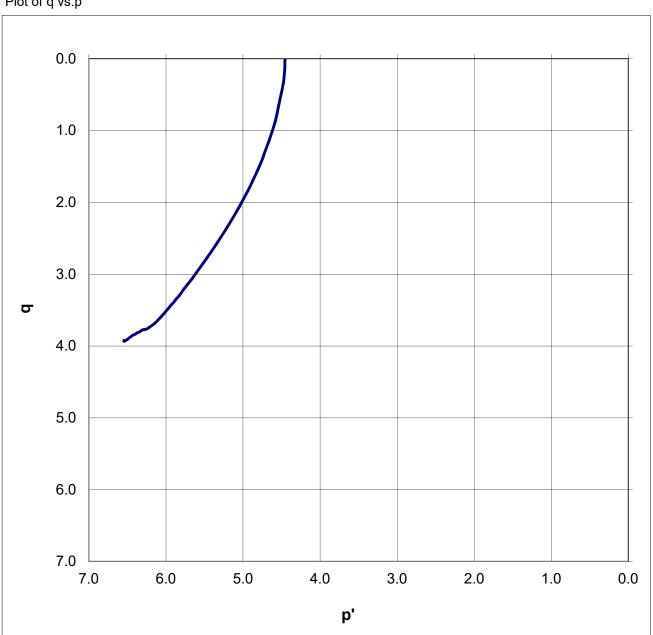
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 2 (4.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## Plot of q vs.p'



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 2 (4.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### **Raw Data**

Raw Data								
Pore Pressure	Axial Strain	Effective Major Stress	Effective Minor Stress	Pore Pressure	Axial Strain	Effective Major Stress	Effective Mino Stress	
(psi)	(%)	(psi)	(psi)	(psi)	(%)	(psi)	(psi)	
80.54	0.00	4.01	4.01	,, ,	• • • • • • • • • • • • • • • • • • • •	.,	.,	
80.74	0.03	4.23	3.81					
80.90	0.05	4.43	3.65					
81.04	0.08	4.65	3.51					
81.18	0.10	4.84	3.38					
81.30	0.12	5.04	3.25					
81.42	0.15	5.26	3.13					
81.54	0.19	5.49	3.02					
81.64	0.20	5.70	2.91					
81.73	0.22	5.91	2.82					
81.82	0.26	6.12	2.73					
81.90	0.28	6.34	2.65					
81.98	0.20	6.57	2.58					
82.05	0.33	6.79	2.51					
82.12	0.35	7.02	2.44					
82.17	0.38	7.24	2.38					
82.23	0.41	7.46	2.33					
82.28	0.43	7.67	2.28					
82.32	0.46	7.86	2.24					
82.36	0.49	8.05	2.20					
82.39	0.51	8.19	2.17					
82.41	0.54	8.34	2.15					
82.43	0.56	8.48	2.13					
82.45	0.59	8.58	2.11					
82.47	0.62	8.68	2.09					
82.48	0.65	8.78	2.08					
82.49	0.67	8.84	2.07					
82.50	0.69	8.93	2.06					
82.51	0.71	8.99	2.05					
82.51	0.73	9.05	2.05					
82.52	0.76	9.09	2.04					
82.52	0.79	9.12	2.04					
82.53	0.82	9.17	2.03					
82.53	0.84	9.20	2.03					
82.53	0.88	9.24	2.03					
82.54	0.90	9.27	2.02					
82.54	0.92	9.31	2.02					
82.54	0.95	9.33	2.02					
82.54	0.97	9.35	2.02					
82.54	1.01	9.37	2.02					
82.54	1.03	9.39	2.02					
82.53	1.14	9.44	2.02					
82.53	1.14	9.49	2.03					
82.52	1.24	9.49 9.54	2.04					
82.51	1.43	9.56	2.04					
82.50	1.43	9.56 9.59	2.04					
82.49	1.64	9.61	2.06					
82.48	1.74	9.61	2.07					
82.47	1.84	9.63	2.08					
82.46	1.93	9.64	2.09					
82.46	2.04	9.70	2.09					
82.44	2.14	9.73	2.11					
82.44	2.24	9.74	2.11					
82.43	2.34	9.80	2.12					
82.42	2.44	9.81	2.13					
82.41	2.54	9.84	2.14					
82.40	2.63	9.91	2.15					
82.40	2.75	9.97	2.15					
82.39	2.85	10.02	2.16					
82.38	2.95	10.04	2.17					
82.36	3.04	10.02	2.18					

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 3 (8.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Stage 3

Date/Time Shear Initiated: 6/15/18 1315 Date/Time Shear Completed: 6/15/18 1345

#### **Consolidation Data**

Length (cm): 11.44

Diameter (cm): 4.91

Measured outflow (cm<sup>3</sup>): 1.356

Area (cm2): 18.97

Area Determined by Method: ☑ A ☐ B

Volume (cm<sup>3</sup>): 217.01

Dry Density (g/cm<sup>3</sup>): 1.69

Dry Unit Weight (lbf/ft<sup>3</sup>): 105.57

Equivalent Height of Solids (cm): 7.30

Porosity (%, vol): 36.2

Void Ratio (e): 0.567

Time to 50% Primary Consol. (t50) (min): 0.80

### **Shear Data**

Effective Consolidation Stress (psi): 7.99

Total Back Pressure (psi): 80.73

Failure Criterion: Peak

Deviator Stress at Failure (psi): 12.2

Effective Minor Stress at Failure (psi): 3.3

Effective Major Stress at Failure (psi): 15.4

Membrane Correction Required/Applied: ✓ Yes ☐ No

Axial Strain (ε) at Failure (%): 1.13

Strain Rate (%/hr): 29.86

#### Test Notes:

Test was halted after reaching the target of 15% strain. Failure was interpreted as the peak deviator stress achieved.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

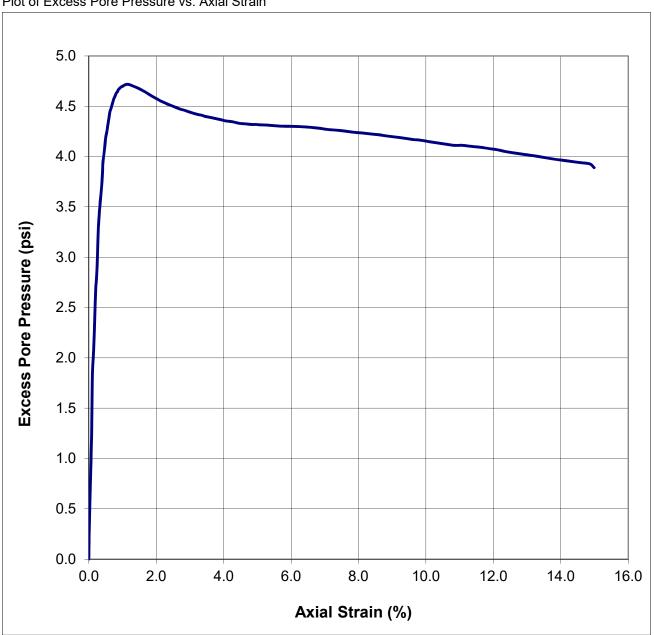
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 3 (8.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Excess Pore Pressure vs. Axial Strain



Job Name: Stantec Consulting Services Inc

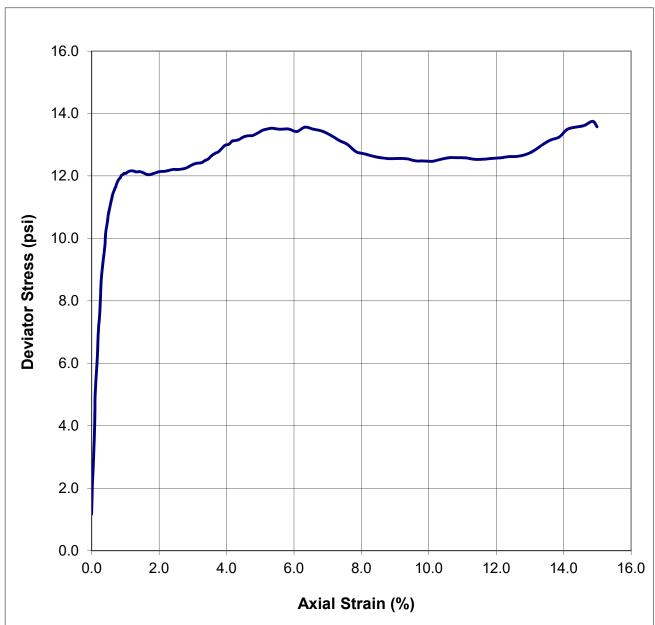
Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 3 (8.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Deviator Stress vs. Axial Strain



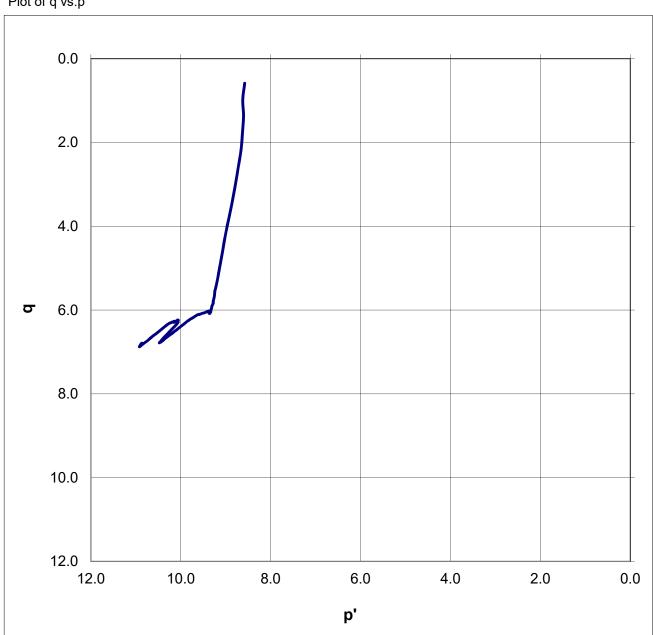
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 3 (8.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## Plot of q vs.p'



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-5 (5'B) CU Stage 3 (8.0 psi)

Project Name: St. Anthony Geotech Investigation

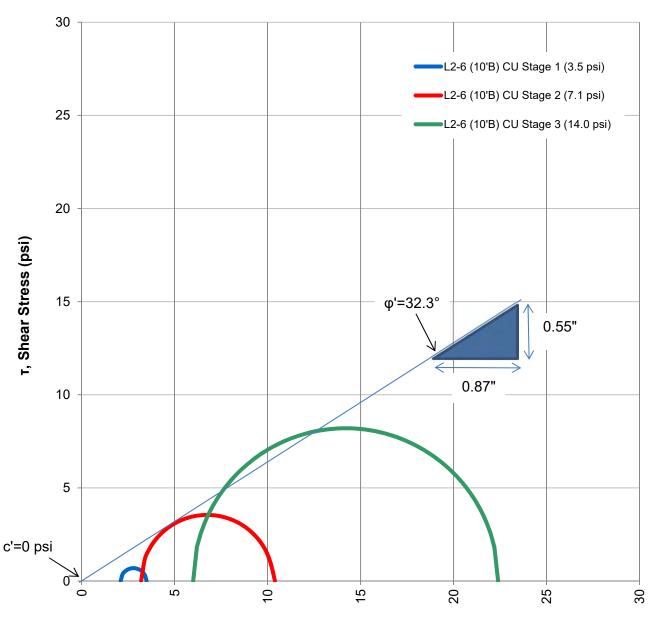
PO Number: 233001076-DBS

#### **Raw Data**

Axial Effective Major Effective Minor Axial Effective Major Effective											Avial	Avial Effective Major		
Doro Brocouro		•	Stress	Dava Dragacina	Axial Strain	Effective Major Stress	Effective Minor							
Pore Pressure	Strain			Pore Pressure			Stress							
(psi)	(%)	(psi)	(psi)	(psi)	(%)	(psi)	(psi)							
80.73	0.00	9.16	7.99	85.15	3.15 3.26	15.98	3.57 3.57							
81.08 81.49	0.02 0.05	9.59 9.97	7.65 7.24	85.14 85.14	3.26	16.00 16.07	3.58							
81.88	0.05		6.84	85.12	3.35 3.45	16.13	3.59							
		10.42												
82.25	0.09	10.85	6.47	85.12	3.55	16.24	3.60							
82.57	0.11	11.29	6.15	85.11	3.66	16.33	3.60							
82.87	0.15	11.70	5.85	85.10	3.76	16.39	3.61							
83.14	0.18	12.07	5.58	85.10	3.86	16.50	3.62							
83.38	0.20	12.41	5.34	85.09	3.96	16.61	3.63							
83.58	0.24	12.72	5.14	85.08	4.07	16.65	3.63							
83.77	0.26	13.00	4.95	85.08	4.17	16.76	3.64							
83.94	0.28	13.24	4.78	85.07	4.25	16.77	3.64							
84.10	0.30	13.47	4.62	85.06	4.37	16.81	3.65							
84.24	0.33	13.65	4.48	85.06	4.47	16.89	3.66							
84.36	0.36	13.84	4.36	85.05	4.57	16.93	3.66							
84.48	0.39	13.99	4.24	85.05	4.67	16.95	3.66							
84.58	0.41	14.14	4.14	85.05	4.77	16.96	3.67							
84.68	0.42	14.27	4.04	85.04	4.87	17.02	3.67							
84.76	0.46	14.39	3.96	85.04	4.97	17.07	3.67							
84.84	0.48	14.51	3.88	85.04	5.07	17.14	3.67							
84.91	0.50	14.61	3.81	85.04	5.33	17.21	3.68							
84.97	0.53	14.71	3.75	85.03	5.58	17.18	3.69							
85.03	0.56	14.80	3.69	85.03	5.84	17.20	3.69							
85.08	0.58	14.85	3.64	85.03	6.08	17.12	3.69							
85.13	0.61	14.91	3.59	85.02	6.33	17.26	3.70							
85.17	0.63	14.98	3.55	85.02	6.58	17.20	3.70							
85.21	0.66	15.04	3.51	85.01	6.82	17.15	3.71							
85.24	0.69	15.08	3.48	85.00	7.09	17.03	3.72							
85.27	0.72	15.11	3.45	84.99	7.34	16.87	3.73							
85.30	0.74	15.16	3.42	84.98	7.59	16.75	3.74							
85.32	0.76	15.21	3.40	84.97	7.84	16.53	3.75							
85.33	0.79	15.24	3.39	84.96	8.09	16.46	3.75							
85.36	0.81	15.27	3.36	84.95	8.35	16.39	3.76							
85.37	0.85	15.29	3.35	84.94	8.60	16.35	3.77							
85.38	0.86	15.32	3.33	84.93	8.85	16.34	3.78							
85.39	0.89	15.35	3.32	84.92	9.10	16.35	3.79							
85.41	0.92	15.35	3.31	84.91	9.35	16.35	3.80							
85.42	0.95	15.38	3.30	84.90	9.60	16.30	3.81							
85.42	0.98	15.38	3.30	84.89	9.85	16.30	3.82							
85.42	1.01	15.37	3.29	84.87	10.10	16.31	3.84							
85.43	1.01	15.38	3.29	84.86	10.10	16.38	3.85							
	1.13			84.85			3.86							
85.44	1.13	15.43	3.28		10.61	16.44								
85.44		15.44	3.28	84.84	10.85	16.45	3.87							
85.42	1.32	15.43	3.29	84.84	11.10	16.45	3.87							
85.41	1.43	15.45	3.31	84.83	11.35	16.41	3.88							
85.39	1.54	15.43	3.33	84.82	11.62	16.42	3.89							
85.38	1.63	15.40	3.34	84.81	11.85	16.46	3.90							
85.36	1.74	15.41	3.36	84.79	12.12	16.49	3.91							
85.33	1.83	15.47	3.38	84.78	12.36	16.55	3.93							
85.32	1.93	15.51	3.40	84.76	12.61	16.57	3.94							
85.30	2.03	15.56	3.42	84.75	12.87	16.64	3.95							
85.28	2.14	15.59	3.44	84.74	13.10	16.76	3.96							
85.26	2.25	15.62	3.46	84.73	13.37	16.98	3.98							
85.25	2.34	15.66	3.47	84.71	13.61	17.14	3.99							
85.23	2.44	15.70	3.48	84.70	13.87	17.25	4.00							
85.22	2.54	15.70	3.50	84.69	14.11	17.50	4.01							
85.21	2.64	15.73	3.51	84.68	14.37	17.59	4.03							
85.19	2.74	15.76	3.52	84.66	14.60	17.65	4.03							
85.19	2.84	15.80	3.53	84.65	14.86	17.80	4.05							
85.17	2.94	15.88	3.54	84.62	14.99	17.66	4.08							
85.16	3.05	15.95	3.56	·										

## **Mohr's Circles: Effective**

## L2-6 (10'B) CU



σ', Effective Normal Stress (psi)

# Estimated Effective Mohr-Coulomb Failure Parameters<sup>1</sup>:

cohesion (c')(psi) = 0 friction angle  $(\phi')(\circ)$  = 32.3

<sup>&</sup>lt;sup>1</sup>The cohesion and friction angle provided represent one possible interpretation of a Mohr-Coulomb failure envelope. Qualified persons familiar with the material and the site should evaluate the test results independently prior to use in the intended application.

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-6 (10'B) CU

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### **Remolded or Initial Sample Properties**

Initial Mass (g): 365.40

Length (cm): 11.35

Diameter (cm): 4.81

Area (cm<sup>2</sup>): 18.15

Volume (cm<sup>3</sup>): 205.89

Dry Mass (g): 320.37

Dry Density (g/cm<sup>3</sup>): 1.56

Dry Unit Weight (lbf/ft3): 97.14

Equivalent Height of Solids (cm): 6.66

Water Content (%, g/g): 14.1

Water Content (%, vol): 21.9

Water Content Based On: ☐ Cuttings ☐ Whole Specimen

Porosity (%, vol): 41.3

Void Ratio (e): 0.703

Saturation (%): 53.0

### **Test and Sample Conditions**

Height to Diameter Ratio: 2.4

Largest Particle Dimension (approx.) (cm): 0.475

Diameter to Largest Particle Ratio (approx.): 10.12

Visual Description of Sample: Clayey Silt-Brittle

USCS Classification: NA

Plastic Limit: NA

Liquid Limit: NA

Sample Preparation:  $\ oxdot$  In situ sample, extruded  $\ oxdot$  Remolded Sample

Trimming Procedure: NA

Split: NA

Percent Coarse Material (%): <5%

Particle Density (g/cm<sup>3</sup>): 2.65 ☑ Assumed ☐ Measured

B-Value Post Saturation: 0.96

Method for Specimen Saturation: ☐ Dry ☑ Wet

Laboratory analysis by: D. O'Dowd

Data entered by: C. Krous

Checked by: J. Hines



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00 Sample Number: L2-6 (10'B) CU

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

Remarks on Failure: Buldge failure.

General Notes: The entire sample was extruded and subjected to CU triaxial shear testing.

## Photograph of Failure



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 1 (3.5 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Stage 1

Date/Time Shear Initiated: 6/6/18 1513 Date/Time Shear Completed: 6/6/18 1514

#### **Consolidation Data**

Length (cm): 11.21

Diameter (cm): 4.81

Measured outflow (cm<sup>3</sup>): 2.46

Area (cm2): 18.15

Area Determined by Method: <a> A</a> <a> B</a>

Volume (cm<sup>3</sup>): 203.43

Dry Density (g/cm<sup>3</sup>): 1.57

Dry Unit Weight (lbf/ft<sup>3</sup>): 98.32 Equivalent Height of Solids (cm): 6.66

Porosity (%, vol): 40.6

Void Ratio (e): 0.683

Time to 50% Primary Consol. (t50) (min): 0.32

#### **Shear Data**

Effective Consolidation Stress (psi): 3.48

Total Back Pressure (psi): 81.60

Failure Criterion: Peak

Deviator Stress at Failure (psi): 1.4

Effective Minor Stress at Failure (psi): 2.1

Effective Major Stress at Failure (psi): 3.5

Membrane Correction Required/Applied: ☐ Yes ☑ No

Axial Strain (ε) at Failure (%): 0.69

Strain Rate (%/hr): 57.0

#### Test Notes:

Test was halted prior to reaching a maximum target of 3% strain, after a reduction in deviator stress was recorded. Failure was interpreted as the peak deviator stress achieved.

> Laboratory analysis by: D. O'Dowd Data entered by: C. Krous Checked by: J. Hines

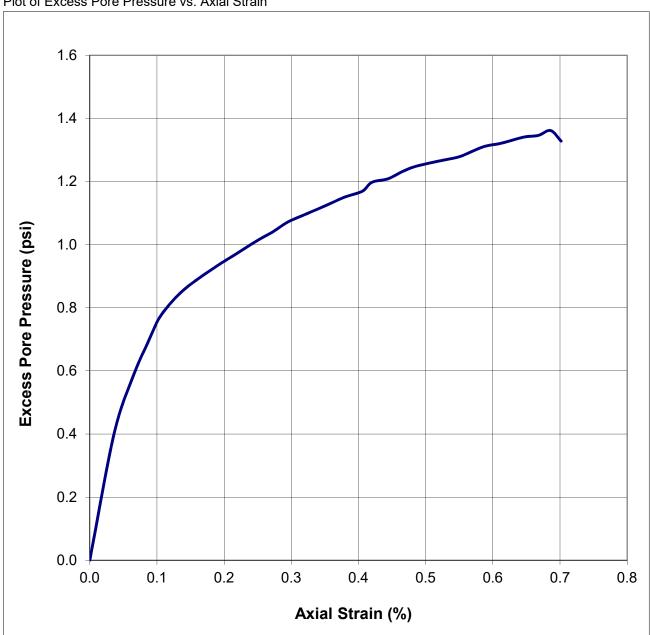
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 1 (3.5 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Excess Pore Pressure vs. Axial Strain



Job Name: Stantec Consulting Services Inc

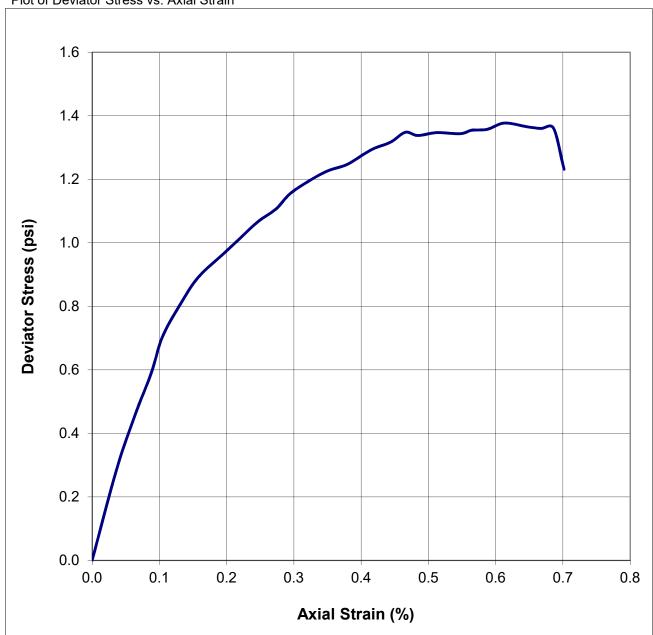
Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 1 (3.5 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## Plot of Deviator Stress vs. Axial Strain



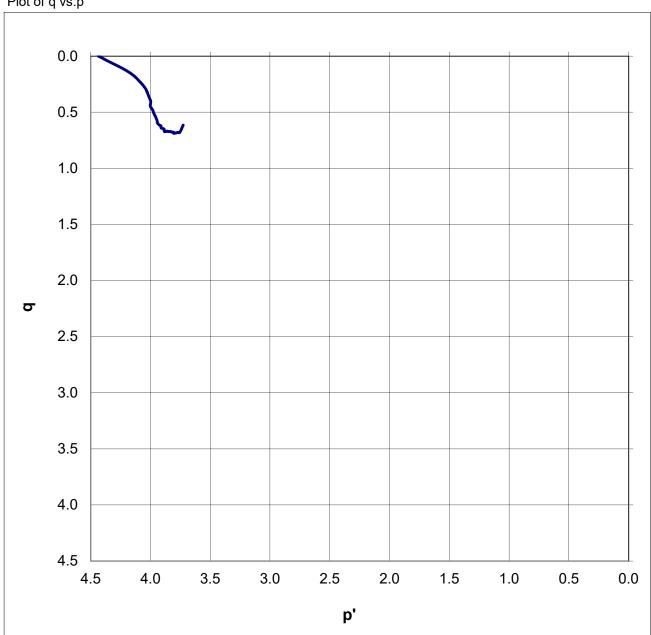
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 1 (3.5 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS







Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 1 (3.5 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### **Raw Data**

D D	Axial	Effective Major	Effective Minor		Axial	Effective Major	Effective Minor
Pore Pressure	Strain	Stress	Stress	Pore Pressure	Strain	Stress	Stress
(psi)	(%)	(psi)	(psi)	(psi)	(%)	(psi)	(psi)
81.60	0.00	3.48	3.48				
82.00	0.04	3.37	3.08				
82.18	0.06	3.36	2.90				
82.29	0.09	3.38	2.79				
82.37	0.10	3.41	2.71				
82.44	0.13	3.45	2.64				
82.48	0.16	3.49	2.60				
82.54	0.19	3.51	2.54				
82.57	0.22	3.52	2.51				
82.60	0.25	3.54	2.47				
82.64	0.27	3.55	2.44				
82.67	0.29	3.57	2.41				
82.69	0.32	3.58	2.39				
82.72	0.35	3.59	2.36				
82.75	0.38	3.58	2.33				
82.77	0.41	3.60	2.31				
82.79	0.42	3.58	2.28				
82.81	0.44	3.59	2.27				
82.83	0.47	3.60	2.25				
82.84	0.48	3.57	2.24				
82.86	0.51	3.57	2.22				
82.87	0.55	3.55	2.21				
82.89	0.56	3.55	2.19				
82.91	0.59	3.53	2.17				
82.92	0.61	3.54	2.16				
82.94	0.65	3.51	2.14				
82.94	0.67	3.50	2.14				
82.96	0.69	3.48	2.12				
82.92	0.70	3.39	2.16				

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 2 (7.1 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

### Stage 2

Date/Time Shear Initiated: 6/7/18 825 Date/Time Shear Completed: 6/7/18 841

#### **Consolidation Data**

Length (cm): 11.20

Diameter (cm): 4.81

Measured outflow (cm<sup>3</sup>): 2.60

Area (cm<sup>2</sup>): 18.15

Area Determined by Method: ☑ A ☐ B

Volume (cm<sup>3</sup>): 203.30

Dry Density (g/cm<sup>3</sup>): 1.58

Dry Unit Weight (lbf/ft<sup>3</sup>): 98.38

Equivalent Height of Solids (cm): 6.66

Porosity (%, vol): 40.5

Void Ratio (e): 0.682

Time to 50% Primary Consol. (t50) (min): 0.5

#### **Shear Data**

Effective Consolidation Stress (psi): 7.06

Total Back Pressure (psi): 81.58

Failure Criterion: Peak

Deviator Stress at Failure (psi): 7.1

Effective Minor Stress at Failure (psi): 3.2

Effective Major Stress at Failure (psi): 10.3

Membrane Correction Required/Applied: ☐ Yes ☑ No

Axial Strain (ε) at Failure (%): 3.02

Strain Rate (%/hr): 11.1

#### Test Notes:

Test was halted after reaching a maximum target of 3% strain. Failure was interpreted as the peak deviator stress achieved.

Laboratory analysis by: D. O'Dowd

Data entered by: C. Krous

Checked by: J. Hines

Job Name: Stantec Consulting Services Inc

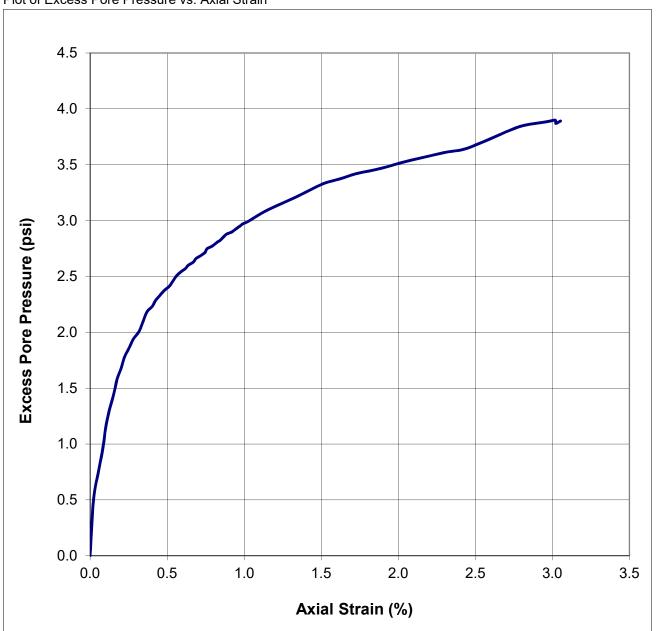
Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 2 (7.1 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Excess Pore Pressure vs. Axial Strain



Job Name: Stantec Consulting Services Inc

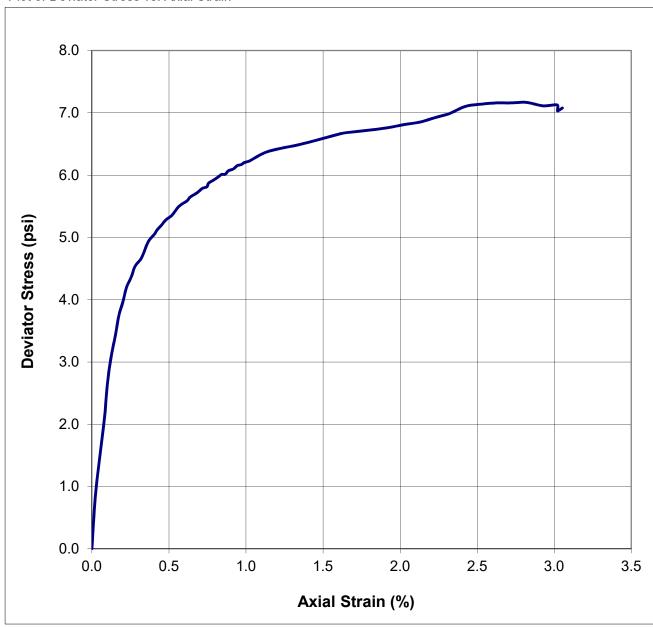
Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 2 (7.1 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

#### Plot of Deviator Stress vs. Axial Strain



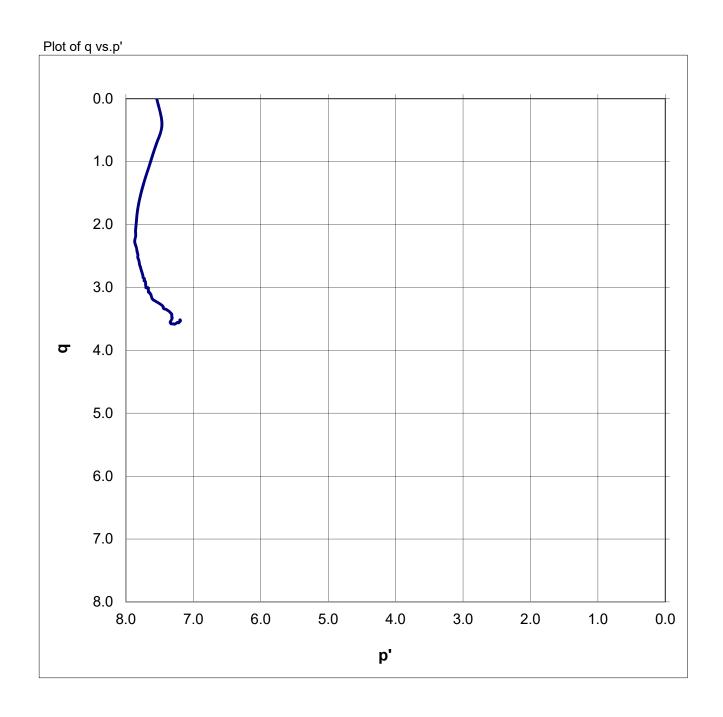
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 2 (7.1 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS



85.48

3.02

10.30

## Data for Consolidated Undrained (CU) Triaxial Shear Testing

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 2 (7.1 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## **Raw Data**

			Raw	Data			
Pore Pressure	Axial Strain	Effective Major Stress	Effective Minor Stress	Pore Pressure	Axial Strain	Effective Major Stress	Effective Minor Stress
(psi)	(%)	(psi)	(psi)	(psi)	(%)	(psi)	(psi)
81.58	0.00	7.06	7.06	85.47	3.02	10.24	3.18
82.08	0.02	7.40	6.57	85.45	3.02	10.23	3.20
82.33	0.05	7.86	6.31	85.47	3.05	10.26	3.18
82.54	0.08	8.24	6.10				
82.72	0.10	8.57	5.92				
82.88	0.12	8.84	5.76				
83.02	0.15	9.06	5.62				
83.16	0.18	9.23	5.48				
83.26	0.20	9.35	5.37				
83.36	0.22	9.47	5.28				
83.44	0.25	9.55	5.19				
83.52	0.28	9.65	5.12				
83.58	0.32	9.70	5.05				
83.65	0.34	9.73	4.98				
83.71	0.35	9.78	4.92				
83.77	0.37	9.82	4.86				
83.81	0.40	9.86	4.82				
	0.42	9.89					
83.86 83.91			4.77				
	0.45	9.92	4.72				
83.95	0.48	9.95	4.67				
83.99	0.52	9.97	4.63				
84.04	0.54	10.00	4.59				
84.08	0.56	10.02	4.54				
84.12	0.59	10.04	4.51				
84.15	0.62	10.06	4.48				
84.18	0.64	10.09	4.44				
84.21	0.67	10.11	4.41				
84.24	0.69	10.10	4.38				
84.26	0.72	10.14	4.35				
84.29	0.75	10.13	4.32				
84.32	0.76	10.16	4.29				
84.35	0.79	10.19	4.26				
84.38	0.83	10.21	4.23				
84.40	0.84	10.22	4.21				
84.43	0.87	10.19	4.18				
84.46	0.89	10.22	4.15				
84.47	0.92	10.23	4.13				
84.50	0.94	10.26	4.11				
84.53	0.97	10.25	4.08				
84.55	0.99	10.26	4.06				
84.57	1.02	10.26	4.03				
84.65	1.12	10.31	3.95				
84.72	1.23	10.30	3.87				
84.78	1.33	10.28	3.80				
84.85	1.42	10.27	3.73				
84.91	1.52	10.27	3.67				
84.95	1.62	10.27	3.62				
85.00	1.72	10.27	3.57				
85.03	1.82	10.26	3.54				
85.06	1.93	10.26	3.49				
85.10	2.03	10.26	3.45				
85.13	2.13	10.26	3.41				
85.16	2.22	10.30	3.38				
85.19	2.32	10.33	3.34				
85.22	2.42	10.41	3.31				
85.27	2.53	10.42	3.28				
85.33	2.63	10.42	3.27				
85.38	2.72	10.40	3.24				
85.43	2.82	10.37	3.21				
85.45	2.93	10.30	3.19				
85 48	3.02	10.30	3 17				

Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 3 (14.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## Stage 3

Date/Time Shear Initiated: 6/7/18 1254 Date/Time Shear Completed: 6/7/18 1437

#### **Consolidation Data**

Length (cm): 11.08

Diameter (cm): 4.81

Measured outflow (cm<sup>3</sup>): 4.85

Area (cm2): 18.15

Area Determined by Method: ☑ A ☐ B

Volume (cm<sup>3</sup>): 201.04

Dry Density (g/cm<sup>3</sup>): 1.59

Dry Unit Weight (lbf/ft<sup>3</sup>): 99.48

Equivalent Height of Solids (cm): 6.66

Porosity (%, vol): 39.9

Void Ratio (e): 0.663

Time to 50% Primary Consol. (t50) (min): 2.06

## **Shear Data**

Effective Consolidation Stress (psi): 14.01

Total Back Pressure (psi): 81.60

Failure Criterion: Peak

Deviator Stress at Failure (psi): 16.3

Effective Minor Stress at Failure (psi): 6.0

Effective Major Stress at Failure (psi): 22.4

Membrane Correction Required/Applied: ✓ Yes ☐ No

Axial Strain (ε) at Failure (%): 11.74

Strain Rate (%/hr): 8.7

## Test Notes:

Test was halted after reaching the target of 15% strain. Failure was interpreted as the peak deviator stress achieved.

Laboratory analysis by: D. O'Dowd

Data entered by: C. Krous

Checked by: J. Hines

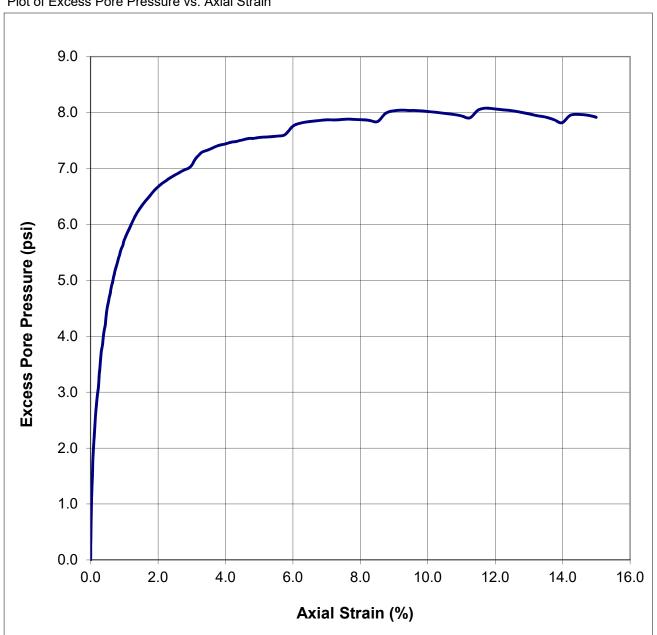
Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 3 (14.0 psi) Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## Plot of Excess Pore Pressure vs. Axial Strain



Job Name: Stantec Consulting Services Inc

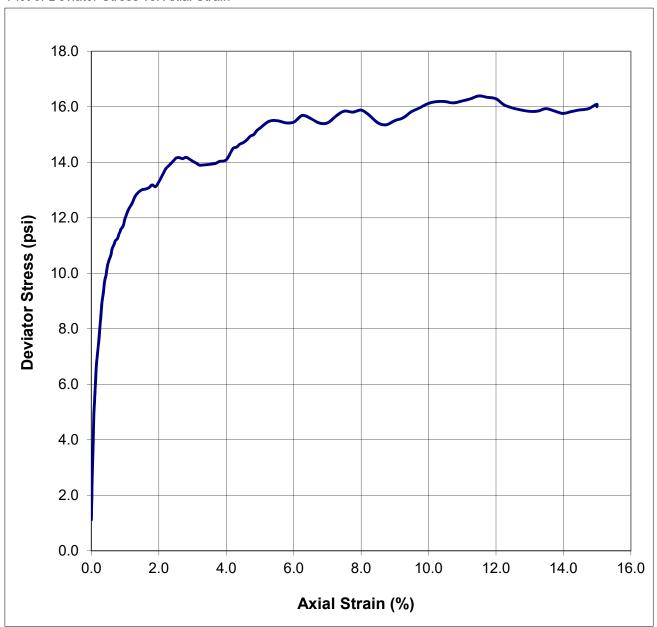
Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 3 (14.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## Plot of Deviator Stress vs. Axial Strain



Job Name: Stantec Consulting Services Inc

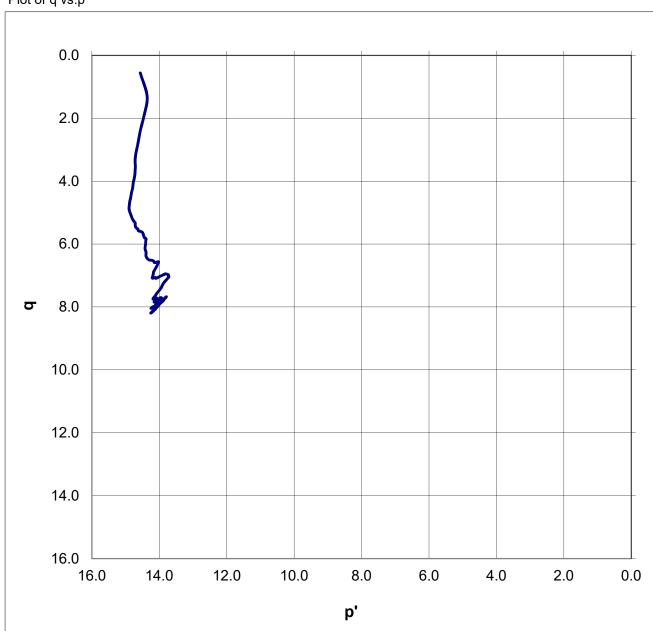
Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 3 (14.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## Plot of q vs.p'



Job Name: Stantec Consulting Services Inc

Job Number: DB18.1151.00

Sample Number: L2-6 (10'B) CU Stage 3 (14.0 psi)

Project Name: St. Anthony Geotech Investigation

PO Number: 233001076-DBS

## **Raw Data**

	Axial	Effective Major	Effective Minor		Axial	Effective Major	Effective Minor
Pore Pressure	Strain	Stress	Stress	Pore Pressure	Strain	Stress	Stress
(psi)	(%)	(psi)	(psi)	(psi)	(%)	(psi)	(psi)
81.60	0.00	15.13	14.01	88.77	3.11 3.21	20.88	6.91 6.88
82.55 83.06	0.02 0.05	15.67 16.36	13.05 12.54	88.84 88.90	3.21	20.77 20.75	6.84
83.43	0.03	16.96	12.17	88.92	3.40	20.74	6.83
83.74	0.07	17.41	11.85	88.94	3.51	20.74	6.80
83.99	0.10	17.78	11.60	88.96	3.60	20.73	6.77
84.20	0.14	18.05	11.38	88.99	3.70	20.71	6.74
84.39	0.18	18.23	11.19	89.02	3.81	20.75	6.71
84.56	0.20	18.42	11.02	89.03	3.91	20.74	6.70
84.72	0.24	18.62	10.86	89.05	4.02	20.78	6.67
84.90	0.25	18.84	10.71	89.06	4.11	20.95	6.65
85.06	0.28	19.00	10.58	89.08	4.21	21.14	6.63
85.20	0.30	19.19	10.46	89.08	4.31	21.16	6.62
85.33	0.32	19.35	10.34	89.10	4.41	21.25	6.59
85.46	0.36	19.52	10.23	89.11	4.50	21.28	6.57
85.57	0.37	19.65	10.12	89.13	4.61	21.35	6.55
85.69	0.40	19.77	10.02	89.14	4.71	21.47	6.53
85.80	0.43	19.84	9.92	89.14	4.81	21.52	6.52
85.91	0.45	19.89	9.82	89.15	4.91	21.65	6.50
86.01	0.47	19.94	9.73	89.16	5.02	21.73	6.48
86.10	0.49	19.99	9.64	89.17	5.27	21.93	6.45
86.20	0.52	20.02	9.54	89.18	5.52	21.90	6.41
86.29	0.55	20.03	9.46	89.21	5.76	21.80	6.37
86.37	0.58	20.05	9.38	89.36	6.01 6.25	21.80	6.35 6.31
86.44 86.51	0.60 0.62	20.11 20.16	9.31 9.24	89.42 89.44	6.50	22.00 21.87	6.28
86.57	0.65	20.17	9.24	89.46	6.76	21.68	6.26
86.64	0.67	20.17	9.10	89.47	7.01	21.65	6.23
86.71	0.70	20.20	9.04	89.47	7.26	21.89	6.21
86.77	0.72	20.17	8.98	89.48	7.50	22.03	6.19
86.82	0.74	20.14	8.93	89.48	7.76	21.97	6.16
86.87	0.77	20.13	8.87	89.48	8.01	22.02	6.14
86.93	0.80	20.15	8.82	89.46	8.26	21.81	6.13
86.99	0.82	20.18	8.76	89.44	8.51	21.53	6.12
87.04	0.85	20.21	8.70	89.59	8.75	21.47	6.11
87.09	0.87	20.24	8.66	89.63	8.99	21.59	6.10
87.14	0.89	20.23	8.61	89.64	9.25	21.69	6.08
87.19	0.93	20.23	8.56	89.64	9.49	21.90	6.08
87.23	0.96	20.28	8.52	89.64	9.73	22.02	6.07
87.27	0.97	20.34	8.47	89.62	9.99	22.18	6.06
87.32	1.00	20.39	8.42	89.61	10.24	22.24	6.06
87.47	1.10	20.57	8.27	89.59	10.49	22.24	6.06
87.60	1.21	20.65	8.14	89.57	10.73	22.19	6.05
87.72	1.29	20.78	8.01	89.54	10.99	22.26	6.05
87.83	1.40	20.82	7.89	89.51	11.25	22.34	6.05
87.92	1.51	20.80	7.79	89.64	11.49	22.45	6.06
88.00	1.60	20.74	7.70	89.68	11.74	22.39	6.05
88.08	1.71	20.71	7.62	89.67	12.00	22.35	6.06
88.14	1.80	20.73	7.55	89.65	12.24	22.14	6.07
88.22	1.90	20.59	7.46	89.64	12.48	22.03	6.07
88.28	2.01	20.71	7.40	89.61	12.74	21.96	6.08
88.33	2.10	20.86	7.34	89.58	12.99	21.92	6.09
88.37	2.20	21.04	7.29	89.55	13.24	21.94	6.10
88.42	2.31	21.13	7.23	89.52	13.48	22.03	6.10
88.45	2.41	21.20	7.18	89.47	13.75	21.96	6.12
88.49	2.50	21.29	7.14	89.42	13.98	21.90	6.14
88.52	2.60	21.27	7.10	89.55	14.23	21.98	6.15
88.55	2.70	21.18	7.05	89.57	14.49	22.05	6.16
88.58 88.61	2.80 2.90	21.19 21.09	7.01 6.97	89.56 89.52	14.73 14.98	22.09 22.29	6.17 6.20
	4.50	∠ 1.03	0.51	00.02	17.50	<b>44.43</b>	0.20

Laboratory Tests and Methods



## Daniel B. Stephens & Associates, Inc.

## **Tests and Methods**

Dry Bulk Density: ASTM D7263

Moisture Content: ASTM D7263, ASTM D2216

Calculated Porosity: ASTM D7263

Particle Size Analysis: ASTM D7928, ASTM D6913

USCS (ASTM) Classification: ASTM D7928, ASTM D6913, ASTM D2487

USDA Classification: ASTM D7928, ASTM D6913, USDA Soil Textural Triangle

Atterberg Limits: ASTM D4318

Visual-Manual Description: ASTM D2488

Standard Proctor Compaction: ASTM D698

Coarse Fraction (Gravel)

Correction (calc):

ASTM D4718; Bouwer, H. and Rice, R.C. 1984. Hydraulic Properties of Stony Vadose

Zones. Groundwater Vol. 22, No. 6

Consolidated Undrained

Triaxial:

**ASTM D4767** 

Cohesion & Friction Angle: Das, Braja M. 2002. Principles of Geotechnical Engineering. Chp. 11: Shear Strength of

Soil. Brooks/Cole, Pacific Grove, CA

Mohr's Circles: ASTM D4767; Das, Braja M. 2002. Principles of Geotechnical Engineering. Chp. 11:

Shear Strength of Soil. Brooks/Cole, Pacific Grove, CA



# Attachment G. Analytical Laboratory Testing Reports



# Gross Alpha Case Narrative

# **Stantec Consulting Services**

St. Anthony Geotechnical Investigation – 233001076

Work Order Number: 1804492

- 1. This report consists of the analytical results for 17 soil samples received by ALS on 04/23/2018.
- 2. These samples were prepared according to the current revisions of SOP 702 and SOP 736.
- 3. The samples were analyzed for gross alpha activity by gas flow proportional counting according to the current revision of SOP 724. The analyses were completed on 05/17/2018. Gross alpha results are referenced to <sup>241</sup>Am.
- 4. The analysis results for these samples are reported on a 'Dry Weight' basis in units of pCi/gram.
- 5. No anomalous situations were encountered during the preparation or analysis of these samples. All quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Pik Yee Yuen Date

Radiochemistry Primary Data Reviewer

5/23/18
Date

5/29/18
Date

# **ALS -- Fort Collins**

## Sample Number(s) Cross-Reference Table

**OrderNum:** 1804492

Client Name: Stantec Consulting Services

Client Project Name: St. Anthony Geotechnical Investigation

**Client Project Number: 233001076** 

Client PO Number: 233001076-ALS2

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
P1-2 20'	1804492-1		SOIL	09-Apr-18	11:00
P1-2 40'	1804492-2		SOIL	09-Apr-18	11:30
P1-2 60'	1804492-3		SOIL	11-Apr-18	14:30
P2-1 10'	1804492-4		SOIL	14-Apr-18	16:15
P2-1 20'	1804492-5		SOIL	14-Apr-18	16:25
P2-2 10'	1804492-6		SOIL	15-Apr-18	8:30
P4-3 5'	1804492-7		SOIL	16-Apr-18	12:10
P4-5 5'	1804492-8		SOIL	16-Apr-18	10:00
P4-5 15'	1804492-9		SOIL	16-Apr-18	10:10
P4-9 20'	1804492-10		SOIL	15-Apr-18	13:30
P4-9 30'	1804492-11		SOIL	15-Apr-18	13:50
BW-1 10'	1804492-12		SOIL	18-Apr-18	9:35
BW-4 5'	1804492-13		SOIL	18-Apr-18	12:00
BW-4 15'	1804492-14		SOIL	18-Apr-18	12:15
BW-3 10'	1804492-15		SOIL	18-Apr-18	12:50
BW-2 5'	1804492-16		SOIL	18-Apr-18	13:45
BW-2 20'	1804492-17		SOIL	18-Apr-18	14:05

2 of 29

Date Printed: Wednesday, May 23, 2018

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225 Commerce Drive, Fort Collins, Colorado 80524 TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

ALS WORKORDER#

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Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

Turnaround time for samples received Saturday will be calculated beginning from the next business day.

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		PURCHASE ORDER		1			<b>⋖</b>	ارم م	-336	EPA	EPA 901.1	_		:		
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*Time Zone (Circle):	ST Matrix: O = oil	S=soil NS=non-soil solid W=water L=liquid E=extract F=filter	liquid E = extract F = fille	, L			F							ŀ		
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RECEIVED BY	Prinky 1,1 dust	Emily Lyons	4.23.18 0900	0900
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Summary
(Standard QC)
LEVEL II
(Standard QC)
LEVEL III (Std QC + forms)
LEVEL IV (Std QC + forms + raw

1-HCI 2-HNO3 3-H2SO4 4-NeOH 5-NeOH/ZnAcetate 6-NeHSO4 7-4°C 8-Other

PRESERVATION KEY

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225 Commerce Drive, Fort Collins, Colorado 80524 TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

ALS WORKORDER#

8644081

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

Turnaround time for samples received Saturday will be calculated beginning from the next business day.

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FAX			FAX					<u>ن</u>								
E-MAIL	cameron. Firtz @ stantec. com	E-MAIL		son. cumba	es (Ost	Jason. cumber @stantec. com		I								
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14	191 h-MB	<del>П</del>	1181) h	13:15pm		A)u		>	>	>						
15	BM-3 10,	T S	81/81/2	md os: e1		<u>∢</u> 2		>	,	>						
16	BW-2 5'		81/81/14	1:45pm		NA		)	/	>						
7	BW-2 20'	S	81/81/h	2:05pm		N/A		<u> </u>	/ /	>						
					_											
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RECEIVED BY

PRESERVATION KEY 1-HC 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcelale 6-NaHSO4 7-4°C 8-Other



# ALS Environmental - Fort Collins CONDITION OF SAMPLE UPON RECEIPT FORM

Client: Stantec	Workorder No: 1804	1497	<u>_</u>	
Project Manager: L25	Initials: Gw	Date:	4.23.19	- 'S
Does this project require any special handling in addition to standard	ard ALS procedures?		YES	(NO)
2. Are custody seals on shipping containers intact?		NÓNE	YES	NO
3. Are Custody seals on sample containers intact?		MONE	YES	NO
4. Is there a COC (Chain-of-Custody) present or other represen	ntative documents?		(TES)	NO
5. Are the COC and bottle labels complete and legible?			YES	NO
6. Is the COC in agreement with samples received? (IDs, dates containers, matrix, requested analyses, etc.)	, times, no. of samples, no. of		YES	NO
Were airbills / shipping documents present and/or removabl	le?	DROP OFF	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly	y? (excluding volatiles)	AV/A	YES	NO
9. Are all aqueous non-preserved samples pH 4-9?		(N)A	YES	NO
10. Is there sufficient sample for the requested analyses?			XES	NO
Were all samples placed in the proper containers for the req	uested analyses?			NO
12. Are all samples within holding times for the requested analy	yses?		(TE)s	NO
13. Were all sample containers received intact? (not broken or	leaking, etc.)	,	YES	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/) headspace free? Size of bubble: < green pea	MEE, Rx CN/S, radon)> green pea	(N/A)	YES	NO
Amount of sediment: dusting moderate	Amount heavy	N/A	YES	NO
16. Were the samples shipped on ice?		'	YES	(NO)
17. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #2 #4	RAD	YES	NO
Cooler #: 1 3				
Temperature (°C): Amb Amb				
No. of custody seals on cooler:				
DOT Survey/ Acceptance External µR/hr reading:				
Background μR/hr reading:				
Were external μR/hr readings ≤ two times background and within DOT acceptance	e criteria? YES / NO / NA (If no, see	Form 008.)		
Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPO				
	11			
If applicable, was the client contacted? YES / NO / NA Contact:		_ Date/Ti	me:	· · · · · · · · · · · · · · · · · · ·
Project Manager Signature / Date:/	A/V( 4/4/18	_		

\*IR Gun #2: Oakton, SN 29922500201-0066 \*IR Gun #4: Oakton, SN 2372220101-0002 FROM: CAMERON FRITZ

(907) 947-2225

SHIP DATE: 19APR18 ACTHGT: 36.00 LB CAD: 006993643/SSFE1904 DIMMED: 15 X 12 X 12 IN

. 718 MARIGOLD LN

FORT COLLINS CO 80526 US

TO

## ALS ENVIRONMENTAL 225 COMMERCE DR

FORT COLLINS CO 80524

(US)



1 of 2 TRK# 7805 9618 7711 ## MASTER ##

80524

9622 0019 0 (000 000 0000) 0 po 7805 9618 7711



FROM: CAMERON FRITZ

(907) 947-2225

718 MARIGOLD LN

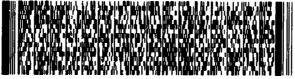
FORT COLLINS CO 90526

TO

## **ALS ENVIRONMENTAL** 225 COMMERCE DR

# FORT COLLINS CO 80524

(US)





2 of 2 MPS# 7805 9618 7722 Mstr# 7805 9618 7711

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7722



## **PAI 724 Rev 12 Method Blank Results**

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Lab ID: AB180514-1MB

Sample Matrix: SOIL

Prep Batch: AB180514-1 QCBatchID: AB180514-1-1 Final Aliquot: 1.50 g Result Units: pCi/g File Name: ABC0517E

Date Collected: 14-May-18 Date Prepared: 14-May-18

Prep SOP: PAI 702 Rev 21

Run ID: AB180514-1A

Count Time: 45 minutes

Date Analyzed: 17-May-18

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	0.02 +/- 0.18	0.51	3	NA	U

#### **Comments:**

#### Qualifiers/Flags:

 $\ensuremath{\mathsf{U}}\xspace$  - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018

## **PAI 724 Rev 12**

## **Laboratory Control Sample(s)**

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Lab ID: AB180514-1LCS

Sample Matrix: SOIL

Prep Batch: AB180514-1

Count Time: 45 minutes

Final Aliquot: 2.50 g

Prep SOP: PAI 702 Rev 21 Date Collected: 14-May-18

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

Result Units: pCi/g File Name: ABC0517E

Date Prepared: 14-May-18

Date Analyzed: 17-May-18

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added		Contro I Limits	Lab Qualifier
12587-46-1	GROSS ALPHA	16.9 +/- 3.0	0.4	15.06	112	70 - 130	Р

## Comments:

## Qualifiers/Flags:

U - Result is less than the sample specific MDC.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

Data Package ID: AB1804492-1

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Page 1 of 1 Date Printed: Wednesday, May 23, 2018 **ALS -- Fort Collins** 

## PAI 724 Rev 12 Matrix Spike Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-9 20'

**Lab ID:** 1804492-10MS

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

**Date Collected:** 15-Apr-18 **Date Prepared:** 14-May-18

Date Analyzed: 17-May-18

**Prep Batch:** AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 3.07 g

Prep Basis: Dry Weight Moisture(%): NA

Result Units: pCi/g File Name: ABC0517D

CASNO	Target Nuclide	Matrix Spike	Sample Results	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
12587-46-1	GROSS ALPHA	22.6	7.0	0.5	14.7	106	70 - 130	Р

## **Comments:**

#### Qualifiers/Flags:

 $\mbox{\bf U}~$  - Result is less than the sample specific MDC.

 $\ensuremath{\mathsf{LT}}$  - Result is less than Requested MDC, greater than sample specific MDC.

Y1 - Chemical Yield in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

N - Matrix Spike Recovery outside control limits

P - Matrix Spike Recovery within control limits

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

Data Package ID: AB1804492-1

Abbreviations:

MDC - Sample specific Minimum Detectable Concentration

Date Printed: Wednesday, May 23, 2018 ALS -- Fort Collins Page 1 of 1

## **PAI 724 Rev 12**

## **Duplicate Sample Results (DER)**

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 20'

Lab ID: 1804492-5DUP

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 14-Apr-18 Date Prepared: 14-May-18

Date Analyzed: 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 0.503 g

Prep Basis: Dry Weight Moisture(%): NA

Result Units: pCi/g File Name: ABC0517C

CASNO	Analyte	Sample			Duplicate			DER	DER
	Allalyte	Result +/- 2 s TPU	MDC	Flags	Result +/- 2 s TPU	MDC	Flags		Lim
12587-46-1	GROSS ALPHA	2.1 +/- 1.5	2.1	U	4.9 +/- 2.1	2.0		1.11	2.13

## Comments:

#### **Duplicate Qualifiers/Flags:**

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
- Y2 Chemical Yield outside default limits.
- W DER is greater than Warning Limit of 1.42
- D DER is greater than Control Limit of 2.13
- LT Result is less than Request MDC, greater than sample specific MDC
- M Requested MDC not met.
- M3 The requested MDC was not met, but the reported
- activity is greater than the reported MDC
- L LCS Recovery below lower control limit.
- H LCS Recovery above upper control limit.
- P LCS, Matrix Spike Recovery within control limits.
- N Matrix Spike Recovery outside control limits

Data Package ID: AB1804492-1

Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

## **PAI 724 Rev 12** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 20'

Lab ID: 1804492-1

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21 Date Collected: 09-Apr-18

Date Prepared: 14-May-18 Date Analyzed: 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 0.501 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q File Name: ABC0517B

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	48.2 +/- 9.6	2.2	3	NA	

## **Comments:**

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

## **PAI 724 Rev 12** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 40' Lab ID: 1804492-2 Sample Matrix: SOIL

Prep Batch: AB180514-1 QCBatchID: AB180514-1-1 Final Aliquot: 0.516 g

Prep SOP: PAI 702 Rev 21 Date Collected: 09-Apr-18

Run ID: AB180514-1A

Prep Basis: Dry Weight Moisture(%): NA

Date Prepared: 14-May-18

Count Time: 30 minutes

Result Units: pCi/q File Name: ABC0517B

Date Analyzed: 17-May-18

Report Basis: Dry Weight

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	5.3 +/- 2.1	1.8	3	NA	

## **Comments:**

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 60'
Lab ID: 1804492-3

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 11-Apr-18

**Date Prepared:** 14-May-18 **Date Analyzed:** 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 0.510 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517B

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	3.7 +/- 1.7	1.7	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 10'
Lab ID: 1804492-4

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 14-Apr-18

**Date Prepared:** 14-May-18 **Date Analyzed:** 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 0.514 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/q

File Name: ABC0517B

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	10.5 +/- 3.2	2.1	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

Abbreviations

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 20'
Lab ID: 1804492-5

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 14-Apr-18

Date Prepared: 14-May-18

Date Analyzed: 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 0.512 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517C

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	2.1 +/- 1.5	2.1	3	NA	U

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018

## **PAI 724 Rev 12**

## Sample Duplicate Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 20'

Lab ID: 1804492-5DUP

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21 Date Collected: 14-Apr-18

Date Prepared: 14-May-18 Date Analyzed: 17-May-18 Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 0.503 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517C

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	4.9 +/- 2.1	2.0	3	NA	

#### Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.

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- M The requested MDC was not met.
- M3 The requested MDC was not met, but thereported activity is greater than the reported MDC.
- W DER is greater than Warning Limit of 1.42
- D DER is greater than Control Limit of 2.13

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

**Date Printed:** 

**ALS -- Fort Collins** 

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## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-2 10'
Lab ID: 1804492-6

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 15-Apr-18

Date Prepared: 14-May-18

Date Analyzed: 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 0.512 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517C

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	2.7 +/- 1.5	1.7	3	NA	LT

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-3 5'

Sample Matrix: SOIL

Prep Batch: AB180514-1

Final Aliquot: 2.07 g

**Lab ID**: 1804492-7

Prep SOP: PAI 702 Rev 21

Date Collected: 16-Apr-18

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

**Prep Basis:** Dry Weight **Moisture(%):** NA

Date Prepared: 14-May-18
Date Analyzed: 17-May-18

Count Time: 30 minutes Report Basis: Dry Weight Result Units: pCi/g File Name: ABC0517C

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	6.8 +/- 1.6	0.7	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-5 5'
Lab ID: 1804492-8

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 16-Apr-18

**Date Prepared:** 14-May-18 **Date Analyzed:** 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 3.03 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517C

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	65 +/- 11	1	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-5 15'
Lab ID: 1804492-9

Sample Matrix: SOIL

**Prep SOP:** PAI 702 Rev 21 **Date Collected:** 16-Apr-18

**Date Prepared:** 14-May-18 **Date Analyzed:** 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 3.07 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517C

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	67 +/- 11	1	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-9 20'
Lab ID: 1804492-10

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 15-Apr-18

Date Prepared: 14-May-18

Date Analyzed: 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 3.03 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517C

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	7.0 +/- 1.5	0.4	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-9 30'
Lab ID: 1804492-11

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 15-Apr-18

**Date Prepared:** 14-May-18 **Date Analyzed:** 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

Count Time: 30 minutes
Report Basis: Dry Weight

Final Aliquot: 0.501 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517D

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	4.8 +/- 2.1	2.1	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-1 10'
Lab ID: 1804492-12

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 18-Apr-18

Date Prepared: 14-May-18

Date Analyzed: 17-May-18

**Prep Batch:** AB180514-1 **QCBatchID:** AB180514-1-1

Run ID: AB180514-1A
Count Time: 30 minutes
Report Basis: Dry Weight

Final Aliquot: 0.501 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517D

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	6.0 +/- 2.5	2.1	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-4 5'
Lab ID: 1804492-13

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 18-Apr-18 Date Prepared: 14-May-18 Date Analyzed: 17-May-18 Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 0.513 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517D

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	5.0 +/- 2.3	2.6	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-4 15'
Lab ID: 1804492-14

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 18-Apr-18

Date Prepared: 14-May-18

Date Analyzed: 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A Count Time: 45 minutes Report Basis: Dry Weight Final Aliquot: 0.508 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517E

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	6.6 +/- 2.5	2.2	3	NA	

## Comments:

## Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

## **Gross Alpha by GFPC**

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-3 10'
Lab ID: 1804492-15

Sample Matrix: SOIL

**Prep SOP:** PAI 702 Rev 21 **Date Collected:** 18-Apr-18

**Date Prepared:** 14-May-18 **Date Analyzed:** 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 0.507 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: ABC0517D

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	3.3 +/- 1.9	2.2	3	NA	

### Comments:

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018

## **Gross Alpha by GFPC**

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-2 5'
Lab ID: 1804492-16

/-2 5' Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 18-Apr-18

Date Prepared: 14-May-18 Date Analyzed: 17-May-18 Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

Count Time: 30 minutes
Report Basis: Dry Weight

Final Aliquot: 0.505 g

Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: ABC0517D

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	5.4 +/- 2.2	1.9	3	NA	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018

## **Gross Alpha by GFPC**

## PAI 724 Rev 12 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-2 20'

Lab ID: 1804492-17

Sample Matrix: SOIL

Prep SOP: PAI 702 Rev 21

Date Collected: 18-Apr-18

Date Prepared: 14-May-18

Date Analyzed: 17-May-18

Prep Batch: AB180514-1

QCBatchID: AB180514-1-1 Run ID: AB180514-1A

Count Time: 30 minutes
Report Basis: Dry Weight

Final Aliquot: 0.503 g

Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/q

File Name: ABC0517D

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	2.2 +/- 1.6	2.3	3	NA	U

### Comments:

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

### Abbreviations

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AB1804492-1

Date Printed: Wednesday, May 23, 2018



# Isotopic Thorium Case Narrative

## **Stantec Consulting Services**

St. Anthony Geotechnical Investigation – 233001076

Work Order Number: 1804492

- 1. This report consists of the analytical results for 17 soil samples received by ALS on 04/23/2018.
- These samples were prepared according to the current revisions of SOP 773, SOP 777, and SOP 736.
- 3. The samples were analyzed for the presence of isotopic thorium according to the current revision of SOP 714. The analyses were completed on 05/10/2018.
- 4. The isotopic analysis results for these samples are reported on a 'Dry Weight' basis in units of pCi/gram.
- 5. No anomalous situations were encountered during the preparation or analysis of these samples. All quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Pik Yee Yuen
Radiochemistry Primary Data Reviewer

5/23/18
Date

5/29/18

Radiochemistry Final Data Reviewer

Date

## **ALS -- Fort Collins**

## Sample Number(s) Cross-Reference Table

**OrderNum:** 1804492

Client Name: Stantec Consulting Services

Client Project Name: St. Anthony Geotechnical Investigation

Client Project Number: 233001076

Client PO Number: 233001076-ALS2

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
P1-2 20'	1804492-1		SOIL	09-Apr-18	11:00
P1-2 40'	1804492-2		SOIL	09-Apr-18	11:30
P1-2 60'	1804492-3		SOIL	11-Apr-18	14:30
P2-1 10'	1804492-4		SOIL	14-Apr-18	16:15
P2-1 20'	1804492-5		SOIL	14-Apr-18	16:25
P2-2 10'	1804492-6		SOIL	15-Apr-18	8:30
P4-3 5'	1804492-7		SOIL	16-Apr-18	12:10
P4-5 5'	1804492-8		SOIL	16-Apr-18	10:00
P4-5 15'	1804492-9		SOIL	16-Apr-18	10:10
P4-9 20'	1804492-10		SOIL	15-Apr-18	13:30
P4-9 30'	1804492-11		SOIL	15-Apr-18	13:50
BW-1 10'	1804492-12		SOIL	18-Apr-18	9:35
BW-4 5'	1804492-13		SOIL	18-Apr-18	12:00
BW-4 15'	1804492-14		SOIL	18-Apr-18	12:15
BW-3 10'	1804492-15		SOIL	18-Apr-18	12:50
BW-2 5'	1804492-16		SOIL	18-Apr-18	13:45
BW-2 20'	1804492-17		SOIL	18-Apr-18	14:05

Date Printed: Wednesday, May 23, 2018

SEE NOTES RETURN ALS WORKORDER# PARAMETER/METHOD REQUEST FOR ANALYSIS 5644081 (BY IAB) I EPA 901.1 DISPOSAL EPA 901 ø PAGE (EPA 901.1) Ra-236 (EPA 901.1 u. w Thorium - 230 Gross alpha ٥ > > Uranium ပ > Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day. Turnaround time for samples received Saturday will be calculated beginning from the next business day. 8 > ۵ ш **L** O I 7 ⋖ ဗွ Excel Spreadsheet #/50 PRESERVATIVE Jason.cumbers a stanfec.com **∀**/2 <u>₹</u> 2 Stantec Consolting Sewhees <u>≺</u> Z **2**0536 <u>×</u> Chain-of-Custody Z SAMPLER # OF BOTTLES 5 Timbertha (970) 214 - 2755 Firt Collins, CO St. Anthony Mine Jason Compars 11:30am SAMPLE TIME 4114 A115 pm 13:10 pm 10:10 00 3:30 4:85 pm 8:30 am 11:00an 4/16/18 10:00 ar Microsoft 3335 81 U H 81/99/16 1 16 18 419118 81 417 81/6/18 SAMPLE DATE 4/15/18 SITEID PHONE ADDRESS TURNAROUND TIME **EDD FORMAT** BILL TO COMPANY INVOICE ATTN TO CITY / STATE / ZIP ξ¥ E-MAIL PURCHASE ORDER MATRIX 108 Soil ار فر S.1. 50.1 هَنَ Sø; / PROJECT NAME St. Anthrony Geofconital Involting they Converon. fritz @ stanger.com #150 TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522 225 Commerce Drive, Fort Collins, Colorado 80524 80575 Stanter Consulting Services 3326 S Timberline Rd **ALS Environmental** P215- 616 (OLP) 2159 FEDTO Fort Collins, CO Lameron Fists **1**9e 9 S 9 5 S S PROJECT No. | 233001016 6-19 4-10 P1-2 8-td P4-3 5- Hd 1-69 1-40 5-Hd ADDRESS CITY / STATE / ZIP COMPANY NAME E-MAIL SEND REPORT TO ¥ 28  $\mathcal{R}$ و 80 a

Form 202r9	SIGNATURE	PRINTED NAME	DATE	TIME
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1-HCI 2-HN03 3-H2SO4 4-NeOH 5-NeOH/ZnAcelate 6-NeHSO4 7-4°C 8-Other

PRESERVATION KEY

3 of 28

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A Z

Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

CST (MST) PST

EST

Time Zone (Circle):

RW-1

NOTES

REPORT LEVEL / QC REQUIRED

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1:30pm 1:50pm 9:35am

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225 Commerce Drive, Fort Collins, Colorado 80524 TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

ALS WORKORDER#

C6hho81

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

Turnaround time for samples received Saturday will be calculated beginning from the next business day.

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LABID	FIELD ID	MATRIX	SAMPLE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	8	8	ပ	٥	ш	<u> </u>	_ 	-		SEE NOTES SECTION	_
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Emily Lyons

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Summary
(Standard QC)
LEVEL II
(Standard QC)
LEVEL III (Standard QC)
LEVEL III (Standard QC + forms)
LEVEL IV (Standard QC + forms + raw,

RECEIVED BY

RELINQUISHED BY

RECEIVED BY

PRESERVATION KEY 1-HC 2-HNO3 3-H2SO4 4-N8OH 5-N8OHIZhAcelale 6-N8HSO4 7-4°C 8-Other

4 of 28



## ALS Environmental - Fort Collins CONDITION OF SAMPLE UPON RECEIPT FORM

Client: Stantec Workorder No: 1804	<u>1497</u>		_
Project Manager: Lf5 Initials: Gu	Date:	4.23.19	Š
Does this project require any special handling in addition to standard ALS procedures?		YES	(NO)
2. Are custody seals on shipping containers intact?	NÓNE	YES	NO
3. Are Custody seals on sample containers intact?	MONE	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		(E)	NO
5. Are the COC and bottle labels complete and legible?		YES	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		YES	NO
Were airbills / shipping documents present and/or removable?	DROP OFF	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	AVIA	YES	NO
9. Are all aqueous non-preserved samples pH 4-9?	(N)A	YES	NO
10. Is there sufficient sample for the requested analyses?		XES	NO
11. Were all samples placed in the proper containers for the requested analyses?		(E)	NO
12. Are all samples within holding times for the requested analyses?		(TE)S	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		YES	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: < green pea > green pea		YES	NO
Amount of sediment: dusting moderateheavy	N/A	YES	NO
16. Were the samples shipped on ice?		YES	(QA)
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	RAD	YES	NO
Cooler #: 1			
Temperature (°C): Amb Amb			
No. of custody seals on cooler:			
DOT Survey/ Acceptance External μR/hr reading:			
Background μR/hr reading:			
Were external μR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / NA (If no, see	Form 008.)		
Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EX		ND #16.	
If applicable, was the client contacted? YES / NO / NA Contact:	Date/Tir	ne:	
Project Manager Signature / Date:	_		

\*IR Gun #2: Oakton, SN 29922500201-0066 \*IR Gun #4: Oakton, SN 2372220101-0002 FROM: CAMERON FRITZ (907) 947-2225

SHIP DATE: 19APR18 ACTHGT: 36.00 LB CAD: 006993643/SSFE1904 DIMMED: 15 X 12 X 12 IN

.718 MARIGOLD LN

FORT COLLINS CO 80526 US

TO

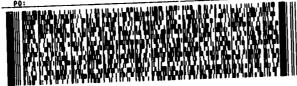
## ALS ENVIRONMENTAL 225 COMMERCE DR

FORT COLLINS CO 80524

(US)

(800) 443-1511

REF:



FedEx Ground

1 of 2 TRK# 7805 9618 7711 ## MASTER ##

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FROM: CAMERON FRITZ

(907) 947-2225

718 MARIGOLD LN

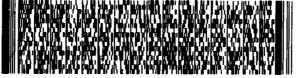
FORT COLLINS CO 90526

TO

## **ALS ENVIRONMENTAL** 225 COMMERCE DR

# FORT COLLINS CO 80524

(US)





2 of 2 MPS# 7805 9618 7722 Mstr# 7805 9618 7711

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## PAI 714 Rev 13 Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Lab ID: AS180430-2MB

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12 Date Collected: 01-May-18

Date Prepared: 01-May-18

Date Analyzed: 10-May-18

Prep Batch: AS180430-2

QCBatchID: AS180430-2-1 Run ID: AS180430-2TH

Count Time: 1000 minutes

Final Aliquot: 2.00 g Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	-0.002 +/- 0.022	0.039	0.2	NA	U

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	2.301	1.50	pCi/g	65.2	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

### **PAI 714 Rev 13**

### Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Lab ID: AS180430-2LCS

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Prepared: 01-May-18 Date Analyzed: 10-May-18

QCBatchID: AS180430-2-1 Date Collected: 01-May-18 Run ID: AS180430-2TH

Count Time: 1000 minutes

**Prep Batch:** AS180430-2

Final Aliquot: 2.00 g Result Units: pCi/g File Name: Spectrum #1

С	CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added		Contro I Limits	Lab Qualifier
1	4269-63-7	Th-230	2.63 +/- 0.42	0.04	2.464	107	85 - 121	Р

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	2.301	1.48	pCi/g	64.3	30 - 110 %	

### Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

Data Package ID: TH1804492-1

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Page 1 of 1 Date Printed: Wednesday, May 23, 2018 **ALS -- Fort Collins** 

### **PAI 714 Rev 13**

### **Duplicate Sample Results (DER)**

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 20'

**Lab ID:** 1804492-5DUP

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12 Date Collected: 14-Apr-18

Date Prepared: 01-May-18

Date Analyzed: 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 0.539 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g

File Name: Spectrum #1

CASNO	NO Analyte Sample		Duplicate			DER	DER		
	Allalyte	Result +/- 2 s TPU	MDC	Flags	Result +/- 2 s TPU	MDC	Flags		Lim
14269-63-7	Th-230	1.15 +/- 0.23	0.13		1.05 +/- 0.21	0.13		0.325	2.13

### Comments:

### Duplicate Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{W}}$  DER is greater than Warning Limit of 1.42
- D DER is greater than Control Limit of 2.13
- LT Result is less than Request MDC, greater than sample specific MDC
- M Requested MDC not met
- M3 The requested MDC was not met, but the reported
- activity is greater than the reported MDC.

  L LCS Recovery below lower control limit.
- H LCS Recovery above upper control limit.
- P LCS, Matrix Spike Recovery within control limits.
- N Matrix Spike Recovery outside control limits

Data Package ID: TH1804492-1

Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 20'
Lab ID: 1804492-1

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12 Date Collected: 09-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

Prep Batch: AS180430-2

QCBatchID: AS180430-2-1 Run ID: AS180430-2TH

Count Time: 1000 minutes Report Basis: Dry Weight

Final Aliquot: 0.542 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	16.6 +/- 2.6	0.1	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.498	6.47	pCi/g	76.2	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 40'
Lab ID: 1804492-2

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 09-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH

Count Time: 1000 minutes Report Basis: Dry Weight

Final Aliquot: 0.554 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	1.11 +/- 0.23	0.14	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.302	5.60	pCi/g	67.5	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 60'
Lab ID: 1804492-3

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 11-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

Prep Batch: AS180430-2

QCBatchID: AS180430-2-1 Run ID: AS180430-2TH

**Count Time:** 1000 minutes **Report Basis:** Dry Weight

Final Aliquot: 0.512 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	0.99 +/- 0.22	0.15	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.990	5.53	pCi/g	61.5	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 10'
Lab ID: 1804492-4

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 14-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

**Prep Batch:** AS180430-2 **QCBatchID:** AS180430-2-1

Run ID: AS180430-2TH Count Time: 1000 minutes

Report Basis: Dry Weight

Moisture(%): NA Result Units: pCi/g

File Name: Spectrum #1

Prep Basis: Dry Weight

Final Aliquot: 0.538 g

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	4.11 +/- 0.69	0.14	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.557	5.68	pCi/g	66.3	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

## **PAI 714 Rev 13** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 20' Lab ID: 1804492-5 Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12 Date Collected: 14-Apr-18

Date Prepared: 01-May-18 Date Analyzed: 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 0.538 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	1.15 +/- 0.23	0.13	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.562	6.10	pCi/g	71.3	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

### **PAI 714 Rev 13**

### Sample Duplicate Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 20'
Lab ID: 1804492-5DUP

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 1:

Prep SOP: PAI 777 Rev 12

Date Collected: 14-Apr-18

Date Prepared: 01-May-18

Date Prepared: 01-May-18

Date Analyzed: 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH Count Time: 1000 minutes Report Basis: Dry Weight Final Aliquot: 0.539 g
Prep Basis: Dry Weight

Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	1.05 +/- 0.21	0.13	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.533	6.20	pCi/g	72.7	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Wednesday, May 23, 2018

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

 $\ensuremath{\text{W}}$  - DER is greater than  $\ensuremath{\text{W}}$  arning Limit of 1.42

 $\ensuremath{\text{D}}$  -  $\ensuremath{\text{DER}}$  is greater than Control Limit of 2.13

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed:

**ALS -- Fort Collins** 

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## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-2 10'
Lab ID: 1804492-6

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 15-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 0.586 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	0.89 +/- 0.19	0.13	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	7.850	5.54	pCi/g	70.5	30 - 110 %	

### Comments:

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-3 5'
Lab ID: 1804492-7

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 16-Apr-18

Date Prepared: 01-May-18

Date Analyzed: 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH
Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 0.590 g

Prinar Aliquot: 0.590 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	1.60 +/- 0.29	0.13	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	7.800	5.45	pCi/g	69.8	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-5 5'
Lab ID: 1804492-8

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 16-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH

Count Time: 1000 minutes Report Basis: Dry Weight

Final Aliquot: 0.541 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	19.5 +/- 3.1	0.1	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.514	5.82	pCi/g	68.4	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-5 15'
Lab ID: 1804492-9

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 16-Apr-18

Date Prepared: 01-May-18

Date Analyzed: 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH Count Time: 1000 minutes Report Basis: Dry Weight Final Aliquot: 0.517 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	15.4 +/- 2.4	0.1	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.906	6.44	pCi/g	72.3	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

### Abbreviations

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-9 20'
Lab ID: 1804492-10

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 15-Apr-18

Date Prepared: 01-May-18

Date Analyzed: 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH

Count Time: 1000 minutes Report Basis: Dry Weight

Final Aliquot: 0.582 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	2.51 +/- 0.42	0.12	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	7.913	6.43	pCi/g	81.2	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-9 30'
Lab ID: 1804492-11

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12 Date Collected: 15-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH
Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 0.510 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

u a a ta al	2	l ob

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	0.93 +/- 0.20	0.14	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	9.028	6.5	pCi/g	72.1	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-1 10'
Lab ID: 1804492-12

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 18-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH
Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 0.567 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	0.90 +/- 0.20	0.14	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.116	5.11	pCi/g	62.9	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-4 5'
Lab ID: 1804492-13

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12

Date Collected: 18-Apr-18

Date Prepared: 01-May-18 Date Analyzed: 09-May-18 Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH

Count Time: 1000 minutes
Report Basis: Dry Weight

Final Aliquot: 0.532 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	1.20 +/- 0.24	0.14	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.658	5.92	pCi/g	68.4	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-4 15'
Lab ID: 1804492-14

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12 Date Collected: 18-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH
Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 0.533 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	0.90 +/- 0.20	0.14	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.631	5.99	pCi/g	69.4	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## **PAI 714 Rev 13** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-3 10' Lab ID: 1804492-15 Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12 Date Collected: 18-Apr-18

Date Prepared: 01-May-18 Date Analyzed: 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH Count Time: 1000 minutes Report Basis: Dry Weight

Final Aliquot: 0.507 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	0.85 +/- 0.19	0.14	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	9.078	6.46	pCi/g	71.2	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-2 5'
Lab ID: 1804492-16

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12 Date Collected: 18-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 09-May-18

Prep Batch: AS180430-2 QCBatchID: AS180430-2-1

Run ID: AS180430-2TH
Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 0.514 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	0.78 +/- 0.18	0.14	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.963	6.6	pCi/g	73.7	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018

## PAI 714 Rev 13 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-2 20'
Lab ID: 1804492-17

Sample Matrix: SOIL

Prep SOP: PAI 777 Rev 12 Date Collected: 18-Apr-18

**Date Prepared:** 01-May-18 **Date Analyzed:** 10-May-18

**Prep Batch:** AS180430-2 **QCBatchID:** AS180430-2-1

Run ID: AS180430-2TH
Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 0.515 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14269-63-7	Th-230	0.64 +/- 0.17	0.16	0.2	NA	

## **Chemical Yield Summary**

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Th-229	8.943	5.14	pCi/g	57.4	30 - 110 %	

### **Comments:**

### Qualifiers/Flags:

- U Result is less than the sample specific MDC.
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- $\ensuremath{\mathsf{LT}}$  Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

### Abbreviations

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: TH1804492-1

Date Printed: Wednesday, May 23, 2018



# Metals Case Narrative

## **Stantec Consulting Services**

## St. Anthony Geotechnical Investigation -- 233001076

Work Order Number: 1804492

- 1. This report consists of 17 soil samples.
- 2. The samples were received intact at ambient temperature by ALS on 04/23/18
- 3. The samples were prepared and analyzed based on SW-846, 3<sup>rd</sup> Edition procedures.

For analysis by ICP-MS, the samples were digested following method 3050B and the current revision of SOP 806.

- 4. Analysis by ICP-MS followed method 6020A and the current revision of SOP 827.
- All standards and solutions are NIST traceable and were used within their recommended shelf life.
- 6. The samples were prepared and analyzed within the established hold times.

All in house quality control procedures were followed, as described below.

- 7. General quality control procedures.
  - A preparation (method) blank and laboratory control sample were digested and analyzed with the samples in this digestion batch.
  - The preparation (method) blank associated with this digestion batch was below the reporting limit for the requested analyte.
  - All laboratory control sample criteria were met.
  - All initial and continuing calibration blanks were below the reporting limit for the requested analyte.



- All initial and continuing calibration verifications were within the acceptance criteria for the requested analyte.
- The interference check samples associated with Method 6020A were analyzed.
- 8. Matrix specific quality control procedures.

Sample 1804492-1 was designated as the quality control sample for this analysis.

Similarity of matrix and therefore relevance of the QC results should not be automatically inferred for any sample other than the native sample selected for QC.

- A matrix spike and matrix spike duplicate were digested and analyzed with this batch. All acceptance criteria for accuracy were met.
- Matrix spike recoveries could not be evaluated for the following analyte:

<u>Analyte</u>	Sample ID
Uranium	-1

The concentration of this analyte in the native sample was greater than four times the concentration of matrix spike added during the digestion. When sample concentration is that much greater than the spike added, spike recoveries may not be accurate. The laboratory control sample indicates that the digestion and analysis were in control.

 A sample duplicate and matrix spike duplicate were digested and analyzed with this batch. All acceptance criteria for precision were met with the following exception:

<u>Analyte</u>	Sample ID
Uranium	-1MS/MSD

The associated sample results are flagged for duplicate failure. Where spike duplicate precision was outside control limits only the duplicate page shows the flag.

- A serial dilution was analyzed with this ICP batch. All acceptance criteria were met.
- 9. It is a standard practice that samples for ICP-MS are analyzed at a dilution.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

C $A$ $A$ $A$ $A$	
mily your	5/21/18
Emily Lyons 🕖 🔍	Date
Inorganics Primary Data Deviewer	
/ la //t	5/29/18
JUN 1 4 -	5/29/16
Inorganics Final Data Reviewer	Date



### **Inorganic Data Reporting Qualifiers**

The following qualifiers are used by the laboratory when reporting results of inorganic analyses:

- Result qualifier -- If the analyte was analyzed for but not detected a "U" is entered.
- QC qualifier -- Specified entries and their meanings are as follows:
  - E The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.
  - M Duplicate injection precision was not met.
  - N Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.
  - Z Spiked recovery not within control limits. An explanatory note may be included in the narrative.
  - \* Duplicate analysis (relative percent difference) not within control limits.
  - S SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

## **ALS -- Fort Collins**

## Sample Number(s) Cross-Reference Table

**OrderNum:** 1804492

**Client Name:** Stantec Consulting Services

Client Project Name: St. Anthony Geotechnical Investigation

Client Project Number: 233001076

Client PO Number: 233001076-ALS2

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
P1-2 20'	1804492-1		SOIL	09-Apr-18	11:00
P1-2 40'	1804492-2		SOIL	09-Apr-18	11:30
P1-2 60'	1804492-3		SOIL	11-Apr-18	14:30
P2-1 10'	1804492-4		SOIL	14-Apr-18	16:15
P2-1 20'	1804492-5		SOIL	14-Apr-18	16:25
P2-2 10'	1804492-6		SOIL	15-Apr-18	8:30
P4-3 5'	1804492-7		SOIL	16-Apr-18	12:10
P4-5 5'	1804492-8		SOIL	16-Apr-18	10:00
P4-5 15'	1804492-9		SOIL	16-Apr-18	10:10
P4-9 20'	1804492-10		SOIL	15-Apr-18	13:30
P4-9 30'	1804492-11		SOIL	15-Apr-18	13:50
BW-1 10'	1804492-12		SOIL	18-Apr-18	9:35
BW-4 5'	1804492-13		SOIL	18-Apr-18	12:00
BW-4 15'	1804492-14		SOIL	18-Apr-18	12:15
BW-3 10'	1804492-15		SOIL	18-Apr-18	12:50
BW-2 5'	1804492-16		SOIL	18-Apr-18	13:45
BW-2 20'	1804492-17		SOIL	18-Apr-18	14:05

SEE NOTES SECTION RETURN ALS WORKORDER# PARAMETER/METHOD REQUEST FOR ANALYSIS 5644081 (BY IAB) I EPA 901.1 DISPOSAL EPA 901 Ø PAGE (EPA 901.1 Ra-236 (EPA 901.1 u. w Thorium - 230 Gross alpha ٥ > Uranium ပ > > Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day. Turnaround time for samples received Saturday will be calculated beginning from the next business day. 8 ۵ ш **L** O I 7 ⋖ ဗွ Excel Spreadsheet #/50 PRESERVATIVE Jason.cumbers @ stantec.com **∀**/2 <u>₹</u> ₹ 7 A Z Stantec Consulting Sewhees <u>≺</u> Z <u>×</u> 20536 Chain-of-Custody Z SAMPLER # OF BOTTLES 5 TImbertha (970) AIR - 275S Firt Collins, CO St. Anthony Mine Jason Compars Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter 4114 18 14:15 pm SAMPLE TIME 11:30am 10:10 00 3:30 4:85 pm 8:30 am 18:10 pm 4/16/18 10:00 am 1.30 pm 1.50pm 9.35 am 11:00 am Microsoft 3335 H (11 18 81/91/14 1 16 18 4 115/18 81/81/17 4/15/18 419118 114 18 4/15/18 81/6/18 SAMPLE DATE SITEID PHONE ADDRESS EDD FORMAT E-MAIL TURNAROUND TIME BILL TO COMPANY INVOICE ATTN TO CITY / STATE / ZIP PURCHASE ORDER MATRIX 1108 ار فر S.1. ڰؙ 50.1 هَنَ Ř -م Sø; / PROJECT NAME St. Anthrony Geofconital Involting they Converon. fritz @ stanger.com #150 TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522 225 Commerce Drive, Fort Collins, Colorado 80524 80575 Stanter Consulting Services ADDRESS 3335 S Timberline Rd **ALS Environmental** P215- 616 (OLP) 2159 FELD 10 CITY/STATE/ZIP | FORY CO | JAS, CO conneron Fritz 0 **1**9e Q 9 36 9 <u>-</u> 5 S S PROJECT No. | 233001016 EST CST (MST) PST 6-19 4-10 P1-3 8-td P4-3 5- Hd P-49 5-Hd 1-69 P4-9 8W-1 1-40 COMPANY NAME E-MAIL SEND REPORT TO ¥ Time Zone (Circle): 28 ٥  $\mathcal{R}$ و 8 ♡ 9

NOTES			Form 202r9	SIGNATURE	PRINTED NAME	DATE	TIME
	REPORT I	REPORT LEVEL / QC REQUIRED	RELINQUISHED BY	Course hol	Cameron Fritz	8//81] 4	4.00 pm
	)	Summary (Standard QC)	RECEIVED BY	Chuily 1,1 out	Emily Lyons	4.23.18	0900
	X	LEVEL II (Slandard QC)	RELINQUISHED BY	e la p	1 (		
		LEVEL III (Std QC + forms)	RECEIVED BY				
	78	LEVEL IV (Std QC + forms + raw	RELINQUISHED BY				
1-HCI 2-HOSH 5-HOSH 5-NBOH 5-NBOH20ARS B-0H-5 1-H-1	NeHSO4 7-4°	C 8-Other	RECEIVED BY				

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PRESERVATION KEY

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225 Commerce Drive, Fort Collins, Colorado 80524 TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

ALS WORKORDER#

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Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

8644931 PAGE Turnaround time for samples received Saturday will be calculated beginning from the next business day. TURNAROUND TIME

SAMPLER

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PROJECT NAME	St. Anthony Geoledantal Involution	STEID	St. Anthony Mine	Mine						DISPOSAL	_	BY LAB	or RETURN	NZ.
PROJECT No.	୬୯୭୯୭୯	EDD FORMAT	_		Sprandsheet			PARAME	TERVMET	PARAMETER/METHOD REQUES		FOR ANALYSIS	s	
		PURCHASE ORDER				<b>*</b>	Pal	Jum-	1) 78	Radium- 236 (EPA 901.1	(0)(1)			
COMPANY NAME	Stanter Consulting Services	BILL TO COMPANY	Spafec	Consulting Sevices	Sevias	В		Uranium	(EP	(EPA 901.1)	1			
SEND REPORT TO	、玩玩、	INVOICE ATTN TO	Jason C	bes ~		ပ		Therium -	930 (I	330 (EPA 901	(1)			
ADDRESS	3	ADDRESS	3335	S Timbedone Rd	Rd #150	٥		Gross whohe		(EPA 901.1	-			
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PHONE	1313-5759	PHONE	(970)	7755		<u> </u>					ļ			
FAX		FAX				٥					<u> </u>			
E-MAIL	Cameron. Firtz @ stantec. com	E-MAIL	Jason. cumber @stantec. com	ber (25)	antec. com	<u> </u>								
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*Time Zone (Circle): E	EST CST (MST) PST Matrix: O = oil S = soil NS = non-soil solid W = water		L = liquid E = extract F = fitter	ilter					_		-			
	NOTES		Form 202r9		SIGNATURE	\		PRINTE	PRINTED NAME		DATE		TIME	
7 of	REPOR	REPORT LEVEL / QC REQUIRED	RELINQUISHED BY	E	um M		7	ameron	n Fri	h 4	118/18		7:00 pm	٤
f 18		Summary (Standard QC)	RECEIVED BY	Sui	u wars		E.	Emila	Lyans		4.23.18		0960	
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		QC + forms)	RECEIVED BY											
		LEVEL IV (Std QC + forms + raw	RELINQUISHED BY						į					
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RECEIVED BY

PRESERVATION KEY 1-HC 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcelale 6-NaHSO4 7-4°C 8-Other



## ALS Environmental - Fort Collins CONDITION OF SAMPLE UPON RECEIPT FORM

Client: Stantec Workorder No:	804497	L	
Project Manager: L15 Initials: G	Date:	4.23.15	Ŗ -
Does this project require any special handling in addition to standard ALS procedures?		YES	(NO)
2. Are custody seals on shipping containers intact?	NÓND	YES	NO
3. Are Custody seals on sample containers intact?	NONE	YES	NO
4 Is there a COC (Chain-of-Custody) present or other representative documents?		(TES)	NO
5. Are the COC and bottle labels complete and legible?		YES	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no containers, matrix, requested analyses, etc.)	o. of	YES	NO
Were airbills / shipping documents present and/or removable?	DROP OFF	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	<b>X</b> 77. <b>3</b> 9	YES	NO
9 Are all aqueous non-preserved samples pH 4-9?	MA	YES	NO
10. Is there sufficient sample for the requested analyses?		XES,	NO
Were all samples placed in the proper containers for the requested analyses?			NO
12. Are all samples within holding times for the requested analyses?		(TE)s	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		YES	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: < green pea > green pea	ÑA	YES	NO
Amount of sediment: dusting moderateheavy	unt N/A	YES	NO
16. Were the samples shipped on ice?		YES	(NO)
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2	#4 RAD ONLY	YES	NO
Cooler #: <b>3</b>			
Temperature (°C): Amb Amb			
No. of custody seals on cooler:			
DOT Survey/ Acceptance External µR/hr reading:			
Background μR/hr reading:			
Were external μR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / NA (1	if no, see Form 008.)		
Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABO			
, ,			
If applicable, was the client contacted? YES / NO / NA Contact:	Date/Ti	me:	
Project Manager Signature / Date:			

\*IR Gun #2: Oakton, SN 29922500201-0066 \*IR Gun #4: Oakton, SN 2372220101-0002 FROM: CAMERON FRITZ

(907) 947-2225

SHIP DATE: 19APR18 ACTHGT: 36.00 LB CAD: 006993643/SSFE1904 DIMMED: 15 X 12 X 12 IN

. 718 MARIGOLD LN

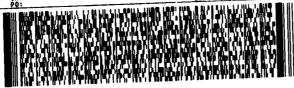
FORT COLLINS CO 80526 US

TO

## ALS ENVIRONMENTAL 225 COMMERCE DR

FORT COLLINS CO 80524

(US)



1 of 2 TRK# 7805 9618 7711 ## MASTER ##

80524

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FROM: CAMERON FRITZ

(907) 947-2225

718 MARIGOLD LN

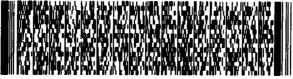
FORT COLLINS CO 90526

TO

## **ALS ENVIRONMENTAL** 225 COMMERCE DR

# FORT COLLINS CO 80524

(US)





2 of 2 MPS# 7805 9618 7722 Mstr# 7805 9618 7711

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7722



## **Total URANIUM**

#### Method SW6020 Revision A

### **Sample Results**

Lab Name: ALS -- Fort Collins
Client Name: Stantec Consulting Services

Client Project ID: St. Anthony Geotechnical Investigation 233001076

Work Order Number: 1804492 Final Volume: 100 ml
Reporting Basis: Dry Weight Matrix: SOIL
Prep Method: SW3050B Result Units: UG/KG

Analyst: Amanda J. Lynn

Client Sample ID	Lab ID	Date Collected	Date Prepared	Date Analyzed	Percent Moisture	Dilution Factor	Result	RptLimit/ LOQ/LOD	Flag	Sample Aliquot
P1-2 20'	1804492-1	04/09/2018	04/26/2018	04/27/2018	9.0	10	36000	11		1.025 g
P1-2 40'	1804492-2	04/09/2018	04/26/2018	04/27/2018	6.0	10	3700	9.9		1.073 g
P1-2 60'	1804492-3	04/11/2018	04/26/2018	04/27/2018	11.4	10	530	11		1.021 g
P2-1 10'	1804492-4	04/14/2018	04/26/2018	04/27/2018	10.3	10	1000	10		1.074 g
P2-1 20'	1804492-5	04/14/2018	04/26/2018	04/27/2018	8.9	10	2000	11		1.002 g
P2-2 10'	1804492-6	04/15/2018	04/26/2018	04/27/2018	9.5	10	1000	11		1.045 g
P4-3 5'	1804492-7	04/16/2018	04/26/2018	04/27/2018	6.8	10	1600	10		1.038 g
P4-5 5'	1804492-8	04/16/2018	04/26/2018	04/27/2018	3.9	10	29000	9.6		1.08 g
P4-5 15'	1804492-9	04/16/2018	04/26/2018	04/27/2018	6.7	10	24000	10		1.058 g
P4-9 20'	1804492-10	04/15/2018	04/26/2018	04/27/2018	2.1	10	5300	9.7		1.057 g
P4-9 30'	1804492-11	04/15/2018	04/26/2018	04/27/2018	8.3	10	580	11		1.001 g
BW-1 10'	1804492-12	04/18/2018	04/26/2018	04/27/2018	4.4	10	480	9.6		1.084 g
BW-4 5'	1804492-13	04/18/2018	04/26/2018	04/27/2018	3.2	10	550	10		1.025 g
BW-4 15'	1804492-14	04/18/2018	04/26/2018	04/27/2018	5.4	10	610	9.9		1.063 g
BW-3 10'	1804492-15	04/18/2018	04/26/2018	04/27/2018	4.7	10	510	10		1.047 g
BW-2 5'	1804492-16	04/18/2018	04/26/2018	04/27/2018	2.2	10	520	9.8		1.041 g
BW-2 20'	1804492-17	04/18/2018	04/26/2018	04/27/2018	4.2	10	460	10		1.018 g

#### **Comments:**

1. ND or U = Not Detected at or above the client requested detection limit.

Data Package ID: IM1804492-1

Date Printed: Monday, May 21, 2018 ALS -- Fort Collins

LIMS Version: 6.862

Page 1 of 1

## Method SW6020A Method Blank

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Lab ID: IP180426-3MB

Sample Matrix: SOILPrep Batch: IP180426-3Sample Aliquot:1 g% Moisture: N/AQCBatchID: IP180426-3-1Final Volume:100 mlDate Collected: N/ARun ID: IM180426-10A8Result Units: UG/KGDate Extracted: 26-Apr-18Cleanup: NONEClean DF:1

Date Analyzed: 27-Apr-18 Basis: N/A
Prep Method: SW3050 Rev B File Name: 096SMPL\_

CASNO	Target Analyte	DF	Result	Result Qualifier	Reporting Limit	DL
7440-61-1	URANIUM	10	10	U	10	

Data Package ID: IM1804492-1

## Method SW6020A Laboratory Control Sample

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Lab ID: IM180426-3LCS

 Sample Matrix: SOIL
 Prep Batch: IP180426-3

 % Moisture: N/A
 QCBatchID: IP180426-3-1

 Date Collected: N/A
 Run ID: IM180426-10A8

 Date Extracted: 04/26/2018
 Cleanup: NONE

 Date Analyzed: 04/27/2018
 Basis: N/A

Prep Method: SW3050B File Name: 097SMPL\_

CASNO	Target Analyte	Spike Added	LCS Result	Reporting Limit	Result Qualifier	LCS % Rec.	Control Limits
7440-61-1	URANIUM	1000	941	10		94	80 - 120%

Data Package ID: IM1804492-1

Date Printed: Monday, May 21, 2018

Sample Aliquot:

**Final Volume:** 

Result Units: UG/KG

Clean DF:

1 g

100 ml

## Method SW6020A Matrix Spike And Matrix Spike Duplicate

Lab Name: ALS -- Fort Collins

**Target Analyte** 

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 20'
LabID: 1804492-1MS

Sample Matrix: SOIL
% Moisture: 9.0
Date Collected: 09-Apr-18
Date Extracted: 26-Apr-18

Date Analyzed: 27-Apr-18

Prep Method: SW 3050 Rev B

Sample

Result

36000

Prep Batch: IP180426-3 QCBatchID: IP180426-3-1 Run ID: IM180426-10A8

Cleanup: NONE

Basis: Dry Weight

MS

Qual

Reporting

Limit

10.7

MS

Result

35100

Sample Aliquot: 1.025 g
Final Volume: 100 ml
Result Units: UG/KG
File Name: 101SMPL

Spike MS % Control Added Rec. Limits

75 - 125%

Field ID: P1-2 20'
LabID: 1804492-1MSD

**URANIUM** 

**CASNO** 

7440-61-1

Sample Matrix: SOIL % Moisture: 9.0 Date Collected: 09-Apr-18

Date Extracted: 26-Apr-18

Date Analyzed: 27-Apr-18

Prep Batch: IP180426-3 QCBatchID: IP180426-3-1 Run ID: IM180426-10A8 Cleanup: NONE Basis: Dry Weight

Sample Aliquot: 1.025 g Final Volume: 100 ml Result Units: UG/KG File Name: 102SMPL\_

1070

Prep Method: SW3050 Rev B

Samp

Qual

CASNO	Target Analyte	MSD Result	MSD Qual	Spike Added	MSD % Rec.	Reporting Limit	RPD Limit	RPD
7440-61-1	URANIUM	49300	*	1070	1229	10.7	20	

Data Package ID: IM1804492-1

## Method SW6020 Duplicate Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

**Field ID:** P1-2 20' **Lab ID:** 1804492-1D

Sample Matrix: SOIL % Moisture: 9.0

Date Collected: 04/09/2018
Date Extracted: 04/26/2018
Date Analyzed: 04/27/2018

Prep Batch: IP180426-3
QCBatchID: IP180426-3-1

Run ID: IM180426-10A8
Cleanup: NONE

Basis: Dry Weight
File Name: 100SMPL

Sample Aliquot: 1.024 g
Final Volume: 100 ml
Result Units: UG/KG

Clean DF: 1

CASNO	Target Analyte	Sample Result	Samp Qual	Duplicate Result	Dup Qual	Reporting Limit	Dilution Factor	RPD	RPD Limit
7440-61-1	URANIUM	36000		36300		10.7	10	1	20

Data Package ID: IM1804492-1

## Method SW6020 Serial Dilution

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 20'
Lab ID: 1804492-1L

Run ID: IM180426-10A8

Date Analyzed: 27-Apr-18

Result Units: mg/l

CASNO	Target Analyte	Sample Result	Samp Qual	SD Result	SD Qual	EPA Qualifier	%D
7440-61-1	URANIUM	0.0337		0.0338			0

Data Package ID: IM1804492-1

Date Printed: Monday, May 21, 2018

## **URANIUM**

### **Method SW6020**

#### **Calibration Verifications**

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Run ID: IM180426-10A8

Result Units: MG/L

Lab ID	Verification Type	Date Analyzed	Time Analyzed	Spike Added	Result	Reporting Limit	Result Qualifier	% Rec.	Control Limits
ICV	Initial Calibration	4/26/2018	17:57	0.002	0.00194	0.00001	N/A	97	90 - 110
CCV1	Continuing Calibration	4/26/2018	18:24	0.001	0.000921	0.00001	N/A	92	90 - 110
CCV2	Continuing Calibration	4/26/2018	19:29	0.001	0.000926	0.00001	N/A	93	90 - 110
CCV3	Continuing Calibration	4/26/2018	20:20	0.001	0.000935	0.00001	N/A	93	90 - 110
CCV4	Continuing Calibration	4/26/2018	21:10	0.001	0.000929	0.00001	N/A	93	90 - 110
CCV5	Continuing Calibration	4/26/2018	21:57	0.001	0.000938	0.00001	N/A	94	90 - 110
CCV6	Continuing Calibration	4/26/2018	22:21	0.001	0.000937	0.00001	N/A	94	90 - 110
CCV7	Continuing Calibration	4/26/2018	23:02	0.001	0.000932	0.00001	N/A	93	90 - 110
CCV8	Continuing Calibration	4/26/2018	23:47	0.001	0.000930	0.00001	N/A	93	90 - 110
CCV9	Continuing Calibration	4/27/2018	0:31	0.001	0.000933	0.00001	N/A	93	90 - 110
CCV10	Continuing Calibration	4/27/2018	1:22	0.001	0.000941	0.00001	N/A	94	90 - 110
CCV11	Continuing Calibration	4/27/2018	2:03	0.001	0.000931	0.00001	N/A	93	90 - 110
CCV12	Continuing Calibration	4/27/2018	2:42	0.001	0.000930	0.00001	N/A	93	90 - 110

Data Package ID: IM1804492-1

Date Printed: Monday, May 21, 2018ALS -- Fort CollinsPage 1 of 1

## **URANIUM**

### **Method SW6020**

#### **Calibration Blanks**

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Run ID: IM180426-10A8

Result Units: MG/L

Lab ID	Verification Type	Date Analyzed	Time Analyzed	Result	Reporting Limit	Flag
ICB	Initial Calibration	4/26/2018	18:03	0.00001	0.00001	U
CCB1	Continuing Calibration	4/26/2018	18:30	0.00001	0.00001	U
CCB2	Continuing Calibration	4/26/2018	19:35	0.00001	0.00001	U
CCB3	Continuing Calibration	4/26/2018	20:25	0.00001	0.00001	U
CCB4	Continuing Calibration	4/26/2018	21:16	0.00001	0.00001	U
CCB5	Continuing Calibration	4/26/2018	22:03	0.00001	0.00001	U
CCB6	Continuing Calibration	4/26/2018	22:27	0.00001	0.00001	U
CCB7	Continuing Calibration	4/26/2018	23:08	0.00001	0.00001	U
CCB8	Continuing Calibration	4/26/2018	23:53	0.00001	0.00001	U
CCB9	Continuing Calibration	4/27/2018	0:37	0.00001	0.00001	U
CCB10	Continuing Calibration	4/27/2018	1:27	0.00001	0.00001	U
CCB11	Continuing Calibration	4/27/2018	2:09	0.00001	0.00001	U
CCB12	Continuing Calibration	4/27/2018	2:48	0.00001	0.00001	U

Data Package ID: IM1804492-1

Date Printed: Monday, May 21, 2018

**ALS -- Fort Collins** 

Page 1 of 1



# Gamma Spectroscopy Case Narrative

## **Stantec Consulting Services**

St. Anthony Geotechnical Investigation – 233001076

Work Order Number: 1804492

- 1. The following report consists of analytical results for 17 soil samples received by ALS on 04/23/2018.
- 2. These samples were prepared according to the current revision of SOP 739. The samples were sealed in steel cans and stored for at least 21 days to allow <sup>222</sup>Rn to approach secular equilibrium with its parent, <sup>226</sup>Ra. The degree of ingrowth achieved prior to analysis is at least 97.8%. Conservatively assuming a radon emanation efficiency of approximately 50%, the effective radon progeny ingrowth for these samples would be greater than 98.9%.
- 3. The samples were analyzed for the presence of gamma emitting radionuclides according to the current revision of SOP 713. The analyses were completed on 05/18/2018.
- 4. The results for these samples are reported on a "Dry Weight" basis in units of pCi/gram.
- 5. ALS has observed a reproducible low bias in <sup>226</sup>Ra results (about -30% for the geometry in question) when using a mixed gamma source for the calibration of HPGe detectors for solid samples. This bias is eliminated by calibration using a NIST traceable <sup>226</sup>Ra source in the same geometry and configuration as the samples.
- 6. The library used for calibration and analysis employs multiple peaks for the <sup>226</sup>Ra progeny, <sup>214</sup>Pb (352 and 295 keV) and <sup>214</sup>Bi (609 and 1120 keV). Using these peaks avoids the use of the problematic <sup>226</sup>Ra photopeak at 186 keV, which suffers from poorly resolvable interference from <sup>235</sup>U at the same energy. Final activity results for <sup>226</sup>Ra are calculated, using the uncertainty-weighted mean of the activities for the four photopeaks, by the Seeker gamma spectroscopy software assuming secular equilibrium.



- 7. There are cases where the sample density is less than the associated calibration standard density. Cases that exceed the limit of +/- 15% of the density of the calibration standard are flagged with a 'G', denoting a significant density difference between the sample and calibration standard. Consequently, the results may be biased high for the flagged results in this work order. If requested, ALS can perform a transmission spike in order to estimate a magnitude of this bias. The results are reported without further qualification.
- 8. The requested detection limit was not met for samples 1804492-1, -1DUP, -5, -8, and -9. The reported activity exceeds the achieved MDC. The results are submitted without further qualification. The results are flagged with an "M3" qualifier on the final reports.
- 9. No further problems were encountered with either the client samples or the associated quality control samples. All remaining quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Pik Yee Yuen Data Reviewer

S/23/18
Date

Radiochemistry Pinal Data Reviewer

5/29/18
Date

## **ALS -- Fort Collins**

## Sample Number(s) Cross-Reference Table

**OrderNum:** 1804492

Client Name: Stantec Consulting Services

Client Project Name: St. Anthony Geotechnical Investigation

Client Project Number: 233001076

Client PO Number: 233001076-ALS2

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
P1-2 20'	1804492-1		SOIL	09-Apr-18	11:00
P1-2 40'	1804492-2		SOIL	09-Apr-18	11:30
P1-2 60'	1804492-3		SOIL	11-Apr-18	14:30
P2-1 10'	1804492-4		SOIL	14-Apr-18	16:15
P2-1 20'	1804492-5		SOIL	14-Apr-18	16:25
P2-2 10'	1804492-6		SOIL	15-Apr-18	8:30
P4-3 5'	1804492-7		SOIL	16-Apr-18	12:10
P4-5 5'	1804492-8		SOIL	16-Apr-18	10:00
P4-5 15'	1804492-9		SOIL	16-Apr-18	10:10
P4-9 20'	1804492-10		SOIL	15-Apr-18	13:30
P4-9 30'	1804492-11		SOIL	15-Apr-18	13:50
BW-1 10'	1804492-12		SOIL	18-Apr-18	9:35
BW-4 5'	1804492-13		SOIL	18-Apr-18	12:00
BW-4 15'	1804492-14		SOIL	18-Apr-18	12:15
BW-3 10'	1804492-15		SOIL	18-Apr-18	12:50
BW-2 5'	1804492-16		SOIL	18-Apr-18	13:45
BW-2 20'	1804492-17		SOIL	18-Apr-18	14:05

Date Printed: Wednesday, May 23, 2018

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225 Commerce Drive, Fort Collins, Colorado 80524 TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

ALS WORKORDER#

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Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

Turnaround time for samples received Saturday will be calculated beginning from the next business day.

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(575)		TURNAROUND TIME		SAMPLER						PAGE			of }	
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		PURCHASE ORDER				٧	Ra-236		(EPA 901.1	961.1				
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+	P4-3 S1	W114 /105	81)	\(\mathbb{V}\)		>	/	<u> </u>						
8	64-5 61	8011 4/11	4/16/18 10:00am	W/N		>	>	<i>&gt;</i>						
Ь	151 5-49	So: 1 4/16/18	0/18 10:10 an	∀/n		/	>	>						
<u>o</u>	p4-9 30'	Sot / 4/19	4/15/18 1:30 pm	A/N		>	>	>						
	p4-9 301	Soil 4/1	4 /15/18 1:50 pm	N/A		/	>	<u> </u>						
	W-1 10'	1 ) jos	4 118/18 9:35 am	VIN		1	/	/   /						
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1-HCI 2-HN03 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

PRESERVATION KEY

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TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522 225 Commerce Drive, Fort Collins, Colorado 80524

Chain-of-Custody

ALS WORKORDER #

8644081

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

Turnaround time for samples received Saturday will be calculated beginning from the next business day.

SEE NOTES SECTION 7:00 pm RETURN 990 TIME PARAMETER/METHOD REQUEST FOR ANALYSIS (BY LAB) 4.23.18 81/81/4 DATE I \* | Androm - 236 (EPA 90).1) Therium - 330 (EPA 901 Stoss alpha (EPA 901.1 DISPOSAL (EPA 901.1) ø PAGE 4 ameron tritz Emily Lyons ш PRINTED NAME ٥ B Uranium O > 7 8 ပ ۵ ш O I <u>.</u> ⋖ မွ Excel Spreadsheet ADDRESS 3335 S Timbedone Rd #150 Jason. cumber @stantec. com SIGNATURE PRESERVATIVE Fort Collins, CO 80536 4 Stantec Consulting Sovies Z SAMPLER # OF BOTTLES PHONE (970) 213 - 2755 SITE ID St. Anthony Mine Jason Combes Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter 19:15pm 13:00pm SAMPLE TIME M8/18 11:45pm 4/18/18 113:50 pm 4(18(18 |3:05pm RELINQUISHED BY RELINQUISHED BY EDD FORMAT Microsoft RECEIVED BY Form 202r9 1181 H SAMPLE DATE 4 118 18 CITY / STATE / ZIP INVOICE ATTN TO E-MAIL TURNAROUND TIME BILL TO COMPANY PURCHASE ORDER Summary
(Standard QC)
LEVEL II
(Standard QC)
LEVEL III (Standard QC)
LEVEL III (Standard QC)
LEVEL IV (StdQC + forms) REPORT LEVEL / QC REQUIRED MATRIX من S S PROJECT NAME St. Anthony George dantal Investigation Cameron. Fritz & stantec. com 4150 COMPANY NAME Stanter Consulting Services CITY/STATE/ZIP | FOLY CONDING CO 80525 ADDRESS 3335 S Timberline Rd PHONE (970) 313- 2754 ameron Firtz Time Zone (Circle): EST CST (MST) PST 8W-2 20, PROJECT No. | 3330 01076 رك BW-3 10 NOTES 8W-3 BW-4 BW-4 SEND REPORT TO E-MAIL ZB B <u>و</u>  $\Xi$ 5 of 29

RELINQUISHED BY RECEIVED BY

RECEIVED BY

PRESERVATION KEY 1-HCI 2-HN03 3-H2SO4 4-NaOH 5-NaOH/ZnAcelais 6-NeHSO4 7-4°C 8-Other



## ALS Environmental - Fort Collins CONDITION OF SAMPLE UPON RECEIPT FORM

Client: Stantec Workorder No: 1804	<u>1497</u>		_
Project Manager: Lf5 Initials: Gu	Date:	4.23.19	Š
Does this project require any special handling in addition to standard ALS procedures?		YES	(NO)
2. Are custody seals on shipping containers intact?	NÓNE	YES	NO
3. Are Custody seals on sample containers intact?	MONE	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		(E)	NO
5. Are the COC and bottle labels complete and legible?		YES	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		YES	NO
Were airbills / shipping documents present and/or removable?	DROP OFF	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	AVIA	YES	NO
9. Are all aqueous non-preserved samples pH 4-9?	(N)A	YES	NO
10. Is there sufficient sample for the requested analyses?		XES	NO
11. Were all samples placed in the proper containers for the requested analyses?		(E)	NO
12. Are all samples within holding times for the requested analyses?		(TE)S	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		YES	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: < green pea > green pea		YES	NO
Amount of sediment: dusting moderateheavy	N/A	YES	NO
16. Were the samples shipped on ice?		YES	(QA)
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	RAD	YES	NO
Cooler #: 1			
Temperature (°C): Amb Amb			
No. of custody seals on cooler:			
DOT Survey/ Acceptance External μR/hr reading:			
Background μR/hr reading:			
Were external μR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / NA (If no, see	Form 008.)		
Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EX		ND #16.	
If applicable, was the client contacted? YES / NO / NA Contact:	Date/Tir	ne:	
Project Manager Signature / Date:	_		

\*IR Gun #2: Oakton, SN 29922500201-0066 \*IR Gun #4: Oakton, SN 2372220101-0002 FROM: CAMERON FRITZ

(907) 947-2225

SHIP DATE: 19APR18 ACTHGT: 36.00 LB CAD: 006993643/SSFE1904 DIMMED: 15 X 12 X 12 IN

. 718 MARIGOLD LN

FORT COLLINS CO 80526 US

TO

## ALS ENVIRONMENTAL 225 COMMERCE DR

FORT COLLINS CO 80524

(US)





1 of 2 TRK# 7805 9618 7711 ## MASTER ##

80524

9622 0019 0 (000 000 0000) 0 po 7805 9618 7711



FROM: CAMERON FRITZ

(907) 947-2225

718 MARIGOLD LN

FORT COLLINS CO 90526

TO

## **ALS ENVIRONMENTAL** 225 COMMERCE DR

# FORT COLLINS CO 80524

(US)





2 of 2 MPS# 7805 9618 7722 Mstr# 7805 9618 7711

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7722



## **PAI 713 Rev 14 Method Blank Results**

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Lab ID: GS180502-2MB

Sample Matrix: SOIL

Prep Batch: GS180502-2 QCBatchID: GS180502-2-1 Final Aliquot: 215 g Result Units: pCi/g

Library: RA226.LIB

Prep SOP: PAI 739 Rev 12 Date Collected: 02-May-18

Run ID: GS180502-2A Count Time: 30 minutes

File Name: 180883d03

Date Prepared: 02-May-18

Date Analyzed: 17-May-18

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.10 +/- 0.17	0.30	0.5	NA	U

#### Comments:

#### Qualifiers/Flags:

 $\ensuremath{\mathsf{U}}\xspace$  - Result is less than the sample specific MDC or less than the associated TP

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

SQ - Spectral quality prevents accurate quantitation.

SI - Nuclide identification and/or quantitation is tentative.

TI - Nuclide identification is tentative.

R - Nuclide has exceeded 8 halflives.

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: GSS1804492-1

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

**ALS -- Fort Collins** Page 1 of 1 Date Printed: Wednesday, May 23, 2018

#### **PAI 713 Rev 14**

#### Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Lab ID: GS180502-2LCS

Sample Matrix: SOIL

Prep Batch: GS180502-2 QCBatchID: GS180502-2-1 Final Aliquot: 215 g Result Units: pCi/g

Library: RA226.LIB

Prep SOP: PAI 739 Rev 12 Date Collected: 02-May-18

Run ID: GS180502-2A Count Time: 30 minutes

File Name: 180592d09

Date Prepared: 02-May-18

Date Analyzed: 18-May-18

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added		Contro I Limits	Lab Qualifier
13982-63-3	Ra-226	454 +/- 53	3	468.3	97.0	85 - 115	P,M3

#### Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TP

TPU - Total Propagated Uncertainty

Abbreviations:

LT - Result is less than Requested MDC, greater than sample specific MDC. Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed. MDC - Minimum Detectable Concentration

Y2 - Chemical Yield outside default limits.

SQ - Spectral quality prevents accurate quantitation.

L - LCS Recovery below lower control limit.

SI - Nuclide identification and/or quantitation is tentative.

H - LCS Recovery above upper control limit. P - LCS Recovery within control limits.

TI - Nuclide identification is tentative.

M - The requested MDC was not met.

R - Nuclide has exceeded 8 halflives.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

Data Package ID: GSS1804492-1

Page 1 of 1 Date Printed: Wednesday, May 23, 2018 **ALS -- Fort Collins** 

#### **PAI 713 Rev 14**

#### **Duplicate Sample Results (DER)**

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 20'

**Lab ID:** 1804492-1DUP

Library: RA226.LIB

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12 Date Collected: 09-Apr-18

Date Prepared: 02-May-18
Date Analyzed: 17-May-18

Prep Batch: GS180502-2 QCBatchID: GS180502-2-1

Run ID: GS180502-2A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 182 g

Prep Basis: Dry Weight Moisture(%): NA

Result Units: pCi/g
File Name: 180673d02

CASNO	Analyte	Sample	<del>)</del>		Duplica	ate		DER	DER
	Allalyte	Result +/- 2 s TPU	MDC	Flags	Result +/- 2 s TPU	MDC	Flags		Lim
13982-63-3	Ra-226	11.5 +/- 1.5	0.6	M3,G	16.1 +/- 2.0	0.7	M3,G	1.84	2.13

#### Comments:

#### Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

 $\ensuremath{\mathsf{W}}$  - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

PDI P

TPU - Total Propagated Uncertainty
DER - Duplicate Error Ratio
BDL - Below Detection Limit

NR - Not Reported

Abbreviations:

SQ - Spectral quality prevents accurate quantitation.

SI - Nuclide identification and/or quantitation is tentative.

TI - Nuclide identification is tentative.

R - Nuclide has exceeded 8 halflives.

G - Sample density differs by more than 15% of LCS density.

Data Package ID: GSS1804492-1

Date Printed: Wednesday, May 23, 2018 ALS -- Fort Collins Page 1 of 1

## PAI 713 Rev 14 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 20'
Lab ID: 1804492-1

Library: RA226.LIB

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12

Date Collected: 09-Apr-18

**Date Prepared:** 02-May-18 **Date Analyzed:** 17-May-18

Prep Batch: GS180502-2

QCBatchID: GS180502-2-1 Run ID: GS180502-2A

Count Time: 30 minutes
Report Basis: Dry Weight

Final Aliquot: 167 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: 180692d01

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	11.5 +/- 1.5	0.6	0.5	NA	M3,G

#### **Comments:**

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level
- Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- $\mbox{G}$  Sample density differs by more than 15% of LCS density.

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#### **PAI 713 Rev 14**

#### **Sample Duplicate Results**

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 20'

**Lab ID:** 1804492-1DUP

Library: RA226.LIB

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12

Date Collected: 09-Apr-18

Date Prepared: 02-May-18

Date Analyzed: 17-May-18

Prep Batch: GS180502-2 QCBatchID: GS180502-2-1

Run ID: GS180502-2A Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 182 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: 180673d02

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	16.1 +/- 2.0	0.7	0.5	NA	M3,G

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TPU.
- Y1 Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M The requested MDC was not met.
- M3 The requested MDC was not met, but thereported activity is greater than the reported MDC.
- $\ensuremath{\text{W}}$  DER is greater than  $\ensuremath{\text{W}}$  arning Limit of 1.42
- $\ensuremath{\text{D}}$   $\ensuremath{\text{DER}}$  is greater than Control Limit of 2.13

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative.
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

Data Package ID: GSS1804492-1

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## PAI 713 Rev 14 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 40'
Lab ID: 1804492-2

Sample Matrix: SOIL
Prep SOP: PAI 739 Rev 12

Library: RA226.LIB Date Collected: 09-Apr-18
Date Prepared: 02-May-18
Date Analyzed: 17-May-18

**Prep Batch:** GS180502-2 **QCBatchID:** GS180502-2-1

Run ID: GS180502-2-1 Run ID: GS180502-2A Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 199 g
Prep Basis: Dry Wei

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: 180881d03

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	1.25 +/- 0.30	0.48	0.5	NA	

#### Comments:

#### Qualifiers/Flags:

- $\ensuremath{\mathsf{U}}\xspace$  Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- $\mbox{G}$  Sample density differs by more than 15% of LCS density.

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## **PAI 713 Rev 14** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P1-2 60' Lab ID: 1804492-3

Library: RA226.LIB

Sample Matrix: SOIL Prep Batch: GS180502-2 Prep SOP: PAI 739 Rev 12 QCBatchID: GS180502-2-1

Date Collected: 11-Apr-18 Date Prepared: 02-May-18 Date Analyzed: 17-May-18

Run ID: GS180502-2A Count Time: 30 minutes Report Basis: Dry Weight

Final Aliquot: 180 g Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q

File Name: 180539d05

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	1.31 +/- 0.28	0.38	0.5	NA	G

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

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## **PAI 713 Rev 14** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 10' Lab ID: 1804492-4

Library: RA226.LIB

Sample Matrix: SOIL

Prep Batch: GS180502-2 Prep SOP: PAI 739 Rev 12 QCBatchID: GS180502-2-1 Date Collected: 14-Apr-18 Run ID: GS180502-2A

Count Time: 30 minutes

Report Basis: Dry Weight

Date Prepared: 02-May-18 Date Analyzed: 17-May-18

Final Aliquot: 188 g Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q

File Name: 180599d08

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	3.85 +/- 0.58	0.47	0.5	NA	

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

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## **PAI 713 Rev 14** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-1 20' Lab ID: 1804492-5 Sample Matrix: SOIL

Prep Batch: GS180502-2 Prep SOP: PAI 739 Rev 12 QCBatchID: GS180502-2-1 Date Collected: 14-Apr-18 Run ID: GS180502-2A

Count Time: 30 minutes

Report Basis: Dry Weight

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q File Name: 180584d09

Final Aliquot: 184 g

Library: RA226.LIB

Date Prepared: 02-May-18 Date Analyzed: 17-May-18

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	1.25 +/- 0.31	0.54	0.5	NA	M3

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

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## **PAI 713 Rev 14** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P2-2 10' Lab ID: 1804492-6

**CASNO** 

13982-63-3

Sample Matrix: SOIL

Prep Batch: GS180502-2 Prep SOP: PAI 739 Rev 12 QCBatchID: GS180502-2-1 Date Collected: 15-Apr-18 Run ID: GS180502-2A

Final Aliquot: 195 g Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q File Name: 180594d10

NΑ

0.5

Library: RA226.LIB

Ra-226

Date Prepared: 02-May-18 Date Analyzed: 17-May-18

0.91 +/- 0.21

Result +/- 2 s TPU Requested **Target Nuclide MDC** DL Lab **MDC** Qualifier

0.36

Count Time: 30 minutes

Report Basis: Dry Weight

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level
- Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

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# PAI 713 Rev 14 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-3 5'
Lab ID: 1804492-7

Library: RA226.LIB

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12

Date Collected: 16-Apr-18

Date Prepared: 02-May-18

Date Analyzed: 18-May-18

Prep Batch: GS180502-2

QCBatchID: GS180502-2-1 Run ID: GS180502-2A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 201 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: 181104d04

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	2.15 +/- 0.41	0.49	0.5	NA	

#### **Comments:**

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- $\mbox{G}$  Sample density differs by more than 15% of LCS density.

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## **PAI 713 Rev 14** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-5 5' Lab ID: 1804492-8

Library: RA226.LIB

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12 Date Collected: 16-Apr-18 Date Prepared: 02-May-18

Date Analyzed: 17-May-18

Prep Batch: GS180502-2

QCBatchID: GS180502-2-1 Run ID: GS180502-2A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 231 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q File Name: 180693d01

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	29.5 +/- 3.6	0.8	0.5	NA	M3

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

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## **PAI 713 Rev 14** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-5 15' Lab ID: 1804492-9 Sample Matrix: SOIL

Prep Batch: GS180502-2 Prep SOP: PAI 739 Rev 12 QCBatchID: GS180502-2-1 Run ID: GS180502-2A

Final Aliquot: 213 g Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q

Library: RA226.LIB

Date Collected: 16-Apr-18 Date Prepared: 02-May-18 Date Analyzed: 17-May-18

Count Time: 30 minutes Report Basis: Dry Weight File Name: 180674d02

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	18.6 +/- 2.3	0.7	0.5	NA	М3

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

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## PAI 713 Rev 14 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-9 20'
Lab ID: 1804492-10

Sample Matrix: SOIL Prep SOP: PAI 739 Rev 12 Prep Batch: GS180502-2 QCBatchID: GS180502-2-1 Run ID: GS180502-2A Final Aliquot: 246 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/q

File Name: 180882d03

: 1804492-10 **Library**: RA226.LIB

Date Collected: 15-Apr-18 Date Prepared: 02-May-18 Date Analyzed: 17-May-18

Count Time: 30 minutes Report Basis: Dry Weight

 CASNO
 Target Nuclide
 Result +/- 2 s TPU
 MDC
 Requested MDC
 DL Qualifier

 13982-63-3
 Ra-226
 3.14 +/- 0.48
 0.39
 0.5
 NA

#### **Comments:**

#### Qualifiers/Flags:

- $\ensuremath{\mathsf{U}}\xspace$  Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level
- Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- $\mbox{G}$  Sample density differs by more than 15% of LCS density.

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# PAI 713 Rev 14 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Library: RA226.LIB

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: P4-9 30'
Lab ID: 1804492-11

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12

Date Collected: 15-Apr-18

**Date Prepared:** 02-May-18 **Date Analyzed:** 17-May-18

**Prep Batch:** GS180502-2 **QCBatchID:** GS180502-2-1

Run ID: GS180502-2-1 Run ID: GS180502-2A Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 196 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: 180540d05

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	1.26 +/- 0.27	0.38	0.5	NA	

#### **Comments:**

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- $\mbox{G}$  Sample density differs by more than 15% of LCS density.

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## **PAI 713 Rev 14** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-1 10' Lab ID: 1804492-12

Library: RA226.LIB

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12 Date Collected: 18-Apr-18

Date Prepared: 02-May-18 Date Analyzed: 18-May-18

Prep Batch: GS180502-2 QCBatchID: GS180502-2-1

Run ID: GS180502-2A Count Time: 30 minutes Report Basis: Dry Weight

Final Aliquot: 204 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q File Name: 180607d08

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.76 +/- 0.22	0.35	0.5	NA	

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

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# PAI 713 Rev 14 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-4 5'

**Lab ID:** 1804492-13

Library: RA226.LIB

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12

Date Collected: 18-Apr-18

Date Prepared: 02-May-18

Date Analyzed: 17-May-18

Prep Batch: GS180502-2

QCBatchID: GS180502-2-1 Run ID: GS180502-2A Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 202 g
Prep Basis: Dry Weight
Moisture(%): NA

Moisture(%): NA Result Units: pCi/g File Name: 180600d08

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	1.15 +/- 0.27	0.37	0.5	NA	

#### **Comments:**

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- $\mbox{G}$  Sample density differs by more than 15% of LCS density.

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# PAI 713 Rev 14 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-4 15'
Lab ID: 1804492-14

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12 Date Collected: 18-Apr-18 Prep Batch: GS180502-2 QCBatchID: GS180502-2-1 Run ID: GS180502-2A Final Aliquot: 207 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: 180585d09

Library: RA226.LIB

**Date Prepared:** 02-May-18 **Date Analyzed:** 17-May-18

Count Time: 30 minutes
Report Basis: Dry Weight

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.81 +/- 0.25	0.46	0.5	NA	

#### **Comments:**

#### Qualifiers/Flags:

- $\ensuremath{\mathsf{U}}\xspace$  Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- $\mbox{G}$  Sample density differs by more than 15% of LCS density.

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## PAI 713 Rev 14 Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-3 10'
Lab ID: 1804492-15

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12

Date Collected: 18-Apr-18

Date Prepared: 02-May-18

QCBatchID: GS180502-2-1 Run ID: GS180502-2A Count Time: 30 minutes

Report Basis: Dry Weight

Prep Batch: GS180502-2

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/g File Name: 180595d10

Final Aliquot: 209 g

Library: RA226.LIB

Date Analyzed: 17-May-18

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.83 +/- 0.20	0.37	0.5	NA	

#### **Comments:**

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC.
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level
- Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- $\mbox{G}$  Sample density differs by more than 15% of LCS density.

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## **PAI 713 Rev 14** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-2 5' Lab ID: 1804492-16

Library: RA226.LIB

Sample Matrix: SOIL

Prep SOP: PAI 739 Rev 12 Date Collected: 18-Apr-18 Date Prepared: 02-May-18

Date Analyzed: 17-May-18

Prep Batch: GS180502-2

QCBatchID: GS180502-2-1 Run ID: GS180502-2A Count Time: 30 minutes

Report Basis: Dry Weight

Final Aliquot: 222 g

Prep Basis: Dry Weight Moisture(%): NA Result Units: pCi/q File Name: 180694d01

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.73 +/- 0.22	0.37	0.5	NA	

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

- TPU Total Propagated Uncertainty
- MDC Sample specific Minimum Detectable Concentration
- BDL Below Detection Limit
- DL Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

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## **PAI 713 Rev 14** Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1804492

Library: RA226.LIB

Client Name: Stantec Consulting Services

ClientProject ID: St. Anthony Geotechnical Investigation 233001076

Field ID: BW-2 20' Lab ID: 1804492-17 Sample Matrix: SOIL

Date Prepared: 02-May-18

Date Analyzed: 17-May-18

Prep Batch: GS180502-2 Prep SOP: PAI 739 Rev 12 QCBatchID: GS180502-2-1 Date Collected: 18-Apr-18 Run ID: GS180502-2A

Count Time: 30 minutes Report Basis: Dry Weight Final Aliquot: 215 g Prep Basis: Dry Weight Moisture(%): NA

Result Units: pCi/q File Name: 180675d02

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.82 +/- 0.23	0.42	0.5	NA	

#### Comments:

#### Qualifiers/Flags:

- U Result is less than the sample specific MDC or less than the associated TP
- Y1 Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
- Y2 Chemical Yield outside default limits.
- LT Result is less than Requested MDC, greater than sample specific MDC.
- M3 The requested MDC was not met, but the reported activity is greater than the reported MDC
- M The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: GSS1804492-1

- SQ Spectral quality prevents accurate quantitation.
- SI Nuclide identification and/or quantitation is tentative.
- TI Nuclide identification is tentative
- R Nuclide has exceeded 8 halflives.
- G Sample density differs by more than 15% of LCS density.

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#### ST. ANTHONY MINE CLOSEOUT PLAN

Appendix D Material Balance Calculations

## Appendix D MATERIAL BALANCE CALCULATIONS





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# APPENDIX D: MATERIAL BALANCE CALCULATIONS

	Revisioning										
Rev.	Date	Description	Ву	Checked	Date						
0	02/06/19	Draft for Internal Review	C. Fritz	S. Downey	02/07/19						
1	02/11/19	Final	C. Fritz	J. Cumbers	02/11/19						

#### **Location and Format**

Electronic copies of these calculations are located on the Stantec internal project teamsite.

The following calculations were generated using the following software:

- AutoCAD Civil 3D 2017
- Microsoft Office 365: Excel

# Table of Contents Revisioning. 1 Location and Format 1 Table of Contents. 1 Objective. 1 Background. 2 Applicable Codes and Standards. 4 Material Properties. 4 Methods. 5 Results. Error! Bookmark not defined. Attachments. 7 References. 7

#### Objective

This appendix presents the methods and calculations performed for the St. Anthony Mine site (Site) material balance analysis. The objective was to evaluate the source of materials for the pit backfills, as well as the excavation and placement volumes required to achieve the pit reclamation and Site cleanup objectives. As described in the Closure Plan main text, Pits 1 and 2 will be backfilled with waste material from storage piles and other locations throughout the Site. Additional waste not included in the pit backfill volumes will be stabilized in place and covered with non-impacted borrow soil during reclamation.



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#### **Background**

At the conclusion of mining activities, stockpiles of overburden material excavated from the two open pits were left undisturbed at several locations within the mine permit boundary. As part of Site reclamation objectives, the following facilities (shown on Drawing 3 of the closeout plan design drawings) were identified as areas containing waste material to either be excavated and placed within the pits or stabilized in place:

- Shale piles 1 and 2
- Pile 3
- Pile 4
- Pile 5
- Pile 6
- Pile 7
- Crusher/Stockpile Area (CS)
- West Disturbance Area (WDA)
- Ore Storage 1 and 2
- Mine Dump
- Shaft Pad
- Shaft Access Road
- Site Access Road
- Topsoil/Overburden pile (T/O)
- Topsoil South pile (TS)
- Other mine-impacted ground located in intermediate areas between the facilities listed above (Surface Excavation)

The following areas are considered sources of borrow material for soil covers that will be placed in the pits and over other waste materials left in place:

- Lobo Tract borrow area
- Topsoil North pile (TN)
- West Borrow area

The T/O, TN, and TS piles were found to contain clean, non-impacted materials suitable for use as soil covers (TN) or cover subsoils (T/O and TS). However, the remaining facilities contain impacted materials that must be removed and consolidated in one of the two pits or covered with clean soil in their current locations. Pile 4 is expected to be the only partially-excavated facility with excess material covered in place, whereas the remaining facilities (excluding borrow areas) will be fully excavated. Additional impacted material currently located inside Pit 1 (Pit 1 Infill) also will be excavated and placed with other backfill due to its existing location above the expected final surface of the pit backfill and cover. Appendix C of the Closure Plan describes material classifications and geotechnical properties.

Existing volumes available for excavation were estimated by comparing the existing ground and pile surfaces with the pre-mining ground surface on which the piles were placed. The volume of material excavated from the intermediate areas was estimated using the methods described in Section 2 of the Closure Plan main text. Estimated placement volumes, including impounded waste and cover soils, were calculated to evaluate the total amount of material required to backfill Pit 1 above the expected future groundwater table elevation (5966 ft) and Pit 2 to the elevation required for positive surface drainage (approx. 6040 ft). Tables D-1 and D-2 summarize the estimated backfill and available excavation volumes, respectively.



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Table D-1. Estimated Pit Backfill and Cover Volumes

Placement Location	Estimated Placement Volume (cy)
Pit 1 (Waste)	7,215,600
Pit 2 (Waste)	1,980,800
Waste Subtotal	9,196,400
Pit 1 (Cover)	181,100
Pit 2 (Cover)	81,400
Pile 4 (Cover)	801,100
Cover Subtotal	1,063,600
TOTAL	10,260,000

Table D-2. Available Removal Excavation Volumes

Facility	Available Volume (cy)
CS	573,847
Mine Dump	37,658
Ore Storage 1 & 2	29,030
Pile 1	925,912
Pile 2	761,907
Pile 3	2,080,033
Pile 4	16,559,844
Pile 5	633,214
Pile 6	254,375
Pile 7	87,086
Pit 1 Infill	66,487
Shaft Area Access Road	26,401
Surface Excavation	645,000
T/O	661,286
TS	368,502
WDA	83,575
Lobo Tract Borrow	1,065,000
TN	43,538
West Borrow	620,000
TOTAL	25,522,695



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#### **Applicable Codes and Standards**

Stantec used the material balance analysis to achieve Site reclamation goals, including mine waste cleanup and reducing radon emanation, in accordance with 10 CFR Part 40 Appendix A, Criterion 6 (NRC, 2017).

#### **Material Properties**

Stantec conducted a geotechnical investigation during 2018 to supplement the 2007 materials characterization (MWH, 2007). During the 2018 investigation, field staff collected samples from Piles 1 through 4, the three topsoil piles (T/O, TS, TN), and potential borrow areas. The samples were subjected to laboratory testing for geotechnical properties (see Appendix C of the Closure Plan for additional details). Because testing data was not available for the other facilities listed in Table D-2, Stantec assigned measured soil properties for Pile 3 to these materials. Based on visual observations of these facilities and Pile 3, Stantec assumed the materials were excavated from the same source zone during mining activities, and therefore have similar material composition and geotechnical properties.

Laboratory testing results and visual classification of materials indicated that the TN pile may contain soil excavated from the same alluvial deposit that comprises the nearby West Borrow area. Therefore, estimation of in-situ soil properties was based on combined test results for the two facilities and the same properties were assigned to each material.

Data used in the analysis included results of index testing (e.g., in-situ dry densities) and Standard Proctor compaction testing (e.g., maximum dry densities). In-situ dry densities were estimated using the 30<sup>th</sup> percentile of sample results for each facility. Table D-3 summarizes the geotechnical properties in the analysis. Compacted dry densities were calculated as 93 percent of the maximum dry density evaluated for each material type during Standard Proctor (SP) compaction testing.

Table D-3. Representative Geotechnical Properties by Area

Facility	In-Situ Dry Density (pcf)	Max Dry Density (pcf)	Compacted Dry Density (93% SP) (pcf)
Pile 1	81.1	113.8	105.8
Pile 2	101.8	113.8	105.8
Pile 3	103.1	124.6	115.8
Pile 4	102.4	127.7	118.7
T/O	100.6	114.1	106.1
TS	100.3	120.0	111.6
TN	86.6	117.4	109.2
West Borrow	86.6	117.4	109.2
Lobo Tract	95.1	112.9	105.0

pcf – pounds per cubic foot



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#### Methods

Stantec performed volume reduction calculations to convert available excavation volumes to placement volumes, thus accounting for material compaction in the final pit backfill and cover configurations. These calculations were based on the geotechnical properties of the materials and performed using basic weight-volume relationships for soils.

First, Stantec calculated the dry soil weight for a given excavation volume using the following relationship:

$$W_s = V_e * \rho_{de}$$

where  $W_s$  = weight of dry soil (lb)

 $V_e$  = volume of excavated soil (ft<sup>3</sup>)

 $\rho_{de}$  = dry density of excavated soil (lb/ft<sup>3</sup>)

Because the dry weight of excavated material remains unchanged following transport and compaction, the compacted volume of material placed in the pits and covers can be calculated using the re-compacted dry density as follows:

$$V_c = W_s/\rho_{dc}$$

where  $V_c$  = volume of re-compacted soil (ft<sup>3</sup>)

 $W_s$  = weight of dry soil (lb)

 $\rho_{dc}$  = dry density of re-compacted soil (lb/ft<sup>3</sup>)

Most Site facilities contain a known volume of material available for excavation, which was then converted to a recompacted volume following the equations above. This method is applicable to cases where the full excavation volume is transported to a single location for compaction. However, for cases where the re-compacted volume was the known variable, the calculations were performed in reverse to estimate the required excavation volume. The latter method was applicable to Pile 3 (some material will be placed in Pit 2 with the remainder placed in Pit 1) and to Pile 4 (which will be partially excavated with a large portion of the pile remaining in place).

The required Pile 3 placement volume in Pit 2 was estimated as the difference between the pit backfill (waste) volume (see Table D-1) and the placed volume of the nearby TS pile material, which will be used as subsoil beneath the Pit 2 cover. No other waste materials will be transported to Pit 2. The Pile 3 excavation volume for Pit 2 backfill then was calculated using the known placement volume and the equations above. The difference between this excavation volume and the total available Pile 3 excavation volume was equal to the volume of material excavated and transported to Pit 1, which was then converted to a re-compacted volume using the equations above.

As previously stated, Pile 4 will be partially excavated and will provide the remaining Pit 1 backfill volume not encompassed by the compacted volumes of material from the other Site facilities. Aside from the TS pile and the portion of Pile 3 used for Pit 2 backfill, other facilities containing waste material will be fully excavated and placed in Pit 1. Compaction volumes were calculated for each facility and the sum (including the contribution from Pile 3) was compared with the required Pit 1 backfill volume. Based on this comparison, approximately 2.8 million cubic yards of additional backfill volume was required from Pile 4. Therefore, the compacted volume of Pile 4 material in Pit 1 was a known variable and the equations above were used to calculate the required volume to be excavated from the pile. The remaining Pile 4 material will be re-graded and covered in place, as discussed in Section 3 and Section 6 of the Closure Plan.

Attachment D.1 contains a summary table of the volume reduction calculations completed in Excel. The volume reduction percentage calculated for Pile 3 was applied to materials excavated from impacted facilities other than Piles 1 through 4 and the three topsoil piles to estimate the re-compacted volumes of these materials.



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#### Results

Calculations were performed to estimate the required excavation and placement volumes for materials transported from Site facilities and borrow areas. Table D-4 lists the resulting excavation volumes by source, as well as the volume and location of re-compacted materials.

**Table D-4. Excavation and Placement Volumes** 

Source	Excavation Volume (cy)	Destination	Placement Volume (cy)
Crusher Stockpile	573,847	Pit 1	510,814
Mine Dump	37,658	Pit 1	33,522
Ore Storage 1 & 2	29,030	Pit 1	25,841
Pile 1	925,912	Pit 1	709,746
Pile 2	761,907	Pit 1	732,849
Pile 3*	226,900	Pit 1	201,977
Pile 3*	1,853,132	Pit 2	1,649,580
Pile 4	3,218,849	Pit 1	2,775,406
Pile 5	633,214	Pit 1	563,660
Pile 6	254,375	Pit 1	226,434
Pile 7	87,086	Pit 1	77,520
Pit 1 Infill	66,487	Pit 1	59,184
Shaft Area Access Road	26,401	Pit 1	23,501
Surface Excavation	645,000	Pit 1	574,152
Topsoil/Overburden	661,286	Pit 1	626,632
Topsoil South	368,502	Pit 2	331,174
West Disturbance Area	83,575	Pit 1	74,395
Waste Subtotal	10,349,327	-	9,196,387
Lobo Tract Borrow	594,533	Pile 4 Cover	538,440
Topsoil North (borrow)	43,538	Pit 1 Cover	34,523
West Borrow	184,807	Pit 1 Cover	146,540
West Borrow	102,660	Pit 2 Cover	81,403
West Borrow	331,208	Pile 4 Cover	262,627
Cover Subtotal	1,256,746	-	1,063,533
TOTAL	11,606,073	-	10,259,920

<sup>\*</sup>Pile 3 placement is split between Pits 1 and 2



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#### **Attachments**

Attachment D.1 - Volume Reduction Calculations Table

#### References

MWH, 2007. St. Anthony Mine Materials Characterization Report, October.

U.S. Nuclear Regulatory Commission (NRC), 2017. Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content, 10 CFR Part 40 Appendix A. August 29.

Attachment D.1



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#### **Attachment D.1 – Volume Reduction Calculations Table**

		Source				Placed				
Source	Destination	Excavated Vol. (cy)	Excavated Vol (ft <sup>3</sup> )	Dry Density (pcf)	Dry Soil Weight (lb)	Max (Proctor) Dry Density (pcf)	Compacted Dry Density (pcf)	Dry Soil Weight (lb)	Compacted Vol. (cy)	Volume Reduction
Pile 1	Pit 1	925,912	2.50E+07	81.1	2.03E+09	113.8	105.8	2.03E+09	709,746	23.3%
Pile 2	Pit 1	761,907	2.06E+07	101.8	2.09E+09	113.8	105.8	2.09E+09	732,849	3.8%
Pile 3	Pit 1	226,900	6.13E+06	103.1	6.32E+08	124.6	115.8	6.32E+08	201,977	11.0%
Pile 3	Pit 2	1,853,132	5.00E+07	103.1	5.16E+09	124.6	115.8	5.16E+09	1,649,580	11.0%
Pile 4	Pit 1	3,218,849	8.69E+07	102.4	8.90E+09	127.7	118.7	8.90E+09	2,775,406	13.8%
T/O	Pit 1	661,286	1.79E+07	100.6	1.80E+09	114.1	106.1	1.80E+09	626,632	5.2%
TS	Pit 2	368,502	9.95E+06	100.3	9.98E+08	120.0	111.6	9.98E+08	331,174	10.1%
TN	Pit 1 Cover	43,538	1.18E+06	86.6	1.02E+08	117.4	109.2	1.02E+08	34,523	20.7%
West Borrow	Pit 1, Pit 2, Pile 4 Covers	618,675	1.67E+07	86.6	1.45E+09	117.4	109.2	1.45E+09	490,570	20.7%
Lobo Tract	Pile 4 Cover	594,533	1.61E+07	95.1	1.53E+09	112.9	105.0	1.53E+09	538,440	9.4%
	TOTAL	8,016,488	-	-	-	-	-	-	7,027,364	12.3%

#### ST. ANTHONY MINE CLOSEOUT PLAN

Appendix E Surface Water Analysis

## Appendix E SURFACE WATER ANALYSIS





## **APPENDIX E.1**

Flow Characterization

#### **BACKGROUND**

The St. Anthony mine site has two open pits and several waste rock piles that flank the Meyer Draw, the main tributary of the Arroyo del Valle (a large arroyo running through the center of the project site - see Figure 1). The St. Anthony Mine Closeout Plan proposes to excavate all piles located southwest of Meyer Draw and backfill excavated material into the two pits. The largest pile on the Site (Pile 4) will be regraded to stable slopes and left in place with an imported soil cover to support vegetative growth and protect from surface erosion.

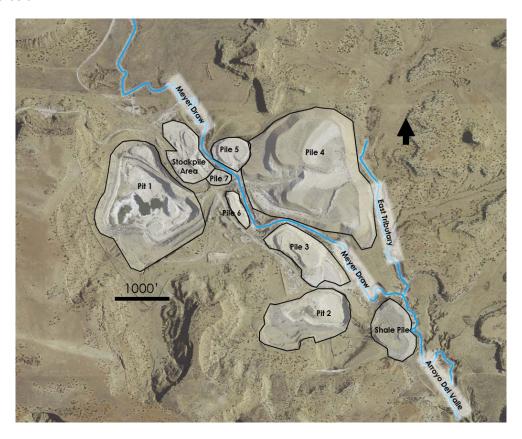


Figure 1: Project Site Existing Conditions (Photo Data: 05/31/2011)

Stantec proposes several surface water control facilities to convey runoff. These facilities are illustrated in the St. Anthony Mine Closeout Plan Design Drawings (design drawings) and are outlined below:

- Grade control structures along the Meyer Draw branch of the arroyo as it passes through the Site
  as well as bank armoring along the Meyer Draw and East Tributary branches of the arroyo where
  they run against regraded Pile 4 (see Sheets 10 and 11 of the design drawings).
- Pile 4 Bench Channels and Downdrain (see Sheets 9 of the design drawings).
- Pit 1 Diversion Channel and Pit 2 Diversion Channel (see Sheets 12 and 13 of the design drawings).

The design flows of these surface water conveyance facilities were the surface water runoff event with a 1 percent annual probability of occurrence (1 in 100-year storm). For reference, Stantec also analyzed the 2-year, 5-year and 10-year storm events under the existing conditions.

For hydrologic evaluations, Stantec developed hydrologic models to predict existing condition flows as well as proposed conditions.

#### **Methods**

#### **Hydrology Model**

The hydrology model used for this evaluation was the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's – Hydrologic Modeling System (HEC-HMS) version 4.2.1, build 28. HEC-HMS simulates the precipitation-runoff processes of dendritic drainage basins and is applicable to a wide range of geographic conditions and drainage basin sizes.

#### Watershed Delineations and Model Element Construction

Attachment A shows watershed delineations and the model element construction within HEC-HMS for the hydrologic model of the existing and proposed site conditions. The site is entirely within the U.S. Geological Survey's (USGS) Hydrologic Unit Code (HUC) level 12 Arroyo del Valle Watershed (130202070802). Arroyo del Valle is the receiving waterbody within the watershed area. Drainage through the proposed remedial area has a watershed area of approximately 29.9 square miles, including existing pits.

Watershed drainage basins were delineated using high-resolution survey data collected by Cooper Aerial (2011) where the data was available (near the mine site). Where no high-resolution survey data was available, Stantec used publicly available elevation data from the National Elevation Dataset (NED) collected by the USGS and published in 2013. This data was collected with 1/3 arc-second resolution.

#### **Hyetograph Development**

Frequency-Based Storms

Stantec developed the precipitation hyetographs for frequency-based storms using the center-peaking alternative block technique with the depth-duration frequency curves built from the National Oceanic and Atmospheric Association (NOAA) Precipitation Data Frequency Server (PDFS) (Bonnin et al, 2011).

The Precipitation Data Frequency Server (PDFS) provides storm depths for return periods ranging from 1-year to 1,000-years and for storm durations of 5 minutes to 60 days. Table 1 shows the PDFS annual maximum series, median confidence interval storm depths used in this analysis for a point located at the Eastern Edge of Pit 1 (Lat: 35.1633° and Long: -107.3030°).

Table 1: Precipitation Data Frequency Server (PDFS) Annual Maximum Series, Median Confidence Interval Storm Depths

Storm				
Duration	100-Year Rainfall	10-Year Rainfall	5-Year Rainfall	2-Year Rainfall
(minutes)	Depth (inches)	Depth (inches)	Depth (inches)	Depth (inches)
5	0.620	0.393	0.325	0.224
10	0.942	0.598	0.494	0.341
15	1.17	0.741	0.612	0.423
30	1.57	0.998	0.825	0.570
60	1.95	1.24	1.02	0.705
120	2.25	1.41	1.16	0.814
180	2.32	1.46	1.21	0.858
360	2.48	1.60	1.35	0.973
720	2.64	1.75	1.48	1.08
1440	2.84	1.89	1.61	1.18

Stantec fit the depth values given in the PDFS to the analytical intensity-duration-frequency (IDF) relationship of the form shown below (Chow et al., 1988):

$$i = \frac{c}{T_d^e + f}$$

Where:

*i* = The design rainfall intensity (mm/hr)

 $T_d$  = The storm duration of the specific return period (15 minutes to 4320 minutes)

c, e, f = Fitting parameters

Table 2 gives the fitting parameters for the IDF curve, and Figure 2 shows the analytical IDF curves with the PDFS depth-duration points.

**Table 2: IDF Curve Fitting Parameters** 

Fitting	100-Year Storm	10-Year Storm	5-Year Storm	2-Year Storm
Parameter	Value	Value	Value	Value
С	88.8	57.3	47.0	32.2
е	0.982	0.896	0.895	0.890
f	7.77	7.95	7.86	7.82

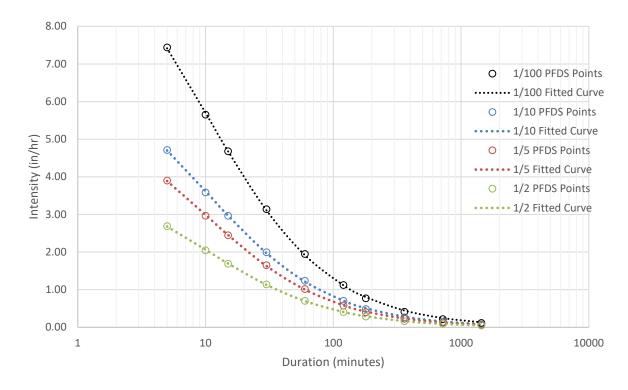


Figure 2: Intensity-Duration-Frequency Curves

Finally, Stantec constructed the cumulative alternating block hyetograph from the analytical IDF curves. Figure 3 shows cumulative hyetographs for the 1 in 100-year return frequency.

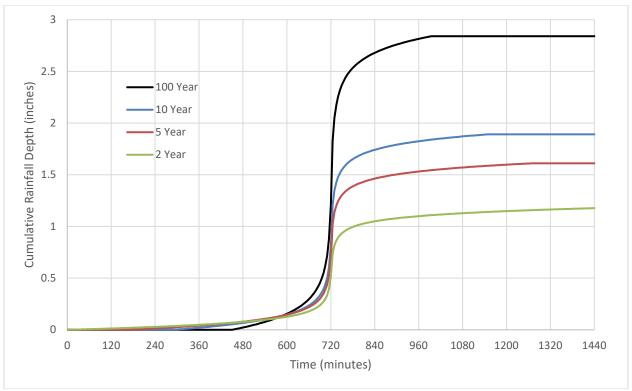


Figure 3: Cumulative Rainfall Hyetographs

Raw data represented in Figure 3 is provided in Attachment B.

#### **Rainfall Losses**

#### **Depression Storage**

Stantec specified a depression storage value of 0.1 inches for all areas excluding the Stockpile 4 regrade area. This value is mid-range of the values recommended for alluvial plains near Albuquerque, New Mexico (Sabol et al., 1982). Stantec assumed no depression storage for the proposed Pile 4 area because the reclaimed pile area is designed to shed water.

#### **Infiltration Losses**

#### Native Terrain Loss Parameters

The hydrologic models used the Green and Ampt (1911) method to simulate losses due to infiltration. The Green and Ampt parameters include the initial volumetric moisture content of the soil, the saturated volumetric moisture content of the soil, an initial suction head value, the saturated hydraulic conductivity of the soil, and the percent impervious area. Stantec applied these parameters as lumped-estimates at the subbasin level. Lumped estimates were calculated based on area-weighted averages of different soil conditions.

Existing condition soil delineations were based on data available from the U.S. Department of Agriculture (USDA) National Resources Conservation Service (NRCS) gridded Soil Survey Geographic (gSSURGO) database for the state of New Mexico. The gSSURGO Database is derived from the official Soil Survey Geographic (SSURGO) Database. SSURGO generally has the most detailed level of soil geographic data developed by the National Cooperative Soil Survey (NCSS) in accordance with NCSS mapping standards

(NRCS, 2019). Stantec used the gSSURGO database to determine watershed-scale Green and Ampt Parameters.

Green and Ampt parameters were adjusted for post-remedy conditions, to reflect construction activities through the remedial action. The extents of the post-remedial work were made equivalent to the planned re-vegetation area, shown by Sheet 15 in the design drawings. This area is approximately equal to the limits of disturbance where soil impacts are most likely.

#### Post-Remedy Loss Parameters

For simplicity, Stantec assumed Green and Ampt parameters within the remedial action revegetation areas to have material properties equivalent to the borrow west material properties (shown in Table 3). The sampled material properties included fines content, clay content, in-situ volumetric water content, and estimated saturated volumetric water content. Soil water characteristic curves or saturated hydraulic conductivity data were not lab tested. To estimate the saturated hydraulic conductivity of the Borrow West material, Stantec used HYDRUS-1D which is coupled with Rosetta DLL (Dynamically Linked Library), which was independently developed by Marcel Schaap at the U.S. Salinity Laboratory. Rosetta implements pedotransfer functions which predict van Genuchten water retention parameters and the saturated hydraulic conductivity (Šimůnek et al., 2013). The saturated hydraulic conductivity was calculated using the percentage of sand, silt, and clay. Saturated conductivity values were also estimated using the Hazen equation for comparison. Compared to the Hazen estimates, the predicted values from Rosetta had lower conductivities and were selected for infiltration modeling. The final Green and Ampt parameters applied for the revegetated footprint are shown in Table 4. These values replaced the gSSURGO map unit values described in the previous section. Stantec calculated lumped watershed parameters for initial volumetric moisture content, saturated volumetric moisture content, and saturated hydraulic conductivity using the methods described in the previous sections. Suction head was also calculated using the previously described regression, based on the lumped saturated hydraulic conductivity values at the watershed level. Attachment C presents final Green and Ampt parameters for post-remedial modeling.

**Table 3: Borrow West Material Properties** 

		1							
						Sat. hydraulic conductivity,	Sat. hydraulic conductivity,	in-situ med. Vol.	median estimated vol. saturated
Soil	fines content (%)	clay content (%)	Silt content (%)	Sand content (%)	median d10 (mm)	Rosetta estimate (cm/sec)	Rosetta estimate (in/hr)	water content (%)	water content (%)
Borrow West	55	18	37	45	0.0011	1.29E-04	0.1829	8.9	28

Table 4: Green and Ampt Parameters for Post-Remedial Mine Areas

Initial Content	Saturated Moisture	Suction	Ksat
(-)	Content (-)	Head (in)	(in/hr)
0.090	0.280	6.622	0.1829

#### Suction Head

Stantec calculated suction head values using a regression between suction head and saturated hydraulic conductivity rates. Figure 4 shows the regression. Stantec obtained the data for this relationship from Rawls et al. (1993). The fitted distribution, using a conductivity in inches per hour and the resulting suction in inches, is:

$$\bar{S}_{S,WS} = 3.729 * \bar{K}_{S,WS}^{-0.338}$$

Where:

 $\overline{K}_{S,WS}$  = The saturated hydraulic conductivity for each watershed (in/hr)

 $\bar{S}_{WS}$  = The suction head for the watershed of interest (in)

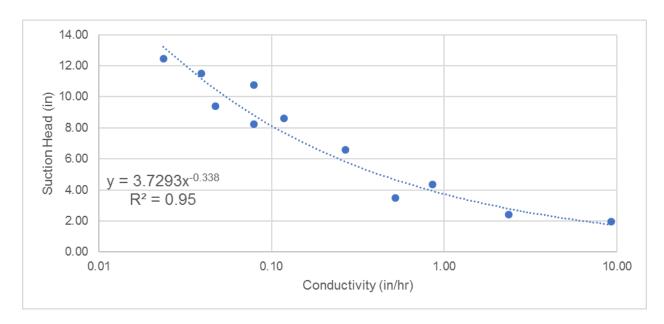


Figure 4: Regression of calculated Suction Head Values as a Function of Hydraulic Conductivity

#### **Hydrograph Transform**

The hydrologic model uses the synthetic Clark Unit Hydrograph (UH) to transform rainfall excess to a runoff hydrograph at a catchment outlet. The Clark UH requires estimating two parameters: the time of concentration, Tc, and the storage coefficient, R, which represent the time translation and attenuation of a flood wave within a watershed.

#### Time of Concentration

Tc values were estimated using two different methods: (1) the empirically based Sabol (1993) Tc equation, and (2) the velocity-based method (McCuen et al., 2002). The following sections describe these approaches and Attachment C provides computation worksheets of the values computed for Tc and R values. Stantec used two Tc methods to address the differing catchment types, because no one method is appropriate for all catchment types. The Sabol (1993) time of concentration method is more appropriate for native catchments. The velocity-based time of concentration method (McCuen et al., 2002) is more appropriate for catchments with drainage dominated by engineered channels or where engineered practices have modified runoff slopes.

As presented below, the Sabol Tc method produces a Tc value constant for all storms; the velocity-based method produces a Tc that varies with the peak storm intensity. Also note that Tc is an input to calculate R. Therefore, for the velocity-based method, Tc and R both vary with the design storm intensity. In this evaluation, the Tc and R values associated with the 100-year event were assumed for all modeled storms.

Also note, nominal values equal to 0.5 hours were assumed for Tc and R for the Pit 1 drainage (hydrologic model element Ex-SB5) in the existing and proposed conditions models. This is justified as this drainage is a sink and does not route into other drainages.

#### Sabol Tc Method

The Sabol (1993) time of concentration, developed specifically for the desert southwest, is calculated as:

$$T_c = 2.4 * A^{0.1} * L^{0.25} * L_{ca}^{0.25} * S^{-0.2}$$

Where:

 $T_c$  = Time of concentration (hours)

A = Area (square miles)

L = Hydraulically most distant length (miles)

 $L_{ca}$  = Length along the longest flow path from centroid (miles)

S = Slope along the longest flow path (ft/mile)

#### Velocity-Based Method

The velocity-based method computes the Tc as the sum of (1) the sheet flow travel time, (2) shallow concentrated flow travel time, and (3) open channel flow travel time (McCuen et al., 2002):

$$T_c = T_{sf} + T_{sc} + T_{oc}$$

Where:

 $T_c$  = Time of concentration (hours)  $T_{sf}$  = Sheet flow travel time (hours)

 $T_{sc}$  = Shallow concentrated flow travel time (hours)

 $T_{oc}$  = Open channel flow travel time (hours)

The following subsections describe methods used to estimate sheet flow, shallow concentrated flow, and open channel flow parameters.

#### Sheet Flow Travel Time, Tsf

The sheet flow travel time, Tsf, was calculated using the expression below (McCuen et al., 2002):

$$T_{sf} = \frac{0.93}{i^{0.4}} \left( \frac{nL}{\sqrt{S_{sf}}} \right)^{0.6} / 60$$

Where:

 $T_{sf}$  = Sheet flow travel time (hours)

*i* = Rainfall intensity for storm of Tc duration (inches/hour)

*n* = Manning's roughness coefficient

 $S_{sf}$  = Surface slope along the flow path length (feet/feet)

 $L_{sf}$  = Flow path length (feet) with a maximum distance of 100 feet or nL/S^0.5

60 = Conversion from minutes to hours

Stantec estimated values for L<sub>sf</sub> and S from available site topography. Manning's n values were estimated from roughness coefficients presented by McCuen et al. (2002, Table 2.1) who recommends roughness values of 0.13 which is similar to values prescribed for natural range land in the reference.

The sheet flow calculation uses iterative computations to solve for storm intensity and the sheet flow travel time. Stantec related storm intensities to travel time using the analytical IDF relationships developed for 100-year storm event.

#### Shallow Concentrated Flow Travel Time, Tsc

The shallow concentrated flow travel time, T<sub>sc</sub>, was calculated as (McCuen et al., 2002):

$$T_{SC} = \frac{L_{SC}}{V_{SC} * 3600}$$

Where:

 $T_{sc}$  = Time of concentration (hours)

 $L_{sc}$  = Shallow concentrated flow path length (feet)

 $V_{sc}$  = Shallow concentrated flow velocity (feet per second)

3600 = Conversion from seconds to hours

$$V_{sc} = 33 * k * \sqrt{S_{sc}}$$

Where:

 $V_{sc}$  = Shallow concentrated flow velocity (feet per second)

*k* = Velocity-slope relationship constant

 $S_{sc}$  = Surface slope along the flow path length (feet/feet)

Stantec estimated values for  $L_{sc}$  and S from the available site topography and then computed the shallow concentrated flow coefficient, k, using McCuen (2002, Table 2.2). The values selected for hydrologic analysis is 0.457 which is approximated to represent Grassed Waterways.

#### Open Channel (Concentrated Flow) Travel Time, Toc

The open channel flow travel time, T<sub>oc</sub>, was calculated as:

$$T_{oc} = \frac{L_{oc}}{V_{oc} * 3600}$$

Where:

 $T_{oc}$  = Open channel travel time (hours)

 $V_{oc}$  = Open channel flow velocity (feet per second) 3600 = Conversion from seconds to hours (seconds/hour)

Open channel flow velocity is calculated using Manning's equation as given below:

$$V_{oc} = \frac{1.486}{n} * Rh^{2/3} * S_{oc}^{0.5}$$

Where:

 $V_{oc}$  = Open channel flow velocity (feet per second)

*n* = Manning's roughness coefficient

Rh = Hydraulic radius of the cross sectional flow area (feet)  $S_{oc}$  = Surface slope along the flow path length (feet/feet)

Values for L<sub>sc</sub> and S were estimated from the available site topography. Manning's roughness coefficient values, n, were determined from (Chow et al., 1988). The values selected for hydrologic analysis is 0.04.

Manning's equation was solved iteratively to find a flow depth (and hydraulic radius) that satisfied the overall  $T_c$ . The representative flow used to compute the depth in the equations was 2/3 of the simulated peak flow at catchment outlet (NMDOT, 1995).

Clark Unit Hydrograph Storage Coefficient (R Parameter)

The Clark UH R parameter was computed using the Sabol (1993) equation:

$$R = 0.37 * T_c^{1.11} * L^{0.80} * A^{-0.57}$$

Where:

R = Clark UH storage coefficient (hours)

 $T_c$  = Time of concentration as calculated in Section 5.1 or 5.2 (hours)

L = Length of the longest hydraulic flow path (miles)

A = Area (square miles)

#### **Channel Routing**

The hydrologic models use the Muskingum-Cunge method to simulate routing through natural and engineered channels between catchment outlet points. The Muskingum-Cunge method couples the Manning formula and the convective-diffusion equation to compute the hydrograph travel time and hydrograph peak attenuation through a channel reach. No additional losses were applied to the channel reaches; therefore, Stantec observed only minor attenuation of the peak flows, indicating that channel reach specifications have a limited impact on the modeled peak flows.

For simplicity, channel dimensions were approximated as triangular shaped channel with 2:1 side slopes. These channel dimensions are simplified versions of the actual channel geometry (which have limited impact on the estimated peak flow values). A roughness of 0.04 was assigned to all channels.

#### **Results**

The simulated peak flows, and total runoff volumes for all model elements outlined in the watershed maps shown in Attachment A are provided in Attachment D.

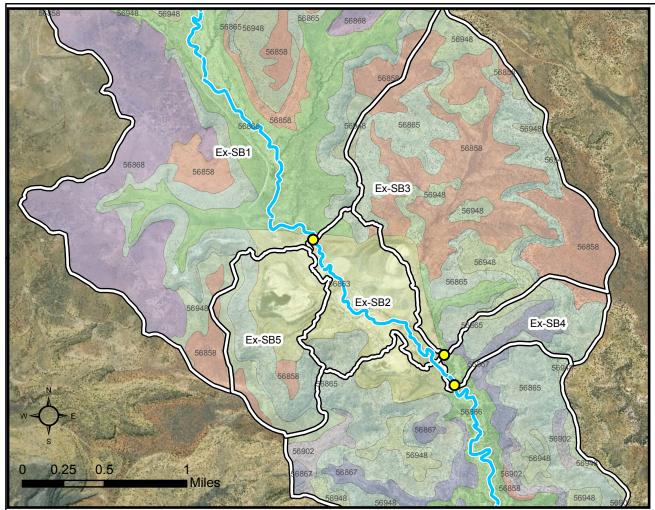
#### **Check with Regional Data**

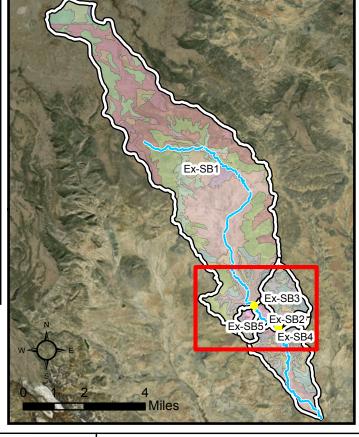
For an independent check of the computed runoff values, Stantec evaluated runoff estimates of the large (approximately 26.6mi²) upstream basin (Ex\_SB-1) using the USGS regression equations (Waltemeyer, 2008). The St. Anthony site is in USGS Flood Region 6. The manual provides regionally regressed estimates of peak discharge in a watershed computed as a function of the drainage basin area. The regression equation predicts a peak 100-year discharge for Ex\_SB-1 to be 4460 cfs which is within 10 percent of the value predicted by the hydrologic model (4067 cfs).

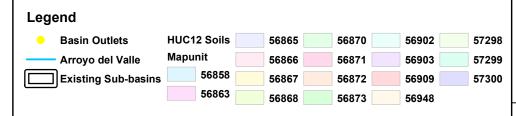
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ATTACHMENT A	
Watershed Delineation Maps, HEC-HMS Element Construction, Watershed Area Tables	







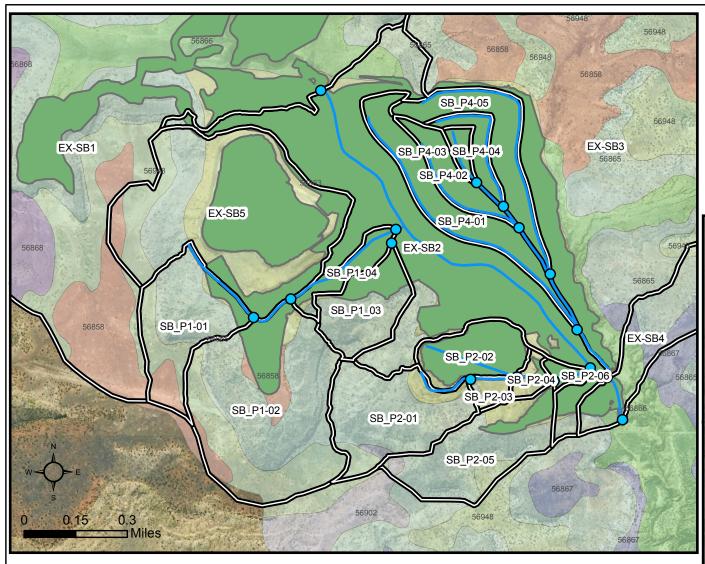


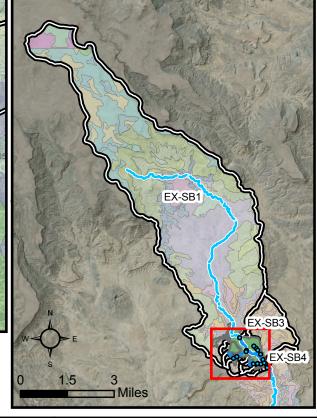
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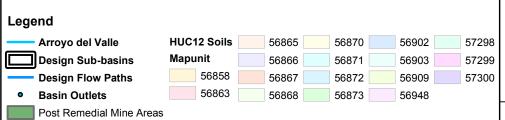
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General Electric St. Anthony Mine Closeout Plan

Attachment A
Watershed Delineation Map
Existing Conditions





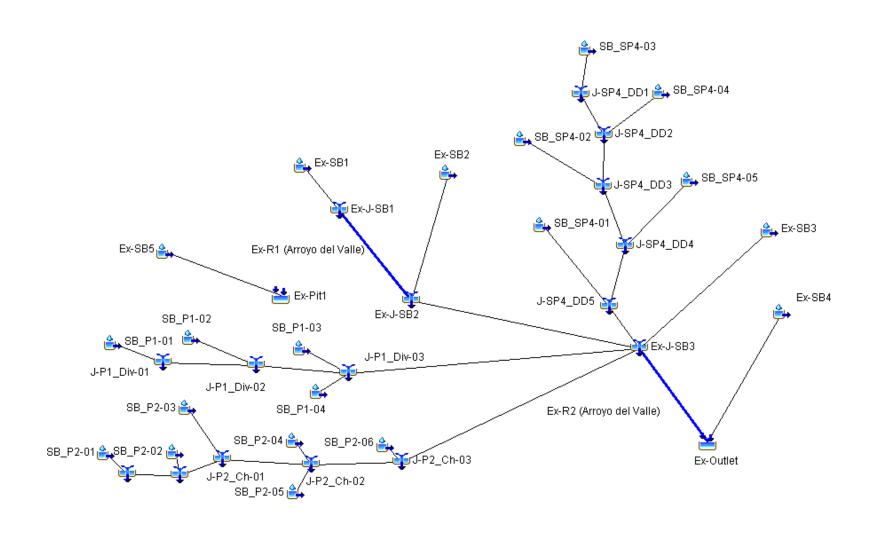




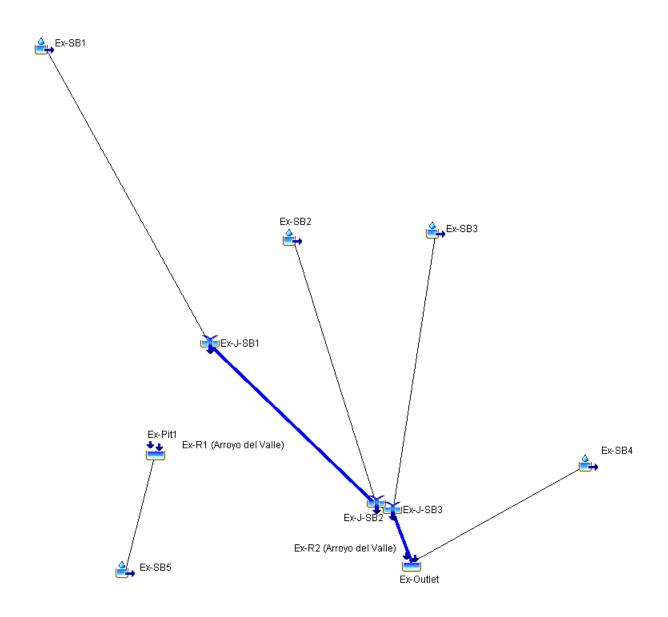
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General Electric St. Anthony Mine Closeout Plan

Attachment A Watershed Delineation Map Proposed Conditions



HEC-HMS Basin Model Schematic – Proposed Conditions



**HEC-HMS** Basin Model Schematic – Existing Conditions

Existing Conditions					
Subbasin	Area (mi <sup>2</sup> )				
Ex-SB1	26.626				
Ex-SB2	0.491				
Ex-SB3	1.876				
Ex-SB4	0.335				
Ex-SB5	0.571				

Proposed Conditions				
Subbasin	Area (mi²)			
Ex-SB1	26.618			
Ex-SB2	0.311			
Ex-SB3	1.898			
SB_P1-02	0.202			
SB_P1-01	0.084			
SB_P1-03	0.054			
SB_P1-04	0.022			
SB_P2-01	0.094			
SB_P2-02	0.047			
SB_P2-03	0.010			
SB_P2-05	0.086			
SB_P2-04	0.010			
SB_P2-06	0.007			
SB_SP4-05	0.056			
SB_SP4-02	0.029			
SB_SP4-04	0.018			
SB_SP4-03	0.009			
SB_SP4-01	0.064			
Ex-SB4	0.319			
Ex-SB5	0.248			

### **ATTACHMENT B**

**Storm Hyetograph Tables** 

		Rainfall De		
Time (min)	2-Year	5-Year	10-Year	100-Year
0	0	0	0	0
5 10	0.001	0	0	0
15	0.001	0	0	0
20	0.002	0	0	0
25	0.002	0	0	0
30	0.003	0	0	0
35 40	0.004 0.004	0	0	0
45	0.005	0	0	0
50	0.005	0	0	0
55	0.006	0	0	0
60	0.006	0	0	0
65 70	0.007	0	0	0
75	0.007	0	0	0
80	0.008	0	0	0
85	0.009	0	0	0
90	0.009	0	0	0
95 100	0.01 0.011	0	0	0
105	0.011	0	0	0
110	0.012	0	0	0
115	0.012	0	0	0
120	0.013	0	0	0
125	0.013	0	0	0
130	0.014	0	0	0
140	0.015	0	0	0
145	0.016	0	0	0
150	0.016	0	0	0
155	0.017	0	0	0
160 165	0.018 0.018	0	0	0
170	0.018	0	0	0
175	0.02	0.001	0	0
180	0.02	0.002	0	0
185	0.021	0.003	0	0
190	0.022	0.004	0	0
195 200	0.022	0.004	0	0
205	0.024	0.006	0	0
210	0.024	0.007	0	0
215	0.025	0.008	0	0
220 225	0.026 0.026	0.009	0	0
230	0.020	0.011	0	0
235	0.028	0.012	0	0
240	0.028	0.013	0	0
245	0.029	0.014	0	0
250	0.03	0.015	0	0
255 260	0.031	0.016	0	0
265	0.032	0.018	0	0
270	0.033	0.019	0	0
275	0.034	0.02	0	0
280	0.034	0.021	0	0
285 290	0.035 0.036	0.022	0	0
295	0.037	0.024	0.001	0
300	0.038	0.026	0.003	0
305	0.039	0.027	0.004	0
310	0.039	0.028	0.005	0
315 320	0.04	0.029	0.007	0
325	0.041	0.03	0.008	0
330	0.043	0.033	0.011	0
335	0.044	0.034	0.013	0
340	0.045	0.035	0.014	0
345 350	0.046 0.047	0.036	0.016 0.017	0
350	0.047	0.038	0.017	0
360	0.048	0.04	0.02	0
365	0.049	0.041	0.022	0
370	0.05	0.043	0.023	0
375 380	0.051 0.052	0.044 0.046	0.025 0.027	0
385	0.052	0.046	0.027	0
390	0.054	0.048	0.03	0
395	0.056	0.05	0.032	0
400	0.057	0.051	0.034	0
405	0.058	0.053	0.035	0
410 415	0.059	0.054	0.037	0
420	0.061	0.057	0.039	0
425	0.062	0.059	0.043	0
430	0.063	0.061	0.045	0
435	0.065	0.062	0.047	0
440	0.066	0.064	0.049	0
445 450	0.067	0.066	0.051	0
450 455	0.068	0.067	0.053	0.003
460	0.071	0.003	0.057	0.003
465	0.072	0.073	0.059	0.011
470	0.074	0.075	0.062	0.014
	0.075	0.077	0.064	0.018
475 480	0.073	0.077	0.066	0.022

Cumulative Rainfall Depth (inches)						
Time (min)	2-Year	5-Year	10-Year	100-Year		
485	0.078	0.081	0.069	0.026		
490	0.08	0.083	0.071	0.03		
495 500	0.081	0.085	0.074	0.034		
505	0.084	0.089	0.079	0.043		
510	0.086	0.091	0.082	0.047		
515	0.088	0.094	0.084	0.052		
520	0.089	0.096	0.087	0.056		
525 530	0.091	0.099	0.09	0.061		
535	0.095	0.101	0.096	0.000		
540	0.097	0.106	0.1	0.076		
545	0.099	0.109	0.103	0.082		
550	0.101	0.112	0.106	0.087		
555	0.103	0.115	0.11	0.093		
560 565	0.105 0.108	0.118	0.113 0.117	0.099		
570	0.108	0.121	0.117	0.103		
575	0.112	0.127	0.125	0.118		
580	0.115	0.131	0.129	0.125		
585	0.117	0.134	0.134	0.132		
590 595	0.12 0.123	0.138 0.142	0.138 0.143	0.139 0.147		
600	0.126	0.142	0.143	0.155		
605	0.129	0.151	0.153	0.163		
610	0.132	0.155	0.158	0.172		
615	0.136	0.16	0.164	0.181		
620	0.139	0.165	0.17	0.191		
625 630	0.143 0.147	0.17 0.176	0.176 0.183	0.201 0.212		
635	0.147	0.176	0.183	0.212		
640	0.156	0.188	0.198	0.236		
645	0.161	0.195	0.206	0.249		
650	0.166	0.202	0.215	0.263		
655	0.172	0.21	0.225 0.235	0.279		
660 665	0.178 0.185	0.219	0.235	0.296 0.315		
670	0.183	0.239	0.247	0.335		
675	0.202	0.251	0.274	0.358		
680	0.211	0.265	0.291	0.385		
685	0.223	0.28	0.31	0.415		
690	0.236	0.299	0.332	0.451		
695 700	0.252 0.272	0.321	0.359 0.393	0.494 0.548		
705	0.298	0.386	0.438	0.619		
710	0.334	0.439	0.501	0.719		
715	0.393	0.522	0.603	0.879		
720	0.514	0.697	0.815	1.212		
725 730	0.737 0.817	1.021	1.206 1.346	1.83 2.05		
735	0.862	1.201	1.425	2.174		
740	0.893	1.244	1.477	2.257		
745	0.916	1.276	1.516	2.319		
750	0.933	1.301	1.546	2.367		
755	0.948	1.321	1.571	2.406		
760 765	0.96 0.97	1.338	1.592 1.609	2.439 2.467		
770	0.97	1.366	1.625	2.492		
775	0.988	1.377	1.638	2.513		
780	0.995	1.387	1.651	2.533		
785	1.002	1.396	1.662	2.551		
790	1.008	1.405	1.672	2.567		
795 800	1.013	1.412 1.42	1.681	2.582 2.596		
800	1.018	1.426	1.697	2.609		
810	1.027	1.432	1.705	2.621		
815	1.032	1.438	1.712	2.632		
820	1.035	1.443	1.718	2.642		
825	1.039	1.449	1.725	2.652		
830 835	1.043 1.046	1.453 1.458	1.73 1.736	2.662 2.671		
840	1.049	1.462	1.741	2.679		
845	1.052	1.467	1.746	2.688		
850	1.055	1.471	1.751	2.695		
855	1.058	1.474	1.756	2.703		
860 865	1.061	1.478 1.482	1.76 1.764	2.71 2.717		
870	1.063	1.482	1.764	2.717		
875	1.068	1.488	1.772	2.73		
880	1.07	1.491	1.776	2.736		
885	1.073	1.495	1.78	2.742		
890 895	1.075	1.497 1.5	1.783 1.787	2.748 2.754		
900	1.077	1.503	1.787	2.754		
905	1.081	1.506	1.793	2.764		
910	1.083	1.508	1.797	2.769		
915	1.085	1.511	1.8	2.774		
920	1.086	1.513	1.803	2.779		
925	1.088	1.516	1.806	2.784		
930	1.09 1.092	1.518 1.52	1.808 1.811	2.789 2.793		
935	1.092	1.523	1.811	2.793		
945	1.095	1.525	1.816	2.802		
950	1.096	1.527	1.819	2.806		
955	1.098	1.529	1.821	2.81		
960	1.099	1.531	1.824	2.814		

Time (	Cumulative 2-Year	Rainfall Dep	oth (inches) 10-Year	100-Year
Time (min) 965	2-Year 1.101	5-Year 1.533	10-Year 1.826	2.818
970	1.102	1.535	1.829	2.822
975	1.104	1.537	1.831	2.826
980	1.105	1.539	1.833	2.829
985 990	1.106 1.108	1.541 1.542	1.835 1.837	2.833 2.836
995	1.108	1.544	1.84	2.84
1000	1.11	1.546	1.842	2.84
1005	1.111	1.548	1.844	2.84
1010	1.113	1.549	1.846	2.84
1015	1.114	1.551	1.848	2.84
1020 1025	1.116	1.553 1.554	1.85 1.852	2.84
1030	1.117	1.556	1.853	2.84
1035	1.118	1.557	1.855	2.84
1040	1.12	1.559	1.857	2.84
1045	1.121	1.56	1.859	2.84
1050 1055	1.122 1.123	1.562 1.563	1.861 1.862	2.84
1060	1.124	1.565	1.864	2.84
1065	1.125	1.566	1.866	2.84
1070	1.126	1.567	1.867	2.84
1075 1080	1.127	1.569	1.869	2.84
1085	1.128 1.129	1.57 1.571	1.87 1.872	2.84
1090	1.13	1.573	1.874	2.84
1095	1.131	1.574	1.875	2.84
1100	1.132	1.575	1.877	2.84
1105	1.133	1.576	1.878	2.84
1110 1115	1.133	1.578 1.579	1.88	2.84
1115	1.134	1.579	1.883	2.84
1125	1.136	1.581	1.884	2.84
1130	1.137	1.582	1.885	2.84
1135	1.138	1.583	1.887	2.84
1140 1145	1.139 1.139	1.585 1.586	1.888	2.84
1150	1.139	1.587	1.891	2.84
1155	1.141	1.588	1.891	2.84
1160	1.142	1.589	1.891	2.84
1165	1.143	1.59	1.891	2.84
1170	1.143	1.591	1.891	2.84
1175 1180	1.144 1.145	1.592 1.593	1.891 1.891	2.84
1185	1.146	1.594	1.891	2.84
1190	1.146	1.595	1.891	2.84
1195	1.147	1.596	1.891	2.84
1200	1.148	1.597	1.891	2.84
1205 1210	1.149 1.149	1.598	1.891	2.84
1215	1.15	1.6	1.891	2.84
1220	1.151	1.601	1.891	2.84
1225	1.151	1.602	1.891	2.84
1230	1.152	1.603	1.891	2.84
1235 1240	1.153 1.154	1.604 1.605	1.891 1.891	2.84
1245	1.154	1.606	1.891	2.84
1250	1.155	1.607	1.891	2.84
1255	1.156	1.608	1.891	2.84
1260	1.156	1.609	1.891	2.84
1265 1270	1.157 1.157	1.609	1.891 1.891	2.84
1275	1.158	1.61	1.891	2.84
1280	1.159	1.61	1.891	2.84
1285	1.159	1.61	1.891	2.84
1290	1.16	1.61	1.891	2.84
1295 1300	1.161 1.161	1.61	1.891	2.84
1305	1.162	1.61	1.891	2.84
1310	1.162	1.61	1.891	2.84
1315	1.163	1.61	1.891	2.84
1320	1.164	1.61	1.891	2.84
1325 1330	1.164 1.165	1.61	1.891 1.891	2.84
1335	1.165	1.61	1.891	2.84
1340	1.166	1.61	1.891	2.84
1345	1.166	1.61	1.891	2.84
1350	1.167	1.61	1.891	2.84
1355 1360	1.168	1.61	1.891	2.84
1365	1.169	1.61	1.891	2.84
1370	1.169	1.61	1.891	2.84
1375	1.17	1.61	1.891	2.84
1380	1.17	1.61	1.891	2.84
1385 1390	1.171 1.171	1.61	1.891 1.891	2.84 2.84
1395	1.171	1.61	1.891	2.84
1400	1.172	1.61	1.891	2.84
1405	1.173	1.61	1.891	2.84
1410	1.173	1.61	1.891	2.84
1415	1.174	1.61	1.891	2.84
1420 1425	1.174 1.175	1.61	1.891	2.84 2.84
1430	1.176	1.61	1.891	2.84
1435	1.176	1.61	1.891	2.84
1440	1.176	1.61	1.891	2.84

ATTACHMENT C
Clark Unit Hydrograph Parameter Calculation and Routing Tables

## Existing and Proposed Conditions - Clark UH Parameters, Tc and R by Sabol (1993)

ID	Tc (HRS)	R (HRS)
Ex-SB1	4.09	2.53
Ex-SB3	1.31	0.75
Ex-SB4	0.66	0.52

		Tin	ne of Conent	ration				Storage Coeff		
Method	Tc (hours)	R (hours)								
Sabol (Desert/Mountain)	26.6	16.2	7.9	8550	6024	156	4.1	2.5		
Sabol (Desert/Mountain)	1.9	2.6	1.4	6305	5960	134	1.3	0.7		
abol (Desert/Mountain)         0.3         1.3         0.7         6345         5951.9         312         0.7										

### Proposed Conditions - Clark UH Parameters, Tc $\,$ and R by FHWA $\,$

ObjectID	Tc (HRS)	R (HRS)
SB_P1-01	0.324	0.217
SB_P1-02	0.283	0.168
SB_P1-03	0.278	0.254
SB_P1-04	0.143	0.195
SB_P2-01	0.309	0.631
SB_P2-02	0.192	0.141
SB_P2-03	0.420	0.483
SB_P2-04	0.182	0.136
SB_P2-05	0.246	0.457
SB_P2-06	0.103	0.065
SB_SP4-01	0.632	1.031
SB_SP4-02	0.362	0.497
SB_SP4-03	0.254	0.304
SB_SP4-04	0.342	0.554
SB_SP4-05	0.616	1.020
SB Ex2	0.696	0.685

1/100-Year Storm Assumed

						Max Sheet								
		High		SF Roughness		Flow Length	Guess Intensity	Select Design	Avg. Effective	New Intensity			Tt_6*7t)	SF Tt
ObjectID	SF Length (ft)	Elevation (ft)	Low Elevation (ft)	Factor "n"	SF Slope (ft/ft)	(ft)	(in/hr)	Storm	Rainfall Depth (in)	(in/hr)	Iterate to 0	Intensity (ft/s)	(s)	(min)
SB_P1-01	120	6399.9	6398.1	0.130	0.02	95.25	4.1	100yr 24hr	1	4.1	0.04	9.5E-05	690	11.5
SB_P1-02	62	6426.7	6426.4	0.130	0.00	48.85	4.4	100yr 24hr	1.24	4.4	0.02	1.0E-04	674	11.2
SB_P1-03	125	6402.0	6400.0	0.130	0.02	97.30	4.5	100yr 24hr	1.23	4.4	0.08	1.0E-04	673	11.2
SB_P1-04	63	6161.8	6125.0	0.130	0.58	588.14	6.1	100yr 24hr	0.87	6.1	0.01	1.4E-04	134	2.2
SB_P2-01	160	6451.8	6447.3	0.130	0.03	129.80	4.2	100yr 24hr	1.29	4.2	0.03	9.7E-05	674	11.2
SB_P2-02	112	6145.0	6143.0	0.130	0.02	102.79	5.4	100yr 24hr	1.03	5.3	0.06	1.3E-04	567	9.4
SB_P2-03	75	6061.3	6060.3	0.130	0.01	90.15	3.5	100yr 24hr	1.46	3.5	0.03	8.1E-05	573	9.6
SB_P2-04	69	6060.3	6057.8	0.130	0.04	145.45	5.6	100yr 24hr	1.00	5.5	0.12	1.3E-04	338	5.6
SB_P2-05	63	6292.5	6291.4	0.130	0.02	101.64	4.8	100yr 24hr	1.16	4.7	0.08	1.1E-04	424	7.1
SB_P2-06	60	6063.9	6059.0	0.130	0.08	219.54	6.9	100yr 24hr	0.71	6.9	-0.01	1.6E-04	225	3.8
SB_SP4-01	308	6150.0	6095.0	0.130	0.18	325.06	2.7	100yr 24hr	1.68	2.7	0.04	6.3E-05	688	11.5
SB_SP4-02	302	6215.0	6155.0	0.130	0.20	342.87	3.8	100yr 24hr	1.38	3.8	0.00	8.8E-05	574	9.6
SB_SP4-03	109	6231.6	6229.4	0.130	0.02	108.79	4.6	100yr 24hr	1.18	4.6	-0.05	1.1E-04	575	9.6
SB_SP4-04	122	6215.0	6190.0	0.130	0.20	348.21	4.0	100yr 24hr	1.34	3.9	0.07	9.3E-05	324	5.4
SB_SP4-05	325	6200.0	6135.0	0.130	0.20	344.01	2.7	100yr 24hr	1.67	2.7	-0.01	6.3E-05	687	11.4
SB Ex2	245	6102.0	6090.7	0.130	0.06	188.42	2.5	100vr 24hr	1.73	2.5	0.01	5.8E-05	858	14.3

		High					Tt	Tt if V=1.0 ft/s	
ObjectID	SCF Length (ft)	Elevation (ft)	Low Elevation (ft)	k value	SCF Slope (ft/ft)	Velocity (ft/s)	(min)	(min)	Tt (min)
SB_P1-01	837.9	6398.1	6370.0	0.457	0.033	2.76	5.06	13.97	5.06
SB_P1-02	491.0	6426.4	6326.0	0.457	0.204	6.82	1.20	8.18	1.20
SB_P1-03	1035.0	6400.0	6082.0	0.457	0.31	8.36	2.06	17.25	2.06
SB_P1-04	316.9	6125.0	6098.0	0.457	0.09	4.40	1.20	5.28	1.20
SB_P2-01	804.0	6447.3	6280.0	0.457	0.21	6.88	1.95	13.40	1.95
SB_P2-02	356.3	6143.0	6060.0	0.457	0.23	7.28	0.82	5.94	0.82
SB_P2-03	1012.8	6060.3	6045.6	0.457	0.01	1.82	9.30	16.88	9.30
SB_P2-04	245.0	6057.8	6040.0	0.457	0.07	4.06	1.00	4.08	1.00
SB_P2-05	996.4	6291.4	6110.0	0.457	0.18	6.43	2.58	16.61	2.58
SB_P2-06	421.9	6059.0	6007.0	0.457	0.12	5.29	1.33	7.03	1.33
SB_SP4-01	0.0	6095.0	6095.0	0.457	#DIV/0!	0.00	0.00	0.00	0.00
SB_SP4-02	0.0	6155.0	6155.0	0.457	#DIV/0!	0.00	0.00	0.00	0.00
SB_SP4-03	721.2	6229.4	6215.0	0.457	0.02	2.13	5.64	12.02	5.64
SB_SP4-04	0.0	6190.0	6190.0	0.457	#DIV/0!	0.00	0.00	0.00	0.00
SB_SP4-05	0.0	6135.0	6135.0	0.457	#DIV/0!	0.00	0.00	0.00	0.00
SB_Ex2	965.1	6090.7	6032.8	0.457	0.06	3.69	4.35	16.09	4.35

											Channel					
				Channel		Guess Flow	Channel Bottom				Hydraulic	Calculated				
		High		Roughness		Depth	Width "B"			Flow Area "A"	Radius "Rh"	Discharge	Modeled	Modeled Discharge		Tt
ObjectID	CF Length (ft)	Elevation (ft)	Low Elevation (ft)	Factor "n"	Channel Slope (ft/ft)	(ft)	(ft)	xH:1V-1	xH:1V-2	(ft2)	(ft)	(cfs)	Discharge	(cfs)	Iterate to 0	(min)
SB_P1-01	2011.8	6370.0	6081.0	0.04	0.144	1.02	5.00	2.0	2.0	7.16	0.75	83.24	83.2	83.20	0.04	2.9
SB_P1-02	3115.5	6326.0	6078.0	0.04	0.080	1.71	5.00	2.0	2.0	14.34	1.14	163.61	245.5	163.67	-0.06	4.6
SB_P1-03	1315.5	6082.0	6021.0	0.04	0.046	0.98	5.00	2.0	2.0	6.78	0.72	43.71	65.9	43.93	-0.23	3.4
SB_P1-04	1855.8	6098.0	5990.0	0.04	0.058	0.70	5.00	2.0	2.0	4.44	0.55	26.64	39.8	26.53	0.11	5.2
SB_P2-01	2367.9	6280.0	6071.0	0.04	0.088	0.69	5.00	2.0	2.0	4.43	0.55	32.65	48.3	32.20	0.45	5.4
SB_P2-02	522.9	6060.0	6039.0	0.04	0.040	1.24	5.00	2.0	2.0	9.25	0.88	63.10	94.7	63.13	-0.03	1.3
SB_P2-03	470.0	6045.6	6039.0	0.04	0.014	0.16	5.00	2.0	2.0	0.85	0.15	1.05	1.5	1.00	0.05	6.3
SB_P2-04	706.0	6040.0	6014.0	0.04	0.037	0.27	5.00	2.0	2.0	1.50	0.24	4.13	6.0	4.00	0.13	4.3
SB_P2-05	1989.6	6110.0	6014.0	0.04	0.048	0.95	5.00	2.0	2.0	6.51	0.71	42.12	62.9	41.93	0.18	5.1
SB_P2-06	401.4	6007.0	5961.0	0.04	0.115	0.39	5.00	2.0	2.0	2.25	0.33	13.65	20.6	13.73	-0.08	1.1
SB_SP4-01	4760.6	6095.0	5995.0	0.04	0.021	0.84	0.00	20.0	5.0	8.72	0.42	26.13	39.1	26.07	0.00	26.5
SB_SP4-02	2141.2	6155.0	6105.0	0.04	0.023	0.75	0.00	20.0	5.0	7.03	0.37	20.69	30.7	20.47	0.05	12.1
SB_SP4-03	0.0	6215.0	6105.0	0.04	#DIV/0!	0.00	0.00	20.0	5.0	0.00	#DIV/0!	#DIV/0!	12.9	8.60	#DIV/0!	0.0
SB_SP4-04	2296.0	6190.0	6140.0	0.04	0.022	0.63	0.00	20.0	5.0	4.96	0.31	12.55	18.4	12.27	0.08	15.1
SB_SP4-05	4414.0	6135.0	6045.0	0.04	0.020	0.81	0.00	20.0	5.0	8.10	0.40	23.35	34.8	23.20	0.02	25.5
SB_Ex2	7000.0	6032.8	5955.0	0.04	0.011	3.09	0.00	3.0	3.0	28.64	1.47	144.75	214.4	142.93	3.29	23.1

ObjectID	Tc (min)	Tc (hrs)	A	L(mi)	Storage Coefficient "R" (hrs)	R/Tc
SB_P1-01	19.45	0.32	0.13	0.56	0.22	0.67
SB_P1-02	16.99	0.28	0.21	0.69	0.17	0.59
SB_P1-03	16.68	0.28	0.06	0.47	0.25	0.91
SB_P1-04	8.59	0.14	0.02	0.42	0.20	1.36
SB_P2-01	18.54	0.31	0.02	0.63	0.63	2.04
SB P2-02	11.54	0.19	0.02	0.19	0.14	0.74
SB_P2-03	25.19	0.42	0.02	0.30	0.48	1.15
SB P2-04	10.90	0.18	0.02	0.19	0.14	0.75
SB_P2-05	14.77	0.25	0.02	0.58	0.46	1.86
SB P2-06	6.18	0.10	0.02	0.17	0.06	0.63
SB SP4-01	37.93	0.63	0.06	0.96	1.03	1.63
SB_SP4-02	21.70	0.36	0.03	0.46	0.50	1.38
SB SP4-03	15.22	0.25	0.01	0.16	0.30	1.20
SB_SP4-04	20.52	0.34	0.02	0.46	0.55	1.62
SB SP4-05	36.97	0.62	0.06	0.90	1.02	1.66

### Existing Conditions - Clark UH Parameters, $\operatorname{Tc}\,$ and R by FHWA

ObjectID Tc (HRS) Ex-SB2 0.743

| High | SF | Elevation | Low Elevation | Complexity | SF | Elevation | Low Elevation | Complexity | Select Design | Storm | (in) | (in) | Roughness | Storm | (in) | (in) | Retart to 0 | Intensity | (in) | (in) | Retart to 0 | Intensity | (in) | (in) | Retart to 0 | Intensity | (in) | (in) | Retart to 0 | Intensity | (in) | (in) | Retart to 0 | Intensity | (in) | (in) | (in) | Retart to 0 | Intensity | (in) | (in) | (in) | (in) | Retart to 0 | Intensity | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in) | (in)

		High							
		Elevation	Low Elevation				Tt	Tt if V=1.0 ft/s	
ObjectID	SCF Length (ft)	(ft)	(ft)	k value	SCF Slope (ft/ft)	Velocity (ft/s)	(min)	(min)	Tt (min)
Ex-SB2	1400.9	6244.1	6178.6	0.305	0.047	2.18	10.73	23.35	10.73

1/100-Year Storm Assumed

							Channel				Channel					
		High		Channel		Guess Flow	Bottom Width				Hydraulic	Calculated		Modeled		
		Elevation	Low Elevation	Roughness		Depth	"B"			Flow Area "A"	Radius "Rh"	Discharge	Modeled	Discharge		Tt
ObjectID	CF Length (ft)	(ft)	(ft)	Factor "n"	Channel Slope (ft/ft)	(ft)	(ft)	xH:1V-1	xH:1V-2	(ft2)	(ft)	(cfs)	Discharge	(cfs)	Iterate to 0	(min)
Ex-SB2	8426.5	6178.6	5960.0	0.04	0.026	1.84	0.00	2.0	2.0	6.77	0.82	35.55	35.5	35.49	0.06	26.7

					Storage Coefficient "R"	
ObjectID	Tc (min)	Tc (hrs)	A	L(mi)	(hrs)	R/Tc
Ev CD2	44 E0	0.74	0.40	1 00	0.66	0.89

Muskingum-Cunge Flow Routing

Reach EX-R1 (Arroyo del Valle) EX-R2 (Arroyo del Valle)

High Elevation (ft)	Low Elevation (ft)	Length (ft)	Slope (ft/ft)	Manning's n	Shape	Side Slope
6024	5960	7410	0.00864	0.04	Triangle	2
5960	5951.9	1492	0.00543	0.04	Triangle	2

# ATTACHMENT D HEC-HMS Model Results

### HEC-HMS Model Results

	Existing Conditions											
	1/100-Yea	ar Event	1/10-Yea	ır Event	1/5-Year	Event	1/2-Year	Event				
			Peak									
	Peak	Volume (ac-	Discharge	Volume (ac-	Peak Discharge	Volume (ac-	Peak Discharge	Volume (ac-				
Hydrologic Element	Discharge (cfs)	ft)	(cfs)	ft)	(cfs)	ft)	(cfs)	ft)				
Ex-SB1	4067	1627	1820	728	1206	482	412	165				
Ex-J-SB1	4067	1627	1819	728	1206	483	412	165				
Ex-R1 (Arroyo del Valle)	4065	1629	1822	735	1206	483	412	165				
Ex-SB2	32	3	1821	739	1205	484	412	165				
Ex-J-SB2	4065	1631	12	1	0	0	0	0				
Ex-SB3	364	45	1819	728	1206	483	412	165				
Ex-J-SB3	4082	1677	1821	735	1205	483	412	165				
Ex-R2 (Arroyo del Valle)	4081	1677	1820	728	1206	482	412	165				
Ex-SB4	155	12	0	0	0	0	0	0				
Ex-Outlet	4081	1688	55	7	0	0	0	0				
Ex-SB5	157	10	45	3	18	1	0	0				
Ex-Pit1	157	10	12	1	0	0	0	0				

Proposed Conditions				
	1/100-Year Event			
	Peak	Volume		
Hydrologic Element	Discharge (cfs)	(ac-ft)		
Ex-J-SB1	4080	1632		
Ex-J-SB2	4080	1654		
Ex-J-SB3	4105	1743		
Ex-Outlet	4103	1755		
Ex-Pit1	172	1733		
Ex-R1 (Arroyo del Valle)	4077	1634		
Ex-R2 (Arroyo del Valle)	4102	1743		
Ex-SB1	4080	1632		
Ex-SB2	214	20		
Ex-SB3	409	51		
Ex-SB4	154	12		
Ex-SB5	172	12		
J-P1_Div-01	83	3		
J-P1_Div-02	321	11		
J-P1_Div-03	424	15		
J-P2_Ch-01	136	7		
J-P2_Ch-02	203	10		
J-P2_Ch-03	214	11		
J-P2_Div-01	48	3		
J-P2_Div-02	135	6		
J-SP4_DD1	13	1		
J-SP4_DD2	31	2		
J-SP4_DD3	61	4		
J-SP4_DD4	87	8		
J-SP4_DD5	122	13		
SB_P1-01	83	3		
SB_P1-02	246	8		
SB_P1-03	66	3		
SB_P1-04	40	2		
SB_P2-01	48	3		
SB_P2-02	95	3		
SB_P2-03	2	0		
SB_P2-04	6	0		
SB_P2-05	63	4		
SB_P2-06	21	1		
SB_SP4-01	39	5		
SB_SP4-02	31	2		
 SB_SP4-03	13	1		
SB_SP4-04	18	1		
SB SP4-05	35	4		



# **APPENDIX E.2**

Design of Hydraulic Stabilization for Meyer Draw and East Tributary Arroyo

### **BACKGROUND**

The Meyer Draw is the main branch of the Arroyo Del Valle and runs through the Site between several mine waste rock piles. These facilities are illustrated on the aerial image shown in Figure 1. This image was collected as part of a topographic survey of the site conducted by Cooper Aerial Surveys in 2011 and is used in this analysis to represent existing site conditions.

The site design proposes to excavate all piles located Southwest of the Meyer Draw arroyo and backfill the excavated mine material into the two pits (Pit 1 and Pit 2). The largest pile on Site (Pile 4) will be regraded to stable slopes and left in place between the Meyer Draw and the East Tributary branches of the arroyo. Since the arroyo runs directly adjacent to the pile, Stantec designed channel stabilization measures to prevent arroyo erosion from destabilizing portions of the regraded Pile 4.

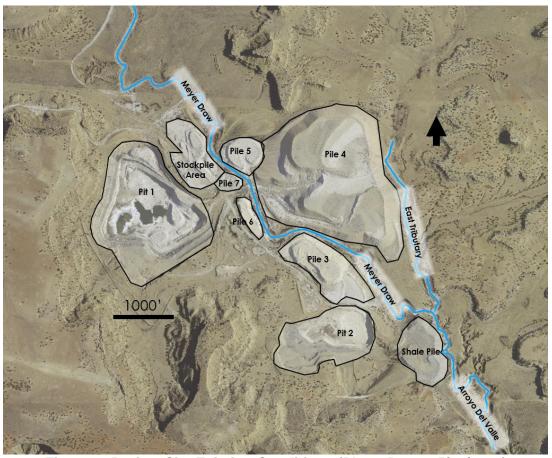


Figure 1: Project Site Existing Conditions (Photo Data: 05/31/2011)

### **Arroyo Geomorphic Assessment**

The arroyo through the Site has been heavily influenced by mining activity. Figure 2 shows an aerial image of the project site prior to mining activities (in the year 1935) with an overlay of the outline of current (as of the 2011 site survey) major mine facilities.

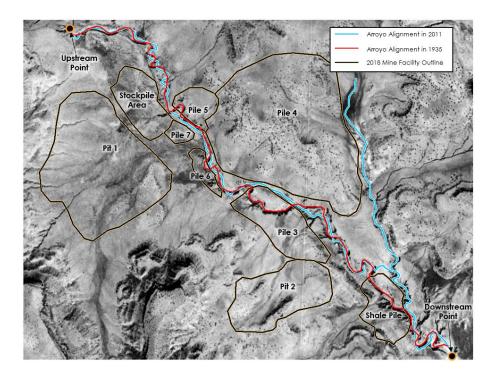


Figure 2: Project Site Prior to Mining Activities

Figure 2 shows that the piles adjacent to the arroyo have altered the pre-mine arroyo alignment between the upstream and downstream extents of the project reach. The pre-mine alignment passes through the current location of Pile 3 and the Shale Pile, and other alignment shifts were made, apparently to accommodate Pile 4, Pile 5, Pile 6, Pile 7 and the Stockpile Area.

Another aerial photograph was taken in 1977, during mining operations (see Figure 3).



Figure 3: Project Site During Mine Operation

Figure 3 shows that during mine operations Pile 3, the Shale Pile, and a mine road located just east of the Stockpile dammed the arroyo and caused flows to pond behind the facilities. Later, arroyo flow eroded new reaches of channel around (Pile 3 and the Shale Pile) or through (road crossing East of the Stockpile Area) the impeding facilities.

From the 2011 survey, the gradients along the arroyo profile appear to be in a state of non-equilibrium as they continue to adjust to impacts of these mining activities, particularly at the narrow "pinch point" between Pile 3 and Pile 4 (profile station 67+00 in Figure 4). The profile shows two sections with abnormally steep slopes (nearly 3 percent) in the reach directly below the pinch point.



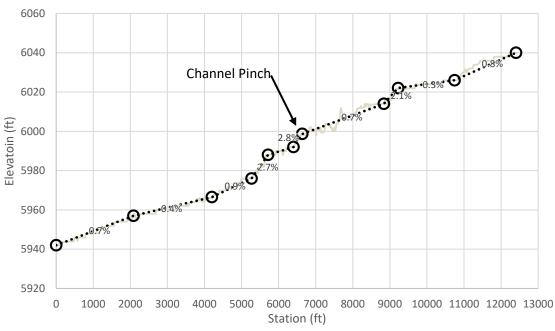


Figure 4: Plan and Profile of the Existing (2011) Arroyo

While visiting the Site, Stantec observed that these steep sloped sections correspond to locations where large slope failures on Pile 3 and Pile 4 at approximate stations 65+00 and 58+00 caused quantities of material from the piles to fall into the channel, depositing large cobbles and boulders (see Figures 5 through 7).

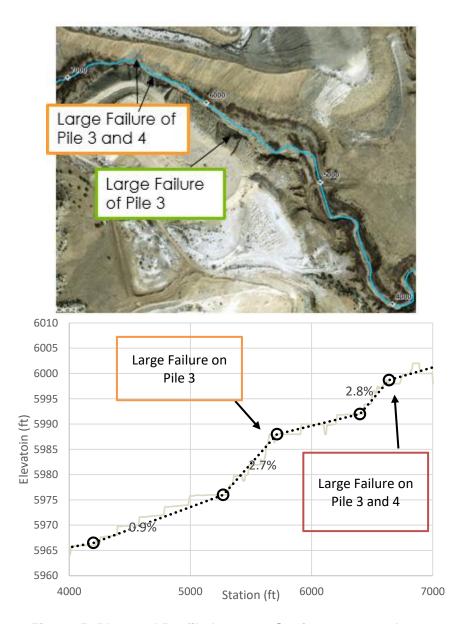


Figure 5: Plan and Profile between Stations 4000 and 7000



Figure 6: Large Failures of Pile 3 (Near Left) and Pile 4 (Far Center) at Approximate Station 65+00



Figure 7: Large Failure Pile 3 at Approximate Station 68+00

Stantec believes the channel through this reach is vertically unstable as the channel is trying to down cut to the gradients present prior to mining actives. This vertical down cutting is slowed when bank failures cause quantities of large boulder and cobble materials stored in Stockpiles 3 and 4 to fall into the channel. It is Stantec's opinion that if the channel were left in its current condition after removal of Stockpile 3 and stabilization of Stockpile 4, the arroyo down cutting would accelerate. Overtime, arroyo down cutting would lead to slope failures along the regraded toe of Stockpile 4 located immediately adjacent to the arroyo.

Stantec proposes installing grade control structures along the Meyer Draw channel to prevent vertical down cutting. The proposed structures will be constructed using roller compacted concrete. Design of the grade control structures is shown on Sheet 18 of the St. Anthony Mine Closeout Plan Design Drawings (design drawings). The structures will lower the channel invert a nominal height. Between structures, the channel will slope at 0.75 percent. Justification for slope is provided below.

To protect against horizonal channel movement a layer of riprap with median stone diameters of 12 inches and 9 inches is proposed along the base of stockpile 4 for both the Meyer Draw and East Tributary

branches of the arroyo, respectively (see details 3 and 4 on Sheet 16 of the design drawings). Methods used to evaluate the suitability of this riprap lining is presented below.

### **Methods**

### **Vertical Grade Control Design Methods**

Improvements for vertical grade stability along the Meyer Draw requires establishment of a stable channel cross section and equilibrium slope. Stantec conducted evaluation of the stable channel cross section and equilibrium slope following guidance provided by the Sediment and Erosion Design Guide published by the Southern Sandoval County Arroyo Flood Control Authority (SSCAFCA, 2008). This manual was used due to its completeness in addressing regional arroyo hydraulics and the proximity of its originating county (Sandoval County) to the project site.

Stantec determined the equilibrium slope by evaluating sediment continuity through the engineered project reach with the relatively undisturbed channel reach located immediately upstream during the dominant discharge flow event.

Observations and measurements used to evaluate the upstream reach were taken from the 2011 site survey (Cooper Aerial, 2011) as well as a site visit by Stantec personnel in spring 2018. The cross section selected to represent the upstream reach is illustrated at the end of this report in Attachment A. This section was selected because it is upstream of the obviously mine impacted region of the Site but is still inside the available site survey extents. The cross section selected to represent this reach is located where the cross-sectional dimensions are not overly widened by bend scour.

The dominant discharge flow is the flowrate primarily responsible for creating the form of the existing arroyo dimensions. For this evaluation, Stantec assumed the dominant discharge to be equal to 820 cubic feet per second (cfs). This value was assumed because, when applied to the computational methods below, it produced an equilibrium slope that mirrored the observed average slope estimates made of undisturbed arroyo alignment (measured from the 1935 aerial photograph – Figure 2).

The assumed dominant discharge corresponds to a discharge between the 2-year (412 cfs) and 5-year (1205 cfs) flow events according to Stantec's hydrologic investigation. It also equals 20 percent of the 100-year discharge (4100 cfs).

### **Evaluation of Channel Hydraulics**

To facilitate the evaluation of sediment continuity, the channel hydraulics during the dominant discharge event were determined for the upstream and design channel reaches assuming normal depth flow conditions using the Manning's equation (Equation 2).

$$Q_d = \frac{1.49}{n} * A * \left(\frac{A}{p}\right)^{\frac{2}{3}} * S^{\frac{1}{2}}$$
 Equation 2

Where:

n = channel roughness, 0.03

A = channel flow area, feet squared

P = channel wetted perimeter, feet

S = channel slope, feet per feet

Stantec determined the channel roughness (n) in this evaluation based on guidance provided by the U.S. Geological Survey for coarse sand bedded channels (USGS, 1989).

The channel flow area (A) and wetted perimeter (P) were determined as a function of the channel cross sectional geometry and the flow depth (Y).

The channel velocity (V<sub>d</sub>) at dominant discharge was determined by fluid continuity (Equation 3).

$$V_d = \frac{Q_d}{A}$$
 Equation 3

Channel geometry measurements of the upstream reach were taken from the Cooper Aerial (2011) survey. An illustration showing the location and topography of the upstream reach sampling location is provided in Attachment A. Stantec estimated channel sediment particle sizes based on a channel bed sample collected by Stantec at the location indicated in Attachment A. Daniel B. Stephens and Associates (2018) analyzed the sample.

The design reach cross sectional geometry was determined considering guidance provided by the SSCAFCA as well as limitations for practical construction. The SSCAFCA (2008) provides Equation 4 as a reasonable estimate of observed stable arroyo bottom widths in the region. Stantec used this relationship to compute the designed reach bottom width (B).

$$B = 0.5 * F_d^{0.6} * F_r^{-0.4} * Q_d^{0.4}$$
 Equation 4

Where:

B = design arroyo bottom width, feet

 $F_d$  = width-depth ratio of flowing water at dominant discharge, (40)

 $F_r$  = channel flow Froude number at dominant discharge, (0.7)

Q<sub>d</sub> = arroyo dominant discharge (820 cubic feet per second – see Equation 1)

The SSCAFCA (2008) suggests the following for the values assumed in Equation 4:

- Width-depth ratios (F<sub>d</sub>) equal to 40 is typically observed in regional arroyos
- Average Froude Number (F<sub>r</sub>) in stable sand-bed streams rarely exceed 0.7 to 1.0

For constructability, Stantec assumed a design reach, cross section side slope angles of 3 feet horizontal for every 1 foot vertical.

### **Equilibrium Slope**

To evaluate sediment continuity, the unit sediment load computed during the design discharge flow event was calculated for the upstream and the downstream reaches. The Zeller-Fullerton Relationship with Colby Correction Factor applied to account for the likely presence of high concentrations of fine suspended sediment as described in SSCAFCA (2008) (Equation 5).

$$q_s = 0.0064 * \frac{n^{1.77} * V^{4.32} * G^{0.45}}{Y^{0.3} * D_{50}^{0.61}} * C$$
 Equation 5

Where:

qs= unit sediment load, cubic feet per second per foot

V = velocity in the channel, feet per second

G = bed sediment gradation coefficient; given as  $G = \frac{1}{2} \left( \frac{D_{85}}{D_{50}} + \frac{D_{50}}{D_{15}} \right)$ 

Y = channel flow depth, feet

D<sub>50</sub> = median arroyo bed particle size, millimeters

C = Colby Correction Factor, given as  $C = 1 + (K_1 * K_2 - 1)$ 

 $K_1 = 0.9$  from SSCAFCA, 2008 Figure C.1 = f (Y, 60 degrees temperature assumed)

K<sub>2</sub> = 2 from SSCAFCA, 2008 Figure C.1 = f (Y, 45000 ppm fine sediment concentration assumed)

The design reach channel slope (S) was evaluated iteratively by Equation 5 to establish a design reach flow depth  $(Y_d)$  and velocity  $(V_d)$  that produced a unit sediment load for the design reach  $(qs_d)$  equal to the unit sediment load in the upstream reach  $(qs_u)$ .

### Pile 4 Side Slope Riprap

As stated above, for lateral stability of the arroyo channel, riprap will be installed on the toe of Pile 4 that intersects the bank of the Meyer Draw and East Tributary channels. The design flow event considered to size arroyo channel riprap and to determine arroyo scour potential is the 100-year discharge taken from Appendix E.1 (4100 cfs and 409 cfs for the Meyer Draw and East Tributary channels, respectively). The design median stone diameter for the riprap gradation was determined by Maynord's equation as described in NEH-TS14c (2007) (Equation 6).

$$D_{50r} = C_s * C_v * C_t * Y * \left[ \left( \frac{\gamma_w}{SG_{rr}*\gamma_w - \gamma_w} \right)^{0.5} * \frac{V}{\sqrt{K_1 * g * Y}} \right]^{2.5} * K_a * K_b$$
 Equation 6

Where:

D<sub>50r</sub> = minimum stable median stone diameter, inches

C<sub>s</sub> = side slope stability coefficient, 0.3 for angular rock on 3:1 side slope

C<sub>v</sub>= velocity distribution coefficient, 1.0 for straight channel

C<sub>t</sub>= riprap thickness coefficient, 1.0 for 2\*D<sub>50</sub> thickness

Y = channel flow depth, feet (100-year event)

 $y_w$  = specific weight of water, 62.4 pounds per foot cubed

SG<sub>rr</sub>= riprap specific gravity, 2.65 assumed

V = channel velocity, feet per second (100-year event)

 $K_1$  = side slope correction factor, given as  $K_1 = \sqrt{1 - \frac{\sin^2 \theta}{\sin^2 \varphi}}$ 

 $\theta$  = bank side slope angle with horizontal, 3H:1Z = 18.4 (deg)

 $\varphi$  = riprap angle of repose, 40 degrees assumed

g = gravitational acceleration constant, 32.2 feet per second squared

K<sub>a</sub>= unit conversion constant, feet to inches (12)

K<sub>b</sub> = gradation conversion constant, 1.15

Channel hydraulic parameters (Y and V) were determined by the Manning's equation (Equation 2).

The channel roughness (n) used for hydraulic evaluation of the Meyer Draw and East Tributary arroyos considered that only one bank of the arroyo would be lined with riprap. The other bank and channel bottom will remain unlined and the channel roughness was computed by Equation 7.

$$n = \frac{P_u n_u + P_l n_l}{P_t}$$
 Equation 7

Where:

Pu = wetted perimeter of the unlined portion of the channel cross section, feet

n<sub>u</sub> = unlined channel roughness, 0.03 (USGS, 1989)

P<sub>I</sub> = wetted perimeter of the lined portion of the channel cross section, feet

n<sub>l</sub> = lined channel roughness, as computed by Strickler's Equation from USACE (1994)

$$n_l = 0.036 * D_{90} *^{\frac{1}{6}}$$

D<sub>90</sub> = diameter which is larger than 90 percent of stones in riprap gradation, 16 inches assumed

Pt = total channel wetted perimeter, feet

A riprap stability factor (SF) that compares the design median riprap size ( $D_{50rr}$  = 12 and 9 inches) against the minimum stable median riprap size ( $D_{50r}$ ) for the Meyer Draw and East Tributary branches of the arroyo was determined by Equation 8. The National Resources Conservation Services National Engineering Handbook – Technical Supplement 14B (NRCS, 2007) states, SF values should usually range between 1.1 and 1.5. For this evaluation a minimum SF value of 1.4 was assumed.

$$SF = \frac{D50_{TT}}{D50_{TT}}$$
 Equation 8

General scour was considered to aid in design of riprap toe protection. The Lacey regime method (Lacey, 1931) as presented in Pemberton and Lara (1984) (Equation 9) as well as the relationship developed by Zeller (1981) (Equation 10) we each considered to evaluate the potential depth of scour that could occur during the design (100-year) discharge event (Q = 4100 cfs). These equations were selected for their specific relevance to silt/sand bottomed channels like the Arroyo del Valle through the Site. For design purposes, the larger predicted scour between the two methods is assumed.

$$Y_s = Z_l * 0.47 * \left(\frac{\varrho}{f}\right)^{\frac{1}{3}}$$
 Equation 9

Where:

Y<sub>s</sub> = predicted scour depth, feet

Z<sub>I</sub> = Lacey's multiplying factor

f = Lacey's silt factor computed as  $f = 1.76 * D_{50n}^{\frac{1}{2}}$ 

D<sub>50n</sub>= native sediment median particle diameter, millimeters

Pemberton and Lara (1984) recommends a multiplying factor (Z) equal to 0.25. The native sediment median particle diameter ( $D_{50n}$ ) was assumed to be equal to 0.045 mm. This value equals the median particle diameter measured at upper end of the Meyer Draw (see Attached Figure 1).

$$Y_s = Y * \left( \frac{0.0685 * V^{0.8}}{Y_h^{0.4} * S^{0.3}} - 1 \right)$$
 Equation 10

Where:

Y = flow depth, feet

V = flow velocity, feet per second

 $Y_h$  = hydraulic depth of flow where  $Y_h = \frac{A}{B+Y*Z}$ 

A = flow area, feet squared

B = channel bottom width, feet

Z = bank angle, horizontal to vertical

### **Arroyo Design Evaluation Results**

### **Arroyo Equilibrium Slope Results**

Table 1 shows the results of evaluations used to determine the arroyo equilibrium slope.

**Table 1: Equilibrium Slope Results** 

Design Parameter	Units	Upstream Reach	Design Reach
Design Discharge, Qd	Cubic Feet per Second	820	820
Median Bed Particle Diameter, D <sub>50</sub>	millimeters	0.045	0.045
Channel Roughness, n	-	0.031	0.031
Flow Area, A	Square Feet	143	144
Wetted Perimeter, P	Feet	99	91
Flow Depth, Y	Feet	1.5	1.7
Flow Velocity, V	Feet per Second	5.7	5.7
Design Arroyo Bottom Width, B	Feet	•	80
Design Arroyo Slope, S	Feet per Feet	•	0.0075
Unit Sediment Load, qs	Cubic Feet per Second per Foot	0.45	0.49

From Table 1, the design channel bottom width computed using the suggested rule of thumb method presented in Equation 4 yields a design channel bottom width of 80 feet. This design arroyo bottom width is approximately equal to the bottom width of the upstream arroyo cross section (see Attachment A). Continuity of the channel cross section between the upstream and design reach is desirable to create a hydraulically smooth transition. The computed unit sediment load for the upstream reach is 0.45 cfs per foot of channel width. The design channel slope computed to mirror this unit sediment load is 0.0075 feet

per feet (0.75 percent). This compares well to slope estimates made by observation of the undisturbed arroyo alignment (measured from the 1935 aerial photograph – see Figure 2). From the 1935 aerial photograph, Stantec estimates the undisturbed channel length through the reach was 12,850 feet. Assuming the bed elevations at the upstream point (6040 feet) and downstream point (5943 feet) indicated in Figure 2 were the same in 1935 as when the site was surveyed in 2011, the average channel slope through the reach would also be 0.75 percent.

It should be noted that the predicted equilibrium slope is fairly sensitive to the arroyo dominant discharge value assumed which is based on observation and rule of thumb metrics and is not known with much certainty. It will be necessary to design robust grade control structures that are capable of remaining stable under a range of slopes between structures.

### Pile 4 Slide Slope Riprap Results

Table 2 lists the channel roughness computed by Equation 7 and the channel hydraulic parameters computed for the design (100-year) discharge by Equation 2. Table 2 also shows the minimum stable median stone diameters computed by Equation 6 and the stability factor for the design riprap with a median stone diameter of 12 inches on the Meyer Draw branch and 9 inches on the East Tributary branch.

East Tributary Channel Meyer Draw Channel Composite Channel Roughness, n 0.031 0.033 Channel Flow Depth, Y 4.4 feet 2.6 feet Channel Flow Velocity, V 10.0 feet per second 8.2 feet per second Minimum Stable Median Stone Diameter, D50<sub>f</sub> 7.5 inches 5.2 inches Stability Factor, SF 1.6 1.7

**Table 2: Riprap Sizing Results** 

From Table 2, Stantec predicts the design riprap will protect the channel during the 100-year flood event with minimum predicted stability factors equal to 1.6. Table 3 shows the design scour depths evaluated by Equation 8 and 9.

	Meyer Draw Channel	East Tributary Channel
Scour Depth – Lacey	2.6 feet	1.2 feet
Scour Depth - Zeller	0.4 feet	0.0 feet
Design Scour Depth	2.6 feet	1.2 feet

**Table 3: Channel Scour Results** 

The scour depths predicted during the 100-year event by the Lacey and Zeller methods range between 2.6 feet and 0.4 feet in the Meyer Draw channel. The scours depths in the East Tributary channel range between 1.2 feet and 0.0 feet. Pile 4 riprap revetments shall be installed to minimum depth of 2.6 feet and 1.2 feet below the invert of the Meyer Draw and East Tributary branches.

### **Future Evaluations**

The roller compacted concrete grade control structure design presented on Sheet 18 of the design drawings represents a conceptual level design only. Future design iterations will take the stable channel slope and cross-sectional geometry presented here and optimize structure drop height to minimize the excavation and material volumes necessary to provide adequate protection along the Meyer Draw Arroyo.

Future design iterations will also address the soil filter systems beneath the riprap revetments. Properly designed soil filters will particularly important at this Site due to the highly erosive soils present. The channel filter system may utilize granular filters (as depicted in the design drawings) or manufactured geotextiles specifically designed for surface water drainage applications.

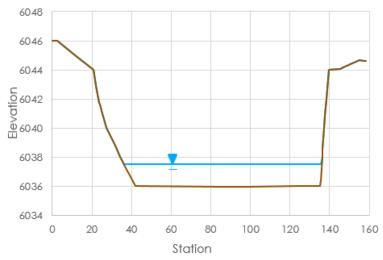
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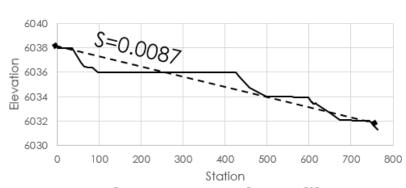
### **ATTACHMENT A**

**Upstream Cross Section Figure** 

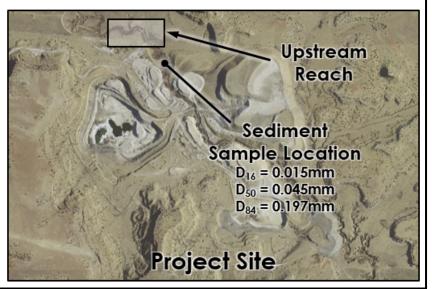




**Upstream Cross Section** 



**Upstream Reach Profile** 



### **ATTACHMENT B**

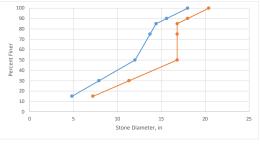
**Calculation Worksheets** 

### Arroyo Riprap Armoing along Pit 4 Calculations

Input Variables	Main		Trib		Notes
Hydrologic Element :	Ex-Outlet		EX-SB3		
Discharge, Q (cfs):	4102		409		Appendix E.1
Slope, S (ft/ft):	0.0075		0.014		Design Drawings
Bottom Width, B (ft):	80		15		Design Drawings
Side Slope, Z1:1:	3		3		Design Drawings
Side Slope, Z2:1:	3		0.5		
RR Specific Gravity, SGs:	2.65		2.65		Assumed Riprap Parameter
RR Anlge of Repose, (deg):	40.00		40.00		Assumed Riprap Parameter
Median Riprap, D50 (in):	12		9		Design Median Riprap Diameter
Natural bed Roughness, nb:	0.030		0.03		Table 1 (USGS, 1989), Assumed Coarse Sand Bed
RR Roughness, nr:	0.041		0.041		Eq. 3.2 (USACE, 1994) Strickler's Equation for RR Line Bank
Composite Roughness, n:	0.031		0.033		
Flow Depth, Y (ft):	4.393	4.39425	2.56	2.56336	Manning's Equation
Iterate to Zero>	2.918		0.020		
Flow Area, A (ft2):	409.34		49.94		A = (B+Z*Y)*Y
Wetted Per., P (ft):	107.8		26.0		P = B+2*Y*(Z^2+1)^0.5
Channel Top Width, TW (ft):	106.4		24.0		T = B+2*Y*Z
Channel Velocity, V (fps):	10.02		8.19		V = Q/A
Unit Discharge, q (cfs/ft):	44.03		20.99		q = V*Y
Channel Shear, T (lbs/ft2):	1.8		1.7		T = 62.4*(A/P)*S

RR Gradation Criteria					
Percent Finer	Min	Max			
100	D50 x 1.5	D50 x 1.7			
85	D50 x 1.2	D50 x 1.4			
50	D50 x 1.0	D50 x 1.4			
15	DE0 :: 0.4	DE0 ** 0.6			

Design RR Gradation				
Percent Finer	Min (in)	Max (in)		
100	18	20.4		
90	15.6	18.0		
85	14.4	16.8		
75	13.7	16.8		
50	12	16.8		
30	7.9	11.3		
15	4.8	7.2		



Method Base	Method	RR at Failure	Stability Factor	RR at Failure	Stability Factor
Velocity*	Maynord Equation	7.54	1.6	5.21	1.7
Shear	HEC-15 Critical Shear	3.58	3.35	4.39	2.05
Shear	NCH Research Program Report 108	5.33	2.25	5.04	1.79
Shear*	Far West States (FWS)	7.00	1.71	7.63	1.18
Velocity	FHWA - HEC-11	5.77	2.08	4.28	2.10
Velocity	Isbash Method	7.88	1.52	5.26	1.71
Velocity	Cal-Trans RSP	6.85	1.75	4.58	1.97

References

USGS, 1989. Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains. United States Geological Survey Water-Supply Paper 2339

HEC-11, 1989. Design of Riprap Revetment. Federal Highway Administration - Hydraulic Engineering Circular No. 11

USACE, 1994. Hydraulic Design of Flood Control Channels. U.S. Army Corps of Engineers. Engineering Manual 11:0-2-1601.

NEH-TS14c, 2007. Stone Sizing Criteria. U.S. Bureau of Reclamation. National Engineering Handbook Part 654. Technical Supplement 14C.

Maynord Equation	Main	Trib	Notes
Stability Coeff, Cs:	0.30	0.30	0.3 for "Angular Rock" and 0.375 for "Rounded Stone"
Vert Vel Coeff, Cv :	1.00	1.00	Use 1.0 for "Straight Channel"
Thickness Coeff, Ct :	1.00	1.00	Use 1.0 if RR thickness is greater then 1.5D50
Side Slope Correction, K1:	0.87	0.87	Eq. 3-4 (USACE, 1994)
Min Stable RR, D30 (in):	6.55	4.53	Eq. TS14c-5 (NEH-TS14c, 2007)
Min Stable RR, D50 (in):	7.54	5.21	D50 = 1.15*D30 Per NEH-TS14C, 2007
RR Stability Factor :	1.59	1.73	
HEC-15 Critical Shear	Main	<u>Trib</u>	Notes
Shear Velocity, u* (fps) :	1.030	1.075	Eq. 6.10 (HEC-15, 2005)
Kinematic Viscosity, v (ft2/s):			Fluid Property of Water (assumed)
Particle Reynolds Number, Re :			
Computed F*:		0.0641	
SF:	1.14	1.08	See Table 6.1 (HEC-15, 2005)
Channel Bottom - D50 (in) :	3.60	4.41	Eq. 6-8 (HEC-15, 2005)
Side Slope Correction for RR, K1 :	0.868	0.868	Eq. 6-16 (HEC-15, 2005)
Side Slope Correction for Shear, K2:	0.871	0.871	Eq. 3.4 (HEC-15, 2005)
SS - Minimum Stable D50 (in) :	3.58	4.39	Eq. 6-15 (HEC-15, 2005)
RR Stability Factor :	3.35	2.05	
NCU Passauch Passauch Passaut 100	Main	Talle	Notes
NCH Research Program Report 108	<u>Main</u> 1.8	<u>Trib</u> 1.7	Notes
Channel Shear, T (lbs/ft2):	4.0	3.0	Eq. TS14C-2 (NEH-TS14c, 2007)
Critical Shera, Tc (lbs/ft2):	5.33	5.04	Eq. TS14C-3 (NEH-TS14c, 2007)
Minimum Stable D50, (in) :		1.79	Eq. TS14C-4 (NEH-TS14c, 2007)
RR Stability Factor :	2.25	1.79	
Far West States (FWS)	Main	Trib	Notes
Channel Curve Correction, C :	1.0	1.0	"Straight Channel" See Figure TS14C-8 (NEH-TS14c, 2007)
Side Slope Correction, K :	0.87	0.87	Eq. 3-4 (USACE, 1994)
Minimum Stable D75, (in) :	8.27	9.00	Eq. TS14C-19 (NEH-TS14c, 2007)
Minimum Stable D50, (in):	7.00	7.63	Assumed D75 = 1.18*D50 (See Manual Example Problems)
Minimum Stable D50, (in) : RR Stability Factor :	7.00 1.71	7.63 1.18	Assumed D75 = 1.18*D50 (See Manual Example Problems)
Minimum Stable D50, (in) : RR Stability Factor : FHWA - HEC-11	7.00 1.71 <u>Main</u>	7.63 1.18 <u>Trib</u>	Assumed D75 = $1.18*D50$ (See Manual Example Problems)  Notes
Minimum Stable D50, (in): RR Stability Factor:  FHWA - HEC-11 Side Slope Correction, K1:	7.00 1.71	7.63 1.18	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989)
Minimum Stable D50, (in):  RR Stability Factor:  FHWA - HEC-11  Side Slope Correction, K1:  RR SG Factor Correction, Csg:	7.00 1.71 <u>Main</u> 0.87	7.63 1.18 <u>Trib</u> 0.87	Assumed D75 = $1.18*D50$ (See Manual Example Problems)  Notes
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, X1: RR SG Factor Correction, Csg: Stability Factor SF:	7.00 1.71 Main 0.87 1.00	7.63 1.18 <u>Trib</u> 0.87 1.00	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, K1: RR SG Factor Correction, C5g: Stability Factor SF: Stablity Factor Correction, C5f:	7.00 1.71 <u>Main</u> 0.87 1.00 1.00	7.63 1.18 <u>Trib</u> 0.87 1.00 1.00	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989)
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, X1: RR SG Factor Correction, Csg: Stability Factor SF:	7.00 1.71 Main 0.87 1.00 1.00 0.76	7.63 1.18 Trib 0.87 1.00 1.00 0.76	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, K1: RR SG Factor Correction, Csg: Stability Factor SF: Stablity Factor Correction, Csf: Minimum Stable D50, (in):	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77	7.63 1.18 Trib 0.87 1.00 1.00 0.76 4.28	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989)
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, K1: RR SG Factor Correction, Csg: Stability Factor SF: Stablity Factor Correction, Csf: Minimum Stable D50, (in):	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77	7.63 1.18 Trib 0.87 1.00 1.00 0.76 4.28	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989)
Minimum Stable D50, (in): RR Stability Factor:  FHWA - HEC-11 Side Slope Correction, K1: RR SG Factor Correction, Csg: Stability Factor SF: Stability Factor Correction, Csf: Minimum Stable D50, (in): RR Stability Factor:	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77 2.08	7.63 1.18 Trib 0.87 1.00 1.00 0.76 4.28 2.10	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989) Eq. 6 (HEC-11, 1989)
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, Csg: Stability Factor SF: Stability Factor Correction, Csf: Minimum Stable D50, (in): RR Stability Factor : Isbash Method	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77 2.08	7.63 1.18  Trib 0.87 1.00 1.00 0.76 4.28 2.10  Trib	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989) Eq. 6 (HEC-11, 1989)
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, C4: RR SG Factor Correction, C5: Stabilty Factor SF: Stabilty Factor Correction, C5: Minimum Stable D50, (in): RR Stability Factor:  Isbash Method Turbulence Coeff. C:	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77 2.08 Main 1.20	7.63 1.18  Trib 0.87 1.00 1.00 0.76 4.28 2.10  Trib 1.20	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989) Eq. 6 (HEC-11, 1989)  Notes For "Low Turbidity" C = 1.2. For "High Turbidity" C = 0.86
Minimum Stable D50, (in): RR Stability Factor:  FHWA - HEC-11 Side Slope Correction, Cs; Stability Factor Correction, Cs; Stability Factor Correction, Cs; Minimum Stable D50, (in): RR Stability Factor:  Isbash Method Turbulence Coeff. C: Min Stable D50: RR Stability Factor:	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77 2.08 Main 1.20 7.88 1.52	7.63 1.18  Trib 0.87 1.00 1.00 0.76 4.28 2.10  Trib 1.20 5.26 1.71	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989) Eq. 6 (HEC-11, 1989)  Notes For "Low Turbidity" C = 1.2. For "High Turbidity" C = 0.86 Eq. TS14C-1 (NEH-TS14c, 2007)
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, K1: RR SG Factor Correction, Csg: Stability Factor SF: Stability Factor Store Stability Factor Fore Minimum Stable D50, (in): RR Stability Factor: Isbash Method Turbulence Coeff. C: Min Stable D50 RR Stability Factor: Cal-Trans RSP	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77 2.08 Main 1.20 7.88 1.52	7.63 1.18  Trib 0.87 1.00 1.00 0.76 4.28 2.10  Trib 1.20 5.26 1.71	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989) Eq. 6 (HEC-11, 1989)  Notes For "Low Turbidity" C = 1.2. For "High Turbidity" C = 0.86 Eq. TS14C-1 (NEH-TS14c, 2007)
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, K1: RR SG Factor Correction, Csg: Stability Factor SF: Stability Factor Correction, Csf: Minimum Stable D50, (in): RR Stability Factor:  Isbash Method Turbulence Coeff. C: Min Stable D50: RR Stability Factor: Cal-Trans RSP Flow Type Coeff, :	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77 2.08 Main 1.20 7.88 1.52 Main 0.67	7.63 1.18  Trib 0.87 1.00 1.00 0.76 4.28 2.10  Trib 1.20 5.26 1.71  Trib 0.67	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989) Eq. 6 (HEC-11, 1989) Notes For "Low Turbidity" C = 1.2. For "High Turbidity" C = 0.86 Eq. T514C-1 (NEH-T514c, 2007)  Notes For "Parallel flow" VM = 0.67, "impinging flow" VM = 1.33
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, K1: RR SG Factor Correction, Csg: Stability Factor SF: Stability Factor Sor: Minimum Stable D50, (in): RR Stability Factor: Isbash Method Turbulence Coeff. C: Min Stable D50: RR Stability Factor: Cal-Trans RSP Flow Type Coeff,; Minimum Stone Weight, W (lbs):	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77 2.08 Main 1.20 7.88 1.52 Main 0.67 30.80	7.63 1.18  Trib 0.87 1.00 1.00 0.76 4.28 2.10  Trib 1.20 5.26 1.71  Trib 0.67 9.17	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989) Eq. 6 (HEC-11, 1989)  Notes For "Low Turbidity" C = 1.2. For "High Turbidity" C = 0.86 Eq. TS14C-1 (NEH-TS14c, 2007)  Notes For "Parallel flow" VM = 0.67, "impinging flow" VM = 1.33 Eq. TS14C-18 (NEH-TS14c, 2007)
Minimum Stable D50, (in): RR Stability Factor: FHWA - HEC-11 Side Slope Correction, K1: RR SG Factor Correction, Csg: Stability Factor SF: Stability Factor Correction, Csf: Minimum Stable D50, (in): RR Stability Factor:  Isbash Method Turbulence Coeff. C: Min Stable D50: RR Stability Factor: Cal-Trans RSP Flow Type Coeff, :	7.00 1.71 Main 0.87 1.00 1.00 0.76 5.77 2.08 Main 1.20 7.88 1.52 Main 0.67	7.63 1.18  Trib 0.87 1.00 1.00 0.76 4.28 2.10  Trib 1.20 5.26 1.71  Trib 0.67	Assumed D75 = 1.18*D50 (See Manual Example Problems)  Notes Eq. 7 (HEC-11, 1989) Eq. 8 (HEC-11, 1989) Assumed Eq. 9 (HEC-11, 1989) Eq. 6 (HEC-11, 1989) Notes For "Low Turbidity" C = 1.2. For "High Turbidity" C = 0.86 Eq. T514C-1 (NEH-T514c, 2007)  Notes For "Parallel flow" VM = 0.67, "impinging flow" VM = 1.33

### Arroyo Scour Depth Calculation

Design Riprap Diameter, D50d (in): 12 9

> Main **Trib** <u>Notes</u> **Design Parameters**

Hydrologic Element: Ex-Outlet EX-SB3

Design Discharge, Qd (cfs/ft): 4102.40 409.00 100-Year Discharge (REF: HYDROLOGY REPORT)

Flow Depth, Y (ft): 4.39 2.56 Flow Velocity, V (fps): 10.02 8.19

Flow Area, A (ft): 409.34 49.94 Unit Discharge, q (cfs/ft): 44.03 20.99

Channel Top Width, Wf (ft): 106.4 24.0 See Arroyo Riprap spreadsheet Cell C18 and E18

Hydrauilc Depth, Yh (ft): 3.8 2.1 Channel Slope, S: 0.0075 0.014

0.045 Median Bed Particle Size, D50b (mm): 0.045 Measured at SA GM 1T

**Predicted Scour Depth - Pemberton and Lara and Zeller** 

Blench Zero Bed Factor, fbo: 0.0271 0.0271 Pemberton and Lara, 1984 Blench Multiplying Factor, Z: 0.6 0.6 Pemberton and Lara, 1984 Blench Scour Depth, Zb (ft): 24.9 15.2 Pemberton and Lara, 1984

Lacey's Silt Factor, f: 0.37 0.37 Pemberton and Lara, 1984 Lacey Multiplying Factor, Z: 0.25 0.25 Pemberton and Lara, 1984 Lacey Scour Depth, ZI (ft): 2.6 1.2 Pemberton and Lara, 1984

Zeller Scour Depth, Zz (ft): 0.42 -0.03 Zeller, M.E. 1981.

Launching Riprap Toe

1.2 Design Scour Protection Depth, Dp (ft): Design Parameter 2.6

Stone Launch Angle, (Z:1): 2 (USACE, 1994) 2 Table 3-2 (USACE, 1994) Stone Volume Increase Factor (%): 25% 25%

Riprap Layer Thickness, Trr (ft): 2 1.5 Trr = 2\*D50

Design Parameter Riprap Buried Depth, Drr (ft): 3 3

Required RR Toe Volume, Vrr (ft3/ft): -2.2 -7.5

### Arroyo Equilibrium Slope Calculation

Design Criteria: Iterate the Design Channel Slope until the Corrected Unit Sediment Discharge in the Design Reach matches the Correctied Unit Sediment Discharge in the Upstream Reach

### **Upstream Cross Section**

Design Discharge, Qd (cfs) : Channel Roughness, n : 0.031 Bed Slope, S (ft/ft): 0.0087 Channel Invert Ele. (ft): 6035.9702

> Flow Depth, Y (ft): 15 Iterate - Try: 1.5002 Iterate to Zero : 0.1

Area, A (ft2): 143.30 Wetted Perimeter, P (ft) : 99.40 Average Channel Velocity, V (fps) : 5.7

Median Particle Diameter, D50 (mm): 0.045 Measured at GM 1T Bed Gradation, D84 (mm) : 0.197 Measured at GM 1T Bed Gradation, D16 (mm) : 0.015 Measured at GM 1T Bed Gradation Coeff. G: 3.69 Eq. 3.14 From SSCAFCA, 2008

Unit Sediment Discharge, qs (cfs/ft) Eq. C.1 From SSCAFCA, 2008 Colby's Correction Factor (K1) : 0.9 See Figure C.1 From SSCAFCA, 2008 Colby's Correction Factor (K2): 2 See Figure C.1 From SSCAFCA, 2008 Colby's Correction Factor (K3): See Figure C.1 From SSCAFCA, 2008 Colby Correction Factor : Eq. C.2 From SSCAFCA, 2008

0.49

91

#### **Design Cross Section**

Corrected Unit Sediment Discharge, qs (cfs/ft):

Design Discharge, Qd (cfs) : Channel Roughness, n : 0.031 Bed Slope, S (ft/ft) : Channel Bottom Width, B (ft) : 0.0075 Eq. 3.35 From SSCAFCA, 2008 80 Design Width Depth Ratio, Fd : 40 40 from SSCAFCA, 2008 Design Froude Number, Fr: 0.7 Between 0.7 to 1.0 from SSCAFCA, 2008 Channel Side Slope, (Z:1): 3 Flow Depth, Y (ft): Iterate - Try: 1.6978 Iterate to Zero : 0.1 Area, A (ft2): 144

See Figure C.1 From SSCAFCA, 2008

See Figure C.1 From SSCAFCA, 2008

See Figure C.1 From SSCAFCA, 2008 Eq. C.2 From SSCAFCA, 2008

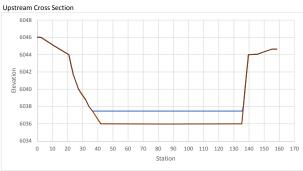
Median Particle Diameter, D50 (mm) : Bed Gradation, D84 (mm) : 0.045 Measured at GM 1T 0.197 Measured at GM 1T Bed Gradation, D16 (mm) : 0.015 Measured at GM 1T Bed Gradation Coeff. G: Eq. 3.14 From SSCAFCA, 2008 Eq. C.1 From SSCAFCA, 2008

Unit Sediment Discharge, gs (cfs/ft) 0.252 Colby's Correction Factor (K1): 0.9 Colby's Correction Factor (K2): 2 Colby's Correction Factor (K3): Colby Correction Factor: 1.8

Wetted Perimeter, P (ft):

Average Channel Velocity, V (fps) :

Corrected Unit Sediment Discharge, qs (cfs/ft):



Station	Elevation	WSE	Flow Depth	Flow Area	Wetted Perimeter
0	6046	6046.02	0.00	0.00	0.00
2	6046	6046.00	0.00	0.00	0.00
11	6045	6045.00	0.00	0.00	0.00
21	6044	6044.00	0.00	0.00	0.00
22	6043	6042.87	0.00	0.00	0.00
23	6042	6042.00	0.00	0.00	0.00
24	6042	6041.72	0.00	0.00	0.00
24	6042	6041.60	0.00	0.00	0.00
25	6041	6041.16	0.00	0.00	0.00
27	6040	6040.00	0.00	0.00	0.00
30	6039	6039.26	0.00	0.00	0.00
32	6039	6038.77	0.00	0.00	0.00
34	6038	6038.00	0.00	0.00	0.00
36	6037	6037.47	0.00	0.00	0.00
42	6036	6037.47	1.47	4.03	5.68
42	6036	6037.47	1.47	0.51	0.35
42	6036	6037.47	1.47	0.14	0.09
44	6036	6037.47	1.47	1.82	1.24
87	6036	6037.47	1.50	64.17	43.19
88	6036	6037.47	1.50	1.63	1.09
89	6036	6037.47	1.50	1.34	0.89
98	6036	6037.47	1.49	13.64	9.11
123	6036	6037.47	1.48	37.61	25.30
135	6036	6037.47	1.47	17.62	11.95
135	6036	6037.47	1.06	0.38	0.51
136	6038	6038.00	0.00	0.41	0.00
137	6039	6038.58	0.00	0.00	0.00
137	6040	6040.00	0.00	0.00	0.00
138	6041	6040.89	0.00	0.00	0.00
138	6042	6042.00	0.00	0.00	0.00
139	6043	6043.34	0.00	0.00	0.00
140	6044	6044.00	0.00	0.00	0.00
145	6044	6044.04	0.00	0.00	0.00
146	6044	6044.04	0.00	0.00	0.00
148	6044	6044.20	0.00	0.00	0.00
155	6045	6044.65	0.00	0.00	0.00
157	6045	6044.63	0.00	0.00	0.00
158	6045	6044.64	0.00	0.00	0.00



# **APPENDIX E.3**

**Design of Bench and Downdrain Channels for Pile 4** 

### BACKGROUND

The proposed closure plan for Pile 4 is to push the pile material to the borders of the Meyer Draw and East Tributary branches of the Arroyo del Valle that flanks the southwest and eastern pile edges. From the arroyo edges, the pile will be sloped at a design grade of 20 percent. The pile slopes will be broken by benches that capture and convey rainfall runoff from the Pile interbench slopes. The maximum length of the interbench slopes will be 400 feet (see Appendix G). Stormwater conveyance channels constructed on the stockpile benches will extend from the north face of the pile at an approximate 2 percent grade toward an armored downdrain channel at the southern end of the stockpile (see Figure 1, see also Sheet 9 of the St. Anthony Mine Closeout Plan design drawings). The bench channel cross sections will be triangular with riprap armoring near the channel invert and vegetation lining on the outer portions (see Detail 1 on Sheet 16 of the design drawings). The downdrain channel will convey flow at a slope which decreases from approximately 11 percent at the upstream portion to approximately 5 percent at the downstream portion. The downdrain channel will be riprap lined with a trapezoidal cross section (see Detail 2 on Sheet 16 of the design drawings). The downdrain will convey flow off the stockpile and will discharge near the confluence of the Arroyo de Valle's Meyer Draw and East Tributary branches. This document describes Stantec's evaluations of hydraulic conditions in the Stockpile 4 bench and downdrain channels during a runoff event with a 1 in 100-year probability of occurring.

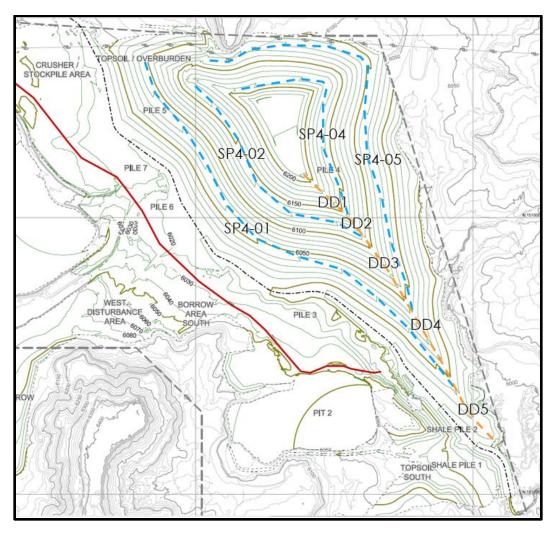


Figure 1: Plan View of the Proposed Stockpile 4

### **Design Data**

The bench channels and downdrain are designed to protect against hydraulic scour during the rainfall event with a 1 in 100-year probability of occurrence.

The design discharge values for the bench channels and downdrains were taken from the site hydrologic study (see Appendix E.1). Detail 1 on Sheet 16 of the design drawings shows channel geometric parameters for the bench channels. Detail 2 on Sheet 16 of the design drawings show downdrain geometric parameters. Tables 1 and 2 present these design values for the bench channels and downdrain, respectively.

**Table 1: Bench Channel Design Parameters** 

	Units	SP4-01	SP4-02	SP4-04	SP4-05
Design Discharge, Q	cfs	40	31	19	35
Channel Slope, S	ft/ft	0.02	0.02	0.02	0.02
Minimum Riprap Armoring Depth, d <sub>rr</sub>	ft	1.15	1.15	1.15	1.15
Bench Side Slope, Z <sub>1</sub> :1	-	20	20	20	20
Bench Side Riprap Armoring Width, W <sub>dd</sub>	ft	23	23	23	23
Hill Side Slope, Z <sub>2</sub> :1	-	5	5	5	5
Channel Depth, H <sub>b</sub>	-	2	2	2	2
cfs = cubic feet per second; ft/ft = feet per feet					

**Table 2: Downdrain Design Parameters** 

	Units	DD1	DD2	DD3	DD4	DD5
Design Discharge, Q	cfs	13	31	61	88	123
Channel Slope, S	ft/ft	0.11	0.10	0.08	0.05	0.05
Channel Side Slopes, Z:1	-	3	3	3	3	3
Channel Depth, H <sub>dd</sub> ft 2.5 2.5 2.5 2.5					2.5	
cfs = cubic feet per second; ft/ft = feet per feet; ft = feet						

### **Methods**

### **Bench Channel Design Methods**

The bench channels will be stabilized using riprap at the channel thalweg where the flow depth, and shear stress (see Equation 1), is highest. The bench cross slope is gradual (5 percent or 20 feet horizontal to 1 foot vertical). A significant bench width that will convey flow during the design storm event will flow shallow enough that vegetation lining alone will be sufficient for scour protection.

Bench channel riprap was evaluated using the methods described in the Federal Highway Administrations Design of Roadside Channels with Flexible Linings (FHA, 2005). Stantec evaluated the vegetative lining using Stability Design of Grass-Lined Open Channels (Temple et. al, 1987).

Table 2 provides parameters used to characterize the channel lining riprap and vegetation. Vegetative parameters used in this analysis were chosen to be consistent with those used for the Pile 4 vegetated cover analysis (see Appendix F).

**Table 3: Channel Lining Parameter Characterization** 

Parameter	Value	Units	Reference			
		Bench Chan	nel Riprap			
Median Diameter, D <sub>50</sub>	6	inches Design Parameter				
Specific Gravity, SG	2.6	•	Assumed			
Vegetation						
Soil Plasticity Index, PI	10	•	Approximated from cover borrow soil characterizations			
Soil Void Ratio, e	0.605	•	Approximated from cover borrow soil characterizations			
Soil Roughness, ns	0.0156	•	Table 3.3 (Temple et.al., 1987) – For cohesive soils			
Vegetation Stem Height, h	0.5	feet	Assumed			
Vegetation Stem Density, m	67	Stems per foot	Table 3.1 (Temple et.al., 1987) – Grass Mixture with			
vegetation Stem Density, III	07	Sterns per 100t	Poor Cover			
Vegetation Cover Factor, C <sub>f</sub>	0.38	_	Table 3.1 (Temple et.al., 1987) – Grass Mixture with			
vegetation cover Factor, Cr	0.36	-	Poor Cover			

### **Channel Hydraulics**

Stantec evaluated channel hydraulics assuming normal flow depth, using the Manning's equation (Equation 1).

$$Q = \frac{1.49}{n_c} * A * \left(\frac{A}{P}\right)^{\frac{2}{3}} * S^{\frac{1}{2}}$$
 Equation 1

Where:

n<sub>c</sub> = composite channel roughness (see Equation 3)

A = channel flow area, square feet

$$A = \frac{Y * (Z_1 * Y + Z_2 * Y)}{2}$$

P = channel wetted perimeter, feet

$$P = Y * (\sqrt{1 + Z_1} + \sqrt{1 + Z_2})$$

Y = channel flow depth, feet

Stantec developed a composite channel roughness  $(n_c)$  where the weighted average roughness for the riprap and vegetation lined portions of the channel were considered by Equation 2.

$$n_c = \frac{P_{rr} * n_{rr} + P_v * n_v}{P_t}$$
 Equation 2

Where:

n<sub>c</sub> = composite roughness

n<sub>rr</sub> = riprap lining roughness

n<sub>v</sub> = vegetation lining roughness

P<sub>rr</sub> = wetted perimeter of the riprap lining, feet

P<sub>v</sub> = wetted perimeter of the vegetation lining, feet

Pt = wetted perimeter of the channel

Stantec used the riprap lining roughness computation method recommended in HEC-15 (FHA, 2005)in this analysis (Equation 3).

$$n_{rr} = \frac{1.49*d\frac{1}{6}}{\sqrt{g}*f(Fr)*f(REG)*f(CG)}$$
 Equation 3
$$f(Fr) = \left(\frac{0.28*Fr}{b}\right)^{\log\left(\frac{0.755}{b}\right)}$$

$$f(REG) = 13.434*\left(\frac{T}{D_{50}}\right)^{0.492}*b^{1.025*\left(\frac{T}{D_{50}}\right)^{0.118}}$$

$$f(CG) = \left(\frac{T}{d_d}\right)^{-b}$$

Where:

da = average channel flow depth, feet

$$d_a = \frac{T}{A}$$

T = channel top width, feet

$$T = Y * (Z_1 + Z_2)$$

A = channel flow area, square feet

g = gravitational acceleration constant, 32.2 feet per second squared

Fr = channel Froude number

$$Fr = \frac{V}{\sqrt{g * \frac{A}{T}}}$$

b = parameter describing the effective roughness concentration

$$b = 1.14 * \left(\frac{d_{50}}{T}\right)^{0.453} * \left(\frac{d_a}{D_{50}}\right)^{0.814}$$

D<sub>50</sub> = median riprap particle diameter, feet

The vegetation lining roughness was evaluated by Equation 4 (Temple et.al., 1987).

$$n_v = e^{C_i * (0.0133*[\ln(q_v)]^2 - 0.0954*\ln(q_v) + 0.297) - 4.16}$$
 Equation 4

Where:

C<sub>i</sub> = vegetation retardance curve index value

$$C_i = 2.5 * \left(h * \sqrt{M}\right)^{\frac{1}{3}}$$

qv = maximum unit discharge over the vegetation, cubic feet per second per foot

$$q_v = Y_v * V$$

Y<sub>v</sub> = maximum flow depth over the vegetation lining, feet

$$Y_v = Y - d_{rr}$$

V = average channel flow velocity, feet per second

$$V = \frac{Q}{A}$$

### **Riprap Stability**

Stantec evaluated the bench channel stability using shear stress methods. The applied channel shear stress was calculated by Equation 5.

$$\tau = \gamma * Y * S$$
 Equation 5

Where:

τ = applied channel shear stress, pounds per foot squared

γ = unit weight of water, 62.4 pounds per foot cubed (assumed)

Y = channel flow depth, feet

S = channel slope, feet per feet

The maximum permissible shear stress for the riprap was evaluated by Equation 6 (FHA, 2005).

$$\tau_{p-rr} = \frac{F_* * \gamma_W * (SG-1) * D_{50}}{SF}$$
 Equation 6

Where:

T<sub>p-rr</sub> = maximum permissible shear stress on the riprap, pounds per foot squared

F∗ = Shield's parameter, dimensionless

 $y_w$  = unit weight of water, 62.4 pounds per foot cubed

SF = manual recommended safety factor, dimensionless

The values prescribed in the manual for the Shield's parameter (F·) and the safety factor (SF) are determined as a function of the particle Reynolds number (Re) (Equation 7). If Re is less than  $4x10^4$  then the manual recommends using an F· equal to 0.047 and SF equal to 1. If Re is greater than  $2x10^5$  the manual recommends using F· equal to 0.15 and SF equal to 1.5. If Re lands between  $4x10^4$  and  $2x10^5$  then a linear interpolation with Re is to be used.

$$Re = \frac{\sqrt{g*Y*S*D_{50}}}{v}$$
 Equation 7

Where:

v = kinematic viscosity of water, 1.21\*10<sup>-5</sup> square feet per second

### **Vegetation Stability**

The reference manual (Temple et.al., 1987) instructs that vegetation lining stability be evaluated with consideration for the capacity of the soil particles underlying the vegetation to resist washout and the capacity of the vegetation itself to resist washout during the design flow event.

Equation 8 computes the applied shear stress on the soil ( $\tau_s$ ) and is directly impacted by the vegetation covering as the full channel shear forces are resisted by the combined soil and vegetation system.

$$\tau_S = \gamma_W * Y_v * S * (1 - C_f) * (\frac{n_S}{n_v})^2$$
 Equation 8

The remainder of the total shear stress is applied to the vegetation. The applied vegetal stress  $(\tau_v)$  is computed by Equation 9.

$$\tau_v = \gamma_w * Y_v * S - \tau_s$$
 Equation 9

Stantec evaluated the maximum permissible effective shear stress on the underlying soil particles (Ta) using Equation 10. This equation is recommended in the manual (Temple et.al., 1987) for cohesive Unified Soil Classification System (USCS)[BK1] silty sand (SM) type soils with a plasticity index less than 20.

$$\tau_a = (1.07 * I^2 + 7.15 * I + 11.9) * 10^{-4} * C_e^2$$
 Equation 10

Where:

Ta = permissible effective shear stress on the soil, pounds per square foot

Ce = soil void ratio correction factor, unitless

$$C_e = 1.42 - 0.61 * e$$

Equation 11 computes the maximum permissible effective shear stress on the vegetation (Tva).

$$\tau_{va} = 0.75 * C_i$$
 Equation 11

Equation 12 computes a stability factor (SF) for the riprap and both the soil and vegetation lining .

$$SF = \frac{\tau_{p^*}}{\tau_{a^*}}$$
 Equation 12

Where:

SF = stability factor

 $\tau_{p^*}$  = maximum permissible stress

 $T_a$  = applied stress

### **Downdrain Design Methods**

Stantec evaluated the riprap armoring for stabilizing the downdrain channels using methods suggested by Robinson, et.al. (1998).

The downdrain was designed assuming riprap with a median stone diameter (D<sub>50</sub>) as outlined in Table 4.

**Table 4: Downdrain Design Median Stone Diameter** 

	DD1	DD2	DD3	DD4	DD5
Median Stone Diameter, D <sub>50</sub>	6"	9"	9"	9"	12"

### **Channel Hydraulics**

Similar to the bench channels, Stantec evaluated the downdrain hydraulics assuming normal depth using the Manning's equation (Equation 1). The downdrain channel roughness (n<sub>dd</sub>) was evaluated using Equation 13.

$$n_{dd} = 0.029 * (25.4 * D_{50} * S)^{0.147}$$
 Equation 13

### **Riprap Stability**

As recommended by Robinson et. al. (1998), If the downdrain slope (S) is less than 0.1 feet per feet then Stantec used Equation 14 to compute the downdrain riprap stability. If the downdrain slope (S) is greater than 0.1 feet per feet then Equation 15 is used.

$$D_{50f} = 1.413 * q^{0.529} * S^{0.794} * K$$
 Equation 14

$$D_{50f} = 0.46 * q^{0.529} * S^{0.307} * K$$
 Equation 15

Where:

D<sub>50f</sub> = median stone diameter at the brink of failure, inches

q = design unit discharge of flow, cubic feet per second per foot

K = conversion factor, feet to inches (12)

A stability factor for the downdrain riprap was determined by Equation 16.

$$SF = \frac{D_{50}}{D_{50f}}$$
 Equation 16

### Results

#### **Bench Channel Results**

Table 5 summarizes the results of bench channel hydraulic computations.

**Table 5: Bench Chanel Hydraulic Computation Results** 

	Units	SP4-01	SP4-02	SP4-04	SP4-05			
Flow Depth, Y	ft	1.41	1.29	1.10	1.36			
Flow Velocity, V	fps	1.61	1.49	1.25	1.52			
Riprap Roughness, nrr	-	0.110	0.114	0.126	0.113			
Vegetation Roughness, n <sub>v</sub> - 0.074 0.106 N/A¹ 0.086								
Composite Roughness, nc	-	0.103	0.114	0.126	0.109			
ft = feet; fps = feet per second								
<ol> <li>Flow is predicted to be contained entirely inside of the riprap lining</li> </ol>								

Table 6 provides the results of the bench channel riprap stability computations.

**Table 6: Bench Channel Riprap Stability Results** 

	Units	SP4-01	SP4-02	SP4-04	SP4-05
Applied Shear, т	lbs/ft <sup>2</sup>	1.76	1.61	1.37	1.69
Maximum Permissible Shear, τ <sub>p-rr</sub>	lbs/ft <sup>2</sup>	2.42	2.42	2.42	2.42
Riprap Stability Factor, SF	-	1.4	1.5	1.8	1.4
lbs/ft <sup>2</sup> = pounds per square foot					

The maximum permissible shear stream for the 6-inch bench channel riprap computed by Equation 5 is 2.42 pounds per square foot. This permissible shear stress is at least 1.4 times greater than maximum applied shear stress predicted by Equation 1. Therefore, all bench channel riprap is predicted to be protective during the 100-year flow event.

Table 7 provides the results of the bench channel vegetation lining stability computations.

Table 7: Bench Channel Vegetation and Soil Stability Results

	Units	SP4-01	SP4-02	SP4-04	SP4-05	
Soil Applied Shear, τ <sub>s</sub>	lbs/ft <sup>2</sup>	0.009	0.002	N/A <sup>1</sup>	0.005	
Vegetation Applied Shear, τ <sub>ν</sub>	lbs/ft <sup>2</sup>	0.32	0.17	N/A <sup>1</sup>	0.25	
Maximum Permissible Soil Shear, τ <sub>a</sub>	lbs/ft <sup>2</sup>	0.021	0.021	0.021	0.021	
Maximum Permissible Vegetation Shear,	lbs/ft <sup>2</sup>	3.00	3.00	3.00	3.00	
Tva						
Soil Stability Factor	=	2.3	8.9	N/A <sup>1</sup>	3.9	
Vegetation Stability Factor	-	9.5	17.4	N/A <sup>1</sup>	11.9	
lbs/ft² = pounds per square foot						

<sup>1.</sup> Flow is predicted to be contained entirely inside of the riprap lining

From Table 7, the maximum permissible shear stress for bench channel vegetation and the underlying soil is 3.00 pounds per square foot and 0.021 pounds per square foot, respectively. Compared against the shear stress predicted to be applied during the 1 in 100-year event for each of the bench channels yields a soil stability factor of at least 2.0 and a vegetation stability factor of at least 8.2 for all bench channel. Therefore, the vegetative linings are predicted to be stable during the 1 in 100-year flow event.

#### **Downdrain Channel Results**

Table 8 presents the channel hydraulics and riprap stability results computed for the downdrain channels.

**Table 8: Downdrain Channel Hydraulic and Channel Stability Computation Results** 

	Units	DD1	DD2	DD3	DD4	DD5
Flow Depth, Y	ft	0.39	0.48	0.74	1.00	1.22
Flow Velocity, V	fps	5.34	5.76	6.73	6.80	7.35
Roughness, ndd	-	0.044	0.046	0.044	0.041	0.043
Unit Discharge, q	cfs/ft	2.10	2.75	5.01	6.80	9.01
Minimum Stable Riprap, D <sub>50f</sub>	in	4.4	4.7	5.8	6.0	7.0
Riprap Stability Factor	-	1.4	1.9	1.5	1.5	1.7
Channel Freeboard	ft	2.1	2.0	1.8	1.5	1.3
ft = feet, fps = feet per second, cfs/ft = cubic feet per second per foot, in = inch						

From Table 8, the predicted minimum stable median riprap diameter on the downdrain increases from 4.4 inches at the top to 7.0 inches at the bottom. The design median riprap diameter also increases from 6 inches at the top to 12 inches at the bottom to maintain a minimum riprap stability factor of 1.4 through all sections of the downdrain. A minimum channel freeboard of 1.3 feet will be maintained through all downdrain segments.

#### **Future Evaluations**

The information presented here reflects a preliminary design. Future design iterations will address the soil filter systems beneath the riprap revetments. Properly design soil filter will be particularly important at this site due to the highly erosive soils. The channel filter system may utilize granular filters (as depicted in the preliminary St. Anthony Mine Closeout Plan design drawings) or manufactured geotextiles specifically designed for surface water drainage applications.

# **References**

- Federal Highways Administration (FHA), 2005. Design of Roadside Channels with Flexible Linings. Hydraulic Engineering Circular No. 15, Third Edition.. September.
- Robinson, K.M., Rice, C.E., Kadavy, K.C., 1998. Design of Rock Chutes. American Society of Agricultural Engineers. Vol. 41(3):621-626.
- Temple, D.M., Robinson, K.M., Ahring, R.M., Davis, A.G., 1987. Stability Design of Grass-Lined Open Channels. Agriculture Handbook Number 667. United States Department of Agriculture.

.

# **ATTACHMENT A**

**Calculation Worksheets** 

# **Bench Channel Stability Calculations**

Channel :	SP4-01	SP4-02	SP4-04	SP4-05	
Input Variables					Notes
Hydrologic Element :	SB_SP4-01	SB_SP4-02	SB_SP4-04	SB_SP4-05	
Discharge, Q (cfs):	39	31	18	35	Appendix E.1
Slope, S (ft/ft) :	0.02	0.02	0.02	0.02	Design Drawings
Bottom Width, B (ft) :	0	0	0	0	Design Drawings
Hillside Side Slope, ZI:1:	5	5	5	5	Design Drawings
Bench Side Slope, Zr:1:	20	20	20	20	
RR Specific Gravity, SGs :	2.65	2.65	2.65	2.65	Assumed Riprap Parameter
Median Riprap, D50 (in) :	6	6	6	6	Design Median Riprap Diameter
Bench Depth, H:	2	2	2	2	
•					
Grass Roughness, ng:	0.075	0.095	#NUM!	0.084	Temple
RR Roughness, nr :	0.111	0.119	0.135	0.115	Eq. 6.2 (HEC-15, 2005)
Reletive Roughness, da/D50 :	1.406	1.335	1.150	1.372	Check that da/D50<1.5 (HEC-15, 2005)
f(FR) :	0.631	0.596	0.555	0.614	Eq. 6.3 (HEC-15, 2005)
f(REG):	8.331	7.992	7.109	8.167	Eq. 6.4 (HEC-15, 2005)
f(CG):	0.424	0.431	0.451	0.428	Eq. 6.5 (HEC-15, 2005)
b:	0.219	0.215	0.204	0.217	Eq. 6.6 (HEC-15, 2005)
Composite Roughness, n:	0.104	0.116	0.135	0.110	
, ,					
Flow Depth, Y (ft):	1.41	1.33	1.15	1.37	Manning's Equation
Iteration Parameter :	0.04	0.00	0.32	0.02	0.38
Flow Area, A (ft2) :	24.7	22.3	16.5	23.5	A = (B+Z*Y)*Y
Wetted Per., P (ft) :	35.3	33.5	28.9	34.5	P = B+2*Y*(Z^2+1)^0.5
Top Width, T (ft):	35.2	33.4	28.7	34.3	T = B+2*Y*Z
Channel Velocity, V (fps) :	1.58	1.38	1.11	1.48	V = Q/A
Average Flow Depth, da (ft) :	0.7	0.7	0.6	0.7	
Froude Number, Fr:	0.33	0.30	0.26	0.31	
,					
RR Lining Depth, Yrr (ft):	1.15	1.15	1.15	1.15	
RR Lining Width, Wrr (ft):	28.8	28.8	28.8	28.8	
RR Lining Wetted Per, Prr (ft):	28.9	28.9	28.9	28.9	
RR Lining Width (Bench), (ft):	23.0	23.0	23.0	23.0	
Grass Depth, Yg (ft):	0.26	0.18	0.00	0.22	
Grass Width, Wg (ft):	6.4	4.6	0.0	5.5	
Grass Wetted Per, Pg (ft):	6.4	4.6	0.0	5.6	
Riprap Stability					
RR Shear, Trr (lbs/ft2):	1.75	1.67	1.44	1.71	T = 62.4*(A/P)*S
Shear Velocity, u* (fps):	0.9	0.9	0.7	0.9	Eq. 6.10 (HEC-15, 2005)
Kinematic Viscosity, v (ft2/s):	1.21E-05	1.21E-05	1.21E-05	1.21E-05	Assumed
Particle Reynolds Number, Re:	3.74E+04	3.55E+04	3.06E+04	3.65E+04	Eq. 6.9 (HEC-15, 2005)
Computed F*:	0.047	0.047	0.047	0.047	Table 6.1 (HEC-15, 2005)
SF:	1.00	1.00	1.00	1.00	Table 6.1 (HEC-15, 2005)
Maximum Permissible Shear, Tp (lbs/ft2):	2.42	2.42	2.42	2.42	Eq. 6.8 (HEC-15, 2005)
RR Stability Factor :	1.4	1.5	1.7	1.4	
Grass Stability					
Veg Unit Discharge, qv (cfs/ft) :	0.41	0.25	0.00	0.33	q = V*Yv
Max Allowable Soil Shear, Ta (lbs/ft2):	0.021	0.021	0.021	0.021	Ta = Tab*Ce^2, Eq. (Temple, 1987)
Max Allowable Veg Shear, Tva (lbs/ft2):	3.00	3.00	3.00	3.00	Tva = 0.75*Ci, Eq. 1.17 (Temple, 1987)
Effective Soil Stress, Te (lbs/ft2):	0.009	0.004	#NUM!	0.006	Eq. 1.13 (Temple, 1987)
Vegitation Stress, Tv (lbs/ft2):	0.31	0.23	#NUM!	0.27	Tv = T - Te, Eq. 1.18 (Temple, 1987)
Soil Stability Factor, :	2.5	5.4	#NUM!	3.5	
Vegetation Stability Factor :	9.6	13.2	#NUM!	11.1	

Soil

#### **Vegitation**

Stem Height, h (ft): 0.5 Assumed

Stem Density, m: 67 Table 3.1 (Temple, 1987) Grass Mixture, Poor Condition

Retardance Index, Ci: 4.00 Eq. 1.3 (Temple, 1987)

Cover Factor, Cf: 0.375 Table 3.1 (Temple, 1987) Grass Mixture, Poor Condition

### **Channel Hydraulics**

Input Variables	SP4-DD1	SP4-DD2	SP4-DD3	SP4-DD4	SP4-DD5	Notes			
Hydrologic Element :	J-SP4_DD1	J-SP4_DD2	J-SP4_DD3	J-SP4_DD4	J-SP4_DD5				
Discharge, Q (cfs):	12.90	30.90	60.70	87.40	121.70	REF Hydrology Report			
Slope, S (ft/ft):	0.11	0.10	0.08	0.05	0.05	REF Design Drawings			
Bottom Width, B (ft) :	5	10	10	10	10	REF Design Drawings			
Hillside Side Slope, ZI:1:	3	3	3	3	3	REF Design Drawings			
Bench Side Slope, Zr:1:	3	3	3	3	3	REF Design Drawings			
RR Specific Gravity, SGs :	2.65	2.65	2.65	2.65	2.65	Assumed Riprap Parameter			
RR Anlge of Repose, (deg):	40.0	40.0	40.0	40.0	40.0	Assumed Riprap Parameter			
Median Riprap, D50 (in) :	6	9	9	9	12	Design Median Riprap Diameter			
RR Roughness, nr :	0.044	0.046	0.044	0.041	0.043	Eq. 14 (Rice et al, 1998)			
Flow Depth, Y (ft) :	0.39	0.48	0.74	1.00	1.22	Manning's Equation			
Iteration Parameter :	0.01	0.25	0.36	1.00	2.25	3.87			
Flow Area, A (ft2) :	2.4	5.5	9.1	13.0	16.8	A = (B+Z*Y)*Y			
Wetted Per., P (ft) :	7.5	13.0	14.7	16.3	17.7	P = B+2*Y*(Z^2+1)^0.5			
Channel Top Width, TW (ft):	7.4	7.9	9.5	11.0	12.3	T = B+2*Y*Z			
Channel Velocity, V (fps):	5.30	5.67	6.67	6.72	7.27	V = Q/A			
Flow Unit Discharge, q (cfs/ft):	2.09	2.70	4.96	6.72	8.90	q = V*Y			

**Riprap Stability** 

HEC-15	SP4-DD1	SP4-DD2	SP4-DD3	SP4-DD4	SP4-DD5	Notes
RR Shear, Trr (lbs/ft2):	2.7	3.0	3.5	3.0	3.7	T = 62.4*(A/P)*S
Shear Velocity, u* (fps):	1.4	1.6	1.8	1.5	1.9	Eq. 6.10 (HEC-15, 2005)
Kinematic Viscosity, v (ft2/s) :	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05	
Particle Reynolds Number, Re :	5.82E+04	9.61E+04	1.11E+05	9.58E+04	1.60E+05	Eq. 6.9 (HEC-15, 2005)
Computed F*:	0.059	0.083	0.093	0.083	0.124	Table 6.1 (HEC-15, 2005)
SF:	1.06	1.18	1.22	1.17	1.37	Table 6.1 (HEC-15, 2005)
Minimum Stone Diameter, D50f (in):	5.7	5.0	5.3	4.9	4.8	Eq. 6.8 (HEC-15, 2005)
RR Stability Factor :	1.05	1.82	1.68	1.82	2.48	

Robinson	SP4-DD1	SP4-DD2	SP4-DD3	SP4-DD4	SP4-DD5	Notes
Minimum Stone Diameter, D50f (in):	4.4	4.6	5.8	6.0	7.0	Eq. 1 and Eq. 2 (Robinson et al. 1998)
RR Stability Factor :	1.4	1.9	1.5	1.5	1.7	

**Channel Capacity** 

	SP4-DD1	SP4-DD2	SP4-DD3	SP4-DD4	SP4-DD5	Notes
Design Channel Depth, (ft):	2.5	2.5	2.5	2.5	2.5	
Channel Freeboard, (ft):	2.1	2.0	1.8	1.5	1.3	



# **APPENDIX E.4**

Design of Pit 1 Diversion Channel and Pit 2 Diversion Channel

# **BACKGROUND**

The Meyer Draw is a large arroyo that runs through the Site between several mine waste rock stock piles (see Figure 1). The preliminary site design proposes to excavate all piles southwest of the Meyer Draw (Stockpile Area, Pile 7, Pile 6, Pile 3 and the Shale Pile) and backfill the excavated mine material into the two pits (Pit 1 and Pit 2). The backfilled waste will be covered with clean material borrowed from elsewhere on Site. Stantec designed diversion channels to capture as much surface runoff water as possible from the drainages upgradient of Pit 1 and Pit 2 to prevent this water from cascading down the pit walls and onto the backfilled waste rock material (which could cause scour of the cover material, potential exposing waste rock material and/or interrupting vegetation growth). Also, the diversion channels will minimize water volumes in the pit areas. The diversion channels utilize a combination of trapezoidal channels excavated below existing grade and berms constructed on side hills at existing grade. The diversions will direct flow around the pit areas and into the Meyer Draw channel. Sheets 12 (Diversion Channel 1) and 13 (Diversion Channel 2) of the St. Anthony Mine Closeout Plan design drawings show the diversion channel alignments.

Riprap will be installed (where necessary) to prevent scour/erosion along the diversion channel alignment. The riprap revetments will be installed with either a geotextile or granular filter system to prevent washout of the underlying soils. A properly designed filter system will be critical at this site due to the highly erosive nature of the soils. This report outlines methods used to evaluate the geometry and stability of the designed diversion channels.

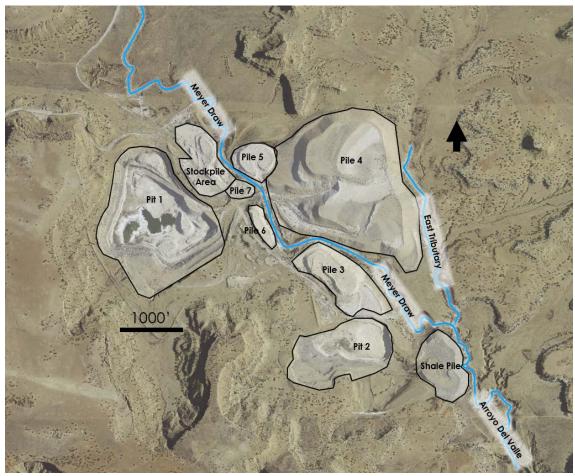


Figure 1: Project Site Existing Conditions (Photo Data: 05/31/2011)

# **Design Criteria**

Table 1 lists criteria used to design the diversion channels.

**Table 1: Diversion Channel Design Criteria** 

Criteria	Value
Design Flood Frequency	1/100-year event
Minimum Channel Freeboard	1.0 – feet
Minimum Riprap Stability Factor (SF)	1.4

Table 2 provides channel design parameters used to evaluate channel capacity and channel lining stability.

**Table 2: Diversion Channel Design Parameters** 

Parameter			ion Channe		Pit 2 Diversion Channel					
Channel Station	5+00 to 8+00	8+00 to 14+00	14+00 to 27+50	27+50 to 41+00 (End)	4+50 to 10+25	10+25 to 17+50	17+50 to 22+50	22+50 to 25+85	25+85 to 28+50 (End)	
Design Discharge (Q)	83 cfs	83 cfs	321 cfs	424 cfs	48 cfs	135 cfs	136 cfs	203 cfs	214 cfs	
Minimum Channel Slope (S <sub>min</sub> )	0.098	0.008	0.005	0.043	0.004	0.039	0.048	0.037	0.037	
Maximum Channel Slope (S <sub>max</sub> )	0.098	0.019	0.009	0.074	0.004	0.06	0.05	0.039	0.209	
Channel Type	Armored Trapezoid	Armored Berm	Armored Berm	Armored Trapezoid	Armored Berm	Armored Trapezoid	Armored Trapezoid	Armored Trapezoid	Armored Trapezoid	
Channel Bottom Width (B)	10 ft	O ft	O ft	0 ft	10 ft	10 ft	10 ft	10 ft	15 ft	
Channel Side Slope Angle (Z:1)	3	3 <sup>1</sup>	3 <sup>1</sup>	3	3	3	3	3	3	
Channel Depth (H)	2.0 ft	4.0 ft	4.0 ft	4.0 ft	2.5 ft	2.5 ft	2.5 ft	3.0 ft	3.0 ft	
Design Median Riprap Diameter (D <sub>50d</sub> )	12 in	3 in	3 in	18 in	3 in	9 in	9 in	9 in	18 in	
Riprap Specific Gravity (SG)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	

Note: cfs = cubic feet per second; ft = feet; in = inch; Z:1 = Z units horizontal to 1 unit vertical

1. Sidehill berm with native terrain forming the channel side slope opposite the berm. Native terrain side slope angle approximately equal to 0.5% or 20:1.

# **Methods**

# Riprap Sizing

Diversion channel riprap was evaluated using methods suggested by the National Resource Conservation Service (NRCS) in NEH-TS14c (NRCS, 2007).

For this evaluation Stantec assumed normal depth flow conditions, and evaluated channel hydraulics through iterative approximations of flow depth (Y) to balance the Manning's equation (Equation 1).

$$Q = \frac{1.49}{n} * A * \left(\frac{A}{P}\right)^{\frac{2}{3}} * S^{\frac{1}{2}}$$
 Equation 1

Where:

Q = design discharge, cubic feet per second (see Table 2)

n = channel roughness

A = channel flow area, feet squared; given as A = (B + Z \* Y) \* Y

P = channel wetted perimeter, feet; given as  $P = B + 2 * Y * \sqrt{Z^2 + 1}$ 

B = channel bottom width, feet (see Table 2)

Y = channel flow depth, feet

Z = channel side slope angle, Z feet horizontal to 1 foot vertical (see Table 2)

S = channel slope, feet per feet (see Table 2)

Stantec determined the channel roughness (n) using the method described by Rice et. al. (1998) (Equation 2) for all channels with a slope (S) greater than 0.02. If the channel slope was less than 0.02, Stantec used a channel roughness value equal to 0.033. This is the median value recommended in Chow (1959) for "lined or built-up channels" with a "dry rubble or riprap" lining.

$$n = 0.0292 * (D_{50d} * 25.4 * S)^{0.147}$$
 Equation 2

The channel hydraulic conditions were computed twice for each channel; once using the minimum channel slope (see Table 2) to determine the maximum flow depth (used to evaluate channel freeboard) and another using the maximum channel slope (see Table 2) to evaluate riprap stability.

Stantec evaluated the channel flow velocity (V) by continuity of the incompressible fluid (Equation 3).

$$V = \frac{Q}{4}$$
 Equation 3

To evaluate the design riprap ( $D_{50d}$ ), the median riprap gradation stone diameter that is on the verge of failure/mobilization during the design discharge event ( $D_{50f}$ ) was computed for each channel. For channel slopes greater than 0.02 the National Engineering Handbook – Technical Supplement 14c (NRCS, 2007) suggests the method developed by Robinson et. al (1998) (Equation 4a and 4b).

for 
$$0.02 < S \le 0.1$$
;  $D_{50f} = 12 * (1.923 * q * S)^{0.529}$  Equation 4a

for 
$$0.1 < S$$
;  $D_{50f} = 12 * (0.233 * q * S^{0.58})^{0.529}$  Equation 4b

Where:

 $D_{50f}$  = median riprap gradation stone diameter at the brink of failure, inches q = unit discharge, cubic feet per second per foot where q = V \* Y

If the channel slope is less than 0.02, the manual suggests the Maynord Method presented by the U.S. Army Corps of Engineers (USACE, 1994) (Equation 5).

$$D_{50f} = 12 * K_1 * C_s * C_v * C_t * Y * \left[ \left( \frac{1}{SG - 1} \right)^{0.5} * \frac{V}{\sqrt{K_1 * 32.2 * Y}} \right]^{2.5}$$
 Equation 5

Where:

K = gradation coefficient, 1.15 assumed as suggested in NEH TS14c (NRCS, 2007b)

C<sub>s</sub> = stability coefficient, 0.3 as suggested in USACE (1994) angular riprap

C<sub>v</sub> = velocity distribution coefficient, 1 as suggested in USACE (1994) for straight channel reach

 $C_t$  = thickness coefficient, 1 as suggested in USACE (1994) for riprap thickness > 1.5\* $D_{50d}$ 

 $K_1$  = side slope correction factor,  $k_1 = \sqrt{1 - \frac{\sin^2 \theta}{\sin^2 \phi}}$ 

 $\theta$  = side slope angle, degrees where  $\theta = \tan^{-1} \left(\frac{1}{2}\right)$ 

 $\Phi$  = riprap angle of repose, 40 degrees assumed

Stantec evaluated the design riprap by computing a riprap stability factor using Equation 6.

$$SF = \frac{D_{50d}}{D_{50f}}$$
 Equation 6

#### Channel Scour

The design for Sections 8+00 to 14+00 and 14+00 to 27+50 of the Pit 1 Diversion Channel and Section 4+50 to 10+25 of the Pit 2 Diversion Channel includes a riprap armored berm to form one bank of the channel. The rest of the channel will be unarmored (see Details 6 and 8 on Sheet 17 of the design drawings). To evaluate the potential for channel scour to occur during the design discharge event in the unarmored channel Stantec used the Lacey Equation (Pemberton and Lara, 1984) (Equation 7) and Zeller Equation (Zeller, 1981) (Equation 8). These equations were chosen because they relate specifically to silt/sand bedded streams. The maximum scour depth predicted by the two methods was used for design.

$$Y_s = Z_l * 0.47 * \left(\frac{Q}{f}\right)^{\frac{1}{3}}$$
 Equation 7

Where:

Y<sub>s</sub> = predicted scour depth, feet

 $Z_{l}$  = Lacey's multiplying factor

f = Lacey's silt factor computed as  $f = 1.76 * D_{50n}^{2}$ D<sub>50n</sub>= native sediment median particle diameter, millimeters

Pemberton and Lara (1984) recommends a multiplying factor (Z) equal to 0.25. The native sediment median particle diameter (D<sub>50n</sub>) was assumed to be equal to 0.06 mm. This value approximately equals the median particle size from samples measured in the lab by Daniel B. Stevens and Associates (2018) at the borehole sample locations shown on Sheet 4 of the design drawings.

$$Y_s = Y * \left(\frac{0.0685*V^{0.8}}{Y_h^{0.4}*S^{0.3}} - 1\right)$$
 Equation 8

Where:

 $Y_h$  = hydraulic depth of flow where  $Y_h = \frac{A}{B + Y \times Z}$ .

# **Channel Evaluation Results and Discussion**

Table 3 presents the channel evaluation results.

**Table 3: Channel Evaluation Results** 

		Diversion	Channel 1		Diversion Channel 2				
Channel Station	5+00 to 8+00	8+00 to 14+00	14+00 to 27+50	27+50 to 41+00 (End)	4+50 to 10+25	10+25 to 17+50	17+50 to 22+50	22+50 to 25+85	25+85 to 28+50 (End)
Channel Roughness, n <sup>1/2</sup>	0.048/ 0.048	0.033/ 0.033	0.033/ 0.033	0.043/ 0.049	0.033/ 0.033	0.038/ 0.043	0.039/ 0.042	0.039/ 0.040	0.043/ 0.057
Channel Flow Depth, Y <sup>1</sup>	0.86 ft	1.48 ft	2.68 ft	2.42 ft	1.26 ft	1.32 ft	1.27 ft	1.66 ft	1.50 ft
Channel Freeboard	1.1 ft	2.5 ft	1.3 ft	1.6 ft	1.2 ft	1.2 ft	1.2 ft	1.3 ft	1.5 ft
Channel Flow Velocity, V <sup>2</sup>	7.66 fps	4.56 fps	4.83 fps	11.15 fps	2.79 fps	8.14 fps	7.80 fps	8.27 fps	11.06 fps
Riprap Computation Method <sup>2</sup>	Equation 4a	Equation 5	Equation 5	Equation 4a	Equation 5	Equation 4a	Equation 4a	Equation 4a	Equation 4b
Median Riprap at Brink of Failure, ${\sf D_{50f}}^2$	7.3 in	1.5 in	1.5 in	12.1 in	0.63 in	6.1 in	5.3 in	5.1 in	12.6 in
Riprap Stability Factor, SF	1.65	2.0	2.0	1.5	6.9	1.5	1.7	1.8	1.4

Notes: ft = feet; in = inch; fps = feet per second

1. Minimum Reach Channel Slope Assumed

From Table 3, flow depths range between 0.86 and 2.68 feet during the 100-year event in Diversion Channel 1, and between 1.26 and 1.50 in Diversion Channel 2. Diversion Channel 1 and 2 will maintain a minimum channel freeboard of 1.1 feet and 1.2 feet, respectively which meets the design criteria outlined in Table 1.

The high variability in slope along both diversion channels results in a wide range of predicted riprap sizes necessary for channel stability. As outlined in Table 2, the design uses riprap with median stone diameters ranging between 3 inches and 18 inches for each channel. These design riprap sizes result in predicted stability factors ranging between 1.4 and 6.9.

Table 4 shows the results of the channel scour evaluation from Equations 7 and 8.

Table 4: Scour Depth Evaluation Results

	Diversion Channel 1	Diversion Channel 1	Diversion Channel 2					
Parameter	Sta. 08+00 to 14+00	Sta. 14+00 to 27+50	Sta. 0+00 to 10+25					
Lacey Scour Depth	0.7 feet	1.1 feet	0.6 feet					
Zeller Scour Depth	0.2 feet	0.4 feet	0.1 feet					
Design Scour Depth	0.7 feet	1.1 feet	0.6 feet					

Maximum Reach Channel Slope Assumed

From Table 4, the scour depth predicted by the Lacey Equation was consistently deeper than that predicted by the Zeller Equation. The scour depth predicted by Lacey will be adopted for design. The information presented here reflects a preliminary design. Future design iterations will address:

- Design of soil filter systems beneath the riprap revetments. Properly designed soil filters will be
  particularly important due to the highly erosive soils. The channel filter system may utilize
  granular filters (as depicted in the preliminary St. Anthony Mine Closeout Plan design drawings)
  or manufactured geotextiles specifically designed for surface water drainage applications.
- Cost optimization of the channel alignments and lining systems. Particularly, in the lower sloping segments of the diversion channels where vegetative lining systems may be protective.
- Potential issues that could arise due to aggradation of sediments in reaches of the diversion channels were shear stresses decrease.
- Detailed designs of the area where the diversion channels transition into the Meyer Draw channel.

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# **ATTACHMENT A**

**Calculation Worksheets** 

# **Diversion Channel 1 Freeboard Calculations**

	Sta 500 to 800	Sta 800 to 1400	Sta 1400 to 2750	Sta 2750 to 4300	
Hydrologic Element :	J-P1_Div-01	J-P1_Div-01	J-P1_Div-02	J-P1_Div-03	
Discharge, Q (cfs):	83.2	83.2	320.7	424.3	Appendix E.1
Slope, S (ft/ft):	0.098	0.008	0.005	0.043	Design Drawings
Bottom Width, B (ft):	10	0	0	10	Design Drawings
Side Slope, Z:1:	3	11.5	11.5	3	Design Drawings
Median Riprap, D50 (in):	12	3	3	12	Design Drawings
Median Riprap, D50 (ft):	1	0.25	0.25	1	
RR SG :	2.6	2.6	2.6	2.6	
Roughness, n:	0.048	0.033	0.033	0.043	if S>2% (Rice et al., 1998) Else, n = 0.03
Flow Depth, Y (ft) :		1.48	2.68	2.42	
Iterate to Zero>	0.0	0.0	0.0	0.0	Use Solver
Flow Area, A (ft2):	10.86	25.23	82.79	41.86	
Wetted Per., P (ft):	15.5	34.2	61.9	25.3	
Top Width, TW (ft):	15.2	34.1	61.7	24.5	
Channel Velocity, V (fps):	7.66	3.30	3.87	10.14	V = Q/A
Channel Shear, T (lbs/ft2):	4.3	0.4	0.4	4.4	T = 62.4*(A/P)*S
Unit Discharge, q (cfs/ft):	6.6	4.9	10.4	24.6	q = V*Y
Froude Number :	1.6	0.68	0.6	1.4	Fr = V/(32.2*A/T)^0.5
	4.00	3.23	3.27	4.48	
Design Channel Depth, ft :	2	4	4	4	Design Drawings
Channel Freeboard, ft :	1.1	2.5	1.3	1.6	

# **Diversion Channel 1 Riprap Calculations**

	Sta 500 to 800	Sta 800 to 1400	Sta 1400 to 2750	Sta 2750 to 4300	
Hydrologic Element :		J-P1_Div-01	J-P1_Div-02	J-P1_Div-03	
Discharge, Q (cfs):	_	83.2	320.7	424.3	Appendix E.1
Slope, S (ft/ft):		0.019	0.009	0.074	Design Drawings
Bottom Width, B (ft) :		0	0	10	Design Drawings
Side Slope, Z:1:	3	11.5	11.5	3	Design Drawings
Median Riprap, D50 (in) :	12	3	3	18	Design Drawings
Median Riprap, D50 (ft):	1	0.25	0.25	1.5	
RR SG :	2.6	2.6	2.6	2.6	
Roughness, n :	0.048	0.033	0.033	0.049	if S>2% (Rice et al., 1998) Else, n = 0.03
Flow Depth, Y (ft) :	0.86	1.26	2.40	2.27	
Iterate to Zero>	0.0	0.0	0.0	0.0	Use Solver
Flow Area, A (ft2) :		18.24	66.41	38.06	
Wetted Per., P (ft):		29.1	55.5	24.3	
Top Width, TW (ft):	15.2	29.0	55.3	23.6	
Channel Velocity, V (fps) :	7.66	4.56	4.83	11.15	V = Q/A
Channel Shear, T (lbs/ft2):		0.7	0.7	7.2	T = 62.4*(A/P)*S
Unit Discharge, q (cfs/ft):	6.6	5.7	11.6	25.3	q = V*Y
Froude Number :	1.6	1.01	0.8	1.5	Fr = V/(32.2*A/T)^0.5
Robinson					
Min RR Diameter, D50f (in):	7.28	#VALUE!	#VALUE!	11.84	Robinson, 1998
FS Riprap :	1.65	#VALUE!	#VALUE!	1.52	FS = D50f/D50
Applicability:	Applicable	N/A	N/A	Applicable	Applicable is S>0.02
Maynord					
Stability Coeff, Cs:	0.3	0.3	0.3	0.3	
Vert Vel Coeff, Cv :	1	1	1	1	
Thickness Coeff, Ct:	1	1	1	1	
Side Slope Correction, K1:	0.87	0.87	0.87	0.87	
Min Stable RR, D30 (in):	5.23	1.30	1.28	10.49	
Min Stable RR, D50 (in):	6.01	1.50	1.47	12.06	
FS Riprap :	2.00	2.01	2.04	1.49	

# **Diversion Channel 2 Freeboard Calculations**

	Sta 4+50 - 10+25	Sta 10+25 - 17+50	Sta 17+50 - 22+50	Sta 22+50+25+85	Sta 25+85 - 28+25	
Hydrologic Element :	J-P2_Div-01	J-P2_Div-02	J-P2_Ch-01	J-P2_Ch-02	J-P2_Ch-03	
Discharge, Q (cfs):	48.3	134.9	135.9	203	214.4	Appendix E.1
Slope, S (ft/ft):	0.004	0.039	0.048	0.037	0.037	Design Drawings
Bottom Width, B (ft):	10	10	10	10	15	Design Drawings
Side Slope, Z:1:	3	3	3	3	3	Design Drawings
Median Riprap, D50 (in):	3	9	9	9	18	Design Drawings
Median Riprap, D50 (ft):	0.25	0.75	0.75	0.75	1.5	
RR SG :	2.6	2.6	2.6	2.6	2.6	
Roughness, n:	0.033	0.040	0.042	0.040	0.044	Rice et al., 1998
Flow Depth, Y (ft):	1.26	1.32	1.27	1.66	1.50	
Iterate to Zero>	0.0	0.0	0.0	0.0	0.0	Use Solver
Flow Area, A (ft2):	17.32	18.42	17.59	24.88	29.36	
Wetted Per., P (ft):	18.0	18.3	18.1	20.5	24.5	
Top Width, TW (ft):	17.5	17.9	17.6	20.0	24.0	
	0	0	0	1	0	
Channel Velocity, V (fps):	2.79	7.32	7.73	8.16	7.30	V = Q/A
Channel Shear, T (lbs/ft2):	0.2	2.4	2.9	2.8	2.8	T = 62.4*(A/P)*S
Unit Discharge, q (cfs/ft):	3.5	9.7	9.8	13.5	11.0	q = V*Y
Froude Number :	0.5	1.3	1.4	1.3	1.2	
		3.05	2.81	2.63	2.68	
Design Channel Depth, ft:	2.5	2.5	2.5	3	3	
Channel Freeboard, ft:	1.2	1.2	1.2	1.3	1.5	

# **Diversion Channel 2 Riprap Calculations**

	Sta 4+50 - 10+25	Sta 10+25 - 17+50	Sta 17+50 - 22+50	Sta 22+50+25+85	Sta 25+85 - 28+25	
Hydrologic Element :	J-P2_Div-01	J-P2_Div-02	J-P2_Ch-01	J-P2_Ch-02	J-P2_Ch-03	
Discharge, Q (cfs):	48.3	134.9	135.9	203	214.4	Appendix E.1
Slope, S (ft/ft):	0.004	0.06	0.05	0.039	0.209	Design Drawings
Bottom Width, B (ft):	10	10	10	10	15	Design Drawings
Side Slope, Z:1:	3	3	3	3	3	Design Drawings
Median Riprap, D50 (in):	3	9	9	9	18	Design Drawings
Median Riprap, D50 (ft):	0.25	0.75	0.75	0.75	1.5	
RR SG :	2.6	2.6	2.6	2.6	2.6	
Roughness, n:	0.033	0.043	0.042	0.040	0.057	Rice et al., 1998
Flow Depth, Y (ft) :	1.26	1.21	1.26	1.64	1.07	
Iterate to Zero>	0.0	0.0	0.0	0.0	0.0	Use Solver
Flow Area, A (ft2):	17.33	16.56	17.41	24.55	19.39	
Wetted Per., P (ft):	18.0	17.7	18.0	20.4	21.7	
Top Width, TW (ft):	17.5	17.3	17.6	19.9	21.4	
	0	0	0	1	0	
Channel Velocity, V (fps):	2.79	8.14	7.80	8.27	11.06	V = Q/A
Channel Shear, T (lbs/ft2):	0.2	3.5	3.0	2.9	11.6	T = 62.4*(A/P)*S
Unit Discharge, q (cfs/ft):	3.5	9.9	9.9	13.6	11.8	q = V*Y
Froude Number :	0.5	1.5	1.4	1.3	2.0	
Robinson						
Min RR Diameter, D50f (in):	#VALUE!	6.11	5.27	5.13	12.59	Robinson, 1998
FS Riprap :	#VALUE!	1.47	1.71	1.75	1.43	FS = D50f/D50
Applicability :	N/A	Applicable	Applicable	Applicable	Applicable	Applicable if S>0.02
Maynord						
Stability Coeff, Cs :	0.3	0.3	0.3	0.3	0.3	
Vert Vel Coeff, Cv :	1	1	1	1	1	
Thickness Coeff, Ct:	1	1	1	1	1	
Side Slope Correction, K1 :	0.87	0.87	0.87	0.87	0.87	
Min Stable RR, D30 (in) :	0.38	5.59	4.98	5.38	12.41	
Min Stable RR, D50 (in):	0.44	6.43	5.73	6.19	14.27	
FS Riprap :	6.86	1.40	1.57	1.45	1.26	
i o impilop i	0	2.10	=:31	=: .9		

# **Diversion Channel Scour Depths**

	<u>Р</u>	<u>it 1</u>	Pit 2	Notes						
<u>Design Parameters</u>										
Channel Reach :	Sta 800 to 1400	Sta 1400 to 2750	0+00 to 10+25							
Hydrologic Element :	J-P1_Div-01	J-P1_Div-02	J-P2_Div-01							
Dseign Discharge, Qd (cfs/ft):	83.2	320.7	48.3	100-Year Discharge (Appendix E.1)						
Flow Depth, Y (ft):	1.26	2.40	1.26							
Flow Velocity, V (fps):	4.56	4.83	2.79							
Flow Area, A (ft):	18.24	66.41	17.33							
Unit Discharge, q (cfs/ft):	5.74	11.60	3.51							
Channel Top Width, Wf (ft):	29.0	55.3	17.5	See Arroyo Riprap spreadsheet Cell C18 and E18						
Hydrauilc Depth, Yh (ft):	0.6	1.2	1.0							
Channel Slope , S :	0.019	0.009	0.004							
Median Bed Particle Size, D50b (mm) :	0.06	0.06	0.06	Approximate average of all borehole PSD data						
	Predicted Sco	our Depth - Pembe	rton and Lara a	nd Zeller						
Lacey's Silt Factor, f:	0.43	0.43	0.43	Pemberton and Lara, 1984						
Lacey Multiplying Factor, Z:	0.25	0.25	0.25	Pemberton and Lara, 1984						
Lacey Scour Depth, ZI (ft) :	0.7	1.1	0.6	Pemberton and Lara, 1984						
Zeller Scour Depth, Zz (ft) :	0.18	0.38	0.04	Zeller, M.E. 1981.						

# ST. ANTHONY MINE CLOSEOUT PLAN

Appendix F Cover Design Calculations

# Appendix F COVER DESIGN CALCULATIONS





# **APPENDIX F**

# **COVER DESIGN CALCULATIONS**

# F.1 RADON CALCULATIONS F.2 EROSIONAL STABILITY CALCULATIONS

# **BACKGROUND**

This appendix presents modeling results for radon attenuation and required cover thicknesses for facilities containing impounded waste materials at the St. Anthony Mine (Site) following Site reclamation. Stantec performed the analyses in accordance with the long-term radon emanation guidelines specified in 10 CFR Part 40 Appendix A, Criterion 6 (NRC, 2017). An analyses summary of radon attenuation through the proposed covers and underlying waste rock materials is presented and incorporates the reclamation designs (e.g., pit backfill and pile regrading) for the facilities in question.

Cover systems were evaluated for Pit 1, Pit 2, and Pile 4. Because Pits 1 and 2 will be backfilled with impacted soil and rock from various locations throughout the Site, a cover comprising non-impacted materials is required at each location to mitigate radon emanation from the waste. Pile 4 currently contains a large volume of impacted waste material, much of which will remain in place and be regraded during reclamation, therefore requiring a non-impacted cover for radon attenuation. The following sections describe the materials analyzed in the models, as well as the methods used to develop model input parameters.

### **DESCRIPTION OF MODEL AND INPUT VALUES**

Cover thicknesses required to limit radon emanation from the disposal areas were evaluated using the NRC RADON model (NRC, 1989). The model utilizes the one-dimensional radon diffusion equation, which uses the physical and radiological characteristics of waste and cover materials to calculate radon emanation through the cover. Stantec used the model to calculate the cover thickness required to limit the radon emanation rate through the cover to no more than 20 picocuries per square meter per second (pCi/m²-s), following the guidance presented in U.S. Nuclear Regulatory Commission (NRC) publications NUREG/CR-3533 and Regulatory Guide 3.64 (NRC 1984, 1989). The rate of emanation standard is applied to the average emanation over the entire disposal area surface. Stantec also used the model to evaluate radon emanation for pre-determined cover thicknesses estimated during the material balance analysis for the Site.

The model input parameters are based on engineering experience with similar projects, results of waste and potential borrow material testing conducted in 2018 (DB Stephens, 2018), and soil analytical testing for radionuclides conducted in 2007 and 2018 (summarized in Appendix A). The input parameters and values in the model are outlined for all cover systems below.

#### Thickness of Cover and Waste Materials

Cover thicknesses for Pits 1 and 2 were selected based on the results of the 2018 Revegetation Plan (Cedar Creek, 2018). For materials included in the cover designs (West Borrow, Lobo Tract, and North Topsoil), Cedar Creek recommended minimum cover thicknesses of 24 inches to ensure suitable planting media for revegetation during Site reclamation. The Pit 1 cover design includes 4 inches of North Topsoil material overlying 20 inches of West Borrow material; these borrow areas were selected due to their proximity to the pit. Although each material will be placed in separate lifts, the cover was modeled as a single, 24-inch layer with input properties based on laboratory results for both materials. The Pit 2 cover design comprises a single, 24-inch layer of West Borrow Material. The Pile 4 cover thickness was optimized to meet the required maximum radon emanation rate. The model inputs specified a maximum flux of 20 pCi/m²-s along with an initial guess for the required cover thickness. The model then adjusted the thickness until the calculated radon flux did not exceed the specified maximum value. Material for the Pile 4 cover includes a combination of West Borrow and Lobo Tract material.

Although the Pit 1 backfill profile consists of materials (excluding cover) from 14 distinct site facilities placed in lifts of varying thicknesses, only the uppermost layers were considered in the models. As documented in NRC Regulatory Guide 3.64, a tailings/waste thickness greater than 100 to 200 cm is effectively equivalent to an infinitely thick radon source and may be represented in RADON using a thickness of 500 cm.

Therefore, the Pit 1 backfill layers within a depth of approximately 500 cm from the base of the cover layer were included in the model. These layers include (from top to bottom) the Topsoil/Overburden subsoil (223 cm) and waste rock from the West Disturbance Area (79 cm) and Crusher Stockpile (226 cm). Covered material in Pit 2 includes the full volume of the South Topsoil pile and sufficient material from Pile 3 to achieve the remaining pit backfill volume requirement. South Topsoil material encompasses an approximately 8-ft (244-cm) subsoil layer beneath the final cover and was modeled using the actual layer thickness. Pile 3 material comprises the remaining pit backfill depth with an average thickness of 44 ft. Stantec assumed this layer represented an infinitely thick radon source and was modeled using a thickness of 500 cm. Because the re-graded Pile 4 does not contain material transported from other site facilities, Stantec evaluated a single layer of Pile 4 waste material in the model. Similar to Pit 2, the depth of waste material is considerably greater than 200 cm. A thickness of 500 cm was used in the model to represent an infinite source.

# **Radium Activity Concentration**

Radium-226 activity concentration input values are estimated based on the results of both the 2007 and 2018 analytical testing. Guidance in Regulatory Guide 3.64 (NRC, 1989) states that radium activity in the cover soils may be neglected for cover design purposes provided cover soils are obtained from background materials not associated with ore formations or other radium-enriched materials. Results for borrow areas and topsoil piles (including Lobo Tract, North Topsoil, South Topsoil, Topsoil/Overburden, and West Borrow) indicated Ra-226 concentrations less than 1 picocurie per gram (pCi/g), with a maximum value of 1.5 pCi/g. Therefore, each material was assigned a concentration of 1 pCi/g in the RADON models. Input values for the other, impacted materials used in the models were estimated as the 75<sup>th</sup> percentile of the values measured during analytical testing for samples collected from each area. Table 1 summarizes the input concentrations for all materials.

**Table 1: Radium Activity Concentrations** 

Material	75 <sup>th</sup> Percentile Ra-226 Activity Concentration (pCi/g)
Crusher Stockpile	98.1
Lobo Tract	1.0
North Topsoil Pile	1.0
Pile 3	20.6
Pile 4	20.5
South Topsoil Pile	1.0
Topsoil/Overburden Pile	1.0
West Borrow	1.0
West Disturbance Area	117.0

# **Radon Emanation Coefficient**

The radon emanation coefficient in each model for the cover and waste layers was 0.35. This is the conservative default value used in the RADON model (NRC, 1989) and was used due to insufficient site-specific data.

# **Density and Porosity**

The densities and porosities of the waste rock and cover materials are based on laboratory testing results (DB Stephens, 2018). For materials except Pile 4 waste rock, the placed density was assumed to be 93 percent of the Standard Proctor (SP) maximum compaction density (based on a construction specification of 90 percent), which was measured for each material type during laboratory testing. In-situ density of the Pile 4 waste rock was assumed to be 90 percent of the SP density (based on a specification of 85 percent) because much of the material will be left in place versus excavated and re-compacted.

Conservative porosity values were determined using the 70<sup>th</sup> percentile of all laboratory testing results available for each material type. Table 2 summarizes the values for the material layers evaluated; these values are discussed in greater detail below. Attachment F.1.1 includes the estimation of densities and porosities for all materials.

**Table 2: Density and Porosity Values** 

Material	Degree of Compaction (%)	Placed Density (pcf)	Placed Density (g/cm³)	Porosity
Crusher Stockpile	93% SP	116	1.86	0.376
Pile 3	93% SP	116	1.86	0.376
Pile 4	90% SP	115	1.84	0.399
South Topsoil Pile	93% SP	112	1.79	0.393
Topsoil/Overburden Pile	93% SP	106	1.70	0.392
West Borrow/North Topsoil	93% SP	109	1.74	0.476
West Borrow/Lobo Tract Mix	93% SP	105	1.68	0.476
West Disturbance Area	93% SP	116	1.86	0.376

SP = Standard Proctor compaction

Laboratory data for density and porosity were available for all materials except Crusher Stockpile (CS) and West Disturbance Area (WDA), which were not included in the 2018 geotechnical investigation. Stantec assumed these materials have similar properties as material in Pile 3 due to observed similarities in the materials' physical appearance and composition. Therefore, the density and porosity values determined for Pile 3 based on laboratory results were also assigned to the CS and WDA materials. The 70<sup>th</sup> percentile porosities and 93 percent SP compaction densities for the South Topsoil and Topsoil/Overburden piles were calculated directly from laboratory testing results for samples collected from each pile during the 2018 investigation.

Laboratory results from West Borrow and North Topsoil samples were combined into a single dataset for estimating geotechnical input parameters (due to limited available data for each facility). Furthermore, materials from the two locations were assumed to be similar based on laboratory results (e.g., nearly identical SP compaction densities as well as similar porosities and in-situ moisture contents), visual classification, and the proximity of the West Borrow area to the apparent location of origin of the North Topsoil material within the current boundaries of the Pit 1 excavation. Therefore, as previously discussed, the Pit 1 cover was modeled as a single layer with soil properties representative of both materials. The cover density was determined as the lower value of the 93 percent SP compaction density calculated for each material, whereas porosity was calculated as the 70<sup>th</sup> percentile of the combined dataset from the West Borrow and North Topsoil laboratory results. The same method was implemented for the Pit 2 cover; although the cover consists only of West Borrow material, the North Topsoil datapoint was included in the parameter calculations due to the aforementioned similarities between the materials.

Stantec estimated the Pile 4 cover properties by evaluating the cover material as a combination of West Borrow and Lobo Tract materials. Because the two materials will be placed either as separate layers within the cover or as a mixture placed in a single layer, Stantec calculated parameters for both the West Borrow/North Topsoil and Lobo Tract datasets. The resulting conservative values (i.e., lowest density and highest porosity) then were used as model inputs for the Pile 4 cover.

# Long-term Moisture Content

Per NRC Regulatory Guide 3.64 (NRC, 1989), 6 percent by weight represents the lower bound for moisture in western soils and is typically used as a conservative default value for the long-term water content of the cover. However, Stantec estimated actual moisture contents used for this analysis using laboratory testing results for the moisture content of each material type, with the exception of the CS and WDA materials. As previously discussed, these materials were assigned the same properties (including moisture content) as those estimated for Pile 3 due to a lack of available laboratory data. Stantec calculated the 30<sup>th</sup> percentile moisture contents for the covers based on the combined laboratory results for all materials included within each cover design, similar to the method previously discussed for 70<sup>th</sup> percentile porosity calculations.

Stantec compared the 30<sup>th</sup> percentile laboratory moisture contents with the NRC-recommended value of 6 percent. Because the laboratory values were less than 6 percent, the 30<sup>th</sup> percentile moisture contents were used in the models. Actual lab values also were used for the waste materials, since cover thickness calculations are less sensitive to changes in the moisture content of the waste compared to that of the cover and use of the default value may be overly conservative (NRC, 1989). Moisture contents for cover materials ranged from 4.2 to 5.1 percent, whereas results for waste materials were greater and ranged from 6.9 to 7.8 percent. Attachment F.1.1 includes the estimated long-term water content for each material, and Table 3 summarizes the results.

To obtain a more conservative estimate of long-term moisture conditions, Stantec excluded testing results from the 30<sup>th</sup> percentile calculation for Lobo Tract samples containing relatively high percentages of clay compared to the majority of samples from the area. Moisture contents measured for these samples were greater than those measured for samples that generally were more representative of materials found within the borrow area (e.g., 12-14 percent vs. 4-8 percent). One sample also was excluded from the West Borrow moisture calculation due to its depth of recovery (30 ft) and relatively high moisture content (9.3 percent) compared to other West Borrow samples. These conditions likely were not representative of long-term moisture conditions due to potential isolation at depth from climatological influences.

Table 3: Estimated Long-Term Moisture Contents

Material	Gravimetric Water Content (%)
Crusher Stockpile	6.9
Pile 3	6.9
Pile 4	7.8
South Topsoil Pile	6.9
Topsoil/Overburden Pile	6.9
West Borrow/North Topsoil	5.1
West Borrow/Lobo Tract Mix	4.2
West Disturbance Area	6.9

### **Diffusion Coefficient**

The radon diffusion coefficient used in the RADON model can either be calculated based on an empirical relationship that depends on porosity and the degree of saturation or input directly in the model using values measured from laboratory testing. Due to limited laboratory test data, Stantec calculated diffusion coefficients within the RADON model; these are summarized in Table 4.

**Table 4: Estimated Radon Diffusion Coefficients** 

Material	Diffusion Coefficient (cm²/s)
Crusher Stockpile	0.0213
Pile 3	0.0213
Pile 4	0.0204
South Topsoil Pile	0.0239
Topsoil/Overburden Pile	0.0252
West Borrow/North Topsoil	0.0393
West Borrow/Lobo Tract Mix	0.0442
West Disturbance Area	0.0213

# **MODEL RESULTS**

The radon emanation modeling results show that the designed cover systems (presented in Table 5) will reduce radon emanation to values not exceeding 20 pCi/m²-s averaged over the entire area of the tailings impoundments, which is the regulatory criterion (NRC, 2017). Attachment F.1.2 provides a complete table of model input parameters and Attachment F.1.3 shows the RADON model output files.

**Table 5: Summary of Results** 

Facility	Cover Material	Cover Thickness (ft)	Cover Thickness (cm)	Surface Ra-226 Emanation (pCi/m²/s)
Pit 1	North Topsoil (4") & West Borrow (20")	2.0	61.0	16.2
Pit 2	West Borrow	2.0	61.0	3.8
Pile 4	West Borrow/Lobo Tract	2.6	79.3	20.0

# **REFERENCES**

- Cedar Creek Associates, Inc. (Cedar Creek), 2018. St. Anthony Mine: 2018 Revegetation Plan Update. December.
- Daniel B. Stephens & Associates, Inc. (DB Stephens), 2018. Laboratory Report for Stantec: St. Anthony Geotech Investigation. July 2.
- U.S. Nuclear Regulatory Commission (NRC), 2017. Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content, 10 CFR Part 40 Appendix A. August 29.
- U.S. Nuclear Regulatory Commission (NRC), 1984. Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, NUREG/CR-3533.
- U.S. Nuclear Regulatory Commission (NRC), 1989. Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers, Regulatory Guide 3.64.

# ATTACHMENT F.1.1 MATERIAL PARAMETERS ESTIMATION TABLES

	Pit 1									
			Lab Results			RADON Program Input Parameters				
Layer#	Material	Data Sample ID*	Moisture Content (%, g/g)	ρ <sub>d,max</sub> (g/cm <sup>3</sup> )	Porosity (%)	30th Percentile Moisture Content (%, g/g)	ρ <sub>d</sub> (g/cm³)	70th Percentile Porosity (%)	Ra-226 Activity (pCi/g)	
==, =:		TN-2 (20'A)	6.0	1.89	50.8	5, 5,		· · ·		
		BW-1 (30'A)			47.3					
1	North Topsoil/West Borrow (Cover)	BW-2 (10'A)	5.9	1.87	42.8	5.1	1.74	47.6	1.0	
		BW-3 (5'A)	3.8	1	38.9					
		T/O-1 (20'A)	11.4		35.6		1.70			
		T/O-1 (45'B)	7.2		42.9					
		T/O-2 (15'A)	11.3		38.6					
2	Topsoil/Overburden (Subsoil)	T/O-3 (15'B)	9.9	1.83	29.5	6.9		39.2	1.0	
	Topson/Overburden (Subson)	T/O-3 (40'B)	6.8	1.03	39.3	0.9	1.70	33.2	1.0	
		T/O-4 (5'A)	8.9		30.0					
		T/O-5 (20'A)	6.3		43.1					
		T/O-6 (5'A)	6.9		34.1					
3	West Disturbance Area (Waste)	-				6.9	1.86	37.6	117.0	
4	Crusher Stockpile (Waste)	-				6.9	1.86	37.6	98.1	

<sup>\*</sup>TN = North Topsoil, BW = West Borrow, T/O = Topsoil/Overburden

			Pit 2						
		Lab Results RADON Program Inp					Program Inpu	ut Parameters	
Layer#	Material	Data Sample ID*	Moisture Content (%, g/g)	ρ <sub>d,max</sub> (g/cm <sup>3</sup> )	_	30th Percentile Moisture Content (%, g/g)	ρ <sub>d</sub> (g/cm³)	70th Percentile Porosity (%)	Ra-226 Activity (pCi/g)
		TN-2 (20'A)	6.0	1.89	50.8				
1	West Borrow (Cover)	BW-1 (30'A)			47.3	5.1	1.74	47.6	1.0
1	west Bollow (Cover)	BW-2 (10'A)	5.9	1.87	42.8	] 3.1	1.74	47.0	1.0
		BW-3 (5'A)	3.8		38.9				
		TS-1 (5'A)	7.8		30.8				
2	South Topsoil (Subsoil)	TS-2 (15'A)	8.9	1.92	39.6	6.9	1.79	39.3	1.0
		TS-3 (10'A)	6.0		39.3				
		TS-4 (10'A)	7.0		25.4				
		P3-1 (5'A)	7.3		29.7				
		P3-1 (15'A)	9.4		64.8				
		P3-2 (10'A)	6.6	  -	36.2				
		P3-2 (20'A)	11.3		37.1				
		P3-3 (20'A)	8.1		36.2				
		P3-3 (40'A)	14.7		32.3				20.6
3	Pile 3 (Waste)	P3-4 (10'A)	9.3	2.00	41.8	6.9	1.86	37.6	
		P3-4 (30'A)	6.0		42.4				
		P3-4 (40'A)	7.1		29.3				
		P3-5 (10'A)	8.3		30.0				
		P3-6 (5'A)	4.8	]	38.4				
		P3-6 (20'A)	9.3		34.8				
		P3-6 (50'A)	6.0		33.1				

<sup>\*</sup>TN = North Topsoil, BW = West Borrow, TS = South Topsoil, P3 = Pile 3

	Pile 4								
			Lab Results			RADON Program Input Parameters			
Layer#	Material	Data Sample ID*	Moisture Content (%, g/g)	ρ <sub>d,max</sub> (g/cm <sup>3</sup> )	Porosity (%)	30th Percentile Moisture Content (%, g/g)	ρ <sub>d</sub> (g/cm³)	70th Percentile Porosity (%)	Ra-226 Activity (pCi/g)
		TN-2 (20'A)	6.0	1.89	50.8				
		BW-1 (30'A)			47.3				
		BW-2 (10'A)	5.9	1.87	42.8			47.6	1.0
		BW-3 (5'A)	3.8		38.9	4.2	1.68		
		L1-1 (10'A)	6.3		47.6				
	West Borrow & Lobo Tract	L1-2 (20'B)			33.9				
1	Combination (Cover)	L1-3 (5'A)	4.2		43.4				
	combination (cover)	L1-4 (5'B)	7.5		46.7				
		L2-1 (5'B)	4.1	1.81	36.3				
		L2-1 (15'A)	5.0		34.4				
		L2-3 (5'A)	3.8		39.3				
		L2-5 (5'B)			36.6				
		L2-6 (10'B)			41.3				
		P4-5 (20'A)	7.3		34.4				20.5
		P4-6 (10'A)	10.0		40.2				
2	Pile 4 (Waste)	P4-7 (5'A)	9.8	2.05	43.7	7.8	1.84	39.9	
		P4-7 (25'B)	6.2		33.5				
		P4-8 (15'B)	13.0		38.9				

<sup>\*</sup>TN = North Topsoil, BW = West Borrow, L1 = Lobo Tract (West), L2 = Lobo Tract (East), P4 = Pile 4

# ATTACHMENT F.1.2 MATERIAL PARAMETERS AND RESULTS TABLE

Facility	Layer No.	Material	Porosity	ρ <sub>d</sub> (g/cm³)	Ra-226 Activity (pCi/g)	Emanation Coefficient <sup>(4)</sup>	Moisture Content (%, g/g)	Layer Thickness (cm)	Layer Thickness (ft)	Radon Emanation (pCi/m²/s)
	1	North Topsoil (4") West Borrow (20")	0.476	1.74	1	0.35	5.1	61.0	2.00	
Pit 1 <sup>(1)</sup>	2	Topsoil/Overburden	0.392	1.70	1	0.35	6.9	223	7.32	16.2
	3 <sup>(3)</sup>	West Disturbance Area	0.376	1.86	117	0.35	6.9	79.3	2.60	
	4	Crusher Stockpile	0.376	1.86	98.1	0.35	6.9	226	7.41	
	1	West Borrow (24")	0.476	1.74	1	0.35	5.1	61.0	2.00	
Pit 2	2	South Topsoil	0.393	1.79	1	0.35	6.9	243.8	8.00	3.8
	3	Pile 3	0.376	1.86	20.6	0.35	6.9	500	16.40	
Pile 4 <sup>(2)</sup>	1	West Borrow/Lobo Tract Mix	0.476	1.68	1	0.35	4.2	79.3	2.60	20.0
riie 4	2	Pile 4	0.399	1.84	20.5	0.35	7.8	500	16.40	20.0

<sup>(1)</sup> Pit 1 cover was modeled as a single 24" layer comprising 20" of West Borrow material and 4" of North Topsoil material

<sup>(2)</sup> Pile 4 cover was modeled using a fixed radon flux to determine the minimum required cover thickness

<sup>(3)</sup> Layer thickness includes Pit 1 Infill material from in-pit excavation (assumed to have similar material properties)

<sup>(4)</sup> NRC Regulatory Guide 3.64 default value of 0.35 was used for all materials

# ATTACHMENT F.1.3 RADON MODEL OUTPUTS

# Pit 1 Cover Radon Flux

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000 U.S. Nuclear Regulatory Commission Office of Research

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Pit 1 Cover Radon Flux

DESCRIPTION: Calculation of radon flux from covered Pit 1. Assumes 2-foot cover overlying 7+ feet of subsoil overlying impounded waste rock.

# **CONSTANTS**

RADON DECAY CONSTANT	. 0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	. 26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAIL	_I NGS	2. 65

#### GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	4	
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi I^-1
SURFACE FLUX PRECISION	. 001	pCi m^-2 s^-1

### LAYER INPUT PARAMETERS

# LAYER 1 Crusher Stockpile Waste Rock

THI CKNESS	226	CM
POROSI TY	. 376	
MEASURED MASS DENSITY	1. 86	g cm^-3
MEASURED RADIUM ACTIVITY	98. 1	g cm^-3 pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	
CALCULATED SOURCE TERM CONCENTRATION	3.567D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6. 9	%
MOISTURE SATURATION FRACTION	. 341	
CALCULATED DIFFUSION COEFFICIENT	2. 128D-02	cm^2 s^-1

# LAYER 2 West Disturbance Area Waste Rock

THI CKNESS POROSI TY	79. 3 . 376	CM
MEASURED MASS DENSITY	1. 86	g cm^-3
MEASURED RADIUM ACTIVITY	117	pCi /g^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	. 3
CALCULATED SOURCE TERM CONCENTRATION	4. 254D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6. 9	%
MOISTURE SATURATION FRACTION	. 341	
CALCULATED DIFFUSION COEFFICIENT	2. 128D-02	$cm^2 s^-1$

¥ LAYER 3 Topsoil Overburden Subsoil

### Pit 1 Cover Radon Flux

THI CKNESS	223	CM
POROSI TY	. 392	
MEASURED MASS DENSITY	1. 7	g cm^-3
MEASURED RADIUM ACTIVITY	1	pCi /g^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	. 0
CALCULATED SOURCE TERM CONCENTRATION	3. 187D-06	pCi cm $^-3$ s $^-1$
WEIGHT % MOISTURE	6. 9	<b>%</b>
MOISTURE SATURATION FRACTION	. 299	
CALCULATED DIFFUSION COEFFICIENT	2. 518D-02	cm^2 s^-1

# LAYER 4 Cover - 4" North Topsoil over 20" West Borrow

THI CKNESS	61	CM
POROSI TY	. 476	
MEASURED MASS DENSITY	1. 74	g cm^-3
MEASURED RADIUM ACTIVITY	1	g cm^-3 pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	. 3
CALCULATED SOURCE TERM CONCENTRATION	2. 687D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5. 1	%
MOISTURE SATURATION FRACTION	. 186	
CALCULATED DIFFUSION COEFFICIENT	3. 928D-02	$cm^2 s^-1$

# DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	I COST	CRI TJ	ACC	
4	-1. 000D+00	0. 000D+00	O	0. 000D+00	1. 000D-03	
LAYER	DX	D	P	0	XMS	RH0
1	2. 260D+02	2. 128D-02	3. 760D-01	3.567D-04	3. 413D-01	1. 860
2	7. 930D+01	2. 128D-02	3. 760D-01	4.254D-04	3. 413D-01	1. 860
3	2. 230D+02	2. 518D-02	3. 920D-01	3.187D-06	2. 992D-01	1. 700
4	6. 100D+01	3. 928D-02	4. 760D-01	2.687D-06	1. 864D-01	1. 740

BARE SOURCE FLUX FROM LAYER 1: 1.197D+02 pCi m^-2 s^-1

# RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi I^-1)
1	2. 260D+02	1. 992D+01	1. 284D+05
2	7. 930D+01	7. 780D+01	8. 236D+04
3	2. 230D+02	1. 708D+01	4. 828D+03
4	6. 100D+01	1. 624D+01	0. 000D+00

φ

# Pit 2 Cover Radon Flux ----\*\*\*\*! RADON ! \*\*\*\*\*----

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000 U.S. Nuclear Regulatory Commission Office of Research

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Pit 2 Cover Radon Flux

DESCRIPTION: Calculation of radon flux from covered Pit 2. Assumes 2-foot cover overlying 8 feet of subsoil overlying impounded waste rock.

# **CONSTANTS**

RADON DECAY CONSTANT	. 0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	. 26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAIL	_I NGS	2. 65

#### GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	3	
LAYER THICKNESS NOT OPTIMIZED DEFAULT SURFACE RADON CONCENTRATION	0	pCi   ^-1
SURFACE FLUX PRECISION	. 001	pCi m^-2 s^-1

### LAYER INPUT PARAMETERS

### LAYER 1 Pile 3 Waste Rock

THI CKNESS	500	CM
POROSI TY	. 376	
MEASURED MASS DENSITY	1. 86	g cm^-3
MEASURED RADIUM ACTIVITY	20. 6	pCi /g^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	. 3
CALCULATED SOURCE TERM CONCENTRATION	7. 490D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6. 9	%
MOISTURE SATURATION FRACTION	. 341	
CALCULATED DIFFUSION COEFFICIENT	2. 128D-02	cm^2 s^-1

# LAYER 2 South Topsoil Subsoil

THI CKNESS POROSI TY	243. 8 . 393	CM
MEASURED MASS DENSITY	1. 79	g cm^-3
MEASURED RADIUM ACTIVITY	1	pCi /q^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	1 3
CALCULATED SOURCE TERM CONCENTRATION	3. 348D-06	pCi cm $^-3$ s $^-1$
WEIGHT % MOISTURE	6. 9	%
MOISTURE SATURATION FRACTION	. 314	
CALCULATED DIFFUSION COEFFICIENT	2. 389D-02	$cm^2 s^-1$

¥ LAYER 3 West Borrow Cover

# Pit 2 Cover Radon Flux

THI CKNESS	61	CM
POROSI TY	. 476	
MEASURED MASS DENSITY	1. 74	g cm^-3
MEASURED RADIUM ACTIVITY	1	pCi /g^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	. 3
CALCULATED SOURCE TERM CONCENTRATION	2.687D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5. 1	<b>%</b>
MOISTURE SATURATION FRACTION	. 186	
CALCULATED DIFFUSION COEFFICIENT	3. 928D-02	cm^2 s^-1

# DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N 3	F01 -1. 000D+00	CN1 0. 000D+00	I COST O	CRI TJ 0. 000D+00	ACC 1. 000D-03	
LAYER	5. 000D+02	2. 128D-02		Q 7. 490D-05		
2 3				3. 348D-06 2. 687D-06		

BARE SOURCE FLUX FROM LAYER 1: 2.815D+01 pCi m^-2 s^-1

# RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THI CKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi I^-1)
1	5. 000D+02	1. 451D+01	1. 716D+04
2	2. 438D+02	3. 404D+00	1. 032D+03
3	6. 100D+01	3.824D+00	0. 000D+00

우

# Pile 4 Cover Thickness ----\*\*\*\*! RADON!\*\*\*\*----

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000 U.S. Nuclear Regulatory Commission Office of Research

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Pile 4 Cover Thickness

DESCRIPTION: Optimized cover thickness. Cover properties are based on combination of West Borrow and Lobo Tract materials. Input parameters include conservative values from those determined for each cover material.

#### CONSTANTS

RADON DECAY CONSTANT	. 0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	. 26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILI	NGS	2. 65

## GENERAL INPUT PARAMETERS

2	
20	pCi m^-2 s^-1
2	•
0	pCi I^-1
. 001	pCi m^-2 s^-1
	2

## LAYER INPUT PARAMETERS

#### LAYER 1 Pile 4 Waste Rock

THI CKNESS POROSI TY	500 . 399	CM
MEASURED MASS DENSITY	1. 84	g cm^-3
MEASURED RADIUM ACTIVITY	20. 5	pCi /g^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	
CALCULATED SOURCE TERM CONCENTRATION	6. 948D-05	pCi cm $^-3$ s $^-1$
WEIGHT % MOISTURE	7. 8	%
MOISTURE SATURATION FRACTION	. 360	
CALCULATED DIFFUSION COEFFICIENT	2. 038D-02	$cm^2 s^-1$

#### LAYER 2 Cover

THI CKNESS POROSI TY	76. 2 . 476	CM
MEASURED MASS DENSITY	1. 68	g_cm^-3
MEASURED RADIUM ACTIVITY	1	pCi /g^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	
CALCULATED SOURCE TERM CONCENTRATION	2. 594D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE MOISTURE SATURATION FRACTION	4. 2	%
CALCULATED DIFFUSION COEFFICIENT	. 148 4. 424D-02	cm^2 s^-1

## Pile 4 Cover Thickness

# DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N 2	F01 -1. 000D+00	CN1 0. 000D+00	I COST 2	CRI TJ 2. 000D+01	,	
LAYER	DX	D	Р	Q	XMS	RHO
1	5.000D+02	2.038D-02	3.990D-01	6. 948D-05		1.840
2	7. 620D+01	4. 424D-02	4.760D-01	2. 594D-06	1. 482D-01	1. 680

BARE SOURCE FLUX FROM LAYER 1: 2.714D+01 pCi m^-2 s^-1

# RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THI CKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi I^-1)
1	5. 000D+02	2. 205D+01	6. 369D+03
2	7. 927D+01	2. 002D+01	0. 000D+00

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# APPENDIX F.2: COVER EROSIONAL STABILITY ANALYSES

Revisioning						
Rev.	Date	Description	Ву	Checked	Date	
0	01/28/19	Draft for Internal Review	М. Карр	J. Cumbers / J. Erickson	01/29/19	

## **Location and Format**

Electronic copies of these calculations are located on the Stantec internal project teamsite.

The following calculations were generated using the following software: MS Excel

# 

#### Objective

This calculation sheet describes the erosional stability analyses associated with cover designs for Pit 1, Pit 2, and Pile 4 at the St. Anthony Mine.



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## **Background**

Stantec conducted erosional stability analyses as part of proposed cover design evaluations for Pit 1, Pit 2, and Pile 4. Pit 1 is to be covered with 4 inches of topsoil over 20 inches of soil cover, which overlays 7.3 feet of subsoil material. Pit 2 is to be covered with 20 inches of soil cover over 8.3 feet of subsoil material. Pile 4 is to be covered with 2.6 feet of soil cover. Each cover surface will be revegetated to enhance erosional stability. The uppermost potion of the cover will consist of material to promote vegetation establishment. For the purposes of these analyses, the cover soil for the proposed design will be obtained from on-site borrow sources and is assumed to have similar material properties as the site borrow materials. The slope selected as the most critical for evaluating erosional stability of Pile 4 is a 5H:1V slope, approximately 400 feet in length, located on the southwest portion of the proposed cover design, which is the longest slope of Pile 4, between downdrains. For Pits 1 and 2, Stantec selected the entire length of the proposed cover design slope for evaluation. The proposed cover design for Pit 1 includes a 10H:1V slope that is approximately 1,400 feet in length. Pit 2 proposed cover design includes a slope approximately 1,440 feet long at a 10H:1.5V slope. Figure 1 shows the proposed cover design geometries and slopes.

# **Applicable Codes and Standards**

Table 1 summarizes the slope conditions to be evaluated in the erosional stability analyses and the corresponding factor of safety (FS). These were adopted from NUREG 1623, Sections 2.2, 3.2, and Appendix A (Johnson, 2002).

#### **Methods**

#### **Temple Method**

Temple et al. (1987) outlines procedures for grass-lined channel design. These procedures are recommended in Johnson (2002) for areas of vegetated cover and include methods for estimating stresses on channel vegetation as well as the channel surface soils. The evaluation for the vegetated top cover slope used the peak discharge values from the 100-year design storm event (summarized in Attachment A) to represent the effective stresses from runoff on the cover surface. Calculations include the cases for poor and good vegetation establishment and include soil properties based on the laboratory data for the onsite borrow soils.

Stantec evaluated the erosional stability of the cover surface by calculating a factor of safety against erosion due to the peak runoff from the 100-year design storm event. Factor of safety values were calculated as the ratio of the allowable stresses (the resisting strength of the cover vegetation and soils) to the effective stresses (the stresses imparted by the runoff flowing over the cover). The surfaces were evaluated for two conditions: (1) resistance of poor vegetation, and (2) resistance of fair vegetation. The peak unit discharge flow for the top slope (from Table 1) was conservatively multiplied by a flow concentration factor of three (as outlined in Johnson, 2002).

## **Design Criteria**

The critical (lowest) calculated factor of safety for both fair and poorly vegetated ground conditions for Pit 1, Pit 2, and Pile 4 were evaluated. NRC design guidance includes a minimum acceptable factor of safety for allowable stress to effective stress on the soil of one or greater (FS >= 1) for any vegetation condition, using the probable maximum precipitation (PMP). For the purposes of this design, because a 100-year design storm is being applied, Stantec assumed a minimum required FS > 1.5 is applicable for the design.



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## **Time of Concentration**

Stantec determined slope ratios (horizontal:vertical) of Pit 1, Pit 2, and Pile 4 from design drawings for the backfilled pits and regraded pile and used design drawings to determine maximum slope lengths for the backfilled pits and regraded pile as inputs. Stantec then calculated time of concentration for Pit 1, Pit 2, and Pile 4 using the Kirpich equation as presented in NUREG/CR-4620 (Nelson et al., 1986). As recommended in NUREG/CR-4620 (Nelson et al., 1986), Stantec used a minimum time of concentration of 2.5 minutes.

## **Design Storm Event**

Stantec designed stormwater controls based on a design flood event for the storm with a 1 percent annual occurrence probability (1 in 100-year storm). The study also evaluated the 2-year, 5-year and 10-year storm events under the existing site conditions. Stantec estimated peak discharge values associated with the design flood events at each point of interest on the Site by simulating runoff hydrographs using a center peaking rainfall distribution that included the peak rainfall intensity for every 5-minute interval up to 24 hours.

## **Peak Unit Discharge**

- 1. Stantec determined maximum slope lengths for the side slopes and the top surface from the revised drawing of the disposal cell (Figure 1 attached).
- 2. Stantec calculated the time of concentration for the cover slopes by the Kirpich equation as presented in NUREG/CR-4620 (Nelson et al., 1986). As recommended in NUREG/CR-4620 (Nelson et al., 1986), Stantec used a minimum time of concentration of 2.5 minutes.
- 3. Stantec calculated the rainfall intensity based on time of concentration of a 100-year design storm event.
- 4. Peak unit discharge calculations used the Rational Method for each slope using a unit width analysis. The procedure used is as described in Johnson (2002) and Nelson et al. (1986).
- 5. Stantec selected the runoff coefficient of 0.6 based on surface type and vegetation and referenced values in NRC (1990).
- 6. The cover on the side slopes was represented with slopes of 1 percent (100:1) for Pit 1, 1.5 percent (100:1.5) for Pit 2, and 20 percent (5:1) for Pile 4.

## **Erosional Stability**

**Allowable stresses**. Stantec calculated allowable stresses for the cover soil using the equations in Temple et al. (1987). Material planned for the cover soil consists of on-site borrow material, therefore Stantec used properties of the sample materials in the analyses. For cohesive soils, erosional resistance is based on the plasticity index (PI) and void ratio of the material.

The equation for allowable shear strength for cohesive soils is:

$$\tau_a = \tau_{ab} C_e^2$$

where  $\tau_a$  = allowable shear strength (in psf)

 $\tau_{ab}$  = base allowable shear strength = 1.07\*PI2+14.3\*PI+47.7)\*0.0001 for 10<PI<20

 $C_e$  = void ratio correction factor = 1.48 - 0.57e, where e is the void ratio

For a vegetated surface primarily of mixed grasses, the allowable vegetation shear strength is:



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$$\tau_{va} = 0.75C_I$$

Where  $\tau_{va}$  = allowable vegetation shear strength (in psf)

 $C_1 = cover index = 2.5 [h(M)1/2]1/3$ 

h = stem length (in ft), 0.5 assumed for poor establishment 1.0 for good (average) establishment

M = stem density factor, 67 assumed for poor coverage, 200 for good (average) coverage

The vegetated shear strength was calculated for poor and fair vegetation conditions.

**Effective stresses**. The effective shear stress on soil due to peak runoff from the 100-year design storm event was calculated as:

$$\tau_e = \gamma dS (1 - C_f) (n_s/n)^2$$

Where  $\tau_e$  = effective shear stress (in psf)

 $\gamma$  = unit weight of water = 62.4 pounds per cubic foot (pcf)

d = depth of flow (ft)

S = slope of cover surface (ft/ft), from Table 1

 $C_f$  = cover factor (0.375 for poor, 0.750 for good)

n<sub>s</sub> = soil grain roughness factor (0.0156 for cohesive soil), and

n = Manning's roughness coefficient for vegetated surface

$$n = e^{C_i (0.0133[\ln q]^2 - 0.0954 \ln q + 0.297) - 4.16}$$

The effective shear stress on vegetation is calculated as:

$$\tau_v = \gamma dS - \tau_e$$

Where  $\tau_v$  = effective vegetal stress (in psf)

## **Factor of Safety**

The factor of safety for soil erosion and vegetation stability were calculated as:

$$FS_{soil} = \frac{\tau_a}{\tau_e}$$

$$FS_{veg} = \frac{\tau_{va}}{\tau_v}$$

Where FS = factor of safety against erosion

## **Material Properties**

Material parameters for the erosional stability analyses were based on proposed borrow source material parameters collected from the 2018 field investigation. Table 1 summarizes the parameters for each material.

Pile 4 cover will consist of material excavated from all borrow areas. Combining data from these borrow sources, this material was assigned a dry unit weight of 104.8 pounds per cubic foot, which was calculated from Proctor results.



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Specific gravity was estimated to be 2.65. A plasticity index value of 10 percent was selected using Atterberg limit results from both borrow sources. Void ratio was calculated using the assigned dry unit weight, estimated specific gravity, and unit weight of water. Lastly, the  $D_{75}$  value was selected to be 0.004 inches based on the average result of mechanical analyses of all borrow area soils.

Pit 1 and Pit 2 cover will consist of material excavated from North Topsoil and West Borrow areas. Combining data from these borrow sources, this material was assigned a dry unit weight of 108.6 pounds per cubic foot, which was calculated from Proctor results. Specific gravity was estimated to be 2.65. A plasticity index value of 10 percent was selected using Atterberg limit results from both borrow sources. Void ratio was calculated using the assigned dry unit weight, estimated specific gravity, and unit weight of water. Lastly, the D<sub>75</sub> value was selected to be 0.005 inches based on the average result of mechanical analyses of the North Topsoil and Borrow West soils.

**Dry Unit Specific Plasticity** Calculated **Void Ratio**  $D_{75}^{(1)}$ Weight Gravity Index Material (pcf) (%) (in.) Pile 4 104.8 2.65 10 0.58 0.004 Pit 1 and Pit 2 108.6 2.65 10 0.52 0.005

**Table 1. Soil Properties** 

# **Calculation Inputs**

Table 2 presents the time of concentration for Pit 1, Pit 2, and Pile 4. The time of concentration represents the time it takes for runoff in the upstream extents of the watershed to reach the design point of interest, or basin outlet. Table 3 summarizes the 100-year design storm characteristics.

Description	Slope (ft/ft)	Slope Length (ft)	Calculated T <sub>c</sub> (min)	T <sub>c</sub> used to calculate rainfall intensity (min)
Pile 4	0.20	400	1.46	2.50
Pit 1	0.01	1400	12.15	12.15
Pit 2	0.015	1440	10.62	10.62

Table 2. Time of concentration summary

Table 3. 100-year Design Storm Summary

	Pile 4	Pit 1	Pit 2
Annual Recurrence :	1/100	1/100	1/100
Duration (min) :	2.50	12.15	10.62
Intensity (in/hr) :	8.8	5.2	5.5

Table 4 presents the peak unit discharge result for Pit 1, Pit 2, and Pile 4. The discharge represents downslope flow for a unit-width of the slope. Calculations are attached.

<sup>(1)</sup> Diameter for which 75% of the material is finer



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## Table 4. Peak unit discharge summary

Description	Slope (ft/ft)	Slope Length (ft)	Calculated Time of Concentration (min)	Peak Unit Discharge (cfs)	Design Discharge (cfs)
Pile 4	0.20	400	2.5	0.049	0.147
Pit 1	0.01	1400	12.15	0.101	0.304
Pit 2	0.015	1440	10.62	0.111	0.333

#### Results

Calculation output sheets are included as Attachment A. Table 5 presents a summary of the calculated factors of safety.

Table 5. Summary of Calculated Factors of Safety for Erosional and Vegetation Stability on Vegetated Slopes

	Soil Erosional Stability		Veç	etation Stab	etation Stability	
	Pit 1	Pit 2	Pile 4	Pit 1	Pit 2	Pile 4
Poor Vegetation	5.2	3.5	1.6	13.8	10.2	2.0
Fair Vegetation	16.0	10.5	5.8	13.0	9.6	1.8

# Conclusions

Based on the erosional stability analyses using the methods and material parameters presented above, the representative slope lengths of Pit 1, Pit 2, and Pile 4 exceed the required minimum factor of safety requirements for the 100-year design storm having poor and fair vegetation. Stantec anticipates that the Pile 4 slopes between the downdrains will require active maintenance following large storm events until vegetation is established.

## **Attachments**

Figure 1 – Pit 1, Pit 2, and Pile 4 Cover Slopes Attachment F.2.1 – Factor of Safety Calculations

#### References

Johnson, T.L., 2002. "Design of Erosion Protection for Long-Term Stabilization." U.S. Nuclear Regulatory Commission (NRC), NUREG-1623. September.

Nelson, J., S. Abt, R. Volpe, D. van Zyl, N. Hinkle, and W. Staub, 1986. "Methodologies for Evaluation of Long-term Stabilization Designs of Uranium Mill Tailings Impoundments." NUREG/CR-4620, U.S. Nuclear Regulatory Commission, June.

# **CALCULATIONS**



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Project:St. Anthony Mine Closeout PlanDate:January 30, 2019Description:Cover Erosional StabilityJob No:233001076

Temple, D.M., K.M. Robinson, R.A. Ahring, and A.G. Davis, 1987. "Stability Design of Grass-Lined Open Channels." USDA Handbook 667.

U.S. Nuclear Regulatory Commission (NRC), 1990. Final Staff Technical Position Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites. August.

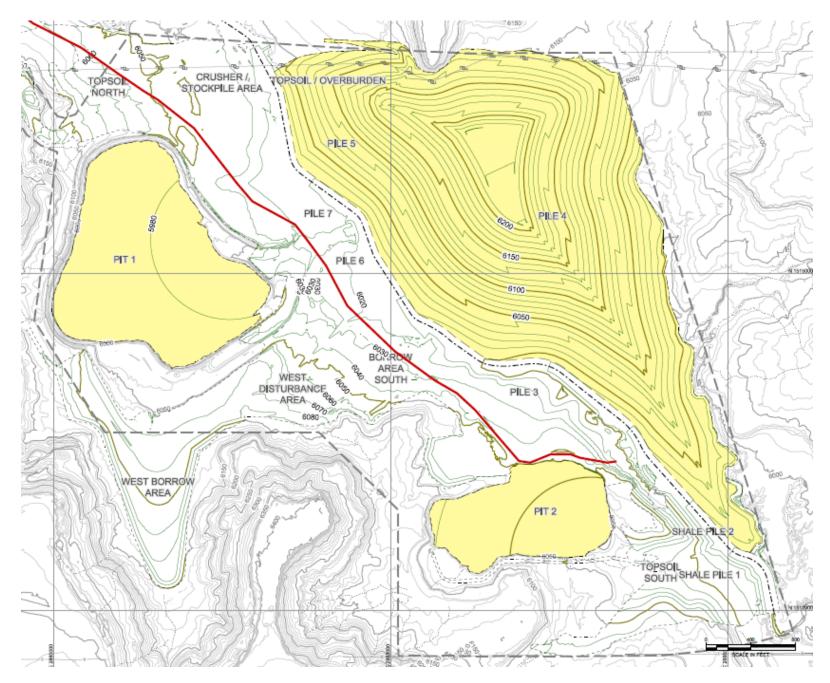


Figure 1. Pit 1, Pit 2, and Pile 4 Cover Slopes

# ATTACHMENT F.2.1 FACTOR OF SAFETY CALCULATIONS

**Project:** St. Anthony Mine

**Detail:** Pile 4 Regrade - Cover Slopes , Erosional Stability

**Job No.:** 233001076 **Date:** 9/12/2018

Calc. By: J. Cumbers/M. Kapp

Checked By: J. Erickson

Description	Slope (ft/ft)	Slope Length (ft)	Calculated T <sub>c</sub> (min)	T <sub>c</sub> used to calculate rainfall intensity (min)
Pile 4	0.200	400	1.46	2.50
Pit 1	0.010	1400	12.15	12.15
Pit 2	0.015	1440	10.62	10.62

# References

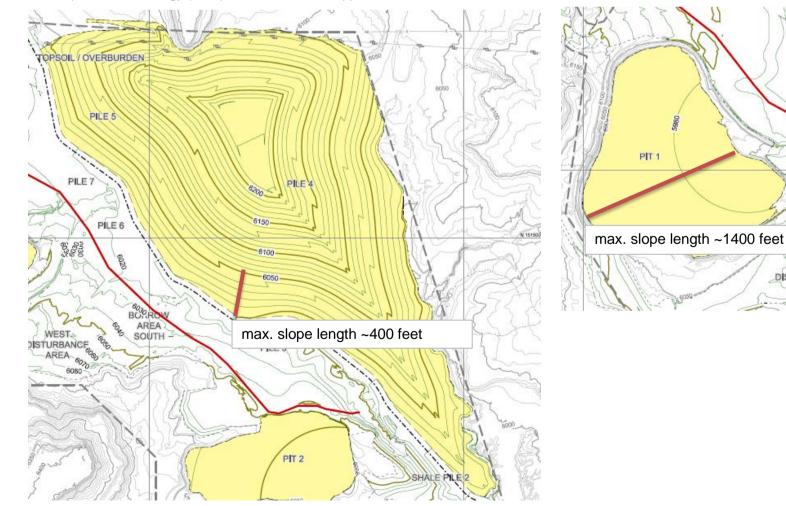
Source: Kirpich (1940) as presented in NUREG CR-4620

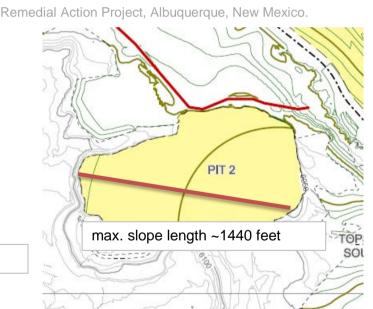
Formula:  $t_c$ =0.00013\*L^0.77/S^0.385 with L in feet,  $t_c$  in hours

Minimum  $T_c = 2.5$  minutes based on recommendation on pg. 12 of NUREG CR-4620 (Nelson et al., 1986)

Nelson, J., S. Abt, R. Volpe, D. van Zyl, N. Hinkle, and W. Staub, 1986. "Methodologies for Evaluation of Long-term Stabilization Designs of Uranium Mill Tailings Impoundments." NUREG/CR-4620, U.S. Nuclear Regulatory Commission, June.

U.S. Department of Energy (DOE), 1989. Technical Approach Document, Revision II, UMTRA-DOE/AL 050425.0002, Uranium Mill Tailings Remedial Action Project, Albuquerque, New Mexico.





WEST DISTURBANG AREA

# St. Anthony Design Storms

Intensity (in/hr)	1/2	1/5	10	25	50	1/100	1/200	1/500	1/1000
5	2.69	3.9	4.72	5.77	6.58	7.44	8.3	9.46	10.4
10	2.05	2.96	3.59	4.39	5	5.65	6.3	7.2	7.92
15	1.69	2.45	2.96	3.63	4.12	4.68	5.24	5.96	6.52
30	1.14	1.65	2	2.44	2.78	3.14	3.52	4	4.4
60	0.71	1.02	1.24	1.51	1.72	1.95	2.17	2.48	2.72
120	0.41	0.58	0.71	0.87	0.99	1.13	1.27	1.46	1.61
180	0.29	0.4	0.49	0.59	0.68	0.77	0.87	1	1.1
360	0.16	0.23	0.27	0.32	0.37	0.41	0.46	0.52	0.57
720	0.09	0.12	0.15	0.18	0.2	0.22	0.24	0.27	0.3
1440	0.05	0.07	0.08	0.09	0.11	0.12	0.13	0.15	0.16

	Pile 4	Pit 1	Pit 2
Annual Recurrence	1/100	1/100	1/100
Duration (min):	2.50	12.15	10.62
С	88.79	88.79	88.79
е	0.89	0.89	0.89
f	7.77	7.77	7.77
Intensity (in/hr):	8.85	5.2	5.5

<b>IDF</b> Fitting	С	е	f
1/2	32.168	0.8903	7.8226
1/5	46.998	0.895	7.8636
10	57.275	0.8961	7.9534
25	70.558	0.8981	8.0195
50	78.29	0.8924	7.7297
1/100	88.785	0.8921	7.768
1/200	100.21	0.8939	7.8952
1/500	113.35	0.8918	7.8198
1/1000	120.75	0.8847	7.4822

# References

Calculation information can be found in Appendix E

$$i = \frac{c}{T_d^e + f}$$

Where:

i = The design rainfall i  $T_d$  = The storm duration c, e, f = Fitting parameters

The design rainfall intensity (mm/hr)
The storm duration of the specific return period

**Project:** St. Anthony Mine

**Detail:** Pile 4 Regrade - Cover Slopes , Erosional Stability

**Job No.:** 233001076.000000

**Date:** 9/12/2018

Calc. By: J. Cumbers/M. Kapp

Checked By: J. Erickson

# **UNIT DISCHARGE RUNOFF CALCULATIONS**

Description	Slope Length (ft)	T <sub>c</sub> used to calculate rainfall intensity (min)	Rainfall Intensity (in/hr)	Peak Unit Discharge (cfs) for a one-foot width	Peak Unit Discharge (cfs) for a one-foot width used for erosion analyses
Pile 4	400	2.50	8.85	0.049	0.049
Pit 1	1400	12.15	5.21	0.101	0.101
Pit 2	1440	10.62	5.55	0.111	0.111

Unit Discharge Notes/References

Incremental rainfall duration percentage of one-hr PMP, NUREG CR-4620 (Table 2.1) and DOE 1989 (Table 4.1)

Calculated. DOE, 1989. Equation (2), page 66.

0.6 Runoff Coefficient, C NRC, 1990

2.5 Minimum T<sub>c</sub> (min) Recommendation on pg. 12 of NUREG CR-4620 (Nelson et al., 1986)

Peak Unit Discharge, q=CIAw

C and I defined above, Aw=Unit width or slope length times a 1-foot width

# References

Nelson, J., S. Abt, R. Volpe, D. van Zyl, N. Hinkle, and W. Staub, 1986. "Methodologies for Evaluation of Long-term Stabilization Designs of Uranium Mill Tailings Impoundments." NUREG/CR-4620, U.S. Nuclear I U.S. Department of Energy (DOE), 1989. Technical Approach Document, Revision II, UMTRA-DOE/AL 050425.0002, Uranium Mill Tailings Remedial Action Project, Albuquerque, New Mexico.

U.S. Nuclear Regulatory Commission (NRC), 1990. Final Staff Technical Position Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites.. August 1990.

**Project:** St. Anthony Mine

**Detail:** Pile 4 Regrade - Cover Slopes , Erosional Stability (poor vegetation)

Job No.: 233001076

Date: 9/12/2018

Calc. By: J. Cumbers/M. Kapp

Checked By: J. Erickson

# **TEMPLE METHOD FOR EROSION OF VEGETATED SLOPES**

# Notes:

# **Slope Geometry**

5 Top Slope, (Xhoriz:1vert) 0.200 Cover Surface Grade, S<sub>0</sub> (ft/ft)

11.3 Slope Angle,  $\theta_0$  (deg) 400 Original Slope Length,  $L_0$  (ft)

**Flow Characteristics** 

0.049 Design Flow (cfs/ft)3 Concentration Factor, F

0.147 Concentrated Design Flow, Q (cfs/ft)

**Cover Soil Properties** 

10 Plasticity Index, PI104.8 Dry Density (pcf)2.65 Specific Gravity

0.578 Calculated Void ratio

0.004 Diameter for which 75% of the Material is Finer, d<sub>75</sub> (in)

Design geometry

Calculated from design geometry
Calculated from design geometry
Calculated from design geometry

Calculated. DOE, 1989. Equation (3), page 66.

As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3. Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB. Calculated from Proctor tests on samples from Lobo and West Borrow

Estimate Calculated

from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.5 Representative Stem Length, h<sub>stem</sub> (ft)

67 Representative Stem Density, M<sub>stem</sub> (stems/ft<sup>2</sup>)

0.375 Cover Factor, C<sub>f</sub>

Lower bound stem length for proposed cover vegetation, assumes poor establishment (see existing conditions photo right)

Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with poor coverage selected to represent established cover vegetation.

Estimated after vegetation is established, Temple 1987 (Table 3.1), poor assumed 50% reduction of grass mixture factors

Other

62.4 Unit Weight of Water,  $\gamma_w$  (pcf)

# **CALCULATIONS**

4.00 Retardance Curve Index, C<sub>i</sub>

3.00 Allowable Shear Stress on Vegetation,  $t_{va}$  (psf) 0.0190 base allowable tractive shear stress (psf)  $t_{ab}$  (psf)

1.07 void ratio correction factor, C<sub>e</sub>

0.0217 Allowable Shear Stress on Soil of Vegetated Slope, ta (psf)

0.0156 Manning's coefficient for the soil particles, n<sub>s</sub>
0.1289 Manning's Coefficient for Vegetated Conditions, n

0.119 Assumed Depth of Flow, d (ft)

0.147 q (cfs/ft), with veg 0.000 qcalc - qdesign

1.24 Average Flow Velocity, V (ft/sec)

0.0136 Effective Stress on the Soil,  $t_{\rm e}$  (psf)

1.47 Effective Stress on the Vegetation, t<sub>ve</sub> (psf)

1.6 Ratio of Allowable Stress to Effective Stress on Soil, FS<sub>soil</sub>

2.0 Ratio of Allowable Stress to Effective Stress on Veg., FS<sub>veg</sub>

Calculated per Temple et. al., 1987. Equation 1.3

Calculated per Temple et. al., 1987. Equation 1.17

Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with  $10 \le PI \le 20$ 

Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML

Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.

Per Temple et. al., 1987. For cohesive soils Calculated per Temple et. al., 1987. Equation 4.1a

Iterate d until q calculated equals q design

q calculated

Iterate d until q calculated equals q design

Calculated as q/d

Calculated per Temple et. al., 1987. Equation 4.3a Calculated per Temple et. al., 1987. Equation 4.9a

Calculated

Calculated

# References

**Project:** St. Anthony Mine

**Detail:** Pile 4 Regrade - Cover Slopes , Erosional Stability (fair vegetation)

Job No.: 233001076

Date: 9/12/2018

Calc. By: J. Cumbers/M. Kapp

Checked By: J. Erickson

# **TEMPLE METHOD FOR EROSION OF VEGETATED SLOPES**

# Notes:

# **Slope Geometry**

5 Top Slope, (Xhoriz:1vert) 0.200 Cover Surface Grade, S<sub>0</sub> (ft/ft)

11.3 Slope Angle,  $\theta_0$  (deg)
400 Original Slope Length,  $L_0$  (ft)

**Flow Characteristics** 

0.049 Design Flow (cfs/ft)

3 Concentration Factor, F

0.147 Concentrated Design Flow, Q (cfs/ft)

**Cover Soil Properties** 

10 Plasticity Index, PI 104.8 Dry Density (pcf) 2.65 Specific Gravity

0.578 Calculated Void ratio

0.004 Diameter for which 75% of the Material is Finer, d<sub>75</sub> (in)

Calculated. DOE, 1989. Equation (3), page 66.
As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3.

Design geometry

Calculated from design geometry

Calculated from design geometry

Calculated from design geometry

Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.

Calculated from Proctor tests on samples from Lobo and West Borrow Estimate
Calculated

from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.75 Representative Stem Length, h<sub>stem</sub> (ft)

133 Representative Stem Density, M<sub>stem</sub> (stems/ft²)

0.6 Cover Factor, C<sub>f</sub>

Stem length for proposed cover vegetation, assumes fair establishment

Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with fair coverage selected to represent established cover vegetation. Estimated after vegetation is established, Temple 1987 (Table 3.1), fair assumed 20% reduction of grass cover factor

Other

62.4 Unit Weight of Water,  $\gamma_w$  (pcf)

# **CALCULATIONS**

5.13 Retardance Curve Index, Ci

3.85 Allowable Shear Stress on Vegetation, t<sub>va</sub> (psf)

0.0190 base allowable tractive shear stress (psf)  $t_{ab}$  (psf)

1.07 void ratio correction factor,  $C_e$ 0.0217 Allowable Shear Stress on Soil of Vegetated Slope,  $t_a$  (psf)

0.0156 Manning's coefficient for the soil particles, n<sub>s</sub>

0.2351 Manning's Coefficient for Vegetated Conditions, n

0.170 Assumed Depth of Flow, d (ft)

0.147 q (cfs/ft), with veg

0.000 qcalc - qdesign

0.87 Average Flow Velocity, V (ft/sec)

0.0037 Effective Stress on the Soil, t<sub>e</sub> (psf)

2.12 Effective Stress on the Vegetation, t<sub>ve</sub> (psf)

5.8 Ratio of Allowable Stress to Effective Stress on Soil, FS<sub>soil</sub>

1.8 Ratio of Allowable Stress to Effective Stress on Veg., FS<sub>veg</sub>

Calculated per Temple et. al., 1987. Equation 1.3

Calculated per Temple et. al., 1987. Equation 1.17

Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with  $10 \le PI \le 20$  Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML

Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, N

Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.

Per Temple et. al., 1987. For cohesive soils

Calculated per Temple et. al., 1987. Equation 4.1a

Iterate d until q calculated equals q design

q calculated

Iterate d until q calculated equals q design

Calculated as q/d

Calculated per Temple et. al., 1987. Equation 4.3a Calculated per Temple et. al., 1987. Equation 4.9a

Calculated
Calculated

# References

**Project:** St. Anthony Mine

**Detail:** Pit 1 Regrade - Cover Slopes. Erosional Stability (poor vegetation)

Job No.: 233001076 Date: 9/12/2018

Calc. By: J. Cumbers/M. Kapp

Checked By: J. Erickson

# **TEMPLE METHOD FOR EROSION OF VEGETATED SLOPES**

# Notes:

# **Slope Geometry**

100 Top Slope, (Xhoriz:1vert)

0.010 Cover Surface Grade, S<sub>0</sub> (ft/ft)0.6 Slope Angle, θ<sub>0</sub> (deg)

1400 Original Slope Length, L<sub>0</sub> (ft)

**Flow Characteristics** 

0.101 Design Flow (cfs/ft)3 Concentration Factor, F

0.3038 Concentrated Design Flow, Q (cfs/ft)

**Cover Soil Properties** 

10 Plasticity Index, PI 108.6 Dry Density (pcf) 2.65 Specific Gravity

0.523 Calculated Void ratio

0.005 Diameter for which 75% of the Material is Finer, d<sub>75</sub> (in)

Vegetation

0.5 Representative Stem Length, h<sub>stem</sub> (ft)

67 Representative Stem Density, M<sub>stem</sub> (stems/ft<sup>2</sup>)

0.375 Cover Factor, C<sub>f</sub>

Other

62.4 Unit Weight of Water,  $\gamma_w$  (pcf)

**CALCULATIONS** 

4.00 Retardance Curve Index, C<sub>i</sub>

3.00 Allowable Shear Stress on Vegetation, t<sub>va</sub> (psf)

0.0190 base allowable tractive shear stress (psf)  $t_{ab}$  (psf)

1.10 void ratio correction factor,  $C_{\rm e}$ 

0.0231 Allowable Shear Stress on Soil of Vegetated Slope,  $t_a$  (psf)

0.0156 Manning's coefficient for the soil particles, n<sub>s</sub>0.0868 Manning's Coefficient for Vegetated Conditions, n

0.354 Assumed Depth of Flow, d (ft)

0.304 q (cfs/ft), with veg 0.000 qcalc - qdesign

0.86 Average Flow Velocity, V (ft/sec)

0.0045 Effective Stress on the Soil,  $t_{\rm e}$  (psf) 0.22 Effective Stress on the Vegetation,  $t_{\rm ve}$  (psf)

5.2 Ratio of Allowable Stress to Effective Stress on Soil, FS<sub>soil</sub>

13.8 Ratio of Allowable Stress to Effective Stress on Veg., FS<sub>veg</sub>

Design geometry

Calculated from design geometry

Calculated from design geometry

Calculated from design geometry

Calculated. DOE, 1989. Equation (3), page 66.

As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3. Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.

Calculated from Proctor tests on samples from Lobo and West Borrow Estimate
Calculated

from particle-size for Lobo and Borrow West, median from 15 results

Lower bound stem length for proposed cover vegetation, assumes poor establishment (see existing conditions photo right)

Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with poor coverage selected to represent established cover vegetation.

Estimated after vegetation is established, Temple 1987 (Table 3.1), poor assumed 50% reduction of grass mixture factors

Calculated per Temple et. al., 1987. Equation 1.3

Calculated per Temple et. al., 1987. Equation 1.17

Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with  $10 \le PI \le 20$ 

Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML

Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.

Per Temple et. al., 1987. For cohesive soils Calculated per Temple et. al., 1987. Equation 4.1a

Iterate d until q calculated equals q design

q calculated

Iterate d until q calculated equals q design

Calculated as q/d

Calculated per Temple et. al., 1987. Equation 4.3a Calculated per Temple et. al., 1987. Equation 4.9a

Calculated
Calculated

# References

Temple, D.M., K.M. Robinson, R.M. Ahring, and A.G. Davis. 1987. Stability Design of Grass-Lined Open Channels. U.S. Department of Agriculture, Agric

**GE/UNC** Client:

**Project:** St. Anthony Mine

Detail: Pit 1 Regrade - Cover Slopes. Erosional Stability (fair vegetation)

Job No.: 233001076 Date: 9/12/2018

Calc. By: J. Cumbers/M. Kapp Checked By: J. Erickson

# TEMPLE METHOD FOR EROSION OF VEGETATED SLOPES

# Notes:

# **Slope Geometry**

100 Top Slope, (Xhoriz:1vert)

0.010 Cover Surface Grade, S<sub>0</sub> (ft/ft) 0.6 Slope Angle,  $\theta_0$  (deg) 1400 Original Slope Length, L<sub>0</sub> (ft)

Flow Characteristics

0.101 Design Flow (cfs/ft) 3 Concentration Factor, F

0.3038 Concentrated Design Flow, Q (cfs/ft)

**Cover Soil Properties** 

10 Plasticity Index, Pl 108.6 Dry Density (pcf) 2.65 Specific Gravity

0.523 Calculated Void ratio

0.005 Diameter for which 75% of the Material is Finer,  $d_{75}$  (in)

Calculated. DOE, 1989. Equation (3), page 66.

Design geometry

Calculated

Calculated from design geometry

Calculated from design geometry

Calculated from design geometry

As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3. Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.

Calculated from Proctor tests on samples from Lobo and West Borrow Estimate

Calculated per Temple et. al., 1987. Equation 1.3

Calculated per Temple et. al., 1987. Equation 1.17

Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.

Calculated per Temple et. al., 1987. Equation 4.1a

Per Temple et. al., 1987. For cohesive soils

Iterate d until q calculated equals q design

Iterate d until q calculated equals q design

from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.75 Representative Stem Length, h<sub>stem</sub> (ft)

133 Representative Stem Density, M<sub>stem</sub> (stems/ft<sup>2</sup>)

0.6 Cover Factor, C<sub>f</sub>

Stem length for proposed cover vegetation, assumes fair establishment

Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with  $10 \le Pl \le 20$ 

Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML

Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with fair coverage selected to represent established cover vegetation. Estimated after vegetation is established, Temple 1987 (Table 3.1), fair assumed 20% reduction of grass cover factor

Other

62.4 Unit Weight of Water,  $\gamma_w$  (pcf)

# **CALCULATIONS**

5.13 Retardance Curve Index, C<sub>i</sub>

3.85 Allowable Shear Stress on Vegetation, tva (psf)

0.0190 base allowable tractive shear stress (psf) t<sub>ab</sub> (psf)

1.10 void ratio correction factor, C<sub>e</sub>

0.0231 Allowable Shear Stress on Soil of Vegetated Slope, t<sub>a</sub> (psf)

0.0156 Manning's coefficient for the soil particles, n<sub>s</sub> 0.1416 Manning's Coefficient for Vegetated Conditions, n

0.475 Assumed Depth of Flow, d (ft)

0.304 q (cfs/ft), with veg

0.64 Average Flow Velocity, V (ft/sec)

0.0014 Effective Stress on the Soil, t<sub>e</sub> (psf) 0.30 Effective Stress on the Vegetation, t<sub>ve</sub> (psf)

0.000 qcalc - qdesign

Calculated as q/d

q calculated

Calculated per Temple et. al., 1987. Equation 4.3a Calculated per Temple et. al., 1987. Equation 4.9a

16.0 Ratio of Allowable Stress to Effective Stress on Soil, FS<sub>soil</sub> 13.0 Ratio of Allowable Stress to Effective Stress on Veg., FS<sub>veq</sub> Calculated Calculated

# References

**GE/UNC** Client:

**Project:** St. Anthony Mine

Detail: Pit 2 Regrade - Cover Slopes. Erosional Stability (poor vegetation)

Job No.: 233001076 Date: 9/12/2018

Calc. By: J. Cumbers/M. Kapp Checked By: J. Erickson

# TEMPLE METHOD FOR EROSION OF VEGETATED SLOPES

# Notes:

# **Slope Geometry**

100 Top Slope, (Xhoriz:1.5vert)

0.015 Cover Surface Grade, S<sub>0</sub> (ft/ft) 0.9 Slope Angle,  $\theta_0$  (deg) 1440 Original Slope Length, L<sub>0</sub> (ft)

Flow Characteristics

0.111 Design Flow (cfs/ft)

3 Concentration Factor, F

0.3329 Concentrated Design Flow, Q (cfs/ft)

**Cover Soil Properties** 

10 Plasticity Index, PI 108.6 Dry Density (pcf)

2.65 Specific Gravity

0.523 Calculated Void ratio

0.005 Diameter for which 75% of the Material is Finer,  $d_{75}$  (in)

Calculated from design geometry

Calculated from design geometry

Calculated from design geometry

Design geometry

Calculated. DOE, 1989. Equation (3), page 66.

As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3. Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.

Calculated from Proctor tests on samples from Lobo and West Borrow

Estimate Calculated

from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.5 Representative Stem Length, h<sub>stem</sub> (ft)

67 Representative Stem Density, M<sub>stem</sub> (stems/ft<sup>2</sup>)

0.375 Cover Factor, C<sub>f</sub>

Lower bound stem length for proposed cover vegetation, assumes poor establishment (see existing conditions photo right) Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with poor coverage selected to represent established cover vegetation. Estimated after vegetation is established, Temple 1987 (Table 3.1), poor assumed 50% reduction of grass mixture factors

Other

62.4 Unit Weight of Water,  $\gamma_w$  (pcf)

# **CALCULATIONS**

4.00 Retardance Curve Index, Ci

3.00 Allowable Shear Stress on Vegetation, tva (psf)

0.0190 base allowable tractive shear stress (psf) t<sub>ab</sub> (psf)

1.10 void ratio correction factor, C<sub>e</sub>

0.0231 Allowable Shear Stress on Soil of Vegetated Slope, t<sub>a</sub> (psf)

0.0829 Manning's Coefficient for Vegetated Conditions, n

0.323 Assumed Depth of Flow, d (ft)

0.333 q (cfs/ft), with veg

0.000 qcalc - qdesign

1.03 Average Flow Velocity, V (ft/sec)

0.0067 Effective Stress on the Soil, t<sub>e</sub> (psf) 0.30 Effective Stress on the Vegetation, t<sub>ve</sub> (psf)

0.0156 Manning's coefficient for the soil particles, n<sub>s</sub>

Calculated per Temple et. al., 1987. Equation 1.3 Calculated per Temple et. al., 1987. Equation 1.17

Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with  $10 \le PI \le 20$ Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML

Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.

Per Temple et. al., 1987. For cohesive soils Calculated per Temple et. al., 1987. Equation 4.1a

Iterate d until q calculated equals q design

q calculated

Iterate d until q calculated equals q design

Calculated as q/d

Calculated per Temple et. al., 1987. Equation 4.3a Calculated per Temple et. al., 1987. Equation 4.9a

3.5 Ratio of Allowable Stress to Effective Stress on Soil, FS<sub>soil</sub> 10.2 Ratio of Allowable Stress to Effective Stress on Veg., FS<sub>veg</sub>

Calculated Calculated

# References

**Project:** St. Anthony Mine

**Detail:** Pit 2 Regrade - Cover Slopes. Erosional Stability (fair vegetation)

Job No.: 233001076 Date: 9/12/2018

Calc. By: J. Cumbers/M. Kapp Checked By: J. Erickson

# Notes:

# **Slope Geometry**

100 Top Slope, (Xhoriz:1.5vert)

TEMPLE METHOD FOR EROSION OF VEGETATED SLOPES

0.015 Cover Surface Grade, S<sub>0</sub> (ft/ft)
0.9 Slope Angle, θ<sub>0</sub> (deg)
1440 Original Slope Length, L<sub>0</sub> (ft)

**Flow Characteristics** 

0.111 Design Flow (cfs/ft)

3 Concentration Factor, F

0.3329 Concentrated Design Flow, Q (cfs/ft)

**Cover Soil Properties** 

10 Plasticity Index, PI 108.6 Dry Density (pcf)

2.65 Specific Gravity0.523 Calculated Void ratio

0.005 Diameter for which 75% of the Material is Finer, d<sub>75</sub> (in)

**Vegetation**0.75 Representative Stem Length, h<sub>stem</sub> (ft)

133 Representative Stem Density, M<sub>stem</sub> (stems/ft<sup>2</sup>)

0.6 Cover Factor, C<sub>f</sub>

Other

62.4 Unit Weight of Water,  $\gamma_w$  (pcf)

**CALCULATIONS** 

5.13 Retardance Curve Index, C<sub>i</sub>

3.85 Allowable Shear Stress on Vegetation, t<sub>va</sub> (psf)

0.0190 base allowable tractive shear stress (psf) t<sub>ab</sub> (psf)

1.10 void ratio correction factor,  $C_{\text{e}}$ 

0.0231 Allowable Shear Stress on Soil of Vegetated Slope,  $t_a$  (psf)

0.0156 Manning's coefficient for the soil particles, n<sub>s</sub>
0.1335 Manning's Coefficient for Vegetated Conditions, n

0.429 Assumed Depth of Flow, d (ft)

0.333 q (cfs/ft), with veg 0.000 qcalc - qdesign

0.78 Average Flow Velocity, V (ft/sec)

0.0022 Effective Stress on the Soil,  $t_{\rm e}$  (psf) 0.40 Effective Stress on the Vegetation,  $t_{\rm ve}$  (psf)

10.5 Ratio of Allowable Stress to Effective Stress on Soil, FS<sub>soil</sub>

9.6 Ratio of Allowable Stress to Effective Stress on Veg., FS<sub>veq</sub>

Design geometry

Calculated from design geometry

Calculated from design geometry

Calculated from design geometry

Calculated. DOE, 1989. Equation (3), page 66.

As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3. Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB. Calculated from Proctor tests on samples from Lobo and West Borrow

Estimate Calculated

from particle-size for Lobo and Borrow West, median from 15 results

Stem length for proposed cover vegetation, assumes fair establishment

Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with fair coverage selected to represent established cover vegetation.

Estimated after vegetation is established, Temple 1987 (Table 3.1), fair assumed 20% reduction of grass cover factor

Calculated per Temple et. al., 1987. Equation 1.3

Calculated per Temple et. al., 1987. Equation 1.17

Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with 10  $\leq$  PI  $\leq$  20

Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML

Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.

Per Temple et. al., 1987. For cohesive soils

Calculated per Temple et. al., 1987. Equation 4.1a

Iterate d until q calculated equals q design

q calculated

Iterate d until q calculated equals q design

Calculated as q/d

Calculated per Temple et. al., 1987. Equation 4.3a Calculated per Temple et. al., 1987. Equation 4.9a

Calculated

Calculated

# References

# ST. ANTHONY MINE CLOSEOUT PLAN

Appendix G Agronomic Data

# Appendix G AGRONOMIC DATA





To: Stantec

From: CEDAR CREEK ASSOCIATES, Inc.

Date: October 4, 2018

**Subject:** St. Anthony Mine Materials Characterization

#### 1.0 Introduction

Cedar Creek Associates, Inc. (Cedar Creek) was contracted by Stantec to complete a materials characterization study pertaining to the suitability of several Borrow Areas, Topsoil Piles, and Waste Piles for use as growth media in the reclamation of the St. Anthony Mine Site in Cibola County, New Mexico. This technical report serves to summarize observations made during field surveys and sample collection which took place from March 26<sup>th</sup> through April 17<sup>th</sup> and subsequent laboratory analysis.

Previous mining activities have resulted in unvegetated piles at the St. Anthony mine site. Limited topsoil salvage and stockpiling occurred during historic mining activities. However, in order to achieve successful reclamation of the St. Anthony Mine Site, in accordance with New Mexico Mining and Minerals Division (NMMMD) – Closeout Plan Guidelines, sufficient volumes of topsoil and/or alternate growth media are required. The Waste Piles, Topsoil Piles, and Borrow Areas were observed and sampled to determine whether materials comprising each facility exhibit suitable chemical and physical characteristics for use as a reclamation planting media (seedbed/surface material) or rooting media (subsurface material).

To optimize the required thickness of suitable growth media, numerous local soil-vegetation systems were also observed. These observations help inform the required thickness of cover materials to support the establishment of a self-sustaining vegetation community.

# 2.0 General Methodology

### 2.1 Field Sampling Preparation

Prior to the field surveys, available site-specific soils and geologic data were gathered. Publicly available data from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soil surveys were reviewed to identify major soils that dominate the project area. Soil characteristics of each identified NRCS soil type along with corresponding mapping, both within and adjacent to the project area, were on hand during the field evaluation. In addition, agronomic analytical laboratory results from previous soil sampling efforts detailed in the 2007 Materials Characterization Report (MWH, 2007) were also reviewed and on hand during field evaluation. Various aerial imagery, geologic maps, and topographic maps were acquired to aid the field surveys.

## 2.2 Bore-Hole Sampling and Cataloging

A drilling program to characterize materials encountered throughout the various mine facilities and potential Borrow Areas was conducted by Stantec. Drilling locations and drilling methodologies were predetermined by Stantec. Selected drilling sites were randomly distributed throughout each of the mine facilities and represented each facility adequately. Cedar Creek was onsite during drilling to observe materials excavated from the boreholes and to describe and characterize the properties and features of the materials encountered. Samples were collected throughout the drilling process for laboratory analysis of agronomic properties of the various material types encountered.

# CEDAR CREEK ARROCKATES, INC.

# Cedar Creek Technical Report

## 2.2.1 Sample Collection Methodology

A hollow stem rotary auger (with and without a core sampler) and a modified California sampler were the primary methods used to extract, observe, and sample soils. Numerous sample locations were selected for material core extraction, where more detailed observations of soil properties could be recorded. On all borehole locations, regardless of whether cores were extracted, cuttings brought up through the auger bit were continually inspected, observations recorded, and occasionally collected for laboratory analysis.

Observations pertaining to the properties and features of soil and geologic materials were recorded. Field characterizations generally followed NRCS soil description protocols and terminology in version 3 of the Field Book for Describing and Sampling Soils. NRCS pedon descriptions focused on features such as color, texture, structure, pedon concentrations, consistence, roots and pores, chemical response, coarse fragments, and any other features that were encountered and deemed potentially pertinent for informing revegetation success.

Soil and geologic materials were sampled by a combination of systematic and targeted sampling approaches. Professional judgement was required in deciding which materials would be sampled and tested for agronomic analysis to adequately characterize the site. Efforts were made to sample all material types, with several duplicates of material types. Samples selected for laboratory analysis came from either:

- 1. Fixed interval composite samples from intact soil cores.
- 2. Horizon sampling from intact soil cores.
- 3. Bulk composite samples from both rotary cuttings and cores.
- 4. Targeted samples of materials with unique or extreme properties or features.

On the Waste Piles and Topsoil Piles, soil and alluvial materials were often mixed with geologic materials as a result of the excavation, transport, and placement during previous mining activities. When materials were mixed, soil sampling defaulted to fixed interval composite sampling.

When intact core samples were extracted with materials in distinct layers (i.e., not mixed), horizon sampling techniques could be utilized to test the properties of the individual soil and geologic material types. This was the most common sampling approach in undisturbed, native Borrow Areas, but occasionally occurred on both Waste Piles and Topsoil Piles.

When intact cores were not extracted or were heavily disturbed and partially intact, bulk composite samples were instead utilized. This method was the least preferred, and was only utilized where necessary.

When unique or extreme variants of a material type were encountered (i.e., unweathered shale, coal, pure white saline sandstone), targeted sampling methods were utilized, to identify the bounds in which soil properties and features could vary within the various distinct geologic materials onsite.

# 2.3 Laboratory Analyses

Laboratory analyses consisted of numerous tests pertaining to the agronomic properties of the soils and geologic materials. The parameters tested, along with the methods and suitability criteria, are found below in Table 1. Methods and suitability criteria either meet or exceed the Soil and Topsoil Suitability Ratings within Attachment 1 of the NMMMD Closeout Plan Guidelines.

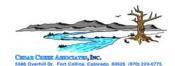


Table 1 St. Anthony Mine - Materials Characterization - 2018										
Soil Laborat	ory Results - Suitabilit	y Criteria								
Paramater	Method	Acceptable Average Values	Units							
pH (paste)	ASTM D4972 - 13	6 - 8.3	N/A							
Electrical Conductivity	4F1a1a1*	< 3 < 6	mmhos/cm							
Organic Matter	Walkley-Black	< 10	% of Total Soil							
NO <sub>3</sub> -N	4D6*	> 0.1 <sup>+</sup>	ppm							
Phosphorus (P)	4D6*	> 1+	ppm							
Potassium (K)	4D6*	> 20+	ppm							
Zinc (Zn)	4D6*	> 0.25 <sup>+</sup>	ppm							
Iron (Fe)	4D6*	> 1.0+	ppm							
Manganese (Mn)	4D6*	> 0.1+	ppm							
Copper (Cu)	4D6*	> 0.1 <sup>+</sup>	ppm							
Calcium (Ca)	EPA Method 3050B	Addressed as SAR	ppm							
Magnesium (Mg)	EPA Method 3050B	Addressed as SAR	ppm							
Sodium (Na)	EPA Method 3050B	Addressed as SAR	ppm							
Texture by hydrometer	ASTM D422-63(2007)e2	No Textural Extremes	% Size Fraction							
Sodium Adsorption Ratio	EPA Method 3050B	< 15	N/A							

<sup>\*</sup> Soil Survey 2014 as Reference

Additionally, textural extremes (very poorly graded or well sorted materials) should be avoided for use in reclamation. Due to the extremely arid climate and challenging soil chemistry, the range of suitable textural classifications is more restrictive than typical for rangeland systems in the arid west. Below is a textural classification triangle highlighting unsuitable textural designations.

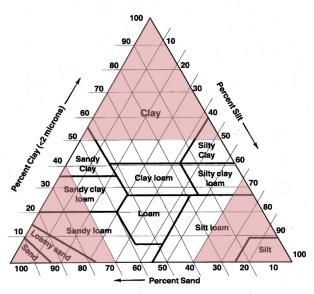


Figure 1: – Soil texture triangle, with unsuitable textural classes highlighted in red.

<sup>+</sup> Values Can Be Increased Through OM Additions

<sup>\*</sup> EC > 6 excludes use as surficial growth media unless mixed. EC between 3-6 requires special consideration in the reclamation plan.

# CEDAR CREEK ARROCKATES, INC.

# Cedar Creek Technical Report

# 2.4 Additional Field Observations

Undisturbed soil-vegetation systems with comparable parent and geologic materials to the projected reclamation systems were targeted for observation, primarily to approximate cover thicknesses needed to support undisturbed plant communities. The depth of topsoil overlying geologic materials, particularly in thinner, lower-quality (productivity) soil systems, were specifically observed and noted. Observations were made contrasting areas that are currently supporting vegetation with unvegetated areas across the site. Emphasis was placed on geomorphic features most comparable to the eventual revegetation communities. Also, successful vegetation species were observed and recorded to assist in the compilation of a site-specific seed mix for inclusion in the reclamation plan.

#### 3.0 Results

Any exceedances of the acceptable ranges for each parameter in Table 1 are denoted in red for easy identification within the tables in Section 3.0. Similarly, moderate or marginally elevated laboratory results below the suitability thresholds defined in Table 1 are denoted in orange. The degree of suitability for any parameter exists on a continuum, and moderate or marginal exceedances of most parameters may still require additional consideration in reclamation planning and design.

#### 3.1 Boreholes

The predetermined sampling approach for the growth media characterization efforts was organized primarily by facility, under the assumption that materials in each pile would be consistent throughout. In reality, several piles contained varying combinations of unique geologic materials, randomly structured (layered and deposited) and often mixed. While conducting the field efforts, and after reviewing laboratory data specifically targeting representative samples of each material type, it became apparent that assessing the reclamation potential of any pile would be wholly dependent upon the material types eventually exposed at the surface of each pile.

The success of any direct revegetation efforts or reclamation of placed cover materials will be directly linked to the properties of the underlying geologic material types. Because the piles include somewhat random mixtures of numerous, individual types of geologic materials, it is inappropriate to discuss reclamation potential by facility, and more suitable to discuss reclamation potential by material type.

The features and properties of soil and geologic materials encountered across the property can be easily differentiated and summarized by color. Section 3.0 presents data as it was sampled, by facility. The discussion section (Section 4.0) will transition to discuss the reclamation potential of pertinent facilities by color coded material types, as it more useful for reclamation planning, design, and implementation.

#### 3.1.1 South Borrow

Ten samples from three boreholes were analyzed from the South Borrow. Overall, field observations indicated that native soils in the South Borrow are relatively uniform, productive soils. The South Borrow is comprised of a small alluvial fan, with a slope alluvium and colluvium influence, exhibiting moderately deep soils with some deeper and shallower areas. Salinity, measured as electrical conductivity (EC), was slightly elevated in four samples, moderately elevated in three samples, and strongly elevated in one sample (above suitability threshold). The pH in one sample was slightly acidic. Two samples exhibited moderate elevations of sodium, measured as the Sodium Adsorption Ratio (SAR). Eight samples exhibited moderately



high proportions of sand, while two samples were very high in sand (above suitability threshold). Otherwise, all agronomic parameters of individual samples were within the suitability criteria.

Table 2	St. Anthony M	line - S	Soil and	Geologia	Materia	ls Chara	rterizatio	n						
Tubic 2	South Borrow		on and	Ccciogic	, materia	15 Oriara	otorizatio	, II						
		Тор	Bottom	Ра	ste		%							
Laboratory		Depth	Depth	pН	EC	Lime	Organic				ppm			
Sample ID	Client Sample ID	(ft)	(ft)		mmhos/cm	Estimate	Matter	NO <sub>3</sub> -N	P	K	Zn	Fe	Mn	Cu
R2608	BS-1	1	5	8.1	0.4	very high	1.3	0.35	1.89	128.20	1.43	3.14	1.08	4.97
R2609	BS-1	5	10	8.0	5.7	very high	0.8	1.10	3.24	98.96	0.22	7.88	1.80	1.29
R2610	BS-1	0	10	7.7	2.7	very high	0.9	3.90	1.68	107.20	0.83	3.52	2.06	2.89
R2611	BS-1	10	20	7.7	2.9	high	0.8	4.10	1.26	81.03	0.16	3.37	0.78	0.66
R2612	BS-1	20	21	6.5	3.5	low	0.7	0.51	1.51	64.30	0.53	22.98	1.38	1.86
R2613	BS-3	0	5	7.5	2.8	high	0.9	1.40	2.00	134.20	0.10	3.08	1.10	0.64
R2614	BS-3	5	10	7.6	3.2	high	0.7	1.70	2.01	81.88	0.09	3.19	1.40	0.73
R2615	BS-3	10	15	7.7	2.7	high	0.6	1.20	1.69	62.19	0.10	5.25	1.42	0.56
R2616	BS-6	0	10	7.9	1.0	high	0.8	0.32	1.68	114.70	0.07	3.31	1.43	0.50
R2618	BS-6	10	20	7.9	6.1	high	0.5	1.50	1.57	45.85	0.07	1.97	0.58	0.37
		Тор	Bottom											
Laboratory		Depth	Depth		meq	/L				%				
Sample ID	Client Sample ID	(ft)	(ft)	Ca	Mg	Na	K	SAR	Sand	Silt	Clay		Texture	
R2608	BS-1	1	5	3.0	0.7	1.3	0.2	1.62	60	22	18		Sandy Loam	
R2609	BS-1	5	10	33.4	0.5	34.4	29.7	4.02	60	16	24	Sa	ndy Clay Loa	am
R2610	BS-1	0	10	32.5	1.6	4.3	1.1	0.80	58	24	18		Sandy Loam	
R2611	BS-1	10	20	29.5	1.0	5.5	2.6	0.98	60	18	22	Sa	ndy Clay Loa	am
R2612	BS-1	20	21	25.8	1.5	8.7	4.2	1.41	74	8	18		Sandy Loam	
R2613	BS-3	0	5	28.8	2.0	4.4	1.0	0.85	56	22	22	Sa	ndy Clay Loa	am
R2614	BS-3	5	10	32.2	1.2	4.3	1.5	0.78	64	18	18	Sandy Loam		
R2615	BS-3	10	15	30.1	0.7	5.4	1.6	0.96	68	16	16	Sandy Loam		
R2616	BS-6	0	10	6.0	0.9	2.3	1.0	1.27	72	10	18	Sandy Loam		
R2618	BS-6	10	20	40.1	0.5	32.1	18.5	3.75	62	20	18		Sandy Loam	ı

 $<sup>\</sup>star$  = Below Reporting Limits

#### 3.1.2 West Borrow

Four bulk composite samples from four boreholes were analyzed from the West Borrow. Overall, it was noted that native soils in the West Borrow are relatively uniform, productive soils. The West Borrow is a large alluvial fan and fan plane, with very deep soils. Salinity was slightly elevated in two samples, and strongly elevated (above the suitability threshold) in one sample. Otherwise, all other agronomic parameters were within the suitability criteria. When averaged, assuming mixing will occur through excavation, transport, and placement/grading, all parameters are within the suitability criteria.

<sup>&</sup>lt;sup>+</sup> Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed

<sup>&</sup>lt;sup>+</sup> Values in orange are moderately elevated, and may require special consideration in the reclamation plan



Table 3 St. Anthony Mine - Soil and Geologic Materials Characterization														
	West Borrow			Ť										
Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	Pa	pH						Fe	Mn	Cu	
R2829	BW-1	0	35	8.0	7.3	very high	0.7	1.50	1.40	138.90	0.15	5.90	1.70	1.60
R2830	BW-2	0	20	8.3	2.0	very high	0.6	0.79	1.50	130.30	0.12	2.80	0.86	1.50
R2831	BW-3	0	15	8.4	1.1	very high	0.6	0.29	1.80	106.00	0.14	2.80	1.20	1.50
R2832	BW-4	0	20	7.9	3.5	medium	0.6	8.60	1.10	153.50	0.11	2.40	0.91	1.20
	Average			8.1	3.5	very high	0.6	2.80	1.45	132.18	0.13	3.48	1.17	1.45
Laboratory		Top Depth	Bottom Depth		meq	/L				%				
Sample ID	Client Sample ID	(ft)	(ft)	Ca	Mg	Na	K	SAR	Sand	Silt	Clay		Texture	
R2829	BW-1	0	35	3.1	0.2	2.8	4.7	0.80	49	20	31	Sa	indy Clay Loa	am
R2830	BW-2	0	20	4.6	1.2	6.1	7.6	1.50	42	28	30		Clay Loam	
R2831	BW-3	0	15	2.4	0.9	3.8	3.3	1.40	40	27	33		Clay Loam	
R2832	BW-4	0	20	27.4	2.4	7	3.4	1.00	49	22	29	Sa	indy Clay Loa	ım
	Average	·	·	9.4	1.2	4.9	4.8	1.18	45	24	31		Clay Loam	

<sup>\*=</sup> Below Reporting Limits

#### 3.1.3 Lobo Tract Borrow

Seventeen samples from seven boreholes were analyzed from the Lobo Tract Borrow. Overall, observations note that native soils in the Lobo Tract Borrow are somewhat variable (salinity), productive soils. The Lobo Tract Borrow is located in a wide valley bottom flood plain. Flowing surface water was observed in the region, with evaporative salt deposits consistently lining the waterway, and along the flood bank of the alluvial features. Salinity was slightly elevated in eleven samples, and moderately elevated in two samples. One sample exhibited a moderate level of sodium, while three samples were slightly elevated. Five samples exhibited moderately high proportions of sand, while two samples were very high in sand (above the suitability threshold). Four samples were high in clay, while three samples were moderately high in clay. Otherwise, all other agronomic parameters were within the suitability criteria. When averaged, assuming mixing will occur through excavation, transport, and placement/grading), all parameters are within the suitability criteria.

 $<sup>^{\</sup>scriptscriptstyle +}$  Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed

<sup>&</sup>lt;sup>+</sup> Values in orange are moderately elevated, and may require special consideration in the reclamation plan



Table 4	St. Anthony N	line - S	Soil and	d Geolog	ic Materi	als Char	acterizat	ion						
Lobo Tract Borrow														
	I			P	aste									
Laboratory		Top Depth	Bottom Depth	pН	EC	Lime	% Organic				mag			
Sample ID	Client Sample ID	(ft)	(ft)		mmhos/cm	Estimate	Matter	NO <sub>3</sub> -N	Р	К	Zn	Fe	Mn	Cu
R2593	L1-1	0	5	8.0	0.6	very high	1.0	4.60	7.12	99.26	1.09	4.03	2.88	1.86
R2597	L1-1	5	6	8.1	1.7	very high	1.3	1.80	1.78	262.30	0.35	12.49	2.53	4.73
R2594	L1-1	7.5	10	7.6	3.1	very high	0.9	4.50	3.56	125.20	0.19	4.28	0.38	2.56
R2595	L1-1	10	15	7.8	1.4	very high	0.8	8.50	2.75	119.20	0.29	4.07	0.53	1.72
R2596	L1-1	15	20	8.0	1.0	very high	0.7	8.00	2.36	80.77	0.20	4.70	0.51	3.40
R2591	L1-4	0	10	7.5	2.5	high	1.5	5.20	3.21	217.50	0.47	9.51	1.66	3.54
R2592	L1-4	13	20	7.7	2.4	high	0.2	2.20	4.36	31.42	0.67	4.81	0.38	3.67
R2598	L1-5	0	5	7.6	4.4	very high	1.0	3.80	1.59	249.40	0.27	8.71	0.59	3.33
R2599	L1-5	7.5	10	7.5	4.5	very high	1.2	18.80	2.56	274.60	0.45	9.69	0.47	3.88
R2600	L1-5	15	20	7.7	3.2	high	0.4	2.60	2.89	56.14	0.18	2.06	0.19	0.56
R2601	L2-1	0	20	7.7	5.0	very high	0.7	0.35	2.27	151.10	2.35	5.34	2.57	8.02
R2604	L2-5	0	10	7.5	3.5	high	1.2	12.00	2.25	330.70	2.27	8.61	3.55	7.73
R2605	L2-5	10	20	7.5	3.3	high	1.7	17.10	2.05	290.10	1.59	12.21	4.87	5.72
R2602	L2-6	7	10	7.6	5.1	very high	1.1	5.50	2.51	214.20	0.43	9.90	0.50	3.29
R2603	L2-6	11	13	7.6	3.9	very high	1.0	3.40	2.51	178.00	0.32	9.42	0.53	3.02
R2606	L2-7	0	10	7.6	2.9	very high	1.2	4.90	2.64	188.80	1.39	4.84	2.27	6.29
R2607	L2-7	10	20	7.7	3.6	very high	1.0	0.30	1.60	105.30	1.64	5.64	2.64	6.22
	Average			7.7	3.1	very high	1.0	6.09	2.82	174.94	0.83	7.08	1.59	4.09
		Тор	Bottom											
Laboratory		Depth	Depth		meq	/L				%				
Sample ID	Client Sample ID	(ft)	(ft)	Ca	Mg	Na	K	SAR	Sand	Silt	Clay		Texture	
R2593	L1-1	0	5	0.3	0.0	0.1	0.0	0.33	64	18	18		Sandy Loam	
R2597	L1-1	5	6	8.3	0.9	5.3	4.8	1.42	34	22	44		Clay	
R2594	L1-1	7.5	10	22.6	0.9	6.4	5.0	1.20	46	22	32	Sa	ndy Clay Loa	am
R2595	L1-1	10	15	9.1	0.5	2.9	4.0	0.88	48	20	32	Sa	ndy Clay Loa	am
R2596	L1-1	15	20	5.5	0.3	2.0	3.4	0.77	60	19	21	Sa	ndy Clay Loa	am
R2591	L1-4	0	10	127.0	6.1	48.7	56.3	3.58	32	30	38		Clay Loam	
R2592	L1-4	13	20	36.4	3.9	15.7	7.9	3.34	84	10	6		Loamy Sand	
R2598	L1-5	0	5	27.0	1.9	6.4	12.3	1.09	32	24	44		Clay	
R2599	L1-5	7.5	10	27.0	1.5	5.8	13.8	1.00	16	28	56		Clay	
R2600	L1-5	15	20	20.0	0.4	5.7	8.4	1.07	74	12	14		Sandy Loam	
R2601	L2-1	0	20	30.4	2.0	18.6	16.9	2.64	62	20	18		Sandy Loam	
	L2-5	0	10	30.2	2.1	4.6	6.0	0.83	28	28	44		Clay	
R2604			20	25.3	1.6	5.0	8.8	0.92	24	22	54		Clay	
R2604 R2605	L2-5	10	20		<u> </u>							Clay		
	L2-5 L2-6	10 7	10	37.8	1.1	16.6	14.7	2.38	26	20	54		Clay	
R2605		***************************************	•		1.1 0.6	16.6 7.2	14.7 10.8	2.38 1.24	26 14	20 22	54 64		Clay Clay	
R2605 R2602	L2-6	7	10	37.8	1		3 1			9		Sa		am
R2605 R2602 R2603	L2-6 L2-6	7 11	10 13	37.8 21.6	0.6	7.2	10.8	1.24	14	22	64		Clay	

<sup>\*=</sup> Below Reporting Limits

## 3.1.4 Waste Piles 1, 2, 3, 4 and 7

Ten samples from nine boreholes were analyzed from Waste Piles 1, 2, 3, 4, and 7. Overall, it was noted that various geologic materials encountered between the piles were consistent, but with extensive variability within each pile. The piles contained a random mixture of saline sandstone, carbonaceous sandstone, shale, and coal. Significant yet variable coarse fragment contents were observed, ranging from gravels to boulders. Salinity was slightly elevated in two samples, moderately elevated in three samples, strongly elevated in two samples (above suitability threshold), and extremely elevated in one sample (specifically targeted for testing due to suspected high salt content). Four samples exhibited moderate levels of sodium, while one sample exhibited a moderately high level of sodium. Four samples exhibited moderately high proportions of sand, while four samples were very high in sand (above suitability threshold). One sample was slightly acidic, one sample was moderately acidic, and two samples were

 $<sup>^{\</sup>scriptscriptstyle +}$  Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed

<sup>&</sup>lt;sup>+</sup> Values in orange are moderately elevated, and may require special consideration in the reclamation plan



extremely acidic. One Sample was high in clay. Otherwise, all other agronomic parameters were within the suitability criteria.

Table 5 St. Anthony Mine - Soil and Geologic Materials Characterization														
	Waste Piles 1													
	T													
		Тор	Bottom		ste		%							
Laboratory	or	Depth	Depth	pН	EC	Lime	Organic	NO <sub>3</sub> -N	P	К	Zn	Fe	Mn	Cu
Sample ID R2586	Client Sample ID P1-2	(ft) 60	(ft) 65	4.2	mmhos/cm 9.8	low	Matter 1.2	0.08	2.93	88.38	6.36	187.20	32.90	3.92
R2586	P1-2 P2-1	25	30	4.2	4.6	low	1.1	<0.1	4.14	136.80	2.29	153.30	32.90 15.69	4.99
R2587	P2-1 P3-2	0	45	8.4	1.9	very high	0.4	3.70	3.46	52.50	0.90	6.01	1.00	1.27
R2590 R2588	P3-2 P3-4	0	25	6.2	2.5	low	0.4	0.39	2.10	34.31	0.90	11.72	1.30	3.80
R2588 R2589	P3-4 P3-4	35	40	5.8	4.1	low	0.4	<0.1	4.13	50.71	0.86	44.53	4.90	2.04
R2585	P4 (white sand)	0	1	8.2	42.1	low	0.7	60.40		94.48	0.32	5.15	0.20	0.77
R2833	P4-5	0	1	7.9	10.7		0.8	0.07	1.43 2.30	44.70	3.70	61.00	27.60	1.60
R2834	P4-5	0	1	6.9	1.3	high low	0.9	0.07	1.60	66.70	0.23	6.70	4.10	0.42
R2835	P4-7	0	1	7.5	3.6	medium		<0.1	2.00	19.90	0.23	2.70	1.10	0.42
R2835	P4-9 P7-1	0	1	7.6	4.8	high	0.4	0.07	1.00	68.50	0.20	5.00	0.97	1.00
R2030	P7-1	U	'	7.0	4.0	nign	0.4	0.07	1.00	06.30	0.16	5.00	0.97	1.00
		Тор	Bottom											
Laboratory		Depth	Depth			/L				%				
Sample ID	Client Sample ID	(ft)	(ft)	Ca	Mg	Na	K	SAR	Sand	Silt	Clay		Texture	
R2586	P1-2	60	65	219.8	37.8	105.9	51.3	4.70	66	10	24		ndy Clay Loa	
R2587	P2-1	25	30	201.6	13.1	54.7	9.6	3.68	58	12	30		ndy Clay Loa	
R2590	P3-2	0	45	236.8	16.1	46.6	55.7	2.88	78	8	14		Sandy Loam	
R2588	P3-4	0	25	249.5	33.6	81.5	65.0	4.17	76	10	14		Sandy Loam	
R2589	P3-4	35	40	9.0	10.6	2.4	169.6	0.22	76	8	16		Sandy Loam	
R2585	P4 (white sand)	0	1	18.3	7.1	84.5	451.8	3.96	76	10	14		Sandy Loam	
R2833	P4-5	0	11	18.8	1.8	17.2	0.9	1.40	42	9	49		Clay	
R2834	P4-7	0	1	6.1	2.0	1.8	5.2	0.50	55	29	16		Sandy Loam	
R2835	P4-9	0	1	17.4	1.7	7.2	16.4	1.00	53	22	25	Sa	ndy Clay Loa	ım
R2836	P7-1	0	1	21.6	1.2	9.3	16.6	1.10	39	32	29		Clay Loam	

Note: Averages Exclude Sample P4 (white sand)

## 3.1.5 North and South Topsoil Piles

One sample from one borehole was analyzed from the North Topsoil Pile. Overall, it was noted that the stockpiled native soils in the North Topsoil Pile were consistent, productive soils. The origin of the topsoil is unknown, but observations suggest that the North Topsoil Pile has not been visibly mixed with geologic materials, and is uniform. Sampling was constrained by the proximity of the North Topsoil Pile to the pit wall, and complicated by signs of cracking and instability adjacent to the North Topsoil Pile. Due to the small size of the North Topsoil Pile, a lone sample was deemed representative of the entire pile. The lone sample exhibited a high proportion of sand (above threshold values). Otherwise, all other agronomic parameters were within the suitability criteria.

Five samples from three boreholes were analyzed from the South Topsoil Pile. Overall, it was noted that soils in the South Topsoil Pile were extensively mixed with crushed, unweathered geologic materials. The origin of the material is unknown. Salinity was slightly elevated in two samples, moderately elevated in two samples, and strongly elevated in one sample (above suitability threshold). Three samples exhibited moderately high proportions of sand, while two samples were high in sand (above suitability threshold). One sample each was slightly acidic, moderately acidic, and strongly acidic. Otherwise, all other agronomic parameters were within the suitability criteria.

<sup>\*=</sup> Below Reporting Limits

<sup>&</sup>lt;sup>+</sup> Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed

<sup>&</sup>lt;sup>+</sup> Values in orange are moderately elevated, and may require special consideration in the reclamation plan



Table 6	able 6 St. Anthony Mine - Soil and Geologic Materials Characterization													
	North and So	uth To	psoil Pi	iles										
Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	pH	EC mmhos/cm	Lime Estimate	% Organic Matter	NO <sub>3</sub> -N	Р	К	ppm Zn	Fe	Mn	Cu
R2619	TN-2	0	25	8.0	1.0	high	0.8	17.90	1.58	98.18	0.07	2.13	0.64	0.59
R2620	TS-2	20	30	5.2	6.3	low	0.6	1.50	4.24	57.54	1.80	69.82	5.85	1.98
R2621	TS-3	0	10	6.9	3.5	low	1.0	0.40	1.59	147.20	1.09	5.80	2.15	3.26
R2622	TS-3	25	30	5.9	5.7	low	0.7	1.70	2.08	90.85	4.81	37.79	7.39	13.22
R2623	TS-4	0	10	7.1	3.8	high	0.6	0.28	1.61	87.64	1.53	5.08	1.88	4.79
R2624	TS-4	10	20	7.2	4.6	high	1.0	3.80	2.10	72.99	1.80	14.67	2.13	6.30
Laboratory		Top Depth	Bottom Depth		meq		1			% I	i			
Sample ID	Client Sample ID		(ft)	Ca	Mg	Na	K	SAR	Sand	Silt	Clay		Texture	
R2619	TN-2	0	25	4.9	0.8	3.1	1.6	1.62	72	12	16		Sandy Loam	
R2620	TS-2	20	30	23.8	2.1	12.9	4.0	1.63	74	12	14		Sandy Loam	
R2621	TS-3	0	10	27.6	2.6	6.5	6.0	1.14	62	16	22	Sa	indy Clay Loa	am
R2622	TS-3	25	30	22.3	2.0	11.9	7.1	1.61	68	6	26	Sa	indy Clay Loa	am
R2623	TS-4	0	10	25.1	1.3	8.3	5.7	1.37	70	8	22	Sa	indy Clay Loa	am
R2624	TS-4	10	20	26.6	1.6	9.4	7.0	1.51	68	11	21	Sa	indy Clay Loa	am

<sup>\*=</sup> Below Reporting Limits

#### 3.1.6 Topsoil / Overburden Pile

Twenty-seven samples from five boreholes were analyzed from the Topsoil/Overburden Pile. Overall, it was noted that soils in the Topsoil/Overburden Pile were somewhat variable, productive soils. Black shale fragments are consistently interspersed throughout the pile, along with precipitated gypsum (CaSO<sub>4</sub>) crystals approximately 1-2 inches in length. Extensive erosion features, including piping, rills, and gullies were observed from the surface of the Topsoil/Overburden Pile. The origin of materials located within the Topsoil/Overburden Pile is unknown, but it is likely a mix of topsoil, alluvium, and slightly weathered shale. Salinity was slightly elevated in seventeen samples, and moderately elevated in ten samples. Thirteen samples exhibited moderately high proportions of sand, while one sample was high in sand (above suitability threshold). One sample was high in clay, while two samples were moderately high in clay. The Topsoil/Overburden Pile was somewhat well mixed, and average values should approximately represent on the ground conditions at any point across the pile.

<sup>\*</sup> Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed

<sup>&</sup>lt;sup>+</sup> Values in orange are moderately elevated, and may require special consideration in the reclamation plan



	St. Anthony M			l Geolog	ic Materi	als Chara	acterizat	ion						
	Topsoil / Ove	rburde	n Pile											
		Тор	Bottom	Pa pH	ste		%				nnm			
Laboratory Sample ID	Client Sample ID	Depth (ft)	Depth (ft)	μ	mmhos/cm	Lime Estimate	Organic Matter	NO <sub>3</sub> -N	Р	К	Zn	Fe	Mn	Cu
R2559	T/O-1	0	25	7.5	3.6	very high	0.8	6.00	1.86	134.50	0.31	10.03	2.36	1.70
R2560	T/O-1	25	50	7.4	3.8	very high	0.7	6.30	1.69	145.60	0.45	14.50	3.09	1.90
R2561	T/O-1	70	90	7.8	2.7	very high	0.8	3.00	2.19	109.10	1.45	4.36	1.94	6.49
R2576	T/O-2	0	20	7.8	4.6	very high	0.7	4.80	1.53	215.60	0.18	13.12	3.83	2.14
R2625	T/O (shale)	-	-	7.6	3.2	high	1.0	2.50	0.86	218.50	0.12	5.34	0.79	0.91
R2562	T/O-3	0	5	7.7	3.6	very high	0.8	0.42	2.23	109.90	0.19	4.14	0.54	1.23
R2563	T/O-3	5	10	7.6	3.9	very high	0.6	4.70	1.64	125.00	0.18	4.94	0.49	1.25
R2564	T/O-3	10	15	7.6	4.0	very high	0.7	6.00	1.18	107.10	0.19	6.76	0.42	1.68
R2565	T/O-3	15	20	7.6	4.0	very high	0.8	9.60	1.94	135.00	0.30	8.62	0.83	1.19
R2566	T/O-3	20	25	7.7	2.4	high	0.8	3.20	2.38	118.90	0.15	6.08	0.83	1.35
R2567	T/O-3	25	30	7.8	3.2	high	0.8	3.20	2.06	85.70	0.18	3.27	0.30	1.66
R2568	T/O-3	30	35	7.6	3.5	very high	0.7	4.90	1.53	117.80	0.23	10.08	2.10	1.38
R2569	T/O-3	35	40	7.7	4.0	very high	0.7	5.80	1.79	112.90	3.60	9.76	1.54	1.48
R2570	T/O-3	40	45	7.6	3.6	very high	0.9	7.10	0.74	115.40	0.56	11.59	2.69	4.76
R2571	T/O-3	50	55	7.8	4.1	very high	0.7	9.20	2.30	117.90	0.23	10.69	1.20	2.05
R2572	T/O-3	55	60	7.7	4.6	very high	0.7	9.40	1.48	123.90	0.29	8.48	1.43	1.49
R2573	T/O-3	65	70	7.8	4.6	very high	0.7	1.30	1.74	115.00	0.19	29.15	5.03	1.79
R2574	T/O-3	70	75	7.7	3.8	high	0.7	4.70	1.62	108.70	0.19	15.45	2.12	0.90
R2575	T/O-3	75	80	8.0	2.1	high	0.7	30.50	2.95	131.70	0.18	14.33	1.08	1.41
R2577 R2578	T/O-4 T/O-4	0 30	10 40	7.7 7.8	2.7 4.1	very high	0.8	3.60 8.60	1.51 1.88	168.70 148.40	0.20	10.11 8.99	2.88 2.93	1.13 5.22
R2576 R2579	T/O-5	0	5	7.8	4.1	very high high	0.8	7.50	2.30	101.20	1.16 0.10	2.91	0.49	0.87
R2579	T/O-5	5	10	7.8	3.7	high	0.7	13.50	2.53	101.20	0.10	3.81	0.47	0.61
R2581	T/O-5	10	15	7.8	4.1	high	0.7	4.20	2.56	112.30	0.15	4.53	0.46	1.16
R2582	T/O-5	15	20	7.9	3.9	very high	0.6	4.70	2.06	104.90	0.13	6.65	1.24	2.88
R2583	T/O-5	20	25	7.8	2.8	very high	0.7	3.90	2.99	101.10	0.11	5.41	0.68	1.23
R2584	T/O-5	25	29	7.9	3.7	very high	0.9	7.40	2.11	118.50	0.28	9.58	1.15	2.19
	Average			7.7	3.6	very high	0.7	6.52	1.91	126.14	0.43	8.99	1.60	1.93
		Тор	Bottom											
Laboratory		Depth	Depth		meq	1				·%				
Sample ID	Client Sample ID	(ft)	(ft)	Ca	Mg	Na	K	SAR	Sand	Silt	Clay		Texture	
R2559	T/O-1	0	25	25.0	13.3	7.9	0.6	1.80	36	34	30		Clay Loam	
R2560	T/O-1	25 70	50 90	24.6	13.4	9.0	0.6		40	30	30		Clay Loam	
R2561 R2576	T/O-1 T/O-2	0	90	12.5				2.07			0.4			
	170-2		20		12.4	6.7	0.4	1.90	60	20	21	Sa	indy Clay Lo	2111
	T/O (chalo)		20	27.3	2.1	8.5	9.4	1.90 1.32	60 36	24	40	Sa	Clay	
R2625	T/O (shale) T/O-3	0	1	27.3 28.7	2.1 1.8	8.5 4.8	9.4 0.4	1.90 1.32 0.90	60 36 16	24 34	40 50		Clay Clay	
R2562	T/O-3	0 0	1 5	27.3 28.7 24.6	2.1 1.8 0.9	8.5 4.8 7.0	9.4 0.4 7.7	1.90 1.32 0.90 1.20	60 36 16 52	24 34 26	40 50 22	Sa	Clay Clay andy Clay Loa	am
R2562 R2563	T/O-3 T/O-3	0 0 5	1 5 10	27.3 28.7 24.6 24.9	2.1 1.8 0.9 0.9	8.5 4.8 7.0 8.0	9.4 0.4 7.7 8.4	1.90 1.32 0.90 1.20 1.33	60 36 16 52 46	24 34 26 24	40 50 22 30	Sa	Clay Clay Indy Clay Loa Indy Clay Loa	am
R2562 R2563 R2564	T/O-3 T/O-3 T/O-3	0 0 5 10	1 5 10 15	27.3 28.7 24.6 24.9 25.9	2.1 1.8 0.9 0.9 1.1	8.5 4.8 7.0 8.0 8.2	9.4 0.4 7.7 8.4 9.8	1.90 1.32 0.90 1.20 1.33 1.34	60 36 16 52 46 34	24 34 26 24 30	40 50 22 30 36	Sa	Clay Clay andy Clay Loa andy Clay Loam Clay Loam	am
R2562 R2563 R2564 R2565	T/O-3 T/O-3 T/O-3 T/O-3	0 0 5	1 5 10	27.3 28.7 24.6 24.9	2.1 1.8 0.9 0.9 1.1 1.2	8.5 4.8 7.0 8.0 8.2 7.9	9.4 0.4 7.7 8.4 9.8 7.5	1.90 1.32 0.90 1.20 1.33 1.34 1.32	60 36 16 52 46 34 44	24 34 26 24 30 26	40 50 22 30 36 30	Sa Sa	Clay Clay andy Clay Loa andy Clay Loam Clay Loam Clay Loam	am am
R2562 R2563 R2564 R2565 R2566	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15	1 5 10 15 20	27.3 28.7 24.6 24.9 25.9 25.9	2.1 1.8 0.9 0.9 1.1 1.2 0.8	8.5 4.8 7.0 8.0 8.2 7.9 5.8	9.4 0.4 7.7 8.4 9.8 7.5 6.7	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38	60 36 16 52 46 34 44 58	24 34 26 24 30	40 50 22 30 36 30 22	Sa Sa Sa	Clay Clay Indy Clay Loa Indy Clay Loa Clay Loam Clay Loam Indy Clay Loam	am am
R2562 R2563 R2564 R2565 R2566 R2567	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15 20 25	1 5 10 15 20 25 30	27.3 28.7 24.6 24.9 25.9 25.9 11.8 18.0	2.1 1.8 0.9 0.9 1.1 1.2 0.8 0.6	8.5 4.8 7.0 8.0 8.2 7.9 5.8 7.9	9.4 0.4 7.7 8.4 9.8 7.5 6.7 9.8	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38 1.42	60 36 16 52 46 34 44 58 56	24 34 26 24 30 26 20 20	40 50 22 30 36 30 22 24	Sa Sa Sa	Clay Clay Clay Loa Indy Clay Loa Indy Clay Loa Clay Loam Clay Loam Indy Clay Loa Indy Clay Loa	am am
R2562 R2563 R2564 R2565 R2566	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15 20	1 5 10 15 20 25	27.3 28.7 24.6 24.9 25.9 25.9 11.8	2.1 1.8 0.9 0.9 1.1 1.2 0.8	8.5 4.8 7.0 8.0 8.2 7.9 5.8	9.4 0.4 7.7 8.4 9.8 7.5 6.7	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38	60 36 16 52 46 34 44 58 56 40	24 34 26 24 30 26 20	40 50 22 30 36 30 22	Sa Sa Sa	Clay Clay Clay Loa Indy Clay Loa Indy Clay Loa Clay Loam Clay Loam Indy Clay Loa Indy Clay Loa Clay Loam Indy Clay Loa Clay Loam	am am
R2562 R2563 R2564 R2565 R2566 R2567 R2568	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15 20 25 30	1 5 10 15 20 25 30 35	27.3 28.7 24.6 24.9 25.9 25.9 11.8 18.0 26.4	2.1 1.8 0.9 0.9 1.1 1.2 0.8 0.6 1.4	8.5 4.8 7.0 8.0 8.2 7.9 5.8 7.9 7.7	9.4 0.4 7.7 8.4 9.8 7.5 6.7 9.8 9.2	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38 1.42 1.28	60 36 16 52 46 34 44 58 56	24 34 26 24 30 26 20 20 28	40 50 22 30 36 30 22 24 32	Sa Sa Sa	Clay Clay Clay Loa Indy Clay Loa Indy Clay Loa Clay Loam Clay Loam Indy Clay Loa Indy Clay Loa	am am
R2562 R2563 R2564 R2565 R2566 R2567 R2568 R2569	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15 20 25 30 35	1 5 10 15 20 25 30 35 40	27.3 28.7 24.6 24.9 25.9 25.9 11.8 18.0 26.4 25.4	2.1 1.8 0.9 0.9 1.1 1.2 0.8 0.6 1.4 1.2	8.5 4.8 7.0 8.0 8.2 7.9 5.8 7.9 7.7 8.0	9.4 0.4 7.7 8.4 9.8 7.5 6.7 9.8 9.2 9.3	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38 1.42 1.28 1.32	60 36 16 52 46 34 44 58 56 40 42	24 34 26 24 30 26 20 20 28 28	40 50 22 30 36 30 22 24 32 30	Sa Sa Sa	Clay Clay Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load	am am am am
R2562 R2563 R2564 R2565 R2566 R2567 R2568 R2569 R2570	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15 20 25 30 35 40	1 5 10 15 20 25 30 35 40 45	27.3 28.7 24.6 24.9 25.9 25.9 11.8 18.0 26.4 25.4 25.3	2.1 1.8 0.9 0.9 1.1 1.2 0.8 0.6 1.4 1.2 1.6	8.5 4.8 7.0 8.0 8.2 7.9 5.8 7.9 7.7 8.0 7.9	9.4 0.4 7.7 8.4 9.8 7.5 6.7 9.8 9.2 9.3 8.3	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38 1.42 1.28 1.32 1.31	60 36 16 52 46 34 44 58 56 40 42 36	24 34 26 24 30 26 20 20 28 28 30	40 50 22 30 36 30 22 24 32 30 34	Sa Sa Sa Sa	Clay Clay Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load Clay Load	am am am am
R2562 R2563 R2564 R2565 R2566 R2567 R2568 R2569 R2570 R2571	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15 20 25 30 35 40	1 5 10 15 20 25 30 35 40 45 55	27.3 28.7 24.6 24.9 25.9 25.9 11.8 18.0 26.4 25.4 25.3 23.1	2.1 1.8 0.9 0.9 1.1 1.2 0.8 0.6 1.4 1.2 1.6	8.5 4.8 7.0 8.0 8.2 7.9 5.8 7.9 7.7 8.0 7.9 8.8	9.4 0.4 7.7 8.4 9.8 7.5 6.7 9.8 9.2 9.3 8.3 7.0	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38 1.42 1.28 1.32 1.31	60 36 16 52 46 34 44 58 56 40 42 36 64	24 34 26 24 30 26 20 20 28 28 30 12	40 50 22 30 36 30 22 24 32 30 34	Sa Sa Sa Sa Sa	Clay Clay Clay Indy Clay Loa Indy Clay Loam Clay Loam Indy Clay Loam Indy Clay Loa Indy Clay Loam Clay Loam Clay Loam Clay Loam Clay Loam Clay Loam Clay Loam	am am am am am
R2562 R2563 R2564 R2565 R2566 R2567 R2568 R2569 R2570 R2571	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15 20 25 30 35 40 50 55	1 5 10 15 20 25 30 35 40 45 55 60	27.3 28.7 24.6 24.9 25.9 25.9 11.8 18.0 26.4 25.4 25.3 23.1 29.8	2.1 1.8 0.9 0.9 1.1 1.2 0.8 0.6 1.4 1.2 1.6 1.5	8.5 4.8 7.0 8.0 8.2 7.9 5.8 7.9 7.7 8.0 7.9 8.8	9.4 0.4 7.7 8.4 9.8 7.5 6.7 9.8 9.2 9.3 8.3 7.0 8.1	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38 1.42 1.28 1.32 1.31 1.46 1.33	60 36 16 52 46 34 44 58 56 40 42 36 64 48	24 34 26 24 30 26 20 20 28 28 30 12 24	40 50 22 30 36 30 22 24 32 30 34 24	Sa Sa Sa Sa Sa Sa Sa	Clay Clay Clay Clay Clay Clay Clay Clay	am am am am am
R2562 R2563 R2564 R2565 R2566 R2567 R2568 R2569 R2570 R2571 R2572 R2573	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15 20 25 30 35 40 50 55 65 70	1 5 10 15 20 25 30 35 40 45 55 60 70	27.3 28.7 24.6 24.9 25.9 25.9 11.8 18.0 26.4 25.4 25.3 23.1 29.8 27.3	2.1 1.8 0.9 0.9 1.1 1.2 0.8 0.6 1.4 1.2 1.6 1.5 1.4	8.5 4.8 7.0 8.0 8.2 7.9 5.8 7.9 7.7 8.0 7.9 8.8 8.5	9.4 0.4 7.7 8.4 9.8 7.5 6.7 9.8 9.2 9.3 8.3 7.0 8.1 10.3	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38 1.42 1.28 1.32 1.31 1.46 1.33 1.32	60 36 16 52 46 34 44 58 56 40 42 36 64 48 48	24 34 26 24 30 26 20 20 28 28 30 12 24 26	40 50 22 30 36 30 22 24 32 30 34 24 28 26	Sa Sa Sa Sa Sa Sa Sa Sa	Clay Clay Clay Clay Clay Clay Clay Clay	am am am am am am am
R2562 R2563 R2564 R2565 R2566 R2567 R2568 R2569 R2570 R2571 R2572 R2573 R2574	T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3 T/O-3	0 0 5 10 15 20 25 30 35 40 50 55 65 70	1 5 10 15 20 25 30 35 40 45 55 60 70 75	27.3 28.7 24.6 24.9 25.9 25.9 11.8 18.0 26.4 25.4 25.3 23.1 29.8 27.3 23.6	2.1 1.8 0.9 0.9 1.1 1.2 0.8 0.6 1.4 1.2 1.6 1.5 1.4	8.5 4.8 7.0 8.0 8.2 7.9 5.8 7.9 7.7 8.0 7.9 8.8 8.5 8.5	9.4 0.4 7.7 8.4 9.8 7.5 6.7 9.8 9.2 9.3 8.3 7.0 8.1 10.3 6.8	1.90 1.32 0.90 1.20 1.33 1.34 1.32 1.38 1.42 1.28 1.32 1.31 1.46 1.33 1.32 1.35	60 36 16 52 46 34 44 58 56 40 42 36 64 48 48 54	24 34 26 24 30 26 20 20 28 28 30 12 24 26 24	40 50 22 30 36 30 22 24 32 30 34 24 28 26 22	Sa Sa Sa Sa Sa Sa Sa Sa	Clay Clay Clay Clay Clay Clay Clay Clay	am am am am am am am
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<sup>\*=</sup> Below Reporting Limits

<sup>&</sup>lt;sup>+</sup> Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed

<sup>&</sup>lt;sup>+</sup> Values in orange are moderately elevated, and may require special consideration in the reclamation plan

# CEDAR CREEK ARROCKATES, INC.

# Cedar Creek Technical Report

# 3.2 Additional Soil-Vegetation System Observations

Both disturbed and undisturbed areas within the project area were observed, specifically to obtain information on locally successful vegetation species and the corresponding edaphic systems.

## 3.2.1 Disturbed Soil Systems

The extent to which disturbed systems were supporting vegetation (both seeded and volunteer) varied greatly across the project area. Areas with visible salt deposits and salt crusts (such as several Waste Piles) were supporting little to no vegetation. Areas with approximately 6 to 8 inches of disturbed topsoil overlying visibly salty geologic materials supported diminutive and sparse vegetation.

Slope angle largely influenced vegetation. Because of how the dump facilities were constructed, materials are either generally flat to gently sloping or approaching angle of repose. Little to no vegetation was observed growing on angle of repose slopes, even when materials seemed suitable for use in reclamation (topsoil/alluvial materials). Only on flat areas (less than 10% slopes) were suitable patches of vegetation observed.

## 3.2.2 Native (Undisturbed) Soil Systems

Native soils in the region vary greatly, particularly in depth and age. Deeper and older alluvial soils in the main drainage channels and alluvial fans are not particularly useful when attempting to estimate the required depth of cover materials on reclamation and were excluded. Therefore, small pockets of residually weathering topsoil with shaley and sandy geologic parent materials were targeted as a proxy to estimate cover requirements.

Native systems observed supporting vegetation sufficient to minimize erosion ranged in depth from 1-4 feet. Vegetation was noticeably diminished in areas with 12-18 inch topsoil depths and mostly productive in areas with topsoil greater than 2 feet. Deeply incised rills and gullies were visible in these native areas, even on relatively shallow slopes (less than 20%) with no topographic variation to concentrate overland flow; demonstrating the high potential for erosion in local soil and geologic systems.

#### 4.0 Technical Discussion

#### 4.1 General Overview

Soils in the project area generally have elevated levels of salt and high proportions of sand. Targeted sampling of unique or unadulterated geologic materials (such as Sample R2585 - Table 5; EC=42.1) provides the bounds for which conditions could be encountered within the reclaimed system. Material types (and corresponding suitability as a top/sub soil) have distinctive colors in the field:

- Brown materials (soils and alluviums) are typically slightly saline and have some potential to
  exhibit textural extremes, but are most often within all suitability criteria. These materials are
  most suited to serve as a reclamation planting media.
- White materials (weathered or crushed sandstone) are typically very saline, and inappropriate
  for use as a rooting media. These materials should be buried if possible (a minimum of 4
  feet), to avoid the upward mobilization of soluble salts and contamination of overlying rooting
  media.
- Grey materials (shale and weathered carbonaceous sand, silt, and clay stone) are typically slightly to moderately elevated in salts, occasionally display low pH's, and exhibit high



- erosivity. These materials should be avoided for use as a planting media, but will act sufficiently as a subsoil rooting media.
- Black materials (coal, shale, and carbonaceous sandstone) are typically elevated in salts, exhibit unsuitably low pH's for native arid western vegetation, and are moderately to highly erosive. These materials should be avoided for use as a planting media, but will act sufficiently as a subsoil rooting media.

Reclamation will be challenging, and a variety of best management practices should be implemented to ensure reclamation success. Observations suggest that at a minimum, 2 feet of suitable cover material should be utilized for reclamation, preferably deeper (especially if reclaiming the white saline sandstone encountered within Waste Piles 1, 2, 3, 4, and 7). Observations also suggest that best management practices will need to be used to control erosion, even on shallow slopes.

## 4.2 Findings from Field and Laboratory Analysis

#### 4.2.1 Waste Piles 1, 2, 3, 4, and 7

Field observations indicated that these Waste Piles consist of large quantities of saline sandstone (white materials), shale, coal, and carbonaceous sandstone (black materials), and shale (grey materials). Laboratory results from Waste Piles 1, 2, 3, 4, and 7 demonstrated that these piles are comprised of materials that exhibit unsuitable subsoil / rooting media conditions. The potential for moderate to exceptionally high salinity, and slight to extreme acidity is possible.

Sodium levels have the potential to be elevated. Samples from this sampling effort suggest that sodium elevations correspond with elevated salinity, balancing the salt to sodium ratio and diminishing the negative effects of sodium presence. Agronomic samples from the 2007 MWH Materials Characterization Report exhibited SAR values up to 19.1 in Non-Economical Material Storage Areas, Shaft Area Ponds, and Mine Dump and Shaft Pads.

Sampling results from 2018 characterization efforts indicate that the upper and middle portions of these piles are not suitable growth media; Yet drilling logs from previous sampling efforts indicate that brown alluvial materials or soils may comprise the lower portions of Pile 4 (although no sampling was conducted to these depths during the 2018 efforts). The lower portions of Pile 4 may be suitable for use as a reclamation growth media or for direct revegetation, but sampling should be conducted if the lower portions of Pile 4 are to be used as a revegetation planting media.

### 4.2.2 South Topsoil Pile

The South Topsoil Pile is comprised more of crushed carbonaceous sandstone (black materials) and shale (black and grey materials), than topsoil (brown materials). This Pile exhibited laboratory results approaching thresholds for salinity, along with slightly to strongly acidic pH's, in addition to high proportions of sand (relative to other potential Borrow Areas). This pile should be considered the least desirable of the identified potential sources for use as a reclamation planting media. It would be suitable for use as a rooting media.

#### 4.2.3 Topsoil / Overburden Pile

The Topsoil/Overburden Pile is likely comprised of mostly topsoil, but with a considerable shale component (grey and black materials) mixed throughout, with occasional concentrated pockets of weathering shale. Laboratory testing parameters were comparable to other potential sources of growth media, yet extensive erosion features were observed on the pile (8-10 foot deep gullies). This is likely due



to the poor consolidation and the erosive nature of the shale material. This pile would be more suited for use on flatter reclamation surfaces (less than 10% slopes) or as a subsoil.

## 4.2.4 Borrow South, Borrow West, Lobo Tract Borrow, and North Topsoil Pile

Borrow South, Borrow West, Lobo Tract Borrow, and North Topsoil Pile can all be considered comparable in quality for use as a reclamation growth media. Each Pile exhibits at least one or more samples with elevated salinity or sand content, but when averaged are suitable for use as a cover material / planting material. Averaging of laboratory values are applicable for these locations, because they are predominantly undisturbed systems that can be definitively characterized, and will be significantly mixed through salvage, transportation, final placement, and grading.

# 4.3 Addressing Reclamation Challenges

#### 4.3.1 Erosion

The erosive nature of locally available growth media, due to elevated sand content, will require best management practices to stabilize the reclamation surface. The proportion of sand found in most soils across the project area will result in poorly structured and non-cohesive soils, especially following disturbance from earth moving and reclamation activities. In addition to direct erosion control measures (i.e., mulching, hydro-seeding, wood chip waddles, etc.), an effort should be made to adjust slope length and minimize steepness wherever possible. By considering the erosive nature of available materials, conservative planning and design will increase the likelihood of a favorable reclamation outcome on the project.

### 4.3.2 Salinity

The moderate salinity consistently found throughout local soils will exacerbate drought stress, particularly during the critical period of germination and establishment. There is no impact threshold with salinity; impacts exist on a continuum, meaning any increase in salinity is a direct increase is plant-water stress. Deeper soil systems have the potential to capture and store more plant available water, increasing the likelihood of a successful reclamation effort.

Relatively deeper soils will also limit the upward migration of soluble salts from underlying salty and acidic geologic materials, such as the white sandstone, black coal, and grey shale. Erosion control efforts, such as mulching, contouring, waddles, etc., will provide additional benefits in mitigating salinity by aiding in soil moisture retention through limiting surface evaporation and facilitating greater infiltration.

## 4.3.3 Acidity

The slight to extreme acidic conditions (in black and dark grey materials) encountered on Borrow South, South Topsoil Pile, and Piles 1, 2, and 3, are challenging to overcome in arid rangeland reclamation systems. Native arid western vegetation is not adapted for acidic soil conditions and will likely result in diminutive vegetation or a lack of germination. Acidity was localized to areas with black materials (coals, shales, and carbonaceous sandstones). The degree and extent of acidity can be managed by ensuring any black materials are buried at least 2 feet below adequate cover materials, or excluded from salvage.



# 5.0 Summary

Local soils and site conditions present significant hurdles to overcome when considering reclamation planning and design. Industry best management practices and conservative reclamation planning will be crucial when attempting to establish vegetation and stabilize reclaimed slopes. Any adversity in climatic conditions will exacerbate these challenges. Expectations for reclamation timelines and overall potential should be tempered, as even favorable weather coupled with conservative best management practices may likely be insufficient to ensure site-wide reclamation success. Reseeding and regrading of erosive areas will likely be required at some point during the liability period.

Table 8 provides a ranking of the relative suitability of Borrow Areas for use as growth media, the recommended minimum thickness, and the soil and geologic material types noted in each location.

Table 8 St. Anthony Mine - Materials Characterization - 2018										
Growth	Media Bor	row Source Summa	nry							
Potential Growth Media Borrow Source	Rank by Preference	Placement Suitability	Recommended Minimum Thickness	Material Types Observed						
North Topsoil Pile	1	Cover / Planting Media	24 inches	Topsoil						
West Borrow	2	Cover / Planting Media	24 inches	Topsoil						
West borrow	2	Cover / Flaming Media	24 menes	Alluvium						
Lobo Tract	Lobo Tract 3 Cover / Planting Media 24 inches									
LODO TTACE	3	24 IIICHES	Alluvium							
Borrow South	4	Cover / Planting Media	24 inches	Topsoil						
borrow South	4	Cover / Flaming Media	24 IIICHES	Alluvium						
		Cover / Planting Media		Topsoil						
		(on < 10% slopes)		Alluvium						
Topsoil / Overburden Pile	5		24-36 inches	Shale						
		Subsoil / Rooting Media		Coal						
		Subsoil / Rootling Media		Gypsum Precipitates						
				Topsoil						
				Alluvium						
South Topsoil Pile	6	Subsoil / Rooting Media	N/A	White Saline Sandstone						
South Topson File	U	Subsoil / Rooting Media	N/A	Black Carbonaceous Sandstones						
				Shale						
				Coal						

The information gathered through field efforts and laboratory testing will be utilized to update the existing reclamation plan to reflect site conditions and developing site-specific strategies for achieving successful revegetation and slope stabilization.



## 6.0 References

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Soil Survey Staff. 2014. Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 51, Version 2.0. R. Burt and Soil Survey Staff (ed.). U.S. Department of Agriculture, Natural Resources Conservation Service.

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MWH. Materials Characterization Report – Saint Anthony Mine Site. October 26, 2007.

# St. Anthony Mine

**United Nuclear Corporation** 

**2018 REVEGETATION PLAN UPDATE** 

DECEMBER, 2018

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#### **List of Abbreviations**

Best Management Practices
Cedar Creek Associates, Inc.
Mining Act Reclamation Program
New Mexico Mining and Minerals Division
Post-Mining Land Use
United Nuclear Corporation
Western Regional Climate Center

BMP's Cedar Creek MARP NMMMD PMLU UNC WRCC

## **United Nuclear Corporation (UNC)**

### St. Anthony Mine 2018 Updated Revegetation Plan

#### 1.0 INTRODUCTION

Cedar Creek Associates, Inc. (Cedar Creek) was contracted in 2018 to update the Revegetation Plan in support of the "Closeout Plan" for United Nuclear Corporation's (UNC) St. Anthony Mine. This updated Revegetation Plan is informed by previous vegetation sampling conducted in 2005, a growth media characterization effort and general site survey conducted in 2018 (Appendix A), and local and regional experience successfully reclaiming uranium sites with similar conditions and challenges. In general, this plan applies to lands within the project area that are subject to revegetation, including the waste piles, soil borrow areas, and revegetated portions of backfilled pits. Revegetation protocols and performance criteria presented in this plan are responsive to the rules, regulations, and guidelines of the New Mexico Mining and Minerals Division (NMMMD). Specifically, the 1996 Closeout Plan Guidelines provide a framework for the monitoring methodology and success criteria (NMMMD, 1996). This revegetation plan identifies and defines reclamation protocols (Section 2.0), monitoring methodology (Section 3.0), success criteria (Section 4.0), and contingency planning / corrective actions (Section 5.0) to be utilized for revegetation of the St. Anthony Mine.

Revegetation planning will consider: 1) local vegetation communities, 2) post-mining (or post-disturbance) land use (PMLU), 3) specific considerations pursuant to desired post-disturbance management of private lands, and 4.) The most scientifically sound methods and state-of-the-art techniques related to revegetation, soil amendments, seedbed preparation, seeding, mulching, and general reclamation science. In addition, quality assurance and quality control procedures in the form of monitoring surveys will be undertaken to confirm that revegetation efforts are implemented correctly and the results of the process meet predetermined expectations and general liability success criteria. This process of monitoring and evaluation will also allow for an adaptive management approach to reclamation, further assuring a positive project outcome at the St. Anthony Mine Site.

#### 1.1 Regulatory Guidance

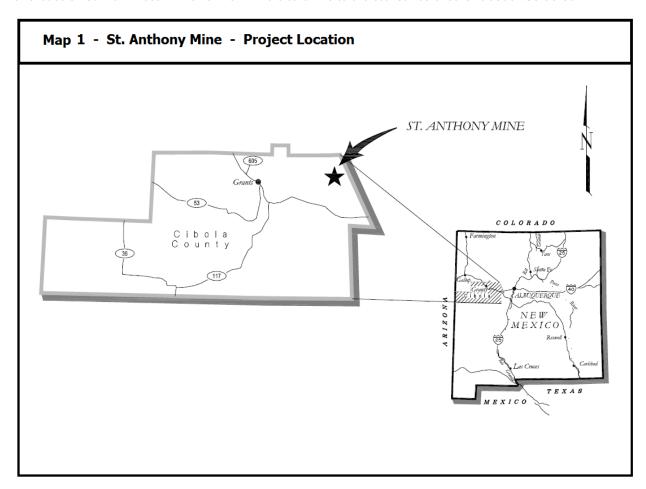
A basic framework for all reclamation including soil/growth media considerations, seeding considerations, and proposed amendments can be established for the entirety of the project. Site-specific considerations in addition to this framework can be applied or adjusted in the future to meet site-specific

requirements. Industry best management practices (BMP's) will be employed wherever possible to increase the likelihood of positive project outcomes.

The St. Anthony Mine existed prior to the state Mining Act Reclamation Program (MARP), which regulates hard rock mining reclamation activities for uranium properties. Regardless, the revegetation protocols and performance criteria for the St. Anthony Mine Site will be guided by, and aim to meet the standards, rules and regulations of the NMMMD (New Mexico Administrative Code [NMAC] 19.10.5). New Mexico Closeout Plan Guidelines (NMMMD, 1996) provide a framework for the revegetation protocols and performance criteria to be applied to the St. Anthony Mine.

#### 1.2 Project Location

The St. Anthony Mine is located approximately 40 miles West of Albuquerque and 10 miles east-northeast of the town of Paguate, in Cibola County, New Mexico (Map 1). The project is located in the USGS 7.5-minute Moquino, New Mexico quadrangle, within the Arroyo de Valle, and is immediately north and east of Gavilan mesa. The former mine site exhibits a disturbance area of about 430 acres.



#### 1.3 General Site Description

The majority of the former mine site lies within an upland valley of floodplains, alluvial fans, and fan remnants dominated by grasses with occasional shrubs. The mine facilities (former pits, ancillary disturbances, several waste piles, and material storage piles) are located in this wide valley, predominantly consisting of fine textured Quaternary alluvium, ranging from approximately 5 to 50 feet in depth. The center of the valley contains an intermittent/ephemeral arroyo with finer, salty soils, supporting tamarisk and other weedy species, along with salt tolerant grasses. Sandstone benches and escarpments, with often shallow and lithic soils, are exposed on the margins of the main alluvial valley, increasing in prominence moving outward to the periphery of the project area. Transitions between these communities are often abrupt, as the vegetation systems are responsive to the soil systems and local geomorphology. Three vegetation ecotypes that correlate well with the soil-landscape relationship have been identified to dominate both the project site, and the area surrounding the project: 1) Grassland ecotype 2) Juniper Scrub ecotype, and 3) Bottomland ecotype.

Grasslands are herbaceous communities dominated by grasses and occasional forbs that can sometimes be seasonally dominant. Trees and larger shrubs are largely absent from this type except for the occasional invader of local sites. Grasslands in this part of New Mexico may be dominated by annual grasses, perennial bunchgrasses, or perennial sod-forming grasses and typically of the warm-season group. In the project area the grasslands are of this latter warm-season perennial sod-forming group. Soils tend to be deep (greater than 6 feet), but are occasionally shallow. Typical geomorphic features are floodplains, alluvial fans, and fan remnants.

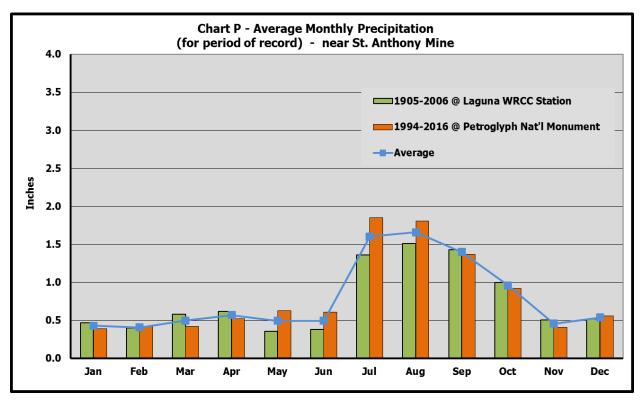
The Juniper scrub ranges between a "savanna" of scattered trees within the benched high-plains grassland, to dense woody dominated areas with very poor herbaceous understories. The Juniper Scrub ecotype is usually associated with rock outcroppings and thin, skeletal soils, often with a sandy texture. Occasional piñon are found throughout the ecotype.

The Bottomland ecotype is primarily characterized as having higher available water within the soil profile (more loamy, less sandy). Also, the higher available water is due to the ecotype being physically located in the arroyo bottoms that tend to collect surface runoff and fine-textured erodible materials. The increased soil moisture and loamy texture leads to increased vegetative cover from herbaceous taxa. Visible salt crusts were noted within the drainage bottom and along the cut banks (Cedar Creek, 2018 attached as Appendix A). The arroyo is deeply incised, and the upland grasslands immediately adjacent to the arroyo are not subject to flooding from typical precipitation events. On occasion, the bottomland community can exhibit areas of shrub domination by four-wing saltbush in areas exhibiting moderately elevated salt accumulations, but can also exhibit areas of dominance by winterfat or Bigelow's sagebrush. Other areas

may be nearly absent of shrubs whereby grasses (and rarely forbs) are dominant. Tamarisk and other noxious weeds were also noted in the drainage bottoms.

#### 1.4 Climate Data

The closest available weather stations to the project site, with prolonged and reliable climate data, are located in Laguna (~10 Miles to the southwest) and at Petroglyph National Monument (~33 miles to the east). The Laguna Western Regional Climate Center (WRCC) station period of record dates from April 1905 to March 2006, where average precipitation measures approximately 9.66 inches per year. The Petroglyph National Monument WRCC station period of record dates from April 1994 to May 2016, where average precipitation measures approximately 9.61 inches per year. The general agreement between these two data sets suggests the Petroglyph national monument site could be applicable to evaluating rainfall at the site in any given year during the reclamation process. Chart P below displays the average monthly data from each site, and averaged between sites, over the respective periods of record.



#### 2.0 REVEGETATION PROTOCOLS

#### 2.1 Growth Medium Considerations and Reapplication Depths

Once waste rock piles and other mine facilities have been graded to final contour, they must be top-dressed with an adequate amount of growth media. The growth media will be applied to develop an acceptable profile conducive to revegetation establishment and sustainability. A growth media characterization study was completed in 2018 (Appendix A), pertaining to the suitability of several soil Borrow Areas, Topsoil Piles, and Waste Piles for use as growth media and/or subsoil rooting media in the reclamation of the St. Anthony Mine Site. The study details the challenging soil chemical and physical properties that exist across the project area, and provides recommendations that have been incorporated into several sections of this work plan. Soils in the project area generally have elevated levels of salts and high proportions of sand, which will exacerbate drought stress and erosion potential, but are suitable for use in reclamation through the use of BMP's and a risk-based approach to reclamation. A variety of BMP's (seeding, mulching, slope design, etc.) and conservative reclamation design elements will be implemented to ensure the likelihood of reclamation success.

The laboratory testing parameters, methodologies, and suitability criteria utilized in the growth media characterization study to inform this reclamation plan are presented below in Table 1. These suitability criteria are in agreement with the Soil and Topsoil Suitability Ratings of the NMMMD Closeout Plan Guidelines.

Table 1 St. Anthony Mine - Reclamation Plan - 2018						
Soil Laboratory Results - Suitability Criteria						
Paramater	Method Acceptable Average V		Units			
pH (paste)	ASTM D4972 - 13	6 - 8.3	N/A			
Electrical Conductivity	4F1a1a1*	< 3 < 6	mmhos/cm			
Organic Matter	Walkley-Black	< 10	% of Total Soil			
NO <sub>3</sub> -N	4D6*	> 0.1*	ppm			
Phosphorus (P)	4D6*	> 1+	ppm			
Potassium (K)	4D6*	> 20+	ppm			
Zinc (Zn)	4D6*	> 0.25 <sup>+</sup>	ppm			
Iron (Fe)	4D6*	> 1.0+	ppm			
Manganese (Mn)	4D6*	> 0.1+	ppm			
Copper (Cu)	4D6*	> 0.1 <sup>+</sup>	ppm			
Calcium (Ca)	EPA Method 3050B	Addressed as SAR	ppm			
Magnesium (Mg)	EPA Method 3050B	Addressed as SAR	ppm			
Sodium (Na)	EPA Method 3050B	Addressed as SAR	ppm			
Sodium Adsorption Ratio	EPA Method 3050B	< 15	N/A			
Texture by hydrometer	ASTM D422-63(2007)e2	No Textural Extremes	% Size Fraction			

<sup>\*</sup> Soil Survey 2014 as Reference

<sup>+</sup> Values Can Be Increased Through OM Additions

Based on the results of laboratory analysis, soils and growth media Borrow Areas have been ranked by preference for use as a surficial reclamation planting and growth media, and appropriate cover depths have been suggested for each borrow source (Table 2). Both the quality of the borrow sources that will be utilized as cover materials, and the quality of the typical underlying waste materials, were considered when recommending cover depth requirements. The erodability and generally elevated salinity in both surficial growth media, and especially in the underlying rooting media, were significant factors when suggesting minimum 24 inch cover depths. Results from all laboratory analysis of borehole samples from each borrow source and waste pile are available in Appendix A.

Table 2 St. Anthony Mine - Reclamation Plan - 2018						
Growth Media Borrow Source Summary						
Potential Growth Media Borrow Source	Rank by Preference	Placement Suitability	Recommended Minimum Thickness	Material Types Observed		
North Topsoil Pile	1	Cover / Planting Media	24 inches	Topsoil		
West Borrow	2	Cover / Planting Media	24 inches	Topsoil		
West Dollow		Cover / Planting Media	24 11101163	Alluvium		
Lobo Tract	3	Cover / Planting Media	24 inches	Topsoil		
Lobo Tract			24 11101163	Alluvium		
Borrow South	4	Cover / Planting Media	24 inches	Topsoil		
BOITOW SOUTH				Alluvium		
		Cover / Planting Media (on < 10% slopes)		Topsoil		
	5			Alluvium		
Topsoil / Overburden Pile			24-36 inches	Shale		
		Subsoil / Rooting Media		Coal		
		Subsoil / Rooting Media		Gypsum Precipitates		
	6	Subsoil / Rooting Media	N / A	Topsoil		
South Topsoil Pile				Alluvium		
				White Saline Sandstone		
				Black Carbonaceous Sandstones		
				Shale		
				Coal		

Handling of growth media should be done prudently as to avoid excessive disruption to soil structure. Handling or disturbance of growth media materials immediately following precipitation events should be avoided, when possible, to limit issues associated with compaction. During construction, final placement, seed bed preparation or amendment application, care should be taken to avoid unnecessary or repeated trafficking of growth media to limit compaction. If compaction is expected, deep ripping or chisel plowing should be implemented, and always on the contour.

#### 2.2 Soil / Growth Media Amendments and Fertility

Nutrient levels within the proposed growth media borrow areas and topsoil piles are within the acceptable ranges (Appendix A), signifying fertility specific amendments are not required. However, when materials are disturbed (plowed, harvested, tilled), organic matter and associated fertility can be released (volatilized) by a subsequent increase in microbial activity. In addition, organic amendments, particularly fibrous composts, can increase the water holding capacity and general condition of the seedbed, particularly during the critical period of germination and plant establishment. Therefore, a general application rate of 2 tons/acre (dry weight) incorporated into 3 inches depth of composted cow manure, green manure, or composted biosolids will be applied, and will benefit establishing vegetation.

If composted cow manure or biosolids are to be utilized, the moisture content, salinity, organic content, and radioactivity will need to be tested by a certified laboratory. All testing should be conducted on representative samples from the same batch intended for use on reclamation, as the composting industry is unregulated and material quality can vary. Moisture and organic matter are used to accurately calculate target application rates. Given the potential for elevated salts in the soils, only low salt amendments should be used. Composted biosolids will be tested to ensure sufficiently low radium activity concentrations prior to use. In specific instances, such as harvesting growth media from very deep in the soil profile or using material stockpiled for more than a year, increased quantities of manure may be beneficial, and will be addressed on an "as needed" basis.

Composted manures and/or composted biosolids are more desirable than inorganic fertilizers and industrial byproducts such as Biosol, because they are significantly lower in inorganic and total nitrogen. Nitrogen preferentially stimulates the growth of undesirable weedy annual species, which reduces available water and nutrients for desirable perennial vegetation. In addition to the low nitrogen levels, the physical structure of the compost increases localized water holding capacity, and creates islands of fertility to aid germination. Plant germination and establishment in the first few years is critical, as native seed sources then begin to supplement the initial seeding, and stabilize the soil medium. Organic amendment application should occur immediately prior to seeding, and be incorporated as soon as possible, preferably by disk harrow. Composted manure and/or biosolids left on the soil surface, exposed to warm temperatures and potential precipitation will readily decompose, thus making it less beneficial.

#### 2.3 Erosion Control and Seedbed Preparation

Where possible, slopes should be kept at or under 25 percent (4:1) to increase the likelihood of a successful seeding effort and reduce the potential for erosion. The proposed growth media available onsite is primarily comprised of sandy soils; these soils are generally acceptable for vegetation growth but pose an elevated erosion risk (Cedar Creek, 2018). Therefore, where steeper slopes must be constructed,

additional erosion control treatments (such as erosion matting, wattles, or rock/wood chip mulch) should be applied. On all sloping sites, reclamation techniques should be applied perpendicular to the direction of water flow as machinery access and safety considerations allow. Slope lengths should be broken by terraces such that no slope ever exceeds 400 feet uninterrupted, and would be best if terraced at 100 or 200-foot length intervals.

Once the project area is regraded to approximate final configuration and overlaid with the native borrow material, areas of steeper slopes (4:1 or greater) should be deeply ripped, with a single or double-toothed chisel plow pulled by a D8 or equivalent dozer. Deep ripping must occur along the contour to a minimum depth of 12 inches to break the "slippage" zone between spoil materials and growth media and to create contour ridges to help preclude erosion. Ripping should occur at nominal intervals of 4 feet (but no more than 6 feet) between the ripper teeth.

A field level assessment of erosion risk should be implemented following construction to determine the appropriate temporary erosion control, if needed. The risk assessment should consider slope gradient, slope length, and contributing area. Areas with high consequences of erosion should receive permanent rock mulches and mixed into the growth media, or a combination of rock and wood shreds. Mulch can help conserve soil moisture for seed germination and aid initial plant establishment as well as provide additional soil erosion protection from both wind and water until a plant cover is established. Areas with lower consequences of erosion should receive certified weed-free wood shred mulch, wood chip mulch, or crimped straw mulch.

#### 2.4 Seeding Considerations

Seed mixes are designed to facilitate growth of appropriate and sustainable species for the targeted reclamation community. Species proposed for this mix are suitable for use, as demonstrated by their establishment on nearby revegetation at the L-Bar Mine Site, and other uranium reclamation projects in similar soils and climates throughout the Grants Uranium Belt and rangelands surrounding Mount Taylor.

Effort will be made to implement seeding at optimal times for site conditions (late fall/early spring). However, if a unit must be seeded during inopportune months, a field level risk assessment will determine whether temporary erosion control measures (such as crimped hay, wood shreds, wattles, etc.) are needed to stabilize the surface prior to anticipated vegetation establishment. Seeding can be accomplished using both broadcasting and drilling techniques, following final contouring and compost application/incorporation. If seed is broadcast, a light disc harrowing perpendicular to the flow of energy (wind and/or water) should immediately follow seeding to increase seed to soil contact and provide some protection from wind or water erosion and granivory. If seed is drilled, drilling must occur on the contour, to create subtle ridges perpendicular to the flow of energy.

The proposed seed mix is comprised of native species suitable for the local climate and edaphic conditions. Select species and application rates are presented on Table 3. Seed mixes have been designed to establish mixed shrub and grassland community, to provide for the PMLU of grazing and incidental wildlife habitat. Trees are not specifically targeted in the seed mix, but are expected to gradually volunteer on reclamation (where site conditions allow) once the site stabilizes and natural successional processes commence. Volunteer vegetation (non-seeded species) are encouraged to establish on the revegetation parcel as long as species are not noxious weeds and do not impact the ability to achieve a sustainable perennial vegetative community.

Seed mixes will be obtained from reputable commercial sources and information regarding the percent purity, percent weed seed, and percent germination will be reported on the seed tag (a legal document describing the contents of the seed you are purchasing). Besides being very useful information to the consumer, state and federal laws require seed companies to provide a description of the seed being sold. The information on the tag comes from tests that have been performed on the seed by a seed testing laboratory.

Reclamation Seed Mix					Recomme	endation	s	This entire mix can be drill seede
No.	Obs. On Site	Common Name	Scientific Nomenclature	PLS/lb.**	Recomd. PLS lbs/ac	PLS /	% of Seeds in Mix	Comment  (Based on Site-specific Findings or Professional Judgment)
1	XX	Western wheatgrass	Agropyron smithii	110,000	1.50	3.8	4.4%	NRCS indicated climax species
2	XX	Alkali Sacaton	Sporobolus airoides	1,758,000	0.75	30.3	35.3%	NRCS indicated climax species
3	ХХ	Blue Grama	Bouteloua gracilis	825,000	0.50	9.5	11.0%	Stong component of native community
4	XX	Galleta	Hiliaria jamesii	159,000	0.50	1.8	2.1%	Stong component of native community
5		Thickspike Wheatgrass	Agropyron dasystachyum	154,000	1.00	3.5	4.1%	Good performer - Offers diversity
6	XX	Indian Ricegrass	Oryzopsis hymenoides	141,000	1.00	3.2	3.8%	Should do well in areas of sandy texture
7	XX	Sideoats Grama	Bouteloua curtipendula	191,000	1.00	4.4	5.1%	Good performer - Offers diversity
8	XX	Bottlebrush Squirreltail	Sitanion hystrix	192,000	0.25	1.1	1.3%	Fair performer - Offers diversity
			Subtotal		6.50	57.6	67.1%	
9	XX	Desert Globemallow	Sphaeralcea ambigua	500,000	0.75	8.6	10.0%	Sufficient performer for diversity
10		Palmer Penstemon	Penstemon palmeri	610,000	0.50	7.0	8.2%	Good performer - Offers diversity
11	XX	Rocky Mountain Penstemo	r Penstemon strictus	592,000	0.25	3.4	4.0%	Fair performer - Offers diversity
12		Lewis Flax	Linum lewisii	293,000	1.00	6.7	7.8%	Good performer - Offers diversity
			Subtotal		2.50	25.7	30.0%	•
13	XX	Fourwing Saltbush	Atriplex canescens	52,000	1.00	1.2	1.4%	NRCS indicated climax species - good forage val
14	XX	Winterfat	Ceratoides lanata	56,700	1.00	1.3	1.5%	Excellent performer - good forage value
			Subtotal		2.00	2.5	2.9%	
			Total		11.00	85.8		This entire mix can be drill seed
ltern	ative	species which may be us	sed as substitutes for terti	arv species	or added t	o the ov	erall mix for a	additional diversity.
	XX	Sand Dropseed	Sporobolus cryptandrus	5,298,000	0.00	0.0		
Grasses		Arizona fescue	Festuca arizonica	550,000	0.00	0.0		Use in moist areas only, likes 14" of precip.
Sra.	XX	New Mexico Needlegrass	Stipa neomexicana	70,000	0.00	0.0		
	XX	Purple three-awn	Aristida purpurea	250,000	0.00	0.0		
orbs		Small Burnet	Sanguisorba minor	55,000	0.00	0.0		
sqr		Wyoming Big Sagebrush	Artemisia tridentata wyo.	2,500,000	0.00	0.0		
Shrubs		Rubber Rabbitbrush	Chrysothamnus naseousus	400,000	0.00	0.0		
υ,		Black Sagebrush	Artemisia nova	907,200	0.00	0.0	l	
		Primary Species - Should Secondary Species - Subs						

<sup>\*</sup> The 11 lb/ac mix is designed for drill seeding. When broadcast and harrow methods are used, the rate should be increased 1.5 times. When hydroseeding methods are to be used, the rate should be doubled (2X). \*\* PLS = Pure Live Seed.

#### 2.5 Noxious Weed Considerations

Prior to construction activities, listed noxious weed species found within the project area should be treated (chemically, mechanically, or biologically) to limit the spread of noxious weeds. Russian thistle is not a listed noxious weed in New Mexico (Witte, 2016) and commonly found in the arid west and decreases as perennial plant communities establish and disturbance diminishes. Russian thistle and other invasive annual species common to the area and do not need to be treated.

#### 3.0 VEGETATION SAMPLING METHODS

Cedar Creek's vegetation sampling protocols involve an emphasis on ground cover to facilitate repeatable statistical comparisons among treatment areas (or unique revegetation units). Concentration on a single variable of plant ecology facilitates improved comprehension and comparability over time and among treatment scenarios. Ground cover data, especially when determined using a very precise method such as the point-intercept procedure, provides some of the most important information regarding community variability that ecologists can evaluate. Such data facilitate the determination of true species composition, relative health (condition), and successional status of the sampled area. Furthermore, the same data can be utilized to develop the "sister" variables of frequency and species composition if desired. In addition, strong inferences can be developed with other reasonably correlated variables such as production when species composition is factored into the analysis. Also, ground cover is a preferred variable for revegetation monitoring because cover data can be readily obtained in a statistically adequate and cost-effective manner (using the proper procedures), has broad application for evaluation (including erosion control modeling), precisely reflects species' dominance of a given area, and when collected using biasfree techniques such as the point-intercept procedure, is one of the most repeatable variables among independent observers.

Deficiencies in vegetation, both general and localized, and other pertinent information relative to the reclamation are also recorded while traversing monitoring units during vegetation evaluations. During these traverses, the observer is vigilant for: 1) areas of poor establishment/growth, 2) pervasively weak or stressed plants, 3) indicators of soil fertility problems, 4) noxious weeds or invasive plant infestation, 5) evidence of unintended livestock grazing, 6) excessive erosion, 7) pockets of the aforementioned, and 8) any other similar revegetation / reclamation related issues.

#### 3.1 Sample Site Selection / Location

The primary field efforts call for sampling revegetation and corresponding reference area(s). The systematic procedure for the determination of sample locations occurs in the following stepwise manner.

- A fixed point of reference is selected for the entire area to facilitate location of the systematic grid in the field.
- 2. A systematic grid of appropriate dimensions (i.e., 200 ft X 200 ft) is selected by Cedar Creek to provide a minimum number of coordinate intersections; reclaimed areas are conducted to a minimum of 20 (for areas greater than 1 acre) or 5 (for areas less than 1 acre) initial transects whereas reference area sampling is conducted to a minimum of 15 initial transects.

- 3. A scaled representation of the grid is overlain on field maps extending parallel to major compass points to facilitate field location.
- 4. Unbiased placement of this grid is controlled by selection of two random numbers between 0 and 200 (used as coordinates).
- 5. Utilizing a handheld GPS, all of the initial sample points are located in the field.

#### 3.2 Determination of Ground Cover

Ground cover at each sampling site is determined utilizing the point-intercept method (Bonham 1989) as illustrated on Figure 1. This method has been utilized for range studies for over eighty years; however, Cedar Creek utilizes state-of-the-art instrumentation that it has pioneered to facilitate much more rapid and accurate collection of data. Implementation of the technique for the sampling effort occurs as follows: First, a transect of 10 meters length is extended from the starting point of each sample site toward the direction of the next site to be sampled. Then, at each one-meter interval along the transect, a laser point bar is situated vertically above the ground surface, and a set of 10 readings recorded as to hits on vegetation (by species), litter, rock (greater than 2mm), or bare soil. Hits are determined at each meter interval by activating a battery of 10 specialized lasers situated along the bar at 10 centimeter intervals and recording the variable intercepted by each of the narrow (0.02 inch) focused beams (see Figure 1). In this manner, a total of 100 intercepts per transect are recorded resulting in 1 percent cover per intercept. The point-intercept procedure has been widely accepted in the scientific community as the protocol of choice for vegetation monitoring and is used extensively within the mining industry in connection with bond release determinations.

#### 3.3 Determination of Woody Plant Density

At each sample site, a 2-meter wide by 50-meter long belt transect is established parallel to the ground cover transect and in the direction of the next sampling point (in a cardinal compass direction – Figure 1). Occasionally 4 x 25 meter transects are employed where distance between points necessitates shorter belts. Then within each belt, all woody plants (shrubs, trees, and succulents) are enumerated by species and age class. Determination of whether or not a plant could be counted depends on the location of its main stem or root collar where it exited the ground surface with regard to belt limits. Sample adequacy is determined for informational purposes only.

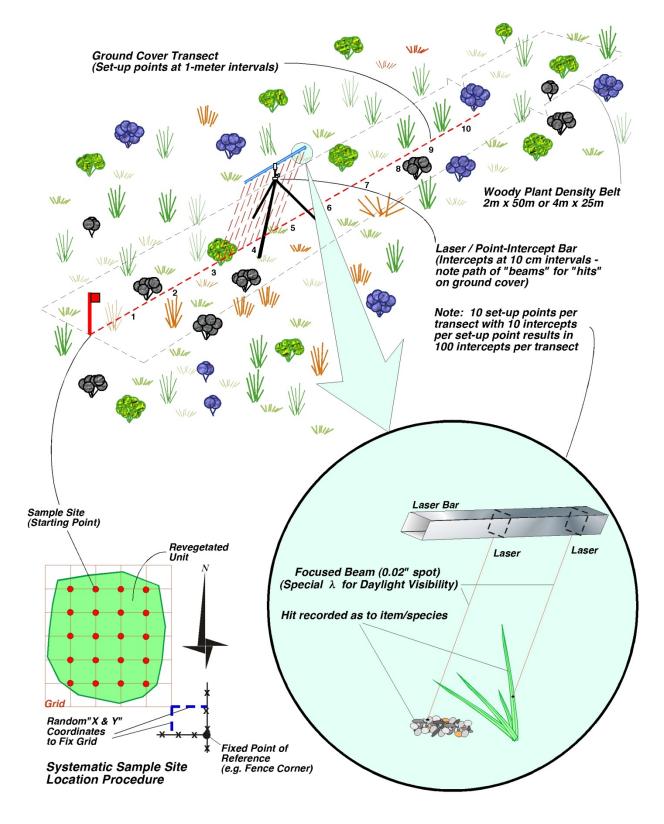


Figure 1
Sampling Procedure at a Systematic Sample Site Location

#### 3.4 Photo Monitoring

Permanent photo-points (marked in the field with wood lathe and GPS coordinates) are established within revegetation areas to visually catalog vegetation progress. At each point, four photos are exposed, one each in a cardinal compass direction (N-E-S-W) using a photo board to indicate photo-point and direction visible in each frame. Photos are exposed in portrait orientation (as opposed to landscape) with the horizon at the very top of each photo. In this manner, all vegetation from very close to very far is observable. A map of the photo points will be provided in the revegetation monitoring reports.

#### 3.5 Year 1 - Emergent Density Monitoring

Following the first growing season after seeding, each reclaimed unit is subjected to a relatively brief one-time evaluation to document plant establishment as well as record other pertinent reclamation considerations. This evaluation consists of a qualified observer traversing the reclamation areas and evaluating vegetation establishment and related physical and biotic conditions. Approximately 1 hour of review time per 20 acres is expended for qualitative efforts. During these traverses, the observer is vigilant for: 1) areas of poor seedling emergence, 2) pervasively weak or stressed seedlings, 3) indicators of soil fertility problems, 4) noxious weeds or invasive plant infestation, 5) evidence of unintended livestock grazing, 6) excessive erosion, 7) pockets of the aforementioned, and 8) any other similar revegetation / reclamation related issues.

In addition to the physical and biotic attributes evaluation, the surveying observer collects semiquantitative samples to document the emergent density of seeded species. In this regard, between 5-15 samples are collected from each of the reclaimed units. Each sample consists of a cluster of five 1.0 ft<sup>2</sup> quadrats distributed in an unbiased manner. Following a random toss of each quadrat, the number of emergent plants rooted within the frame's perimeter is recorded accordingly into one of five classes: perennial grass, perennial forb, shrub/tree (by species), annual grass, or annual forb. This procedure typically takes only 2-3 minutes per sample point (five quadrats) yet yields valuable information on the success of the seeding effort. Typically, efforts that result in an average of fewer than one perennial emergent per ft<sup>2</sup> should be considered to be poor and a possible candidate for remediation. Efforts with 1 – 2 perennial emergents per ft<sup>2</sup> are considered to be fair, 2 - 3 perennial emergents per ft<sup>2</sup> are considered moderately good, 3 – 4 perennial emergents per ft<sup>2</sup> are considered to be good and 4 – 5 perennial emergents per ft<sup>2</sup> are considered to be very good. Finally, greater than five perennial emergents per ft<sup>2</sup> are considered to be excellent. Barring overly adverse events (grazing, drought, etc.), the number of observed emergents following the first growing season provides both an indication of the quality of eventual revegetation as well as the expected time necessary for the new community to reach maturity. This semi-quantitative procedure is also implemented by Cedar Creek to provide perspective to an otherwise difficult visual circumstance. Because new seedlings are putting the vast majority of their energy into underground root systems during the first growing season, the above-ground plant parts are typically very small, obscure, and/or difficult to observe by the untrained eye. Because of this phenomenon, typical observation from a height of 5 - 6 feet (standing human) typically reveals only a small fraction of emergent plants. Oblique angle observation from a distance of more than 15 feet reveals almost zero discernible emergents. Therefore, to obtain a true reading on the success of the seeding effort, visual observation must occur below 3 feet elevation, and occasionally below 2 feet, especially if the ground surface is covered with small gravels or organic debris.

#### 4.0 REVEGETATION MONITORING SCHEDULE AND SUCCESS EVALUATIONS

The monitoring program and success criteria will follow the framework from the NMMMD. In this regard, a qualified revegetation specialist will review the revegetated areas on a pre-scheduled basis (during the peak of the growing season in September or shortly thereafter) to capture developing problems early in the process.

#### 4.1 Revegetation Monitoring Schedule – NMMMD Framework

Under the NMMMD framework, the revegetation liability period (period of time that the owner is responsible for revegetation performance) is 12 years with monitoring every three years. The annual site visits for the revegetation will be as follows:

- Year 1 Emergent Density Evaluation
- Year 3 Qualitative and quantitative evaluations (managerial information only).
- Year 6 Qualitative and quantitative evaluations (managerial information only).
- Year 9 Qualitative and quantitative evaluations (managerial information only).

\_\_\_\_\_\_

- Year 11 Qualitative and quantitative evaluations (final success evaluation).
- Year 12 Qualitative and quantitative evaluations (final success evaluation).

As indicated, the final efforts, during year 11 and 12, would be an evaluation for success determination. Years 11 and 12 information will be collected in such a manner as to provide defensible verification that success has been achieved. If it is determined that vegetation needs additional time to mature, monitoring will continue once every 3 years, thereafter, until success evaluations are positive. Other than first year efforts, annual monitoring would be a combination of both qualitative and quantitative efforts to facilitate tracking and progress toward revegetation success standards.

#### 4.2 Revegetation Success Criteria

Success criteria will also follow the NMMMD framework. The determination of revegetation success will take into account the following four factors:

- Comparison will be to a representative reference area encompassing the adjacent vegetation community and/or desirable ecological conditions (for the variables of ground cover and diversity);
- Plant species from the approved (and planted) seed mixes are present on reclamation;
- Lifeforms found within the reference area are present on reclamation; and
- PMLU (e.g., livestock grazing with incidental wildlife habitat) has been established and the vegetation is capable of being grazed at proper grazing intensity.

A reference area will be utilized for revegetation success comparisons. Because disturbance occurred prior to baseline data collection, original delineations of unique vegetation communities are not available. Site surveys indicate the overwhelming majority of current disturbance and planned reclamation will occur within upland areas, with alluvial soils, within the broader alluvial valley. The areas surrounding planned reclamation are dominated by mixed native grasses with occasional shrubs, and represent the desired PMLU. Reclamation materials (both surficial growth media and subsoil rooting media) will be loose and fine, deep, and generally lacking of coarse fragments; these reclamation conditions will mimic the upland alluvial areas adjacent to reclamation units, and be most conducive to the establishment of mixed grass and shrub rangeland. A reference area in close proximity to the reclamation units, and representative of the edaphic conditions and PMLU of the reclamation system, will be proposed to NMMMD prior to revegetation sampling.

When utilizing reference areas (that are late seral by definition) for determinations of revegetation success, certain allowances must be made when comparing them to early seral revegetated communities; otherwise comparisons would be scientifically invalid. As such, precedent has been set in this regard in both the coal and hard-rock industry's reclamation regulatory mandates. These allowances are a reduction in the amount of ground cover and diversity from late-seral values.

Revegetation success in revegetated units targeting livestock grazing land uses with incidental wildlife habitats will concentrate on two performance standards: (1) vegetative ground cover, and 2) woody plant density. Therefore, revegetation efforts will be considered successful when the following criteria have been met following at least 12 years of growth and development.

#### 1. Vegetative Ground Cover Criterion:

The perennial vegetative ground cover (exclusive of listed noxious species) below breast height (1.25 meters) in the target revegetated unit equals or exceeds 70 percent of the extended reference area's perennial vegetative ground cover, with 90 percent statistical confidence.

The success criterion was developed based on the NMMMD's precedents. The NMMMD has accepted 70% ground cover comparison on legacy mine sites which existed prior to the establishment of the MARP.

#### 2. Woody Plant Density Standard:

Woody plant density, as indicated by number of stems per acre in each revegetated unit equals or exceeds 60% of the stems per acre found in the reference area.

OR

The density of live shrubs, sub-shrubs, trees, and woody cacti rooted within the boundaries of the revegetated unit equals or exceeds a success criterion of 200 plants per acre.

The success criterion was developed based on the NMMMD's precedents. The NMMMD has accepted 60% woody plant density comparison on legacy mine sites which existed prior to the establishment of the MARP. Additional information used to develop this success criterion is data from Hoenes and Bender (2012) for measured native shrub density on grassland communities of New Mexico with results of approximately 200 shrubs per acre on average.

#### 4.3 Sample Adequacy Determination

Ground cover sampling within reclaimed areas is conducted to a minimum of 20 initial transects whereas reference area sampling is conducted to a minimum of 15 initial transects. From these preliminary efforts, sample means and standard deviations for total non-overlapping vegetation ground cover are calculated. The procedure is such that sampling continues until an adequate sample,  $n_{min}$ , has been collected in accordance with the Cochran formula (below) for determining sample adequacy, whereby the population is estimated to within 10% of the true mean ( $\mu$ ) with 90% confidence. These limits facilitate a very strong estimate of the target population.

When the inequality  $(n_{min} \le n)$  is true, sampling is adequate and nmin is determined as follows:

$$n_{min} = (t^2 s^2) / (d \overline{x})^2$$

where: n =the number of actual samples collected

t = the value from the one-tailed t distribution for 90% confidence with n-1 degrees of freedom

 $s^2$  = the variance of the estimate as calculated from the initial samples

 $\overline{x}$  = the mean of the estimate as calculated from the initial samples

If sampling is designed for a formal success evaluation and the initial samples do not provide a suitable estimate of the mean (i.e., had the inequality been false), additional samples will be collected until the inequality ( $n_{min} \le n$ ) became true or until a maximum of 40 samples are collected. If sample adequacy is not achieved after 40 samples are collected, a reverse null approach will be used to demonstrate success. The demonstration of success will utilize the central limit theorem which assumes approximate normality when a sufficiently large number of samples are collected (greater than 30). A one-sided, one-sample, reverse-null t-test is considered appropriate. Since sampling adequacy is not required (nor recommended)

for woody plant density, one density belt will be co-located with each ground cover transect, but adequacy shall not be tested for this variable. Resulting data can then be considered reasonable for the evaluation purposes intended.

#### 5.0 CORRECTIVE ACTIONS / CONTINGENCY

After the initial seeding occurs and monitoring has begun, circumstances may require additional management actions to facilitate revegetation parcels toward the desired outcomes. The management actions presented below are normal land management activities. However, prior to implementing any remedial action, a plan will be submitted to NMMMD for approval. This plan will outline the issue(s) needing corrective action, proposed remedial activities, and a timeline for implementation. The list of remedial actions presented below may not represent an exhaustive list of potential options, as additional management alternatives may be needed to address site-specific issues that arise. Renegotiation of success criteria may be required if unforeseen circumstances occur.

#### 5.1 Inter-Seeding

If undesirable precipitation, wind events, or any other factors contribute to poor seed germination, additional seed can be broadcast or drilled (if topography allows) into the required parcels as required without restarting the liability period.

#### **5.2 Weed Control**

Noxious weeds will be treated to allow desirable revegetation to establish. Best management practices will be employed on vehicles and work equipment to preclude the spread of noxious weeds.

#### 5.3 Range Fencing

Range fencing, cattle guards, and gates should be installed around areas deemed necessary to exclude grazing livestock from revegetated areas. Grazing permittees will be notified that grazing of the revegetated area will not be permitted until approved by a qualified revegetation specialist (biologist or ecologist).

#### 5.4 Mulching

If revegetation parcels are eroding at an unforeseen rate while vegetation is still establishing, mulch can be used to provide rainsplash and wind protection, reduce evaporation, and stabilize the seedbed. Preferably, a wood fiber or wood shred mulch would be used, as it is more robust than hay or straw and more likely to provide wind protection.

If used, wood fiber mulch or wood shred mulch will consist of specially prepared wood fibers and will not be produced from recycled material such as sawdust, paper, cardboard, or residue from pulp and paper plants. If necessary, such as on a steep slope or an area deemed a high wind erosion risk area, a tackifier can be used with the wood-fiber mulch to improve adhesion. If erosion areas are localized, small, or well-sheltered, simple straw mulch should suffice in providing rainsplash protection. Interseeding will most likely be necessary if erosion is sufficient enough to require post-revegetation corrective mulching.

#### 5.5 Supplemental Irrigation

Supplemental irrigation is not considered a suitable treatment mitigation alternative for reclamation in the arid west, even in instances of extreme drought. Underperforming areas will be remediated using common techniques, such as reseeding and applying mulch or other amendments to improve vegetative growing conditions. Previous revegetation efforts in the region demonstrate that successful revegetation can be established without supplemental irrigation.

#### **6.0 LITERATURE CITED**

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