Appendix C GEOTECHNICAL INVESTIGATION MEMO

Stantec

Memo

To:	Roy Blickwedel	From:	Cameron Fritz, EIT Jason Cumbers, PE
	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.

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.

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_2S) 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_2S 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 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	X
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	X
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	X
10	Lobo Tract (E of arroyo)	L2-5	20	20	
11	Lobo Tract (E of arroyo)	L2-6	20	20	X
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	X
16	Borrow Area South	BS-4*	20	N/A	
17	Borrow Area South	BS-5	20	5	X
18	Borrow Area South	BS-6	20	20	X
19	Topsoil North	TN-1	15	15	
20	Topsoil North	TN-2	25	30	
21	Topsoil North	TN-3*	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	X
25	Topsoil/Overburden	T/O-4	45	35	
26	Topsoil/Overburden	T/O-5	30	29	X
27	Topsoil/Overburden	T/O-6	20	15	
28	Topsoil South	TS-1	60	35	
29	Topsoil South	TS-2	60	35	X
30	Topsoil South	TS-3	60	30	
31	Topsoil South	TS-4	25	25	

	Area	Borehole ID	Proposed Depth (ft bgs)	Actual Depth (ft bgs)	Continuous Core
32	Pile 1	P1-1	60	20	X
33	Pile 1	P1-1A	60	35	X
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	X
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	X
51	Pile 4	P4-8	70	20	
52	Pile 4	P4-9	70	40	
53	Borrow Area West	BW-1†	40	35	X
54	Borrow Area West	BW-2†	20	20	
55	Borrow Area West	BW-3†	20	15	
56	Borrow Area West	BW-4†	20	20	

bgs = below ground surface, ft = feet

* Indicates borehole was not drilled due to safety, access, or other concerns.

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

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).

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.

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 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 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_2S 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

Reference: St. Anthony Mine Geotechnical Investigation 2018

References

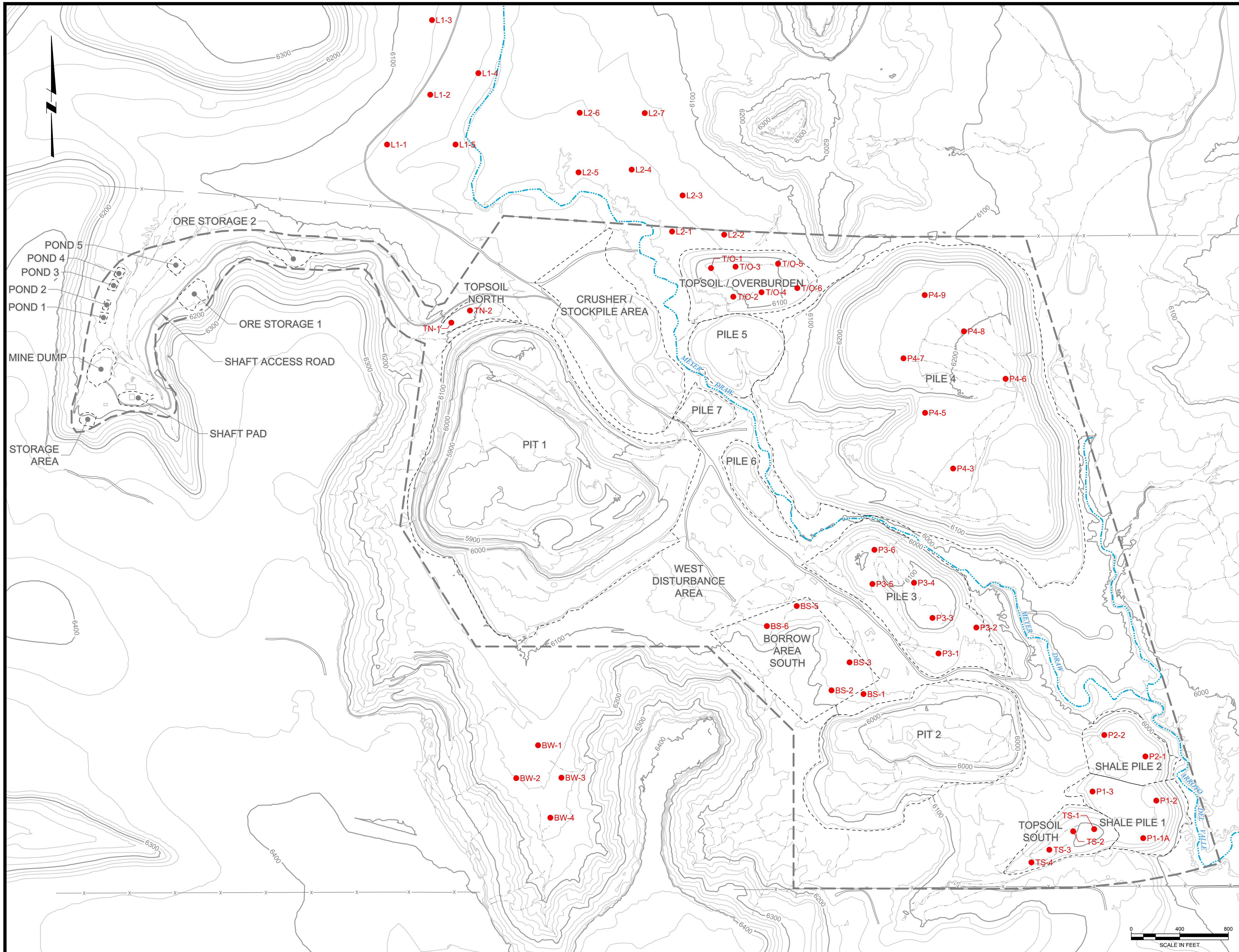
INTERA, 2006. *Stage I Abatement Plan Investigation Report*. INTERA. October 26.

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



LEGEND:

6100	EXISTING GROUND SURFACE CONTOUR & ELEVATION, FEET
	DRAINS
	ARROYO
	EXISTING ROAD
	EXISTING FENCE
	EXISTING OVERHEAD ELECTRIC AND POWER POLES
	UNC PERMIT BOUNDARY
	FACILITY OUTLINES
P4-9	BOREHOLE (STANTEC, 2018)

DRAWING REFERENCES:

1. All coordinates in New Mexico State Plane West, NAD83, Feet (U.S. Survey).
2. Elevations/Topo;
   2.1. On site: Cooper Aerial, 05/09/2011, (050911-1000overview3d.dwg)
   2.2. Supplemental Off Site: USGS DEM 10m
3. Township and Section lines: rgis.unm.edu, 08/04/2014
4. Parcels, and Cebolleta Land Grant: Cibola County, cibolacountynm.com, 02/15/18
5. Permit Boundary: (1008506X001.dwg)

DESIGNED K REED
CHECKED C FRITZ
APPROVED J CUMBERS

Stantec

unc

UNITED NUCLEAR CORPORATION AND ST. ANTHONY MINE
CIBOLA COUNTY, NEW MEXICO

2018 GEOTECHNICAL INVESTIGATION
BOREHOLE LOCATIONS

FIGURE
A1
233001076
JULY 2018

Wednesday, August 01, 2018 10:43:52 AM KWREED C:\PWWORKDIR\D0440989\STA_DRILLED_LOC.DWG Layout:Figure

Attachment B. Borehole Logs

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: BS-1

Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/1/18
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/1/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 15.7 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand with little clay (SM), medium dense, weakly cemented, light brown, slightly moist			
2									
4									
5	5'A 5'B	13 10 11			SM	Same as above			
6									
8									
10	10'A 10'B	9 12 10			SM	Increased carbonate content, same material, slightly darker brown.			
12									
14									
15	15' Bag	21 50/2"			SS	Sandstone bedrock (SS), highly to completely weathered, orange + yellow chemical			
16						EOB @ 15.67'			
18									
20									

COARSE GRAINED SOILS (>50% retained #200 sieve)			
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >11% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
		Poorly-graded: sands, gravelly sands, little or no fines	SP
	SANDS with >11% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50	Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50	Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

¹Note
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: BS-2 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/1/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/1/18
Field Representitive (day / night):	Core Diameter: N/A		Total Depth: 20.75 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM), fairly well-graded, light brown, slightly moist, medium dense, trace organics (roots)			
2									
4									
	5'A 5'B	6 8 7			SM	Same as above.			
6									
8									
10	10'A 10'B	6 4 6			SM	Same as above.			
12									
14									
	15'A	6 8 11			SM	Silty sand (SM), coarser & poorly graded than above, slightly darker light brown.			
16									
18									
20									

			Description	Symbol
COARSE-GRAINED SOILS (<50% passes #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
			Poorly-graded: sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below:

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: BS - 2 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A	22 50/3"			SH	Transitioning into broken rock. Highly weathered shale, dark brown/grey w/ orange + yellow discoloration			
22						EOB @ 20.75'			

COARSE-GRAINED SOILS (>50% retained #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4 75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4 75	1/16 to 3/16
Medium sand	0 425 to 2 0	1/64 to 1/16
Fine sand	0 075 to 0 425	0 003 to 1/64
Silt / clay (fines)	<0 075	<0 003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: BS-3 Sheet 1 of 1

Drilling Company: Cascade Drilling Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria Field Representitive (day / night):	Drilling Rig: CME 85 Drilling Method: Hollow Stem Auger Core Diameter: 4.25"	Bit Type: 4.25" I.D., 8" O.D. Auger Logged by: C. Fritz	Start Date: 4/1/18 Finish Date: 4/1/18 Total Depth: 15.4 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0			41		SM	Loose silty sand (SM), trace clay, trace carbonates, few organics (roots), well-graded, trace sandstone.			
2									
4									
6	5'A 5'B	3 3 4	36		SM	Same as above			
8									
						→ Moderate cementation. Few clay.			
10	10'B	9 9 10	30		SM	Medium dense silty sand, trace red discoloration, trace carbonates, trace sandstone, weakly cemented soil.			
12									
14						→ Beginning transition. Bits of sandstone evident.			
		50/5"			SS	Weathered sandstone			
16						EOB @ 15.4'			
18									
20									

COARSE-GRAINED SOILS >50% retained #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: BS-5

Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/1/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/1/18
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth: 6.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0			44		SM	Silty sand, slightly moist, light brown, trace carbonates, weak to moderate cementation (SM)			
2									
	2.5' Bag								
4									
	5' B	23 10 46			SS	Moderately weathered sandstone (SS)			
6									
						EOB @ 6.5'			
8									
10									
12									
14									
16									
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
			Poorly-graded: sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: BS-6 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/1/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguerie	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/1/18
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0			39		SM	Loose silty sand, slightly moist, light brown, organics in top 2 ft.			
4						→ trace coarse frags			
5	5'A 5'B	12 6 6	41		SM	same as above			
10	10'A 10'B	3 6 6	41		SM	same as above			
15	15'A 15'B	7 5 7	42		SM	Loose to medium dense (some), increasing carbonate content → areas of weak cementation			
20									

COARSE-GRAINED SOILS			Description	Symbol
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines		Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines		Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines		Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines		Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: BS-6 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A 20'B	5 7 9			SM	Same as above			
22						EOB @ 21.5'			

COARSE-GRAINED SOILS (>50% retained #200 sieve): GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve): SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

Blows/ft* — * = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	**SOIL BORING LOG FORM**	BOREHOLE No.: BCO-1 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/18/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguería	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/18/18
Field Represent[i]tive (day / night):	Core Diameter: 4.25"		Total Depth: 35 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0–5			41		SM	Silty sand (SM) little clay, loose, slightly moist, light brown			
5–6.5	5'A 5'B	5 6 4	42		SM	Same as above			
10–11.5	10' Bag	5 3 5	46		SM			Analytical Sample	
12						→ Few clay below 12', medium dense & weakly cemented, trace carbonates, color darker than above, trace shale pieces (black)			
15–16.5	15'A 15'B	7 8 5	45						
20									

GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: BW-1 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A 20' B	8 7 9	48		SM	Same as above			
22									
24									
25	25' A 25' B	5 6 6	40		SM	same as above		5" recovery both liners (no density)	
26									
28									
30	30' A 30' B	5 4 4	40		SM	same as above			
32									
34						(Additional moisture from pouring water down hole to suppress gas)		CO > 500 ppm H_2S = 5.0 ppm LEL = 21% (4' down hole)	
35						EOB @ 35'			
36									
38									
40									

COARSE-GRAINED SOILS (<50% passes #200 sieve)			
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)
Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: BW-2 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/18/18
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/18/18
Field Represenitive (day / night):	Core Diameter: N/A		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand w/ little clay (SM), few carbonates (esp in weakly cemented clods), trace organics (roots, grasses), light brown, slightly moist, medium dense			
2									
4									
6	5' Bag	19 10 13			SM	Same as above		Analytical sample (bulk from A, B, C liners)	
8									
10	10' A 10' B	6 10 10			SM	Same as above, trace clay			
12									
14									
16	15' A 15' B	6 7 17			SM	Same as above			
18									
20									

COARSE-GRAINED SOILS (>50% retained #200 sieve)				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve) SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: BW-2 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' Bag	11 24 32			SM	Dense silty sand (SM), few carbonates, brown + white w/ trace black shale pieces, slightly moist		Analytical sample (bulk from A, B, C liners)	
22						EOB @ ~~20~~ 21.5'			

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines — GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines — GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures — GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures — GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines — SW
			Poorly-graded: sands, gravelly sands, little or no fines — SP
		SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures — SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures — SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity — ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays — CL
			Organic silts and clays of low plasticity — OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt — MH
			Inorganic clays of high plasticity, fat clays — CH
			Organic silts and clays of medium to high plasticity — OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content — PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

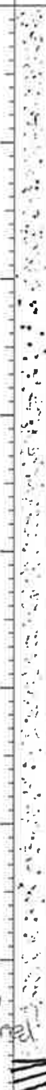
SOIL BORING LOG FORM

BOREHOLE No.: BW-3

Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/18/18
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/18/18
Field Representitive (day / night):	Core Diameter: N/A		Total Depth: 15.9 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty Sand (SM) w/ few clays, slightly moist, brown, trace organics, medium dense			
2									
4									
6	5'A 5'B	8 9 7			SM	Same as above			
8									
10	10' Bag	7 8 9			SM	Same as above, w/ trace broken sandstone, few carbonates		Analytical sample (bulk from A,B,C liners)	
12									
14						Highly weathered shale + sandstone, some chunks solid + less-weathered sandstone			
	15'A	30 50/5"							
16						EOB @ 15.9'			
18									
20									



COARSE-GRAINED SOILS				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
		Poorly-graded: sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50	Inorganic silts/very fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50	Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	**SOIL BORING LOG FORM**	BOREHOLE No.: BW-4 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/18/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/18/18
Field Representitive (day / night):	Core Diameter: N/A		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Loose silty sand, light brown, slightly moist, some weekly cemented clods			
2									
4									
6	5' Bag	3 3 6			SM	Same as above		Analytical Sample (A, B, C liners→bulk)	
8									
10	10' A	4 4 6			SM	Same as above, trace fine gravel			
12						— — — — — —			
14									
16	15' Bag	10 11 7			SM	Silty sand w/ trace clay, slightly darker brown than above, medium dense & weak cementation		Analytical sample (Bulk from A, B, C liners)	
18									
20									

COARSE-GRAINED SOILS				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4" ID	2.0" ID	(modCAL) 2.5" ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4" ID	2.0" ID	(modCAL) 2.5" ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: BW-4

Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguena	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A 20' B	10 8 7			SM	Same as above			
22						EOB @ 21.5'			

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-16
very stiff	15-30	17-39	16-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

[1]Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: L1-1

Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/26/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger Hi torque	Logged by: C. Fritz	Finish Date: 3/26/18
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Dense silty sand (SM), little clay, dry, light brown, trace organics (roots), weak to moderate cementation.			
2			28						
5	5'A	17 25 25						Double blows on 3rd blow count set	
6.5					SC	Clayey sand (SC), dark brown, slightly moist, hard			
7.5			56						
8					SM	Dense silty sand (SM), dry to slightly moist, light brown trace to few calcium carbonate, weak to moderate cementation			
10	10'A	16 25 32			SM	Same as above			
12			51						
15	15'A 15'B	14 19 20			SM	Same as above			
18			46						
20									

COARSE-GRAINED SOILS (>50% retained #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passed #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L1-1 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A 20' B	8 15 18			SM	same as above			
22						EOB @ 21.5'			

COARSE-GRAINED SOILS >50% retained #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
			Poorly-graded: sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-6
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: L1-2

Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR-75 Hi Torque	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/26/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/26/18
Field Representive (day / night):	Core Diameter: N/A		Total Depth: 21.4 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0–5 (0, 2, 4)			16		CL	Lean clay (CL); medium dense, dry, light brown, trace calcium carbonate			
5–10 (6, 8)	5'A 5'B	14 13 20	19		CL	Same as above			
10–15 (10, 12, 14)	10'A 10'B	9 10 16	20		SM	Silty fine sand, tan/light brown, trace clay + gravel, slightly moist, medium dense			
15–20 (16, 18, 20)	15'A 15'B	9 17 22	16		SM	Silty sand, trace to few gravel, tan/light brown, slightly moist, weakly cemented, medium to dense			

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L1-2 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representive (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A	13			SM	C liner → silty sand			
	20'B	14 50/5"			CL	A + B liners → clay (CL) dark brown, very hard, slightly moist, weak cementation			
22									

EOB @ 21.~~4~~'

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L1-3 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR75 Hi torque	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/27/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/27/18
Field Representive (day / night):	Core Diameter: N/A		Total Depth: 21.5 Ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM), few to little clay, light brown/tan, slightly moist, medium dense			
2									
4									
6	5'A 5'B	9 11 12			SM	same as above		Slightly improved Structure in Samples compared to previous holes	
8									
10	10'A	5 7 10			SM	same as above			
12									
14									
16	15'A 15'B	5 8 12			SM	same as above			
18									
20									

COARSE-GRAINED SOILS (>50% retained #200 sieve) — GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
		Poorly-graded: sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve) — SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	**SOIL BORING LOG FORM**	BOREHOLE No.: L1-3 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A 20' B	9 8 22			SM	same as above. trace calcium carbonate, increased cementation			
22						EOB @ 21.5'			

COARSE-GRAINED SOILS >50% retained #200 sieve: GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve: SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity; gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L1-4 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75 hi torque	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/27/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/27/18
Field Representive (day / night):	Core Diameter: N/A		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM), few to little clay, light brown, slightly moist, medium dense			
2									
4									
5–6	5'A 5'B	8 11 13			SM	same as above			
8									
10–11	10'A 10'B	5 13 20			SM	→ few to little clay, darker brown, trace calcium carbonate			
12									
13					SP	Clean sand, loose, light brown w/ grey silica crystals visible, slightly ~~visible~~ moist, medium sand		Driller noted change @ 13'	
14									
15–16	15'A 15'B	2 5 7							
18									
20									

COARSE-GRAINED SOILS (>50% retained #200 sieve) GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve) SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L1-4 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' Bag	5 8 8			SP	Same as above		bag sample w/ all 3 liners combined	
22						EOB @ 21.5'			

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
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FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
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soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
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[1]Note:
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PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)
Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: L1-5

Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75 High Torque	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/26/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/26/18
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0			49		SM	Silty sand (SM) w/ trace calcium carbonate, hard, moderate cementation, slightly moist, brown			
2									
4									
5	5' Bag	17 37 50/4"			SC	Clayey sand, dense, dry, light brown (SC)			
6									
7			54			Clayey sand (SC), slightly moist, very hard, moderate cementation, brown			
8	8' Bag				SC				
10	10' Bag	8 12 30	44		SC	same as above		Bag sample from loose sand in sampler very hard clay in shoe	
12									
14									
15	15' Bag	50/2"						Material in shoe only	
15.5			60		SM	Silty sand (SM), trace silt, light brown, weakly cemented, dry, poorly graded			
16									
18									
20									

COARSE-GRAINED SOILS			
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS: SILTS AND CLAYS liquid limit <50		Inorganic silts/very fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below:

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L1-5 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Represenitive (day / night):	Core Diameter: 4.25"		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A 20' B 20' C	11 17 17			SM	same as above			
22						EOB @ 21.5'			

COARSE-GRAINED SOILS (>50% retained #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines — GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines — GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures — GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures — GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines — SW
			Poorly-graded: sands, gravelly sands, little or no fines — SP
		SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures — SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures — SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity — ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays — CL
			Organic silts and clays of low plasticity — OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt — MH
			Inorganic clays of high plasticity, fat clays — CH
			Organic silts and clays of medium to high plasticity — OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content — PT

CONSISTENCY (Silts and Clays)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below.

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

[1]Note
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L2-1 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/31/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/31/18
Field Represeentitive (day / night):	Core Diameter: N/A		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Dense silty sand (SM), slightly moist, light brown/gray, poorly graded, trace carbonates, some weakly cemented cemented clumps, trace organics			
2									
4									
6	5' A 5' B	24 18 28			SM	Same as above			
8									
10	10' A 10' B	12 14 17			SM	Same material, medium dense, slightly finer			
12									
14									
16	15' A 15' B	9 12 15			SM	Silty sand (SM), few clay (scattered small shale pieces), slightly coarser, increased cementation possibly due to higher carbonate content			
18									
20									

COARSE-GRAINED SOILS >50% retained on #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
	HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-16
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

[1]Note
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY

Nonplastic
Low
Medium
High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L2-1 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A 20' B	11 12 15			SM	same as above			
22						EOB @ 21.5'			

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >11% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >11% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity; gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L2-2 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/31/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/31/18
Field Represertitive (day / night):	Core Diameter: N/A		Total Depth: 15.4 Ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					ML	Silt (ML) with little ~~sand~~, few clay, slightly moist, brown, cemented + medium dense, significant carbonate			
2									
4									
5–6.5	5' A 5' B	10 14 27			ML	same as above			
6									
8									
9						sandstone bedrock, very dense, light brown/grey, slightly to moderately weathered			
10	10' A	50/6"			SS				
12									
14									
15	None	50/5"				No sample collected			
16						EOB @ 15.4'			
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS >50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
	HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	**SOIL BORING LOG FORM**	BOREHOLE No.: L2-3 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/31/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/31/18
Field Represenitive (day / night):	Core Diameter: N/A		Total Depth: 15.2 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM), slightly moist, light brown, medium dense, few roots/organics			
2									
4									
6	5'A 5'B	9 9 14			SM	Same as above			
8									
10	10'B	34 50/5"							
12					SS	Weathered sandstone bedrock			
14									
16	None	50/2"				EOB @ 15.2'			
18									
20									

COARSE-GRAINED SOILS: GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
		Poorly-graded: sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS: SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

*= 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	**SOIL BORING LOG FORM**	BOREHOLE No.: L2-4 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/31/18
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/31/18
Field Represenitive (day / night):	Core Diameter: 4.25"		Total Depth: 20.4 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0			52		ML	Silt with little sand, very stiff, slightly moist, dark brown/gray			
5	5' A 5' B	4 6 4	30		SM	Silty sand, trace clay, loose, light brown, slightly moist		NO recovery 5'-7.5'	
10	10' B 10' C	12 13 11	54		SM	Same as above			
					SH	Highly weathered shale, very hard, dark brown/gray			
					SS	Moderate to highly weathered sandstone, light brown/tan			
15	15' Bag	32 50/5"			SS	Same as above		Bulk sample from all liners → loose rock	
20									

COARSE GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines — GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines — GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures — GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures — GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines — SW
			Poorly-graded sands, gravelly sands, little or no fines — SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures — SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures — SC
FINE GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity — ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays — CL
			Organic silts and clays of low plasticity — OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt — MH
			Inorganic clays of high plasticity, fat clays — CH
			Organic silts and clays of medium to high plasticity — OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content — PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below.

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L2-4 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	NR	50/5"			SS	Same as above			
						EOB @ 20.4'			
22									

COARSE-GRAINED SOILS >50% retained on #200 sieve				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
		Poorly-graded: sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(mod/CAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(mod/CAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: L2-5

Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/31/18
Drillers (day/night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/31/18
Field Representitive (day / night):	Core Diameter: N/A		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					CL	Lean clay with some silt (CL), dark brown/grey, hard, trace carbonates, slightly moist			
2									
4									
	5' A 5' B	18 23 34			CL	Same as above			
6									
8									
10	10' A 10' B	14 14 22			SM	Silty sand (SM) with some clay, medium dense/very stiff, lighter brown, trace to few shale, moderate cementation			
12									
14									
	15' A 15' B	11 16 16			SM	Silty sand (SM) with clay, brown, medium dense/very stiff, few carbonates, moderate cementation			
16									
18									
20									

COARSE-GRAINED SOILS				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS: SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

Blows/ft* — * = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4 75 to 19	3/16 to 3/4
Coarse sand	2 0 to 4 75	1/16 to 3/16
Medium sand	0 425 to 2 0	1/64 to 1/16
Fine sand	0 075 to 0 425	0 003 to 1/64
Silt / clay (fines)	<0 075	<0 003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L2-5 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A 20'B	14 14 22			SC	Clayey sand (SC), silty, few carbonates, slightly moist, brown, moderate cementation & medium dense.			
22						EOB @ 21.5'			

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L2-6 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/31/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/31/18
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0			38		SC	Clayey sand (SC), slightly moist, brown/grey, weak cementation, hard. Few carbonates			
2									
4									
5	5'B	17 24 17	60		SC	Same as above			
6									
8									
10	10'A 10'B	11 26 15	30		SC	same as above			
						Transitioning into sandy mat'l			
12					SM	Silty sand (SM), light brown, medium dense, slightly moist, weak to moderate cementation		No recovery 12.5'-15'	
14									
15	15'A 15'B	10 12 11	40						
16						→ ~6" clay			
18									
20									

			Description	Symbol
COARSE-GRAINED SOILS <50% passes #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
			Poorly-graded: sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
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Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well-graded = poorly sorted
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PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L2-6 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: 4.25"		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A	5			SM	Silty sand			
	20' B	9							
		10							
22						EOB @ 21.5'			

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below:

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)
▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: L2-7 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/31/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/31/18
Field Representitive (day / night):	Core Diameter: N/A		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty Sand (SM), trace highly weathered stand stone & shale, trace plant roots, some weak cementation, medium dense			
2									
4									
6	5' A 5' B	9 13 17			SM	Same as above			
8									
10	10' A	6 8 15			SM	Same as above, less organics, trace carbonates			
12									
14									
16	15' A	13 11 20			SM	Same as above, possibly greater clay content			
18									
20									

COARSE-GRAINED SOILS (>50% retained on #200 sieve)				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
		Poorly-graded: sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: L2-7

Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A	9 18 27			SM	same as above, slightly darker & coarser, medium dense to dense			
22						EOB @ 21.5'			

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below:

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P1 - 1 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/3/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/3/18
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth: 20 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0			37		SM	Silty sand (SM) with clay + gravel, light to dark gray/black, some orange staining			
2									
4									
6	5'A 5'B	6 8 6	42		SM	Same as above, medium dense, slightly moist			
8						→ chunks weathered sandstone			
10	10'A	5 5 2	36		SM	Same as above			
12									
14									
16	15'B	17 13 5	30		SM	Same as above			
18					SS	→ Mostly broken sandstone pieces, strong and moderately hard, gray w/some orange, highly weathered			
20									

			Description	Symbol
COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: P1-1

Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date:
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20		14 11 12			SS	Same as above		No sample collected. Stopped after auger bent upon hitting boulder	
22						EOB @ 21.5'			
24									
26									
28									
30									

			Description	Symbol
COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note:
Well-graded = poorly sorted
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PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: P1-1A

Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/9/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguerìa	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/9/18
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth: 36.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0–20					CL	Highly to completely weathered shale (CL) with silt + sand, stiff and weakly cemented, slightly moist to moist, black/dark gray w/some brown, little gravel		Drilled straight down to 20', then began sampling & coring	
20–25			41						
22									
24					SS	Moderately weathered shale + sandstone, gray w/white carbonates, slightly moist			
25–26.5	25' A	1 2 6	41						
28									
30–31.5	30' A	7 6 3	42			Same as above			
32						↑Fill			
32.5					ML	Topsoil, sandy silt to silty sand, (ML), light brown, (native)			
34.5					SS	Highly weathered sandstone (SS)			
35–36.5	35' Bag	20 15 9							
36.5						EOB @ 36.5'			
38									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded' gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded' gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded' gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded' gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded' sands, gravelly sands, little or no fines	SW
			Poorly-graded' sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded' sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded' sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

'Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P1-2 Sheet 1 of 4

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/9/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/9/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 65 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM) with gravel + clay, black/gray, trace iron staining + carbonates, very stiff to hard fines, slightly moist to moist			
2									
4									
	5'A 5'B	23 18 22			SM	Same as above, dense sand			
6									
8									
10	10'A	12 3 6			SM	Same as above, but loose to medium dense			
12									
14									
	15'A 15'B	5 9 13			SM	Same as above, medium dense			
16									
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines — GW
			Poorly-graded* gravels, gravel-sand mixtures, little or no fines — GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures — GM
			Clayey gravels, poorly-graded* gravel-sand-clay mixtures — GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines — SW
			Poorly-graded* sands, gravelly sands, little or no fines — SP
		SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures — SM
			Clayey sands, poorly-graded* sand-gravel-clay mixtures — SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity — ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays — CL
			Organic silts and clays of low plasticity — OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt — MH
			Inorganic clays of high plasticity, fat clays — CH
			Organic silts and clays of medium to high plasticity — OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content — PT

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P1-2 Sheet 2 of 4

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' Bag	3 4 4			SM	Same as above		Analytical sample from A, B, & C liners	
22									
24									
	25'A	50/6"			SM	Same as above, slightly less weathered			
26									
28									
30	30' B				SM	Same as above, highly to completely weathered		Missing A liner in sampler. Blow counts not recorded	
32									
34									
	35' A 35' B	8 6 10			SM	Sandy w/ fewer fines, significant red + yellow staining, trace organics			
36									
38									
40									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to final water (time and date)
Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P1-2 Sheet 3 of 4

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
40	40' Bag				SM	Same as above		Analytical sample from A + B liners	
42									
44									
	45'A	8 15 14			SM	Weathered sandstone + shale mixture, orange + black (respectively), trace kaolin (or other soft, fine, gray material			
46									
48									
50	50' A 50' B	10 14 14			SM	Same as above, trace sulfur (yellow)			
52									
54									
		50/2"			SM	Same as above			
56									
58									
60									

COARSE-GRAINED SOILS >50% retained on #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below:

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P1-2 Sheet 4 of 4

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
60	60' Bag	4 9 11			SM	Same material as above, but w/increased presence black organic material (possible coal?), black/dark gray, trace orange + yellow		Analytical sample from A, B, + C liners	
62									
64								Drilled to 65' before stopping due to H_2S	
						EOB @ 65'			
66									
68									
70									

COARSE-GRAINED SOILS				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to final water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: P1-3

Sheet 1 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/3/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/3/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 41.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand & sandstone boulders		Large boulders on ground surface in vicinity	
2									
4									
5–6.5	5'A	31 38 32			~~SC~~ SM	Very dense silty sand (SM). Possibly sandstone boulder, light brown/gray			
6									
8									
10	10'A	27 50/2"			SM	Silty sand w/few clay (SM), few broken rock pieces, dense to very dense, slightly moist, brown			
12									
14									
15–16.5	15'A 15'B	26 17 10			SM	Same as above			
16									
18									
20									

COARSE-GRAINED SOILS			
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded¹ gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded¹ gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded¹ gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded¹ gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded¹ sands, gravelly sands, little or no fines	SW
		Poorly-graded¹ sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded¹ sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded¹ sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

¹Note: Well-graded = poorly sorted; Poorly-graded = well sorted

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

PLASTICITY: Nonplastic; Low; Medium; High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P1-3 Sheet 2 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' B	7 7 17			SS	Sandstone, light brown + gray, slightly to moderately weathered			
22									
24									
		17 18 47			SS	Same as above		Broken rock pieces fell out of sampler → no sample	
26									
28									
30	30' A 30' B	12 28 26			SS	Same as above, w/some loose sand			
32									
34								Did not sample @ 35' due to grinding on rock. Continued to 40' in attempt to locate native ground	
36									
38									
40									

COARSE-GRAINED SOILS >50% retained on #200 sieve			
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P1-3 Sheet 3 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
40	40'B	26 47 27			SS	Sandstone, slightly to moderately weathered (broken rock in sampler)		Stopped drilling due to abrasive rock + damage to augers	
42						EOB @ 41.5'			

COARSE-GRAINED SOILS >50% retained #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded[1] gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded[1] gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded[1] gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded[1] gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded[1] sands, gravelly sands, little or no fines	SW
			Poorly-graded[1] sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded[1] sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded[1] sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

[1] Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	**SOIL BORING LOG FORM**	BOREHOLE No.: P2-1 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/14/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/14/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 30 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM), little clay (weathered shale) + trace gravel, slightly moist, gray w/trace black + yellow/orange			
2									
4									
	5'A 5'B 5'C	15 15 18			SM	Same as above, medium dense		VOC = 17.2 ppm	
6									
8									
10	10' Bag	10 8 7			SM	Same as above, but softer + more weathered		Analytical sample from A, B, + C liners	
12									
14									
	15'A	4 6 5			SM	Same as above, loose			
16									
18									
20									

COARSE-GRAINED SOILS				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50	Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50	Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-16
very stiff	15-30	17-39	16-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below:

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: P2-1

Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' Bag	8 50/5"			SM	Same as above, except w/some sandstone (gray)		Analytical sample from A+B liners	
22									
24									
	25'A 25'B 25'C	5 7 7			SM	Same as above		H_2S = 1.0 ppm, CO = 80 ppm LEL = 4% (outside top of hole)	
26									
28									
30						EOB @ 30'		After drilling to 30 ft: LEL = 14% (outside hole) H_2S = 4.5 ppm (outside hole) H_2S = 16.5 ppm (4' down hole) LEL = 56% (4' down hole) Both cases: CO > 500 ppm VOC = 17.6 ppm	

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
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Mostly	50-100

*Note:
Well-graded = poorly sorted
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PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P2-2 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/15/18
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/15/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 20 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SC	Clayey sand (SC) w/some silt + trace gravel, some areas very black w/organics, brown in sandier spots			
2									
4									
	5'A 5'B	11 5 8			SC	Same as above, medium dense, slightly moist to moist		H_2S=0ppm, CO=0, LEL=0 *A liner has very black clayey material in bottom	
6									
8									
10	10' Bag	7 11 20			SC	Same as above, considerable weathered shale, brown + black w/trace orange, few salts in black clayey spots		Analytical sample (bulk from A,B,+C liners) H_2S=0, LEL=0, CO>500 ppm	
12									
14									
		3 7 18	NR		SC	No recovery. Likely similar to above. Driller thought it was perhaps clayey material that shrunk and fell out of sampler.		H_2S=0.4 ppm (outside hole) CO>500 ppm	
16									
18									
								@20': H_2S=4 ppm (outside hole) CO>500 ppm, LEL=28% No sampling @ 20'	
20						EOB @ 20'			

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
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* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
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Little	15-25
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*Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-1 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/18/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/18/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 16.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM) with gravel, trace sandstone cobbles, light gray w/trace darker gray in more cemented spots, trace iron oxidation, trace green discoloration			
2									
4									
	5' A 5' B	2 29 28			SM	Same as above, slightly moist, dense (though possibly just due to cobbles)		Hit void first 6" drive	
6									
8									
10	10' A 10' B	4 5 8			SM	Same material as above, medium-grained sand, loose + moist, light brown + gray w/green		CO = 300 ppm	
12									
14									
	15' A 15' B	5 7 12			SP	Top of sampler (C): poorly-graded medium sand (SP), light gray/white with some green tinge		H_2S = 0 ppm, LEL = 5%	
16					SC	A liner + part of B liner: clayey sand (SC) + weathered shale, silty, dark gray/black w/light gray, orange + yellow oxidation		CO = 140 ppm (and still rising)	
						EOB @ 16.5'			
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded¹ gravels, gravel-sand mixtures, little or no fines — GW
			Poorly-graded¹ gravels, gravel-sand mixtures, little or no fines — GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded¹ gravel-sand-silt mixtures — GM
			Clayey gravels, poorly-graded¹ gravel-sand-clay mixtures — GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded¹ sands, gravelly sands, little or no fines — SW
			Poorly-graded¹ sands, gravelly sands, little or no fines — SP
		SANDS with >15% fines	Silty sands, poorly-graded¹ sand-gravel-silt mixtures — SM
			Clayey sands, poorly-graded¹ sand-gravel-clay mixtures — SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity — ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays — CL
			Organic silts and clays of low plasticity — OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt — MH
			Inorganic clays of high plasticity, fat clays — CH
			Organic silts and clays of medium to high plasticity — OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content — PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

¹Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-2 Sheet 1 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/11/18
Drillers ([✓ day] / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/11/18
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth: 46 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0			44		SM	Silty sand (SM), little fines (~20%), trace cobbles, slightly moist, light gray/white with green tinge + trace brown, loose to medium dense, medium grain-size sand			
2									
4									
	5' A 5' B	18 22 20			SM	Same as above		Higher blow counts likely due to cobbles	
6			44						
8									
10	10' A 10' B	8 7 9			SM	Same as above			
12			44						
14									
	15'B	4 5 3			SM	Same material as above, but moist w/darker green coloring in wettest spots			
16									
18			44						
20									

COARSE-GRAINED SOILS				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
		Poorly-graded: sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

Blows/ft*

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-2 Sheet 2 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A 20'B	7 4 3			SM	Same as above			
22			44						
24									
		35			SM	Same as above, trace cobbles			
26	25'A	9 10							
28			44						
30	30'B	7 9 7			SM	Same as above			
32			44						
34									
		5			SM	Same as above, with increased shale/some fines, dark gray/green			
36	35'B	5 4							
38			44						
40									

COARSE-GRAINED SOILS (>50% passes #200 sieve)				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
		Poorly-graded* sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-2 Sheet 3 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
40	40'A	5 6 9	44		SM	Same as above ↑Fill			
45	45'B	7 21 50/1"			ML	Sandy silt to silty sand (ML), brown, slightly moist. Native Sandstone bedrock		Auger Refusal	
46						EOB @ 46'			
48									
50									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

Blows/ft*

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: P3-3

Sheet 1 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/14/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/14/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 41.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM), trace weathered shale/clay, moist, light brown w/trace black + orange, medium grained sand			
2									
4									
	5'A 5'B	11 5 7			SM	Same as above, loose to medium dense		H_2S = 0 ppm, CO = 0 ppm	
6									
8									
10	10'A 10'B	5 3 5			SM	Same as above, fine to medium sand, slightly moist, now includes trace green coloring		H_2S = 0 ppm, CO = 0 ppm	
12									
14									
	15'A 15'B	9 3 4			SM	Same as above, medium sand, moist, loose, brown w/dark gray			
16								H_2S = 0 ppm, CO = 0 ppm	
18									
20									

COARSE-GRAINED SOILS (>50% passes #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

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MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-3 Sheet 2 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A 20'B	3 6 6			SM	Same as above, brown/tan with trace gray, black, + orange, trace gravel			
22									
24									
	20' A 20'B	3 5 5			SM	Same as above, increased presence green material		H_2S = 0ppm, CO = 0ppm	
26									
28									
30	30' A 30' B	3 4 7			SM	Same as above, trace to few gravel		H_2S = 0ppm, CO = 9 ppm (material getting darker)	
32									
34									
	35'A 35'B	3 4 3			SM	Same as above, few sandstone chunks		CO = 2 ppm, H_2S = 0 ppm	
36									
38									
40									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines — GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines — GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures — GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures — GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines — SW
			Poorly-graded sands, gravelly sands, little or no fines — SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures — SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures — SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity — ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays — CL
			Organic silts and clays of low plasticity — OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt — MH
			Inorganic clays of high plasticity, fat clays — CH
			Organic silts and clays of medium to high plasticity — OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content — PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-16
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to final water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-3 Sheet 3 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
40	40' A 40' B	5 7 12			SM	Sand w/silt & clay (SM), increased fines content (>40%), trace gravel, moist, brown w/trace black shale		CO = 500 ppm, H_2S = 2 ppm LEL = 12%	
42						EOB @ 41.5'		Stopped drilling due to increasing H_2S, CO, & LEL. Possibly just above material that caused issues w/gas at previous holes.	
44									
46									
48									
50									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
			Poorly-graded* sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

*= 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below.

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)
Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-4 Sheet 1 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/12/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguera	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/13/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 41.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM), medium grain-size, trace to few gravel + cobbles, few shale pieces, brown with trace orange + yellow oxidation, moist			
2									
4									
	5' A 5' B	10 6 7			SM	Same as above, medium dense			
6									
8									
10	10' A 10' B	3 2 4			SP-SM	Poorly-graded sand with silt (SP-SM), loose, medium sand, trace gravel, light brown w/gray, green, and orange spots, moist			
12									
14									
	15' A 15' B	3 2 1			SP-SM	Same as above, trace green fines + shale pieces			
16									
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
			Poorly-graded: sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-4 Sheet 2 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguena	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A 20'B	10 13 9			SP-SM	Same as above, trace coarse gravel, medium dense			
22									
24									
	25'A	50/5"			SP-SM	Same as above, fine to medium sand, trace coarse gravel		High blow counts likely due to cobbles	
26									
28									
30	30'B	17 15 11			SP-SM	Same as above			
32									
34									
	35'A 35'B	10 11 21			SP-SM	Same as above, brown w/dark gray, few shale (black), trace yellow, orange, + light gray			
36									
38									
40									

COARSE-GRAINED SOILS >50% retained #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded[1] gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded[1] gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded[1] gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded[1] gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded[1] sands, gravelly sands, little or no fines	SW
			Poorly-graded[1] sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded[1] sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded[1] sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

Blows/ft*

DENSITY (Sands and Gravels)

Term	(SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

Blows/ft*

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below.

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

[1] Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	**SOIL BORING LOG FORM**	BOREHOLE No.: P3-4 Sheet 3 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter:		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
40	40' A 40' B	7 42 38			ML	Sandy silt w/few clay (ML), moist, black + gray, hard to very hard		Encountered H_2S while drilling from 40', stopped work.	
						EOB @ 41.5'			
42									
44									
46									
48									
50									

			Description	Symbol
COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded' gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded' gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded' gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded' gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded' sands, gravelly sands, little or no fines	SW
			Poorly-graded' sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded' sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded' sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-5 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/14/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/14/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 16.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM) w/gravel + few shale pieces, slightly moist, tan/gray w/trace orange			
2									
4									
5–6.5	5'A 5'B	7 27 31			SM	Same as above, medium dense to dense		0 ppm gas readings	
8									
10–11.5	10'A 10'B	10 39 14			SM	Silty sand (SM) w/trace clay, gray + black, dense, some orange staining		H_2S=2.9 ppm (outside hole) H_2S=3.9 ppm (4' down hole) CO=500 ppm LEL=19%	
12									
14									
15–16.5	15'A	11 32 10			SM	Silty sand (SM) w/gravel + trace cobbles, light brown w/black + gray.		H_2S=4.7 ppm (4' down hole) LEL=14% CO=499 ppm →Stopped work	
						EOB @ 16.5'			
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >12% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
			Poorly-graded: sands, gravelly sands, little or no fines	SP
		SANDS with >12% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: P3-6

Sheet 1 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/14/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/14/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 55 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM), fine to medium-grained sand, trace gravel + sandstone chunks, light brown + gray, trace orange, slightly moist			
2									
4									
	5'A 5'B	10 50/4"			SM	Same as above, trace cobbles		H_2S=0 ppm, CO=0 ppm	
6									
8									
10	10'A 10'B	11 5 5			SM	Same as above, but mostly dark brown w/some light brown, gray, and orange, slightly moist, loose to medium dense		0 ppm gas readings ↓	
12									
14									
	15'A 15'B	3 5 6			SM	Sand with silt (SM), less silty than above, loose, medium-grained, moist, brown + tan w/few to little black + gray			
16									
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P3-6 Sheet 2 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A 20' B	3 4 4			SM	Same as above, trace gravel, trace green coloring			
22									
24									
	25' A 25' B	2 5 12			SM	Same as above, trace shale + sandstone pieces			
26									
28									
30	30' A 30' B	2 3 10			SM	Medium to coarse sand with silt (SM), slightly moist to moist, gray + dark brown w/orange + trace black shale, loose to medium dense			
32									
34									
	35' A 35' B	4 4 6			SM	Same as above, w/few clay + few gravel, loose			
36									
38									
40									

COARSE-GRAINED SOILS <50% passes #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure.

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: P3-6

Sheet 3 of 3

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lorn, A. Rodriguez, J. Viguera	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter:		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
40	40'A 40'B	7 7 6			SC	Clayey sand (SC) with gravel, moist, dark brown, trace black weathered shale, few orange weathered sandstone, medium dense			
42									
44									
	45'A 45'B	7 9 9			SM	Sand with silt (SM) and gravel, trace shale, trace coal, brown + gray w/few orange, trace black, slightly moist to moist, medium dense		CO=72 ppm, H_2S=0 ppm	
46									
48									
50	50'A 50'B	8 6 5			SM	Sand with silt (SM), few gravel, moist, dark gray + brown, trace black + yellow/orange, loose to medium dense		CO=105 ppm, LEL=5% H_2S=0 ppm	
52									
54								H_2S=4.2 ppm, CO=500ppm LEL=15% *Stopped work	
56						EOB @ 55'			
58									
60									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
			Poorly-graded* sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below.

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	**SOIL BORING LOG FORM**	BOREHOLE No.: P4-3 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/16/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguerıa	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/16/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 15 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Sand with silt (SM) and gravel (weathered sandstone + shale), gray, slightly moist to moist			
2									
4									
	5' Bag	50/5"			SM	Same as above			
6									
8									
10	10' A	20			SM	Sand with little to some silt (SM)			
	10' B	12							
	10' C	14							
12					CL	Silt and clay w/organics + salts (CL), black, slightly moist, trace to few gray sand		Bottom of A liner has black clay	
14								4 ft down hole: H_2S = 6.5 ppm, LEL = 17%, CO > 500 ppm	
15						EOB @ 15'		*Stopped work due to gas	
16									
18									
20									

COARSE-GRAINED SOILS / FINE-GRAINED SOILS		Description	Symbol
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
		Poorly-graded: sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P4-5 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/16/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/16/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 21.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Sand with silt (SM), trace shale pieces, brown (light) w/some green + purple, medium dense to dense			
2									
4									
5	5' Bag	12 21 24			SM	Same as above, slightly moist		Analytical sample from A, B, + C liners (bulk)	
6									
8									
10	10'A 10'B	3 4 5			SM	Same material, but loose, moist, brown w/some green, trace gravel			
12									
14									
15	15' Bag	5 5 2			SM	Same as above. Black shale + organics in tip of sampler		Analytical sample from A, B, + C liners (bulk) LEL = 3% (no other readings)	
16									
18									
20									

COARSE-GRAINED SOILS <50% passes #200 sieve			
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50	Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50	Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P4-5 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A	4			SM	Same as above, also with some orange staining		4' down hole: H_2S = 2.2 ppm	
	20'B	4 6						LEL = 10%, CO > 500 ppm *stopped work	
22						EOB @ 21.5'			
24									
26									
28									
30									

COARSE-GRAINED SOILS (>50% retained on #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
			Poorly-graded* sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P4-6 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/16/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/16/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 11.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Sandy silt to silty sand, loose, slightly moist, light brown/light gray			
2									
4									
	5'A	3			SM	Silty sand (SM), with weathered sandstone chunks, loose, slightly moist, light brown		CO=20 ppm, H_2S=0, LEL=0	
		8							
6	5'B	14							
						Cuttings turned dark gray/black @ 7 ft			
8									
10	10'A	7			ML	Sandy silt (ML), few to little highly weathered shale, moist, brown & dark gray w/orange staining, trace salts		H_2S=2.8 ppm, CO>500 ppm LEL=18% (just inside top of auger)	
		27							
	10'B	14							
12						EOB @ 11.5'		* Drillers noted sudden smell of H_2S → stopped work	

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P4-7 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/15/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/15/18
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth: 30 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand topsoil, brown, slightly moist, few clay			
						Broken + weathered sandstone w/silt (SM), few clay, brown + gray w/orange iron staining			
2									
			42						
4									
5	5' A 5' B	12 6 15				Same as above			
6									
			46						
8						→ ~6" gray weathered sandstone			
						→ tan + gray			
10	10' A	2 0 2				→ trace brown sand		Poor sample recovery	
12									
			27						
14						→ trace brown sand			
15	15' B	1 2 4			SM	Moderately to completely weathered sandstone with little silt (SM), trace black shale, gray w/trace green + purple, some areas loose + sandy, others solid rock		H_2S = 0 ppm, CO = 40 ppm LEL: 4% Poor CA sample recovery	
16									
18			45						
20									

COARSE-GRAINED SOILS (>50% retained on #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded¹ gravels, gravel-sand mixtures, little or no fines — GW
			Poorly-graded¹ gravels, gravel-sand mixtures, little or no fines — GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded¹ gravel-sand-silt mixtures — GM
			Clayey gravels, poorly-graded¹ gravel-sand-clay mixtures — GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded¹ sands, gravelly sands, little or no fines — SW
			Poorly-graded¹ sands, gravelly sands, little or no fines — SP
		SANDS with >15% fines	Silty sands, poorly-graded¹ sand-gravel-silt mixtures — SM
			Clayey sands, poorly-graded¹ sand-gravel-clay mixtures — SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity — ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays — CL
			Organic silts and clays of low plasticity — OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt — MH
			Inorganic clays of high plasticity, fat clays — CH
			Organic silts and clays of medium to high plasticity — OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content — PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

¹Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P4-7 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A 20'B	6 8 17	45		SM	Same as above			
22									
24									
	25'A 25'B	15 21 11	52		SM	Same as above			
26									
28								H_2S = 4.2 ppm (outside auger) LEL = 10%, CO > 500 ppm 10' down hole: H_2S = 5.3 ppm LEL = 18%, CO > 500 ppm	
30						EOB @ 30'		* Stopped work	
32									
34									
36									
38									
40									

			Description	Symbol
COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded' gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded' gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded' gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded' gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded' sands, gravelly sands, little or no fines	SW
			Poorly-graded' sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded' sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded' sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P4-8 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/15/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/15/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 20 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SC	Clayey sand (SC) w/silt & weathered shale, brown + dark gray/black, trace iron staining, slightly moist			
2									
4									
	5'A	12			SC	Same as above, medium dense			
	5'B	12							
6	5'C	14							
8									
10	10'A	7			SM	Silty sand (SM) w/few to little clay + trace gravel (weathered sandstone pieces), black + gray, medium dense			
		8							
	10'B	9							
12									
14									
	15'A	5			SM	Same as above, black w/some gray & orange			
16		6							
	15'B	6							
18									
20						EOB @ 20'		LEL = 99%, CO > 500 ppm H_2S = 62 ppm (top of hole) * Stopped work	

COARSE-GRAINED SOILS (>50% retained on #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded' gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded' gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded' gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded' gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded' sands, gravelly sands, little or no fines	SW
			Poorly-graded' sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded' sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded' sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note:
Well-graded = poorly sorted
Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P4-9 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/15/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/15/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 40 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand (SM) (topsoil), trace gravel + shale pieces, light brown w/trace gray, slightly moist			
2									
4									
	5'A 5'B	4 11 16			SM	Same as above, medium dense		VOCs = 35 ppm, H_2S = 0, CO = 0, LEL = 0	
6									
8									
10	10'A	14 15 11			SM	Same as above, little sandstone		Auger cuttings contain numerous rounded, alluvial rocks (~1" diameter)	
12									
14									
	15'Bag	9 12 42			SM	Same as above, w/sandstone chunks		Bulk sample from A+B liners (accidentally emptied liners thinking it was analytical sample)	
16									
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: P4-9 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' Bag	6 6 5			SM	Same as above, loose to medium dense		Analytical sample from A,B,C liners	
22									
24									
	25'A	14 21 14			ML	Sandy silt (ML) w/sandstone chunks + trace shale pieces, brown + gray w/white salts and some orange oxidation		B liner = sandstone	
26									
28									
30	30' Bag	12 28 13			ML	Same as above, dense		Analytical sample from A,B liners	
32									
34									
	35'A 35'B	15 50/5"			ML	Sandy silt (ML) with clay + gravel, brown and black w/white salts, very dense (could just be from hitting rock)		Samples got soaked in water poured down hole after stopping due to gas	
36									
38								Drillers noted puff of gas smell H_2S = 18.3 ppm, LEL = 47% CO > 500 ppm, VOC = 43.1 ppm	
40						EOB @ 40'			

COARSE-GRAINED SOILS (>50% retained #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
			Poorly-graded* sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TN-1 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME 85	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/1/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/1/18
Field Representitive (day / night):	Core Diameter: N/A		Total Depth: 16.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand, medium dense, slightly moist, light brown			
2									
4									
6	5' A 5' B	10 18 21			SM	Same as above			
8									
10	10' A 10' B	5 11 9				↑ Fill			
12					SM	Native sand, silty (SM), improved structure & rupture resistance, trace carbonates, slightly darker brown (increased organics)		More "soily"	
14									
16	15' A	7 11 7			SM	Silty sand, carbonates, intact pores visible within samples			
						EOB @ 16.5'			
18									
20									

Soil Group		Description	Symbol
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

*= 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

¹Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TN-2 Sheet 1 of 2
Drilling Company: Cascade Drilling Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria Field Representitive (day / night):	Drilling Rig: CME 85 Drilling Method: Hollow Stem Auger Core Diameter: 4.25"	Bit Type: 4.25" I.D., 8" O.D. Auger Logged by: C. Fritz	Start Date: 4/1/18 Finish Date: 4/1/18 Total Depth: 31.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0			39		SM	Loose to medium dense silty sand (SM), light brown, slightly moist			
2									
4									
5	5' A 5' B	5 9 6	35		SM	Same as above		Loose sand in partially full liners	
6									
8									
						→ Trace carbonates, increased cementation (still weak)			
10	10' A 10' B	6 9 9	36		SM				
12									
14									
15	15' A 15' B	5 8 8	39		SM	Same as above, trace sandstone pieces			
16									
18									
						→ trace to few clay, darker → trace sandstone			
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >11% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >11% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

∇ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TN-2 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig:	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representitive (day / night):	Core Diameter: 7.25"		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A 20'B	7 8 8			SM	Same as above			
22			36			→ Few sandstone chunks			
24						↑ Fill			
25–26	25'A 25'B	7 8 7			SM	Native silty sand, trace carbonates, greater cementation + angularity			
28			35						
30	30'A	5 7 8			SM	Same as above, trace clay + organics (roots)			
32						EOB @ 31.5'			

COARSE-GRAINED SOILS >50% retained #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
			Poorly-graded: sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: T10-1 Sheet 1 of 4

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/30/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/30/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 71.5ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					ML	Sandy silt w/little shale (weathered + flaky), (ML), slightly moist, medium dense, light brown, darker gray shale			
2									
4									
6	5'A 5'B	17 16 16			ML	Same as above			
8									
10	10'A 10'B	14 16 20			ML	Same as above			
12									
14									
16	15'A 15'B	8 10 16			ML	Same as above			
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines SW
			Poorly-graded sands, gravelly sands, little or no fines SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands; silts with slight plasticity ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays CL
			Organic silts and clays of low plasticity OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt MH
			Inorganic clays of high plasticity, fat clays CH
			Organic silts and clays of medium to high plasticity OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4 75 to 19	3/16 to 3/4
Coarse sand	2 0 to 4.75	1/16 to 3/16
Medium sand	0 425 to 2 0	1/64 to 1/16
Fine sand	0 075 to 0 425	0 003 to 1/64
Silt / clay (fines)	<0 075	<0 003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	**SOIL BORING LOG FORM**	BOREHOLE No.: T10-1 Sheet 2 of 4

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A	11 15 15			ML	Silt, some moderately to slightly weathered shale (lean clay), dark brown/grey, slightly moist, very stiff silt, very hard shale			
22									
24									
26	25' A	10 9 10			CL	Lean clay (moderately to highly weathered shale)			
28									
30	30' A	9 14 15			CL	Same as above			
32									
34									
36	35' A 35' B	7 8 10			ML	Sandy silt, light brown, trace moderately weathered sandstone, slightly moist, stiff			
38									
40									

COARSE-GRAINED SOILS				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
		Poorly-graded* sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS: SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure

Depth to final water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: T10-1 Sheet 3 of 4

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter:		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
40	40' A 40' B	13 17 16			CL	Highly weathered shale w/sand + some silt, dark brown, trace iron oxidation			
42									
44									
46	45' B	8 10 10			ML	Sandy silt to silty sand, weakly cemented, medium dense, light brown, slightly moist, few carbonates, trace weathered sandstone			
48									
50	50' A	13 21 22			CL	Highly to completely weathered shale, little silt + sand, slightly moist to moist, dark brown/gray, very stiff to hard			
52									
54						↑Fill			
56	55' A 55' B	11 12 13			ML	Sandy silt (ML), very stiff, light brown, slightly moist (native)		Native may be at 60', unsure due to a bit of clayey material in upper liner @ 60'	
58									
60									

COARSE-GRAINED SOILS >50% retained #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note:
Well-graded = poorly sorted
Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)
▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: T10-1

Sheet 4 of 4

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter:		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	qu (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
60	60'A	14 15 17			ML	Sandy silt, few clay, slightly moist to moist, very stiff, light brown, weak cementation			
62									
64									
66	65'A	7 10 12			ML	Same as above			
68									
70	70'A	12 15 24			ML	Same as above			
						EOB @ 71.5'			

Major divisions			Description	Symbol
COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: T10-2

Sheet 1 of 2

Drilling Company: Cascade Drilling
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguería
Field Representative (day / night):

Drilling Rig: CME LAR 75 High Torque Track Rig
Drilling Method: Hollow Stem Auger
Core Diameter: N/A

Bit Type: 4.25" I.D., 8" O.D. Auger
Logged by: C. Fritz

Start Date: 3/28/18
Finish Date: 3/28/18
Total Depth: 26.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					ML	Sandy Silt (ML) w/weathered shale, light to dark brown (darker in clayey spots), slightly moist			
2									
4									
5–6.5	5'A	20 16 15			ML	Same as above		Auto-hammer was "double bouncing"	
8									
10–11.5	10'A	20 18 13			ML	Same as above			
12									
14									
15–16.5	15'A	10 10 17			ML	Same as above			
18									
20						↑Fill		Native @ 20'	

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY
Nonplastic
Low
Medium
High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TID-2 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75 High Torque Track Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20'A 20'B	8 16 20			ML	Sandy silt (ML) (native), light brown, medium dense, slightly moist			
22									
24									
26	25'A	11 13 20			SS	Moderately to highly weathered sandstone bedrock, dark brown/gray			
						EOB @ 26.5'			
28									
30									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded' gravels, gravel-sand mixtures, little or no fines — GW
			Poorly-graded' gravels, gravel-sand mixtures, little or no fines — GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded' gravel-sand-silt mixtures — GM
			Clayey gravels, poorly-graded' gravel-sand-clay mixtures — GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded' sands, gravelly sands, little or no fines — SW
			Poorly-graded' sands, gravelly sands, little or no fines — SP
		SANDS with >15% fines	Silty sands, poorly-graded' sand-gravel-silt mixtures — SM
			Clayey sands, poorly-graded' sand-gravel-clay mixtures — SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity — ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays — CL
			Organic silts and clays of low plasticity — OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt — MH
			Inorganic clays of high plasticity, fat clays — CH
			Organic silts and clays of medium to high plasticity — OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content — PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note:
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: T10-3 Sheet 1 of 5

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75, CME 85 (below 35')	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/28/18
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/30/18
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth: 81.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					ML	Sandy silt (ML), few to little gravel, little to some shale. Light brown (shale dark gray). Slightly moist, medium dense/very stiff, moderate cementation w/areas of strong rock-like cementation. Trace carbonates.		Flakes of broken shale	
2			48						
4									
	5'A	9							
		9							
6	5'B	14				→ mostly shale, some silt + sand, weathered and weakly cemented			
			52			→ mostly sand			
8									
						→ shale w/silt + sand			
10		11				→ mostly sand			
	10'A	16							
		22							
12						→ sandy silt + shale			
			44						
14									
		10							
16	15'B	10							
		13							
			36						
18									
20									

COARSE-GRAINED SOILS			Description	Symbol
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines		Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines		Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines		Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines		Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4 75 to 19	3/16 to 3/4
Coarse sand	2 0 to 4 75	1/16 to 3/16
Medium sand	0 425 to 2 0	1/64 to 1/16
Fine sand	0 075 to 0 425	0 003 to 1/64
Silt / clay (fines)	<0 075	<0 003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: T10 - 3 Sheet 2 of 5

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75, CME 85 (below 35')	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' B 21' Bag	4 5 5	42		ML	Loose sandy silt w/weathered shale (liners); cores show medium dense-dense sand w/moderate cementation			
22									
24									
25	25'A	8 7 9	42		ML	Sandy silt (ML), medium dense			
26									
28									
29					SM	Silty sand (SM) and slightly to completely weathered shale, medium dense sand, very stiff shale, light brown (sand) + dark gray/black (shale), slightly moist			
30	30' A 30' B	7 10 14	49						
32									
34									
35		11 13 17	48					Used downhole (manual) hammer @ 35'. Began using CME 85 rig to drill beyond 35' bgs.	
36									
37						→ mostly shale, moderate cementation, pockets of hard rock, trace iron oxide + carbonates			
38									
40									

COARSE-GRAINED SOILS: GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
		Poorly-graded* sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS: SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-6	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: T10-3 Sheet 3 of 5

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75, CME 85 (below 35')	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguerie	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
40	40' A	10 10			SM	Sand + shale mixtures (cont'd), medium dense/very stiff, slightly moist, silty			
	40' B	10							
42			49			-> mostly shale, sandy, moderate to strong cementation, few gypsum, trace carbonates			
44									
	45' A	11 9 9			SM	Silty sand (SM), little highly weathered shale, light brown, slightly moist. Some chunks of shale			
46						-> mostly sand, poorly-graded			
			56						
48						-> ~4" very hard, slightly weathered shale		Auger working much harder; loud grinding and groaning noises, plus vibrations	
						-> back to sand + shale mixtures			
50	50' B	11 9 13			SM	Silty sand			
52			41					Additional moisture in cores from drilling fluid poured down hole	
	53' Bag					-> Mostly shale, slightly to highly weathered			
54						-> strongly cemented hard rock, trace gypsum and carbonates			
	55' B	11 9 10			SM	Liner samples: silty sand (SM), medium dense, few stiff clays (dark + weathered shale)			
56									
			55						
58									
60									

COARSE-GRAINED SOILS (>50% retained on #200 sieve): GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50	Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50	Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: T10-3 Sheet 4 of 5

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75, CME 85 (below 35')	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
60	60' A 60' B	9 11 13	54		ML	Sandy silt (ML), few clay, reddish brown, hard, moderate cementation			
62									
64									
	65' B	24 20 23	48		ML	Silt (ML), little clay (weathered shale), few sand			
66									
68									
	69' Bag								
70	70' B	21 33 27	28		ML	Same as above, trace gravel			
72									
74						↑Fill			
	75' A 75' B	6 9 9	40		ML	Sandy silt (ML) (native), light brown, slightly moist, stiff			
76									
78						→Few clay			
80									

COARSE-GRAINED SOILS: GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
		Poorly-graded* sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS: SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, loan clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: T10-3

Sheet 5 of 5

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75, CME 85 (below 35')	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
80	80' A	6			ML	Same as above			
		7							
	80' B	7							
82						EOB @ 81.5'			

COARSE-GRAINED SOILS >50% retained on #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS 50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note:
Well-graded = poorly sorted
Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: T10-4 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75 High Torque Track Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/29/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/29/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 36.5 Ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					ML	Sandy silt topsoil (ML)			
5	5' A 5' B	11 12 11			ML	Weathered shale (broken + flaky pieces) in sandy silt matrix (ML), gray, slightly moist, very stiff, trace carbonates			
10	10' A 10' B	8 16 19			ML	Same as above			
15	15' A 15' B	12 19 13			ML	Same as above, slightly less shale			
20									

COARSE-GRAINED SOILS (>50% passes #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded: gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded: gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded: gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded: gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded: sands, gravelly sands, little or no fines	SW
			Poorly-graded: sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded: sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded: sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-76	42-85
very hard	>60	>76	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: T10-4

Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75 High Torque Track Rig	Bit Type: 4.25" I.D., 8" O.D. Auger
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz
Field Representative (day / night):	Core Diameter: N/A	

Start Date: See Sheet 1
Finish Date:
Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Remarks	Well Details
20	20'B	14 14 16			ML	Sandy silt (ML), little shale (moderately weathered pieces), mostly light brown with darker shale, weak cementation, trace carbonates (less than above)		
22								
24								
	25'B	10 11 20			ML	Same as above, increased shale presence	Mostly sand in C (topmost) liner, mixtures in A + B	
26								
28								
30	30'B	10 10 16			SM	Silty sand (SM) (native), medium dense, trace to few carbonates, slightly moist, light brown	Improved soil structure, more uniform material w/less shale + rock Inter-mixed	
32								
34								
	35'B	11 16 24						
36					SS	Weathered sandstone bedrock, very stiff, dark gray	Rock in A liner @ 36'	
						EOB @ 36.5'		
38								
40								

COARSE-GRAINED SOILS (>50% passes #200 sieve) GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
		Poorly-graded* sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve) SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note
Well-graded = poorly sorted
Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: T10-5 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75 High Torque Track Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/27/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/27/18
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth: 29 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					ML	Silt (ML) and shale mixtures, few to little sand, interlayered light + dark brown, stiff, moderate cementation, slightly moist			
2						-> mostly shale			
			56						
4									
	5'A	6			ML	-> mostly silt			
6	5'B	8							
		11							
			55						
8									
						-> mostly shale			
10		14			ML	Sandy silt (ML), moderate cementation, little shale			
	10'B	17							
		16							
12						-> few shale, still mostly silt			
			48			-> clayey			
14									
	15'A	7			ML	Same as above, trace gravel, less clay			
16	15'B	9							
		10							
			48						
18									
20									

COARSE-GRAINED SOILS >50% passes #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
			Poorly-graded* sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)
Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TJD-5 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75 High Torque Track Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A	11			ML	Silt (ML), few sand & clay, light brown/tan, slightly moist, very stiff			
		10							
	20' B	15							
22			50						
24									
		5			ML	Same as above			
26	25' A	6							
		8							
			26						
28									
		50/bounce							
						EOB @ 29'		Auger Refusal	
30									
32									
34									
36									
38									
40									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded' gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded' gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded' gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded' gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded' sands, gravelly sands, little or no fines	SW
			Poorly-graded' sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded' sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded' sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: T10-6 Sheet 1 of 1

Drilling Company: Cascade Drilling	Drilling Rig: CME LAR 75 High Torque Track Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 3/29/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 3/29/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 15.33 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					ML	Silt with sand (ML), little clay (weathered shale), slightly moist, gray/brown, very stiff			
2									
4									
6	5'A	14 16 19			ML	Same as above			
8									
10						↑Fill			
	10'A	7 8 10			ML	Sandy silt, little clay (ML), native, light brown, slightly moist, stiff			
12									
					SS	Sandstone bedrock, light brown, very dense			
14									
		50/4"							
16						EOB @ 15.33'			
18									
20									

COARSE-GRAINED SOILS (>50% is retained on #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: TS-1

Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger
Drillers (day / night): S. Lom, A. Rodriguez, J. Viguerla	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz
Field Representative (day / night):	Core Diameter: N/A	

Start Date: 4/2/18

Finish Date: 4/2/18

Total Depth: 35 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Silty sand topsoil (SM), few weathered shale pieces, brown, slightly moist, loose			
2									
4									
6	5' A 5' B	23 25 25			SM	Silty sand (SM) and weathered shale, brown + gray, dense + weakly cemented, slightly moist, trace carbonates			
8									
10	10' A 10' B	10 10 10			ML	(est.) Sandy silt (ML), few shale pieces, brown, very stiff, slightly moist			
12									
14									
16	15' A 15' B	15 16 17			ML	(est.) Silt (ML), little weathered shale + sandstone, brown + gray, slightly moist, very stiff			
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

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Well-graded = poorly sorted
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MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TS-1 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Remarks	Well Details
20	20' A 20' B	19 20 22			ML	Same as above		
22								
24								
25–26	25' A 25' B	8 15 14			SM	Silty sand (SM) (native), medium dense, slightly moist, trace carbonates, light brown		
28								
30	30' C	18 28 39				Same as above		
~31					SS	Weathered sandstone bedrock		
32								
34								
35						EOB @ 35'		
36								
38								
40								

Major Division	Group	Description	Symbol
COARSE-GRAINED SOILS: GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
		Poorly-graded sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS: SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-80	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure.

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec

Client: GE - United Nuclear Corporation

Project Number: 233001076

SOIL BORING LOG FORM

BOREHOLE No.: TS-2

Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/2/18
Drillers (day/ night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/2/18
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth: 36.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					ML	Sandy silt topsoil, few clay, brown w/specks of gray, slightly moist, loose			
2			38						
4					SM	Highly weathered sandstone + silty sand (SM), mostly broken rock, gray + brown → trace moderately weathered rock			
6	5'B	13 12 8							
8			39						
10	10' A 10' B	15 21 12			SM	Weathered sandstone + shale, brown w/some gray, iron staining, silty			
12			49			→ mostly sand + silt (less rock)			
14									
16	15' A	12 11 10			SM	Silty sand (SM), few to little weathered shale + sandstone, increased cementation of sand, few carbonates			
18			53						
20									

COARSE-GRAINED SOILS <50% passes #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded' gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded' gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded' gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded' gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded' sands, gravelly sands, little or no fines	SW
			Poorly-graded' sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded' sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded' sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS >50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

'Note:
Well-graded = poorly sorted
Poorly graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TS-2 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: 4.25 inch		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' B 20' C	11 30 50	60		SS	Same as above ↑Fill Highly weathered sandstone, gray, some fines (darker patches, possibly weathered shale), weakly cemented, considerable iron staining, breaks easily along horizontal planes		Topsoil in C (top) liner, rock in mid-B + A	
22									
24									
25	25' A	18 29 19	56		SS	Same as above			
26									
28									
30	30' A 30' B	8 7 6	14		SS	Same as above			
32									
33		20 23 27			SS	Same as above		Initially had auger refusal @ 33'. Drove sampler then were able to continue to 35'. No samples collected due to broken rock.	
34									
35		12 15 10			SS	Same as above			
36									
36.5						EOB @ 36.5'			
38									
40									

COARSE-GRAINED SOILS (>50% retained #200 sieve)				
GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
		Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
	GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
		Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
		Poorly-graded* sands, gravelly sands, little or no fines	SP
	SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
		Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)			
SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
		Organic silts and clays of low plasticity	OL
SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
		Inorganic clays of high plasticity, fat clays	CH
		Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TS-3 Sheet 1 of 2
Drilling Company: Cascade Drilling Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria Field Representative (day / night):	Drilling Rig: CME 85 Truck Rig Drilling Method: Hollow Stem Auger Core Diameter: N/A	Bit Type: 4.25" I.D., 8" O.D. Auger Logged by: C. Fritz	Start Date: 4/1/18 Finish Date: 4/2/18 Total Depth: 31.5 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					ML	Sandy silt/silty sand topsoil			
2									
4									
	5' A	30			ML	Mostly silt, little weathered sandstone + shale, trace gravel. (ML). Brown, slightly moist. Few sand.			
6	5' B	24							
		26							
8									
10	10' A	16			ML	Same as above			
	10' B	20							
		23							
12									
14									
	15' A	15			ML	Weathered shale, sand, + silt mixtures. Mostly silt (ML).			
16	15' B	21							
		39							
18									
						↑Fill above ~20'			
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TS-3 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lorn, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A 20' B	18 19 14			SS	Weathered sandstone, light gray w/red + orange oxidation		Native @ ~20'	
22									
24									
26	25' A	13 24 23			SS	Same as above, but darker gray/black. Still coarse-grained but possible shale influence (?)			
28									
30	30' A	10 14 20			SS	Sandstone, highly weathered, gray			
32						EOB @ 31.5'			
34									
36									
38									
40									

Soil group			Description	Symbol
COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded¹ gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded¹ gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded¹ gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded¹ gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded¹ sands, gravelly sands, little or no fines	SW
			Poorly-graded¹ sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded¹ sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded¹ sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS: Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

¹Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

▽ Depth to first water (time and date)

▼ Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TS-4 Sheet 1 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: 4/1/18
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date: 4/1/18
Field Representative (day / night):	Core Diameter: N/A		Total Depth: 25.25 ft

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
0					SM	Dense silty sand, few to little weathered shale, trace gravel + sandstone pieces, light brown, slightly moist			
2									
4									
	5' A 5' B	22 27 35			SM	Same as above			
6									
8									
10	10' A 10' B	13 22 23			SC	Dense sand w/clay + gravel (SC), brown, slightly moist			
12					SS	Weathered sandstone, few fines (weathered shale + silt) mixed in, brown + gray, iron staining		Estimated contact w/native	
14									
	15' A 15' B	15 19 24				Same as above			
16									
18									
20									

COARSE-GRAINED SOILS	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded* gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded* gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded* gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded* gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded* sands, gravelly sands, little or no fines	SW
			Poorly-graded* sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded* sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded* sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

*Note: Well-graded = poorly sorted; Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Depth to first water (time and date)

Depth to water after drilling (time and date)

Stantec	Client: GE - United Nuclear Corporation Project Number: 233001076	SOIL BORING LOG FORM	BOREHOLE No.: TS-4 Sheet 2 of 2

Drilling Company: Cascade Drilling	Drilling Rig: CME 85 Truck Rig	Bit Type: 4.25" I.D., 8" O.D. Auger	Start Date: See Sheet 1
Drillers (day / night): S. Lom, A. Rodriguez, J. Vigueria	Drilling Method: Hollow Stem Auger	Logged by: C. Fritz	Finish Date:
Field Representative (day / night):	Core Diameter: N/A		Total Depth:

Depth	Sample Number	Blow Count	Recovery (in.)	q_u (tsf)	Lithology / Symbol	Description	Graphic	Remarks	Well Details
20	20' A	15			SS	Same as above			
	20' B	28						shale starting in B liner	
		50/5"			SH	Moderately weathered shale			
22									
24									
		50/3"							
						EOB @ 25.25'			
26									
28									
30									
32									
34									
36									
38									
40									

COARSE-GRAINED SOILS (>50% retained on #200 sieve)	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with >15% fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixtures	GC
	SANDS <50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with >15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS (>50% passes #200 sieve)	SILTS AND CLAYS liquid limit <50		Inorganic silts/very-fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium to high plasticity	OH
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	PT

CONSISTENCY (Silts and Clays)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very soft	0-2	0-2	0-2
soft	2-4	2-4	2-4
medium stiff	4-8	4-8	4-8
stiff	8-15	9-17	9-18
very stiff	15-30	17-39	18-42
hard	30-60	39-78	42-85
very hard	>60	>78	>85

DENSITY (Sands and Gravels)

Term	Blows/ft* (SPT) 1.4"ID	2.0"ID	(modCAL) 2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-30	12-37	18-51
dense	30-50	37-60	51-86
very dense	>50	>60	>86

* = 140 pound hammer dropped 30 inches

GRAIN SIZE

Term	Size (mm)	Size (inches)
Boulders	>300	>12
Cobbles	75 to 300	3 to 12
Coarse gravel	19 to 75	3/4 to 3
Fine gravel	4.75 to 19	3/16 to 3/4
Coarse sand	2.0 to 4.75	1/16 to 3/16
Medium sand	0.425 to 2.0	1/64 to 1/16
Fine sand	0.075 to 0.425	0.003 to 1/64
Silt / clay (fines)	<0.075	<0.003

SOIL TYPE MODIFIERS

Percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages as below

Term	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Note
Well-graded = poorly sorted
Poorly-graded = well sorted

PLASTICITY: Nonplastic, Low, Medium, High

MOISTURE

Term	Field Test
Dry	Absence of moisture, dry to touch
Moist	Damp, does not wet palm
Wet	Visible Free Water

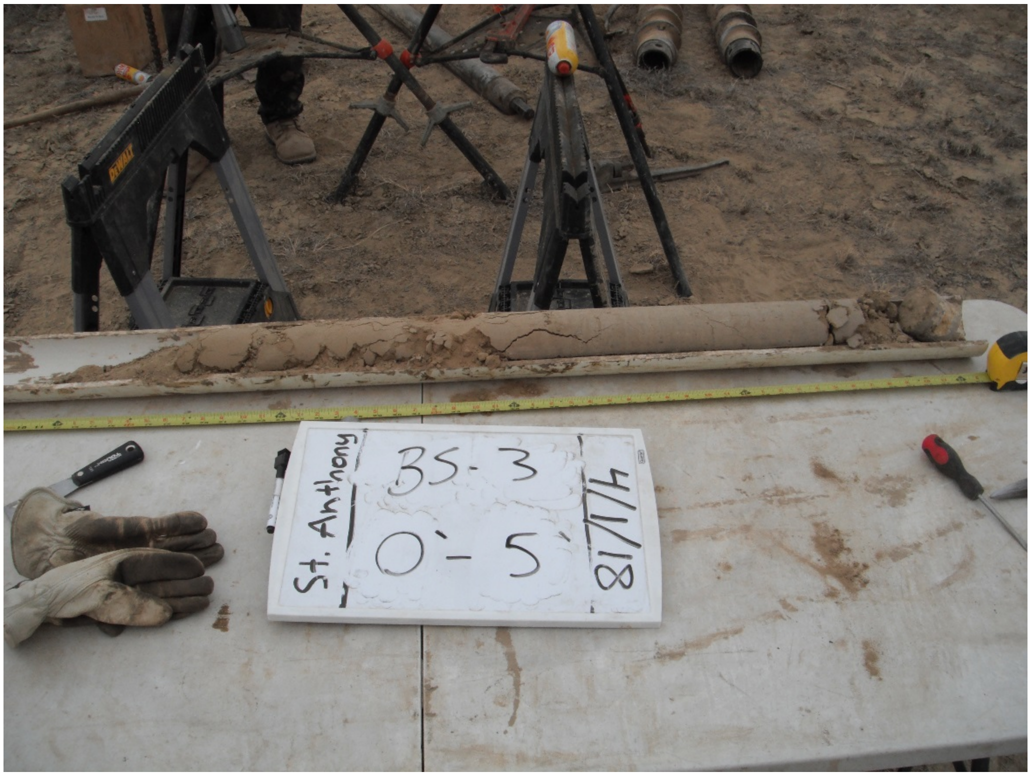
CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure.

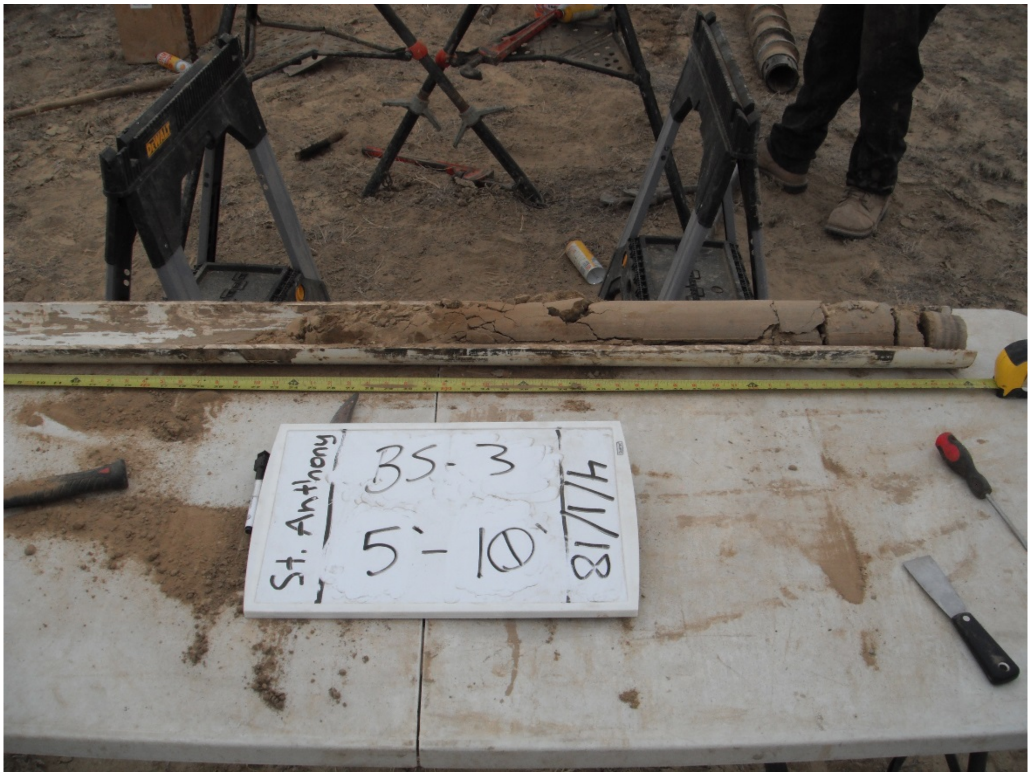
Depth to first water (time and date)

Depth to water after drilling (time and date)

Attachment C. Photos



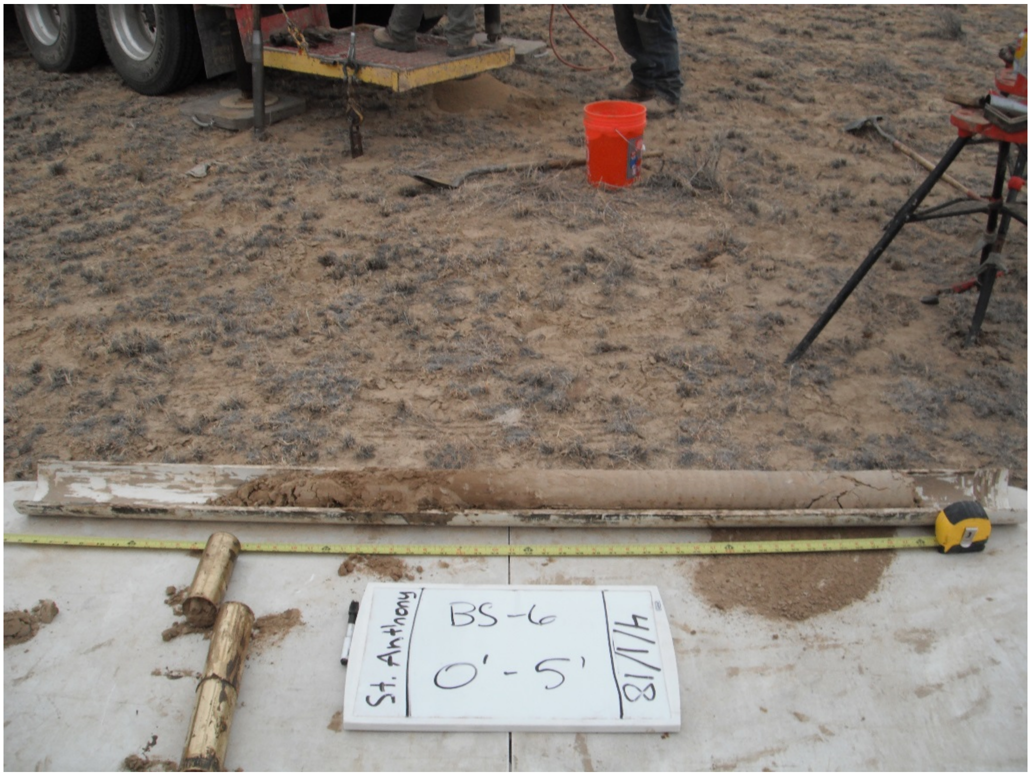
Photograph 1. BS-3: 0' (left) to 5' (right) bgs



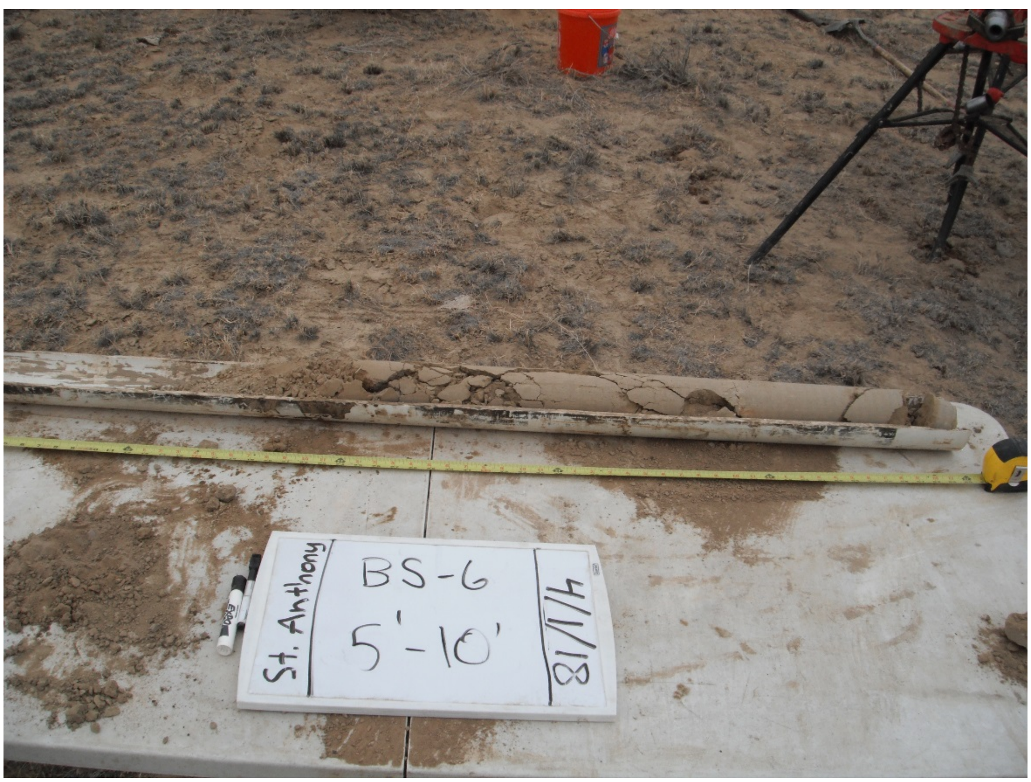
Photograph 2. BS-3: 5' (left) to 10' (right) bgs

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

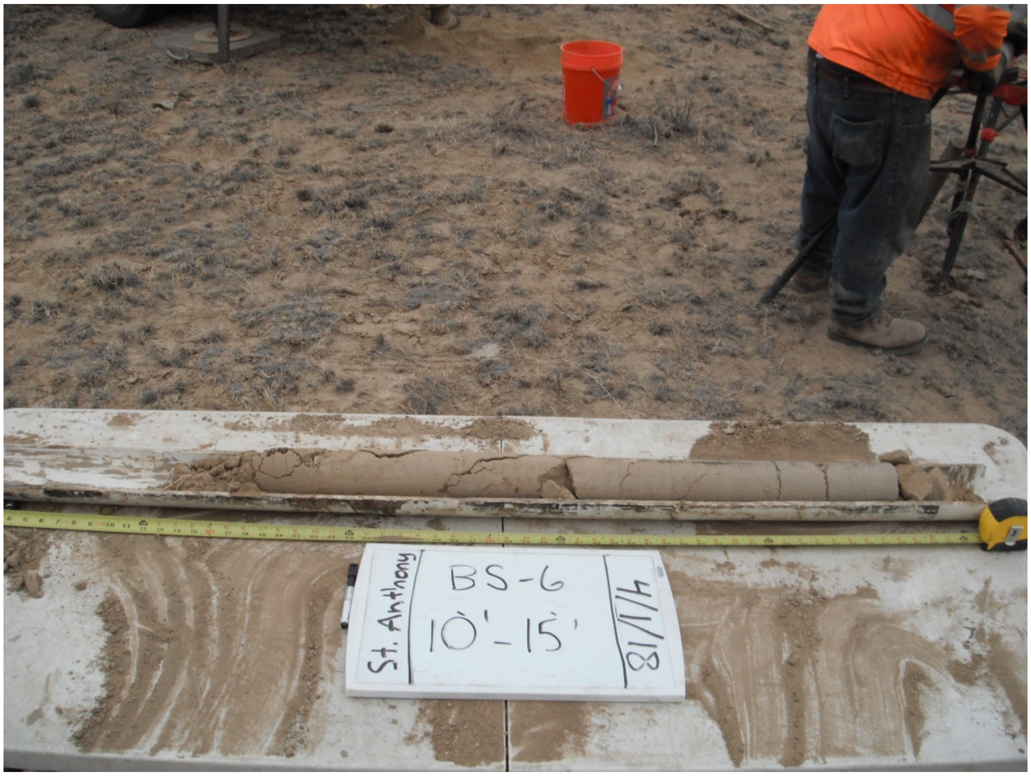
Photograph 4. BS-5: 0’ (left) to 5’ (right) bgs



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

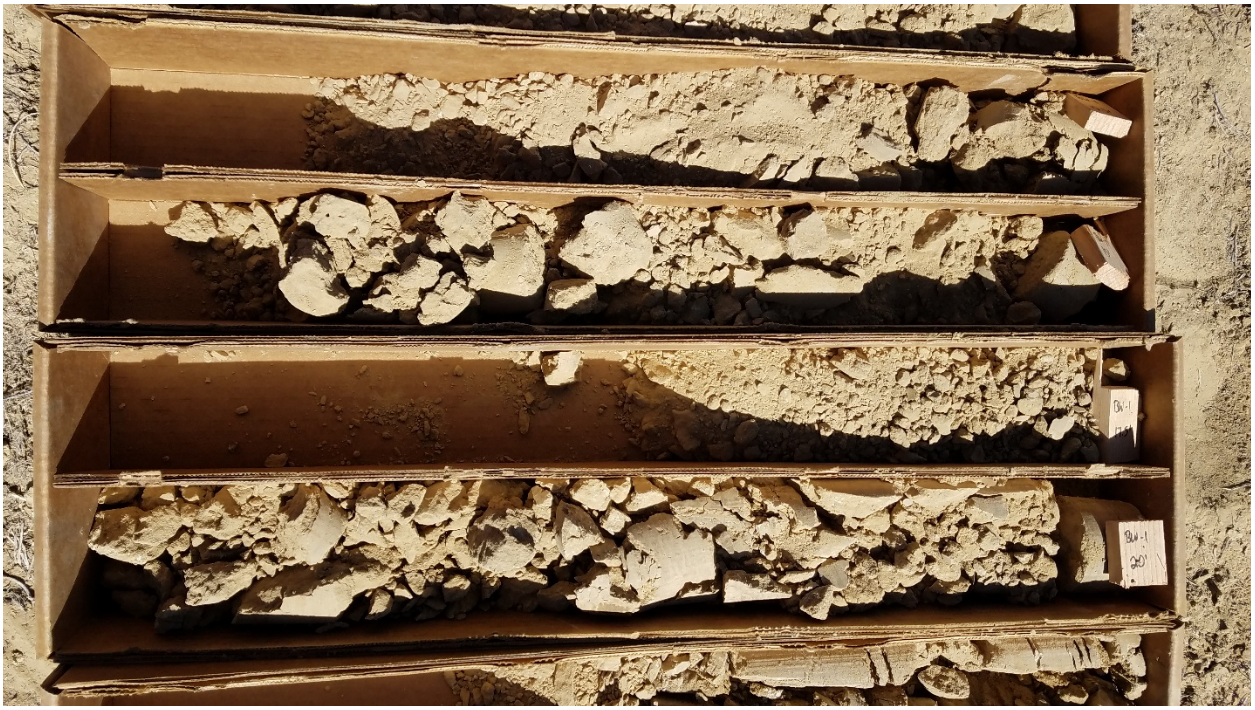


Photograph 6. BS-6: 5’ (left) to 10’ (right) bgs



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

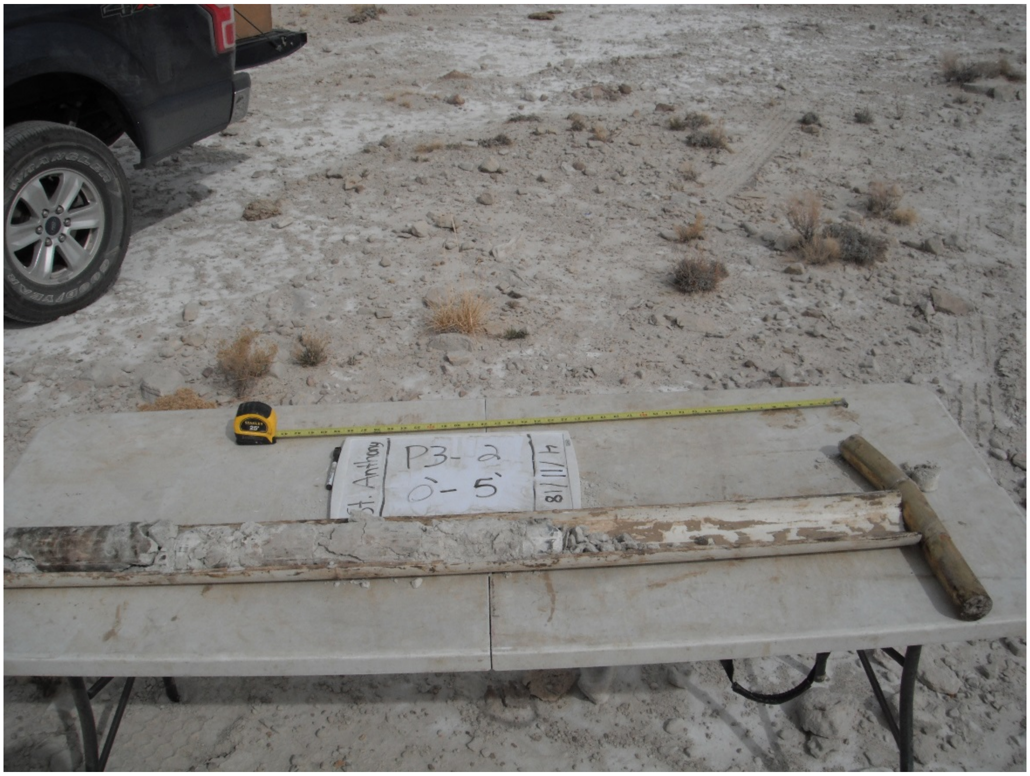
Photograph 12. L1-5 (all cores): 0’ (bottom left) to 20’ (top right) bgs

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

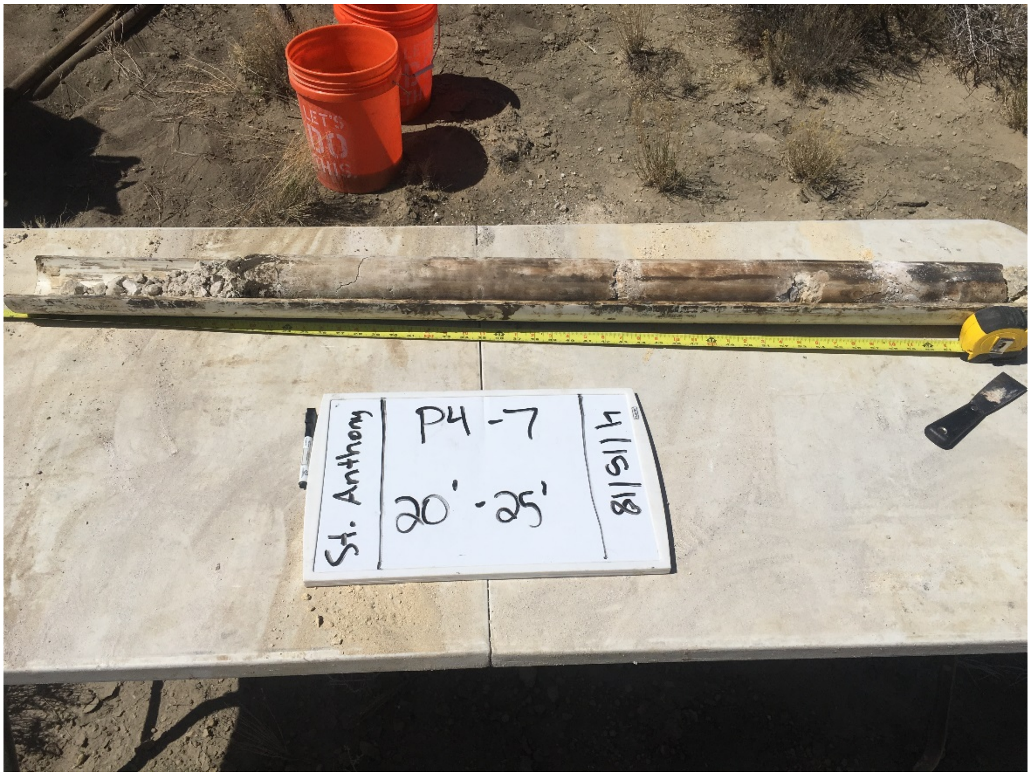
Photograph 21. P3-2: 17.5’ (bottom left) to 45’ (top right) bgs

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

Stantec

Daily Field Report

Date Mon, 3/26/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☐ Sunny	☒ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No.		
Humidity	☐ Dry	☒ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Arnold	Cascade	Drilling Supervisor	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

Item	Company	Op Hrs
CME LAR 75 track rig w/hollow stem auger	Cascade	

Safety:

No incidents reported

Activities Summary:

First day of St. Anthony work. I met the drilling crew and Rob at the gas station next to the Sky City Casino. We then met Breanna Van (Stantec) and followed her to the Site. We arrived at 8am and met with Nat and Victor Patel (AVM) for rad and site safety training. After finishing training at 10:30, we moved to the first drilling location in the Lobo Tract borrow area, L1-1, and began to set up the rig. All boreholes in this borrow area will be only 20' deep.

After completing L1-1, we moved to L1-5 location. This location was completed at 3:20, we then moved to L1-2 and completed drilling to 20' at 4:30. After frisking trucks and persons for radiation, all individuals were cleared to leave and were off-site by 5:15pm.

Total depth drilled: 60 ft
Total depth cored: 40 ft
Total CA brass liner samples collected: 17

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Tue, 3/27/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☐ Sunny	☒ Over-cast	☒ Rain	☒ Snow	
Temp. °F	☐ <32	☒ 32-50	☐ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No. 1		
Humidity	☐ Dry	☐ Moder.	☒ Humid			

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Arnold	Cascade	Drilling Supervisor	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

Item	Company	Op Hrs
CME LAR 75 track rig w/hollow stem auger	Cascade	

Safety:

No incidents reported

Activities Summary:

Arrived to site at 7:10am and had safety tailgate. After our meeting the drillers worked to get the flatbed and support trucks back onto the road before additional rain came and made it too muddy and difficult. The rig was then moved to L1-4 location, and drilling began at 8:30. After drilling to 20' at 9:15, the rig was moved to L1-3. The drillers then went to retrieve the flatbed truck to prepare for loading up the rig to move areas after the next hole. Drilling was completed at 11:00 after drilling to 20' and the rig was loaded up onto the flatbed to move across the arroyo to the L2 holes. However, upon arrival at the L2-1 location, we discovered a cattle fence that blocked access to the borehole locations on the east side of the arroyo. As a result we moved on to the nearby topsoil/overburden pile. Rob and I staked out borehole locations on the pile while the drillers set up at T/O-3.

Drilling began at 1:10 at T/O-3 and continued until 2:30, at which point a thunderstorm moved into the area and we had to stop work due to lightning. After a 1-hr delay, work resumed and continued until encountering auger refusal (and a 50-for-bounce modified CA test) at 29'.

At 4:30, the rig was moved to T/O-3 location and set up such that drilling can start first thing tomorrow. After frisking all persons and trucks for radiation levels, all parties left site at 5pm.

Total depth drilled: 69 ft
Total depth cored: 29 ft
Total CA brass liner samples collected: 21

By: C. Fritz Title: Field Engineer

Daily Field Report

Date Wed, 3/28/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No.	
Humidity	☒ Dry	☐ Moder.	☐ Humid	1	

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Arnold	Cascade	Drilling Supervisor	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

Item	Company	Op Hrs
CME LAR 75 track rig w/hollow stem auger	Cascade	

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 2nd and 4th 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

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Thu, 3/29/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

Item	Company	Op Hrs
CME LAR 75 track rig w/hollow stem auger	Cascade	

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.

Stantec

Daily Field Report

Total depth drilled: 50 ft
Total depth cored: 0 ft
Total CA brass liner samples collected: 12

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Fri, 3/30/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☐ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☐ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No. 1		
Humidity	☒ Dry	☐ Moder.	☐ Humid			

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

Arrived to gate at 7am, and to rig at 7:15 to have our safety tailgate meeting. The drillers checked on the loaded-up LAR track rig to make sure it was secure, then began prepping the CME 85 truck rig for drilling. At 8am, drilling resumed at T/O-3 at 35 ft after the rig was aligned with the existing hole and connected to the augers (still in the hole). Shortly thereafter, Joey left to drive the track rig back to Albuquerque. T/O-3 was finished at 2pm after drilling to 80 ft. The actual depth of contact with native remains fully unknown, Rob and I discussed for some time and came to different conclusions. He noted native material at about 55 ft. The logs and photos will have to be revisited to make a determination.

Around 2:45, Bryan Nydoske (Cascade PM) arrived to the site with Joey and we all had lunch together to discuss the work thus far. At 3:15, drilling began at the nearby T/O-1 location and Bryan left the site. T/O-1 was completed after drilling to 70 ft at 6pm. All individuals left the site by 6:15pm.

Total depth drilled: 115 ft
Total depth cored: 45 ft
Total CA brass liner samples collected:

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Sat, 3/31/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☒ 70-85	☐ 85-100	☐ >100
Wind	☒ Still	☐ Moder.	☐ High	Report No. 1		
Humidity	☒ Dry	☐ Moder.	☐ Humid			

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

Arrived on-site at 7am, had safety tailgate at the rig at 7:20. After our meeting, the drillers started packing up equipment to move areas, and pulled augers out of T/O-1. At 8:20, we moved into the Lobo Tract borrow area (east of the arroyo) and began drilling L2-1 at 9am. This hole was finished after drilling through 20’ of native soil, before moving on to L2-2. In this hole, bedrock was encountered at only 10’ and drilling stopped at 15’. The same conditions were encountered at the following hole (L2-3). After a 30 minute lunch break from 11:20-11:50, drilling began at L2-5, and was completed after 20’. The rig was then moved to L2-7. After 5 minutes of drilling, a mechanical issue with the autohammer resulted in 40 mins of down time from 12:50-1:30pm. L2-7 then was completed after 20’ of drilling. The drillers then took a 30 minute break due to warm weather.

At 2:30, the first hole with coring was begun at L2-6, and finished after 20’ of coring and sampling. The rig was then moved to the other corehole for this area, L2-4. At 4:30, L2-4 was completed after 20’ of coring and sampling. We then moved over to the topsoil north pile and scouted the drilling locations in this area with the drillers. It was determined that borehole TN-3 would not be accessible with the rig due to dangerous slopes on both sides of the narrow pile. As a result, only 2 boreholes likely will be drilled in this pile tomorrow.

The drillers left the site at 5:30pm, and Rob and I followed shortly thereafter once we had finished unloading core samples near the site entrance and covering with a tarp.

Total depth drilled: 130 ft
Total depth cored: 40 ft
Total CA brass liner samples collected: 38

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Sun, 4/1/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☒ Still	☐ Moder.	☐ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

Arrived on-site at 7am, began warming up rig at 7:15 and had our safety tailgate meeting. The drillers then refueled the rig and drilling and coring began at 8am at TN-2 in the topsoil north pile. TN-2 was completed after drilling 30’ and encountering native soil. The rig was then moved to TN-1 in the same pile, and 15’ of drilling was completed at 10:15am.

At 10:30, we moved across the site to the Borrow South area. Drilling began at BS-1 at 11, and continued until bedrock was encountered at 15’. The rig was then moved to BS-2, which was drilled until encountering bedrock in the CA sampler just past 20’. After moving to BS-3, 15’ of coring was completed before hitting bedrock. After completing BS-3, we decided not to drill at location BS-4 due to exposed bedrock at the surface in the general vicinity, which was of no interest to us in terms of potential borrow material. Therefore, we moved on to BS-5. However, this location also had shallow bedrock, resulting in only 5’ of soil coring. BS-6 exhibited improved borrow materials, with 20’ of coring completed and no bedrock encountered.

After completing the final borrow south borehole at 3:15, the rig was moved to the south topsoil pile and set up at location TS-4. Drilling began at 4pm and was completed at 4:45 after drilling to 25’. The rig was then moved to TS-3 and drilling was completed to 15’ before experiencing mechanical issues with the autohammer at 5:15. After 30 mins of work on the hammer, the drillers said they needed to salvage a part from the LAR track rig’s autohammer, which was still on site. We decided to do this in the morning, and left the site at 5:45.

Total depth drilled: 160 ft
Total depth cored: 70 ft
Total CA brass liner samples collected: 52

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Mon, 4/2/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☒ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☐ Moder.	☒ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

Arrived on-site at 7am, the drillers then went to salvage the hammer part from the LAR rig's hammer while I unloaded cores and buckets of samples near the site entrance where the other samples were already stored. The drillers then worked on attaching the part from 7:30-8:30 before resuming drilling at TS-3 at 15' depth. At 10am, drilling was completed at 30' depth, and the rig was moved to TS-2. This location was cored to 35' depth. Significant amounts of rock were encountered at this location beginning around 20', though it was difficult to determine whether the rock was native or fill due to the broken nature of it, as well as relatively low blow counts for such rocky material. The abrasiveness of the material resulted in high temperatures within the hole and steam. We took a break from 11:45-12:15 to allow the tooling to cool before finishing the hole.

Drilling then began at TS-1 at 1:20 after moving the original location to the top of the pile near the road that comes up from pile 1. The original location was on too steep of a slope to jack up the rig. This hole was drilled to 35', again hitting rocky material at shallower depths than anticipated. It appears that the pile is located atop a rock shelf, with topsoil material piled off the north side of the shelf, about 60 ft down to the native ground surface below.

At 3:15, the rig was moved to location P1-3 and towered up. However, drilling was not started at this location due to an increase in wind speeds at this time. It was determined that the wind was too strong to safely work (hard hats were being blown off), and all individuals subsequently left the site at 3:45 after being frisked for radiation.

Total depth drilled: 125 ft
Total depth cored: 35 ft
Total CA brass liner samples collected: 30

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Tue, 4/3/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No. 1		
Humidity	☒ Dry	☐ Moder.	☐ Humid			

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

Arrived to site at 7:10am, began warming up rig and had tailgate meeting. At 8am, began drilling P1-3. Encountered numerous boulders with voids in between, resulted in lots of grinding and wear on the augers. Around 10am, Victor Patel (AVM) arrived with the air sampler to attach to Sop to measure air quality in the drillers' working area. At this time, the drillers went to make a phone call to managers to discuss the need for upcoming maintenance on the augers due to damage resulting from abrasive material in the TS pile and current hole. Resumed drilling at 40' at 11:15, but after progressing 1 ft further we decided to stop drilling the hole due to continued grinding on rock. Sop explained Cascade's desire to stop work for this 10-day rotation one day early so they could return to the shop and perform maintenance on the augers. He said if we were to continue we would risk breaking augers beyond repair and possibly losing equipment down hole, which would result in high replacement costs at Stantec's expense. I then called my supervisor to discuss this option and we agreed to stop after today.

At 12:15, moved the rig to location P1-1 and began coring. After drilling to 20' depth, drillers attempted to lower the sampling rod but encountered a bend in the lowermost auger that prevented the sampling rod from reaching the bottom. Apparently, the auger had shifted off to the side after hitting a large boulder. Sop pulled all 4 augers from the hole and noted cracks and warped blades. It was decided we could not proceed without causing significant dame to additional augers. At 1:45pm, the drillers left the site to return to Cascade's Peoria workshop. I left the site at 2:45 after organizing samples and loading up buckets to take to testing lab in Albuquerque.

Total depth drilled: 60 ft
Total depth cored: 20 ft
Total CA brass liner samples collected: 12

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Mon, 4/9/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

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

Daily Field Report

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Tue, 4/10/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☒ 70-85	☐ 85-100	☐ >100
Wind	☒ Still	☐ Moder.	☐ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Bryan Nydoske	Cascade	Operations Manager	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

At 7:15am, I met the drilling crew off-site to wait for Bryan to meet us before proceeding to the rig to address yesterday's HSSE incident. At 8am, after arriving to location P1-2, Bryan led a safety meeting prior to approaching the borehole. We discussed the methods that would be employed to safely address the situation, including measuring gas levels and removing tooling from the hole. At this time, Bryan noted that he did not have a radiation dosimetry badge on his person and requested a variance from the health and safety plan, which stated the requirements for on-site personnel having said badges. I provided verbal affirmation that he could be on the site today, without a badge, to address the current safety situation. At 9am, after calibrating the gas meter with fresh air readings, Bryan approached the hole while the rest of us stayed back about 150'. He placed the tip of the gas meter just inside the top of the auger opening and measured 4.6 ppm hydrogen sulfide gas and 346 ppm carbon monoxide gas. We all then left the site and gathered at a location with cell phone service to discuss the findings with Cascade health and safety. I also called my supervisor and Stantec health and safety to discuss. It was decided that the drillers would return to Albuquerque with Bryan to prepare engineering controls that will be used to proceed with tooling removal from P1-2.

At 11am, Rob and Bryan left while the drillers and I returned to the rig to set up an exclusion zone around the borehole. We then let the site at 11:45am. Later in the day I had a conference call with Cascade to discuss methods for tooling removal. It was decided that drilling mud would be mixed and placed down-hole to reduce the chance of igniting gases. We will also record gas readings after removal of each 5' auger segment to ensure gas is not pulled up into the working area during removal.

Total depth drilled: 0 ft
Total depth cored: 0 ft
Total CA brass liner samples collected: 0

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Wed, 4/11/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☒ Bright Sun	☐ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☐ 50-70	☒ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel			
Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

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

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 H_2S and CO was detected at top of the hole (3ppm H_2S 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, H_2S 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 to native bedrock based on assessment of surrounding geology. After packing up rig and work area to move to next location, all parties left the site by 6:15pm.

Total depth drilled: 45 ft
Total depth cored: 45 ft
Total CA brass liner samples collected: 12

By: C. Fritz Title: Field Engineer

Daily Field Report

Date Thu, 4/12/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☐ 50-70	☒ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☐ Moder.	☒ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel			
Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

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

Safety:

No incidents reported

Activities Summary:

Arrived to site at 7:10am, began refueling rig after drillers arrived at 7:30. At 8am, the rig was moved from location P3-2 to P3-4, and drilling began at 8:30. Around 9:30, after drilling to 40’, black material similar to what was seen at P1-2 just prior to the explosion was noted in the auger cuttings. It was very black and appeared to have significant organics. Rob suggested that we stop and take a gas reading in the hole as a pre caution. After connecting a small hose to the gas meter and taking a reading about 4’ down the hole, H_2S and CO were measured at 22 ppm and 500 ppm, respectively. Also, the LEL reading was at 62% of the lower explosive limit for methane. We immediately stopped and moved away from the borehole. At 10am, we left the site to make phone calls to supervisors. Cascade health and safety told their drillers to use the same methods to pull out of the hole as previously employed at P1-2. My supervisor and I discussed the possibility of continuing in the same pile using drilling mud to suppress gas and explosion potential, however, the Cascade operations manager noted that mud could not be circulated using a hollow stem auger rig and that mud rotary may be a better option for this site. I told him that I could not make the final call of whether to bring in a different rig, and that he would have to speak with Stantec management about that possibility and its associated costs.

We then returned to the rig, where the gas meter was still reading from 4’ down the hole. The meter at that time read 32 ppm H_2S, 499 ppm CO, and 99% LEL. There also was a noticeable rotten-egg smell down wind of the hole. By this time, winds were picking up significantly and were stronger than Cascade’s 35 mph limit for safe drilling. Because of the wind and the elevated gas readings, we decided to stop work for the day and return tomorrow to pull tooling from the hole. All parties left site at 12:30pm.

Total depth drilled: 40 ft
Total depth cored: 0 ft
Total CA brass liner samples collected: 13

By: C. Fritz Title: Field Engineer

Daily Field Report

Stantec

Date Fri, 4/13/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☒ Snow	
Temp. °F	☐ <32	☒ 32-50	☐ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☐ Moder.	☒ High	Report No.		
Humidity	☐ Dry	☒ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Jesse Dillon	Cedar Creek	Ecologist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

Arrived on-site at 7:10am, had safety tailgate at 7:30 to discuss removal of tooling from P3-4 and possibility of stopping work again if more dangerous gas levels are encountered. At 7:45, drillers began taking readings with the gas meter. Did not detect H2S anywhere outside borehole, though levels up to 2 ppm were measured after extending the measurement tube as deep as 20’ down the hole. CO reached as high as 400 ppm, but LEL remained below 8%. Ectraction of tooling began at 8am with gas readings recorded after each 5’ increment, and backfilling of the hole with cuttings was completed at 9:15. The rig was moved to the next location (P3-3) at 9:40, however, the wind was too strong (>35 mph sustained) to continue with any drilling. All parties left site at 10:15am.

Total depth drilled: 0 ft
Total depth cored: 0 ft
Total CA brass liner samples collected: 0

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Sat, 4/14/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No. 1		
Humidity	☒ Dry	☐ Moder.	☐ Humid			

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Rob Murphy	Cedar Creek	Soil Scientist	
Jesse Dillon	Cedar Creek	Ecologist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

Arrived to site at 7am, had safety tailgate at 7:20 while rig was warming up. Drilling began at location P3-3 at 8am, and was completed upon measuring 2 ppm H_2S, 499 ppm CO, and 12% LEL in the hole after drilling to 40'. The rig was then moved to location P3-6 and drilling began at 9:45. At 55' depth, the auger cuttings became much blacker. Gas readings of 4 ppm H_2S, >500 ppm CO, and 15% LEL were recorded at the top of the hole. Work was then stopped for 30 mins to allow the hole to air out. Extraction of tooling then was completed from 11:30-12pm. At 12:30, the rig was moved to P3-5 and drilling began. The auger hit a boulder at the surface, so the rig was moved over several feet and drilling began again at 1pm after fixing the drill bit. Black material with elevated gas readings was encountered at only 15', thus ending drilling at this location.

The rig was then moved back to pile 2 to attempt shallow borings, with the intent to collect samples before hitting the problematic black, organic material at greater depths. Elevated gas levels were measured after drilling 30', we took a break to air out the hole before extracting tooling. At 5:30, extraction was completed, the hole was backfilled, and all parties left the site.

Total depth drilled: 140 ft
Total depth cored: 0 ft
Total CA brass liner samples collected: 48

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Sun, 4/15/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☐ 50-70	☒ 70-85	☐ 85-100	☐ >100
Wind	☒ Still	☐ Moder.	☐ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Jesse Dillon	Cedar Creek	Ecologist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

Arrived on-site at 7am, had safety tailgate at the rig at 7:30. Drilling began at location P2-2 at 8am and continued until encountering elevated gas levels at 20’ depth. Drilling did not continue past this depth, tooling was extracted and the hole backfilled, and we began the move to pile 4 at 9:30. Because of the difficult access to several of the pile 4 holes, Jesse and I had to scout a route that the rig could navigate. Drilling and coring then began at location P4-7 at 10:45am. An hour later, elevated H2S and LEL were measured after coring to 30’ depth. Work was then stopped for about 30 mins to let the hole air out. Tooling was then extracted and the rig was moved to location P4-9 at 12:45. After drilling to 40’ depth at P4-9, the drillers experienced a sudden puff of gas from the hole and work was stopped. Elevated gas levels were measured at the top of the borehole. After waiting for the hole to air out, tooling was pulled and the rig was moved to location P4-8. Drilling began at 3:40pm. Shortly thereafter, elevated gas levels were recorded at 20’ depth. At 4:30, all parties left the site to allow the hole to air out overnight before extracting tooling.

Total depth drilled: 110 ft
Total depth cored: 30 ft
Total CA brass liner samples collected: 23

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Mon, 4/16/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☐ Sunny	☒ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☐ 50-70	☒ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☒ Moder.	☐ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Jesse Dillon	Cedar Creek	Ecologist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

Safety:

No incidents reported

Activities Summary:

Arrived on-site at 7:15am and unloaded samples at staging area near entrance. Had safety meeting at 7:45 while rig was warming up. At 8:15, drillers began pulling augers from P4-8. We then moved to P4-6 and soon encountered elevated gas levels at 10’ depth. The augers were immediately pulled out in one segment and the hole was backfilled. Cuttings had started to turn dark gray/black at about 7’ depth. Some bubbling was observed in the water poured over the top of the backfilled hole. The rig was then moved at 9:30 to P4-5 and drilling began at 9:45. Gas was encountered at 20’ depth, augers were extracted, and the hole was backfilled. At 11:30 the rig was moved to P4-3 and drilling began. Gas was encountered at 15’ depth, took 30 min break to air out hole. At 12:45, augers were pulled and the hole was backfilled. At 1:15, after moving to P4-4 location, Joey was not feeling well and was acting slightly lethargic. Excessive exposure to CO was suspected since Joey had been measuring gas levels with his face near the top of the borehole. Sop and Anthony also did not feel right and noted they were much more tired and had less energy than they normally should, even given the warm temperatures and amount of work performed to that point. Because of this, we decided to stop work and left the site at 1:30. All drillers later said they felt much better shortly after leaving the work area.

Total depth drilled: 45 ft
Total depth cored: 0 ft
Total CA brass liner samples collected: 11

By: C. Fritz Title: Field Engineer

Daily Field Report

Date Tue, 4/17/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☐ 50-70	☒ 70-85	☐ 85-100	☐ >100
Wind	☐ Still	☐ Moder.	☒ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Jesse Dillon	Cedar Creek	Ecologist	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

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 to determine if additional drilling may be warranted to investigate the area. Jesse then left at 10am, and I returned to where Stantec and AVM personnel were staged to wait for two individuals to return from conducting separate sampling in the arroyo. At 10:45, all individuals besides myself left the site after being frisked for radiological contaminants. I then left at 11:15 after doing inventory of samples in the staging area in preparation for delivering samples to the testing lab in Albuquerque.

Total depth drilled: 0 ft
Total depth cored: 0 ft
Total CA brass liner samples collected: 0

By: C. Fritz Title: Field Engineer

Stantec

Daily Field Report

Date Wed, 4/18/2018

PROJECT: St. Anthony Mine

JOB NO: 233001076

CLIENT: United Nuclear Corporation

CONTRACTOR: Cascade Drilling

PROJECT MANAGER: Melanie Davis

Weather	☐ Bright Sun	☒ Sunny	☐ Over-cast	☐ Rain	☐ Snow	
Temp. °F	☐ <32	☐ 32-50	☒ 50-70	☐ 70-85	☐ 85-100	☐ >100
Wind	☒ Still	☐ Moder.	☐ High	Report No.		
Humidity	☒ Dry	☐ Moder.	☐ Humid	1		

Onsite Personnel

Name	Company	Position	Remarks
Cameron Fritz	Stantec	Field Engineer	
Sopotyn Lorn	Cascade	Driller	
Anthony Martinez	Cascade	Helper	
Joey Vigueria	Cascade	Helper	

Equipment

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

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.

Stantec

Daily Field Report

Total depth drilled: 105 ft
Total depth cored: 35 ft
Total CA brass liner samples collected: 26

By: C. Fritz　　Title: Field Engineer

Attachment E. Laboratory Results

Table E-1. Laboratory Results – Initial Properties

Sample ID	Gravimetric Moisture Content (%, g/g)	Volumetric Moisture Content (%, ft^3/ft^3)	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

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_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	
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_{50} = Median particle diameter

(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

--- = Soil requires visual-manual classification due to non-plasticity

Table E-4. Laboratory Results – Proctor Compaction

	Measured		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

--- = 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	0	35
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		
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	129.6	35.8
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		
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		
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	0	32.3
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		
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		

*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

Joleen Hines
Laboratory Manager

Enclosure

Daniel B. Stephens & Associates, Inc.
Soil Testing & Research Laboratory
4400 Alameda Blvd. NE, Suite C
Albuquerque, NM 87113
505-889-7752
FAX 505-889-0258

Summaries

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		CU[6]	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
SA-GM 1B																X						
SA-GM 1T																X						
SA-GM 2B																X						
SA-GM 2T																X						
SA-GM 3B																X						
SA-GM 3T																X						
SA-GM 4B																X						
SA-GM 5B																X						
SA-GM 5T																X						
SA-GM 6B																X						
SA-GM 6T																X						
SA-GM 7B																X						
SA-GM 8B																X						
SA-GM 8T																X						
L1 Auger Cuttings (1 & 2)																						X

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

[3] 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

[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

[6] CU = Consolidated Undrained Triaxial

Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		CU[6]	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
L2 Auger Cuttings (1 & 2)																						X
T/O Auger Cuttings (1 & 2) (T/O-1 & T/O-3,4)																						X
Topsoil North Cuttings (1 & 2)																						X
Borrow South Cuttings (1 & 2)																						X
Topsoil South Cuttings (1 & 2) (TS-2 & TS-3,4)																						X
Borrow West Auger Cuttings (1 & 2)																						X
P1-2 Auger Cuttings																						X
P3 Auger Cuttings (1 & 2)																						X
P4 Auger Cuttings (1 & 2)																						X
L1-1 (10'A)	X	X														X	X					
L1-2 (20'A)																					X	
L1-2 (20'B)	X	X														X	X					
L1-3 (5'A)	X	X														X	X					
L1-3 (5'B)																						
L1-4 (5'B)	X	X																				

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[6] CU = Consolidated Undrained Triaxial

Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		CU[6]	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
L1-5 (8' Bag)																						
L1-5 (20'B)																X	X					
L2-1 (5'A)																X	X					
L2-1 (5'B)	X	X																				
L2-1 (15'A)	X	X														X	X			X		
L2-2 (5'A)																X	X					
L2-2 (5'B)																					X	
L2-3 (5'A)	X	X														X	X					
L2-3 (5'B)																						
L2-4 (10'B)																X	X					
L2-5 (5'A)																X	X					
L2-5 (5'B)	X	X																		X		
L2-6 (5'A)																X	X				X	
L2-6 (10'B)	X	X																		X		
L2-7 (10'A)																X	X					

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Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		CU[6]	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
T/O-1 (20'A)	X	X														X	X					
T/O-1 (25'A)																					X	
T/O-1 (45'B)	X	X														X	X					
T/O-2 (5'A)																X	X					
T/O-2 (10'A)																					X	
T/O-2 (15'A)	X	X																				
T/O-3 (15'B)	X	X																				
T/O-3 (40'A)																X	X					
T/O-3 (40'B)	X	X																				
T/O-3 (60'A)																					X	
T/O-3 (70'B)																X	X					
T/O-4 (5'A)	X	X																				
T/O-4 (20'B)																X	X					
T/O-5 (10'B)																X	X					
T/O-5 (20'A)	X	X																				

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Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		CU[6]	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
T/O-6 (5'A)	X	X														X	X					
TN-1 (5'A)																X	X					
TN-2 (20'A)	X	X														X	X					
TN-2 (20'B)																						
BS-1 (10'A)	X	X														X	X					
BS-1 (10'B)																						
BS-2 (15'A)																X	X					
BS-6 (20'A)	X	X														X	X					
BS-6 (20'B)																						
TS-1 (5'A)	X	X																				
TS-1 (20'A)																X	X					
TS-2 (10'A)																X	X					
TS-2 (15'A)	X	X																				
TS-3 (10'A)	X	X														X	X					
TS-3 (10'B)																						

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Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		CU[6]	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
TS-4 (5'A)																X	X					
TS-4 (10'A)	X	X																				
P1-1 (5'A)																X	X					
P1-1 (10'A)																					X	
P1-1 (15'B)	X	X																				
P1-1A (30'A)	X	X																				
P1-2 (15'A)																					X	
P1-2 (30'B)																X	X					
P1-2 (50'A)	X	X																				
P2-1 (5'A)	X	X																				
P2-1 (25'A)																X	X					
P2-1 (25'B)	X	X																				
P2-2 (5'A)																					X	
P2-2 (5'B)																X	X					
P3-1 (5'A)	X	X														X						

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Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		CU[6]	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
P3-1 (5'B)																						
P3-1 (15'A)	X	X																			X	
P3-2 (10'A)	X	X																				
P3-2 (15'B)																X						
P3-2 (20'A)	X	X																				
P3-2 (35'B)																X						
P3-3 (5'A)																X						
P3-3 (20'A)	X	X																				
P3-3 (40'A)	X	X																			X	
P3-3 (40'B)																X						
P3-4 (10'A)	X	X																				
P3-4 (20'A)																X						
P3-4 (30'A)	X	X														X						
P3-4 (40'A)	X	X														X	X					
P3-4 (40'B)																					X	

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Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		CU[6]	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
P3-5 (10'A)	X	X														X	X					
P3-5 (10'B)																					X	
P3-6 (5'A)	X	X																				
P3-6 (20'A)	X	X														X						
P3-6 (50'A)	X	X														X						
P4-3 (10'B)																					X	
P4-5 (20'A)	X	X														X						
P4-6 (10'A)	X	X														X	X					
P4-6 (10'B)																						
P4-7 (5'A)	X	X														X						
P4-7 (5'B)																						
P4-7 (25'B)	X	X														X	X					
P4-8 (15'A)																					X	
P4-8 (15'B)	X	X														X	X					
P4-9 (5'A)	X	X																				

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5 F = Fine (<4.75mm), C = Coarse (>4.75mm)
6 CU = Consolidated Undrained Triaxial

Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		CU[6]	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
P4-9 (35'B)	X	X														X	X					
BW-1 (20'A)																X	X					
BW-1 (30'A)	X	X																				
BW-2 (10'A)	X	X														X	X					
BW-2 (10'B)																						
BW-3 (5'A)	X	X														X	X					
BW-4 (20'A)																						
BW-4 (20'B)																						

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[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer
[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)
[6] 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.

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received: Gravimetric (%, g/g)	Moisture Content: As Received: Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded: Gravimetric (%, g/g)	Moisture Content: Remolded: Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated 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

NA = Not analyzed
--- = This sample was not remolded

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity (Continued)

	Moisture Content						
	As Received		Remolded		Dry Bulk	Wet Bulk	Calculated
	Gravimetric	Volumetric	Gravimetric	Volumetric	Density	Density	Porosity
Sample Number	(%, g/g)	(%, cm^3/cm^3)	(%, g/g)	(%, cm^3/cm^3)	(g/cm^3)	(g/cm^3)	(%)
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

NA = Not analyzed
--- = This sample was not remolded

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity (Continued)

Sample Number	Moisture Content: As Received: Gravimetric (%, g/g)	Moisture Content: As Received: Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded: Gravimetric (%, g/g)	Moisture Content: Remolded: Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated 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

NA = Not analyzed

--- = This sample was not remolded

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity (Continued)

Sample Number	Moisture Content: As Received: Gravimetric (%, g/g)	Moisture Content: As Received: Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded: Gravimetric (%, g/g)	Moisture Content: Remolded: Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated 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

NA = Not analyzed
--- = This sample was not remolded

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity (Continued)

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

NA = Not analyzed
--- = This sample was not remolded

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(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 †	(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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(Est)

d_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

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Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(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 †	(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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(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 †	(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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

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	

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.
**Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.

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

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.
**Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.

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		**

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.
**Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.

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	

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

--- = Soil requires visual-manual classification due to non-plasticity

Summary of Proctor Compaction Tests

Sample Number	Measured Optimum Moisture Content (% g/g)	Measured Maximum Dry Bulk Density (g/cm^3)	Oversize Corrected Optimum Moisture Content (% g/g)	Oversize Corrected Maximum Dry Bulk Density (g/cm^3)
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

--- = 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

*Noted percent strain used as failure criterion.

Summary of Consolidated Undrained Estimated Effective Friction Angle and Cohesion

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

[1]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

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received Gravimetric (%, g/g)	Moisture Content: As Received Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded Gravimetric (%, g/g)	Moisture Content: Remolded Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated 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

NA = Not analyzed
--- = This sample was not remolded

Summary of Initial Moisture Content, Dry Bulk Density
Wet Bulk Density and Calculated Porosity (Continued)

Sample Number	Moisture Content: As Received Gravimetric (%, g/g)	Moisture Content: As Received Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded Gravimetric (%, g/g)	Moisture Content: Remolded Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated 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

NA = Not analyzed
--- = This sample was not remolded

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity (Continued)

Sample Number	Moisture Content: As Received: Gravimetric (%, g/g)	Moisture Content: As Received: Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded: Gravimetric (%, g/g)	Moisture Content: Remolded: Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated 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

NA = Not analyzed
--- = This sample was not remolded

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity (Continued)

Sample Number	Moisture Content: As Received: Gravimetric (%, g/g)	Moisture Content: As Received: Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded: Gravimetric (%, g/g)	Moisture Content: Remolded: Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated 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

NA = Not analyzed

--- = This sample was not remolded

Summary of Initial Moisture Content, Dry Bulk Density
Wet Bulk Density and Calculated Porosity (Continued)

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

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:	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):	584.09	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	294.41	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	272.52	
Sample volume (cm^3):	196.40	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	6.3	
Volumetric Moisture Content (% vol):	8.7	
Dry bulk density (g/cm^3):	1.39	
Wet bulk density (g/cm^3):	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
--- = 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:	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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	271.60	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	491.56	
Sample volume (cm^3):	280.53	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	10.2	
Volumetric Moisture Content (% vol):	17.8	
Dry bulk density (g/cm^3):	1.75	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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^3):	289.93	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	4.2	
Volumetric Moisture Content (% vol):	6.3	
Dry bulk density (g/cm^3):	1.50	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	720.27	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	295.01	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	395.59	
Sample volume (cm^3):	279.95	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	7.5	
Volumetric Moisture Content (% vol):	10.6	
Dry bulk density (g/cm^3):	1.41	
Wet bulk density (g/cm^3):	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
--- = 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: 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):	43.78	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	6.50	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	35.80	
Sample volume (cm^3):	21.20	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	4.1	
Volumetric Moisture Content (% vol):	7.0	
Dry bulk density (g/cm^3):	1.69	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	785.37	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	298.50	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	469.13	
Sample volume (cm^3):	291.47	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	3.8	
Volumetric Moisture Content (% vol):	6.1	
Dry bulk density (g/cm^3):	1.61	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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	
Dry weight of sample (g):	451.54	
Sample volume (cm^3):	264.39	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	11.4	
Volumetric Moisture Content (% vol):	19.5	
Dry bulk density (g/cm^3):	1.71	
Wet bulk density (g/cm^3):	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
--- = 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:	T/O-1 (45'B)
Project Name:	St. Anthony Geotech Investigation
PO Number:	233001076-DBS

	As Received	Remolded
Test Date:	10-May-18	---
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 (cm^3):	291.25	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	7.2	
Volumetric Moisture Content (% vol):	10.9	
Dry bulk density (g/cm^3):	1.51	
Wet bulk density (g/cm^3):	1.62	
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
--- = 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:	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):	720.49	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	210.97	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	457.59	
Sample volume (cm^3):	281.26	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	11.3	
Volumetric Moisture Content (% vol):	18.5	
Dry bulk density (g/cm^3):	1.63	
Wet bulk density (g/cm^3):	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
--- = 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: 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):	772.95	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	268.52	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	459.12	
Sample volume (cm^3):	245.75	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	9.9	
Volumetric Moisture Content (% vol):	18.4	
Dry bulk density (g/cm^3):	1.87	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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):	781.23	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	288.04	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	461.86	
Sample volume (cm^3):	286.89	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	6.8	
Volumetric Moisture Content (% vol):	10.9	
Dry bulk density (g/cm^3):	1.61	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	291.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	534.78	
Sample volume (cm^3):	288.20	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	8.9	
Volumetric Moisture Content (% vol):	16.4	
Dry bulk density (g/cm^3):	1.86	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	733.13	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	288.33	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	418.58	
Sample volume (cm^3):	277.52	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	6.3	
Volumetric Moisture Content (% vol):	9.4	
Dry bulk density (g/cm^3):	1.51	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	826.85	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	284.35	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	507.52	
Sample volume (cm^3):	290.82	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	6.9	
Volumetric Moisture Content (% vol):	12.0	
Dry bulk density (g/cm^3):	1.75	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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):	577.54	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	284.28	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	276.75	
Sample volume (cm^3):	212.09	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	6.0	
Volumetric Moisture Content (% vol):	7.8	
Dry bulk density (g/cm^3):	1.30	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	730.69	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	268.40	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	426.30	
Sample volume (cm^3):	291.88	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	8.4	
Volumetric Moisture Content (% vol):	12.3	
Dry bulk density (g/cm^3):	1.46	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	263.67	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	371.11	
Sample volume (cm^3):	273.57	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	7.0	
Volumetric Moisture Content (% vol):	9.5	
Dry bulk density (g/cm^3):	1.36	
Wet bulk density (g/cm^3):	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
--- = 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:	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 (cm^3):	287.39	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	7.8	
Volumetric Moisture Content (% vol):	14.4	
Dry bulk density (g/cm^3):	1.83	
Wet bulk density (g/cm^3):	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
--- = 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:	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 (cm^3):	285.11	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	8.9	
Volumetric Moisture Content (% vol):	14.3	
Dry bulk density (g/cm^3):	1.60	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	790.32	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	292.26	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	470.01	
Sample volume (cm^3):	292.17	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	6.0	
Volumetric Moisture Content (% vol):	9.6	
Dry bulk density (g/cm^3):	1.61	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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):	794.64	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	284.24	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	477.08	
Sample volume (cm^3):	241.45	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	7.0	
Volumetric Moisture Content (% vol):	13.8	
Dry bulk density (g/cm^3):	1.98	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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	
Dry weight of sample (g):	353.60	
Sample volume (cm^3):	262.30	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	10.0	
Volumetric Moisture Content (% vol):	13.4	
Dry bulk density (g/cm^3):	1.35	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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):	553.07	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	269.55	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	272.79	
Sample volume (cm^3):	222.18	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	3.9	
Volumetric Moisture Content (% vol):	4.8	
Dry bulk density (g/cm^3):	1.23	
Wet bulk density (g/cm^3):	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
--- = 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:	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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	282.24	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	437.31	
Sample volume (cm^3):	273.85	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	4.3	
Volumetric Moisture Content (% vol):	6.9	
Dry bulk density (g/cm^3):	1.60	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	862.56	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	269.31	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	523.86	
Sample volume (cm^3):	282.39	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	13.2	
Volumetric Moisture Content (% vol):	24.6	
Dry bulk density (g/cm^3):	1.86	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	739.39	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	209.29	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	459.48	
Sample volume (cm^3):	275.50	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	15.4	
Volumetric Moisture Content (% vol):	25.6	
Dry bulk density (g/cm^3):	1.67	
Wet bulk density (g/cm^3):	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
--- = 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:	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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	208.68	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	541.45	
Sample volume (cm^3):	290.47	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	7.3	
Volumetric Moisture Content (% vol):	13.6	
Dry bulk density (g/cm^3):	1.86	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	555.60	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	258.76	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	271.23	
Sample volume (cm^3):	290.68	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	9.4	
Volumetric Moisture Content (% vol):	8.8	
Dry bulk density (g/cm^3):	0.93	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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):	792.24	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	298.95	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	462.96	
Sample volume (cm^3):	273.96	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	6.6	
Volumetric Moisture Content (% vol):	11.1	
Dry bulk density (g/cm^3):	1.69	
Wet bulk density (g/cm^3):	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
--- = 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:	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	
Dry weight of sample (g):	457.43	
Sample volume (cm^3):	274.45	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	11.3	
Volumetric Moisture Content (% vol):	18.8	
Dry bulk density (g/cm^3):	1.67	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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):	703.70	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	208.56	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	457.99	
Sample volume (cm^3):	270.93	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	8.1	
Volumetric Moisture Content (% vol):	13.7	
Dry bulk density (g/cm^3):	1.69	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	213.53	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	523.50	
Sample volume (cm^3):	291.74	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	14.7	
Volumetric Moisture Content (% vol):	26.3	
Dry bulk density (g/cm^3):	1.79	
Wet bulk density (g/cm^3):	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
--- = 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:	P3-4 (10'A)
Project Name:	St. Anthony Geotech Investigation
PO Number:	233001076-DBS

	As Received	Remolded
Test Date:	15-May-18	---
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 (cm^3):	292.80	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	9.3	
Volumetric Moisture Content (% vol):	14.4	
Dry bulk density (g/cm^3):	1.54	
Wet bulk density (g/cm^3):	1.69	
Calculated Porosity (% vol):	41.8	
Percent Saturation:	34.3	

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

Daniel B. Stephens & Associates, Inc.

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

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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	293.36	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	437.63	
Sample volume (cm^3):	286.94	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	6.0	
Volumetric Moisture Content (% vol):	9.1	
Dry bulk density (g/cm^3):	1.53	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	798.70	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	213.76	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	546.30	
Sample volume (cm^3):	291.43	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	7.1	
Volumetric Moisture Content (% vol):	13.3	
Dry bulk density (g/cm^3):	1.87	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	867.36	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	292.86	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	530.27	
Sample volume (cm^3):	285.93	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	8.3	
Volumetric Moisture Content (% vol):	15.5	
Dry bulk density (g/cm^3):	1.85	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	263.20	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	378.94	
Sample volume (cm^3):	232.31	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	4.8	
Volumetric Moisture Content (% vol):	7.8	
Dry bulk density (g/cm^3):	1.63	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	764.00	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	212.68	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	504.36	
Sample volume (cm^3):	291.86	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	9.3	
Volumetric Moisture Content (% vol):	16.1	
Dry bulk density (g/cm^3):	1.73	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	758.56	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	210.96	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	516.43	
Sample volume (cm^3):	291.09	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	6.0	
Volumetric Moisture Content (% vol):	10.7	
Dry bulk density (g/cm^3):	1.77	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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):	710.57	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	210.11	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	466.53	
Sample volume (cm^3):	268.31	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	7.3	
Volumetric Moisture Content (% vol):	12.6	
Dry bulk density (g/cm^3):	1.74	
Wet bulk density (g/cm^3):	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
--- = 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:	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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	286.81	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	462.06	
Sample volume (cm^3):	291.36	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	10.0	
Volumetric Moisture Content (% vol):	15.9	
Dry bulk density (g/cm^3):	1.59	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	638.50	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	207.42	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	392.69	
Sample volume (cm^3):	263.40	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	9.8	
Volumetric Moisture Content (% vol):	14.6	
Dry bulk density (g/cm^3):	1.49	
Wet bulk density (g/cm^3):	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
--- = 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:	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	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	288.58	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	512.00	
Sample volume (cm^3):	290.35	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	6.2	
Volumetric Moisture Content (% vol):	11.0	
Dry bulk density (g/cm^3):	1.76	
Wet bulk density (g/cm^3):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

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):	803.98	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	297.95	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	447.92	
Sample volume (cm^3):	276.60	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	13.0	
Volumetric Moisture Content (% vol):	21.0	
Dry bulk density (g/cm^3):	1.62	
Wet bulk density (g/cm^3):	1.83	
Calculated Porosity (% vol):	38.9	
Percent Saturation:	54.0	

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:	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):	792.93	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	267.28	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	503.41	
Sample volume (cm^3):	269.21	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	4.4	
Volumetric Moisture Content (% vol):	8.3	
Dry bulk density (g/cm^3):	1.87	
Wet bulk density (g/cm^3):	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
--- = 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:	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):	820.17	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	284.68	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	471.98	
Sample volume (cm^3):	284.05	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	13.5	
Volumetric Moisture Content (% vol):	22.4	
Dry bulk density (g/cm^3):	1.66	
Wet bulk density (g/cm^3):	1.89	
Calculated Porosity (% vol):	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
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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-1 (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):	714.17	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	284.25	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	393.38	
Sample volume (cm^3):	281.54	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	9.3	
Volumetric Moisture Content (% vol):	13.0	
Dry bulk density (g/cm^3):	1.40	
Wet bulk density (g/cm^3):	1.53	
Calculated Porosity (% vol):	47.3	
Percent Saturation:	27.5	

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

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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):	751.25	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	283.91	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	441.31	
Sample volume (cm^3):	290.92	
Assumed particle density (g/cm^3):	2.65	

Gravimetric Moisture Content (% g/g):	5.9	
Volumetric Moisture Content (% vol):	8.9	
Dry bulk density (g/cm^3):	1.52	
Wet bulk density (g/cm^3):	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):	756.43	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	268.23	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	470.38	
Sample volume (cm^3):	290.70	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	3.8	
Volumetric Moisture Content (% vol):	6.1	
Dry bulk density (g/cm^3):	1.62	
Wet bulk density (g/cm^3):	1.68	
Calculated Porosity (% vol):	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_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(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 †	(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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(Est)

d_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(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 †	(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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (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 †	(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 †	(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_{50} = Median particle diameter

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

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

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

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Percent Gravel, Sand, Silt and Clay*

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

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.
**Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.

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

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.
**Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.

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	**

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.
**Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.

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	

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.
**Fractions of silt and clay were not determined by hydrometer analysis; percentages of silt and clay represent fraction finer than 0.075mm.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: SA-GM 1B
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 23-May-18

Initial Dry Weight of Sample (g): 402.69
Weight Passing #10 (g): 402.69
Weight Retained #10 (g): 0.00
Wt. of -10 Sieve Sample (g): 83.95
Calculated Weight of Sieve Sample (g): 83.95

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 calculated 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	

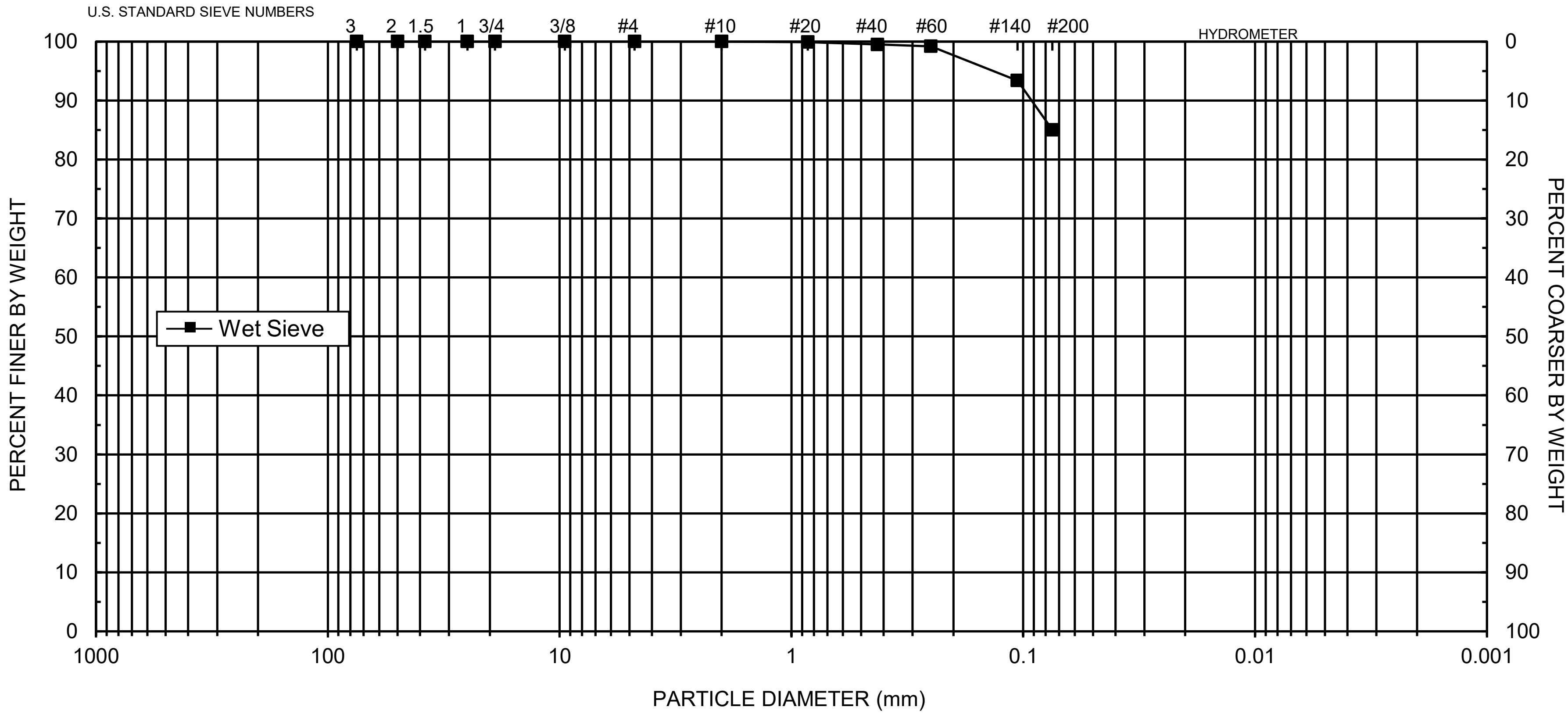
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): NA
d_{60} (mm): NA
d_{84} (mm): NA

Median Particle Diameter --d_{50} (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY					
		Coarse	Fine	Coarse	Medium	Fine						
USDA	COBBLES	GRAVEL	SAND					SILT	CLAY			
			Very coarse	Coarse	Medium	Fine	Very fine					

d_{10} = **NA**	d_{30} = **NA**	d_{50} = **NA**	d_{60} = **NA**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 1B	**233001076-DBS**	**NA**	**NA**

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

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: SA-GM 1T
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 23-May-18

Initial Dry Weight of Sample (g): 394.50
Weight Passing #10 (g): 393.94
Weight Retained #10 (g): 0.56
Wt. of -10 Sieve Sample (g): 55.40
Calculated Weight of Sieve Sample (g): 55.48

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 calculated 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	

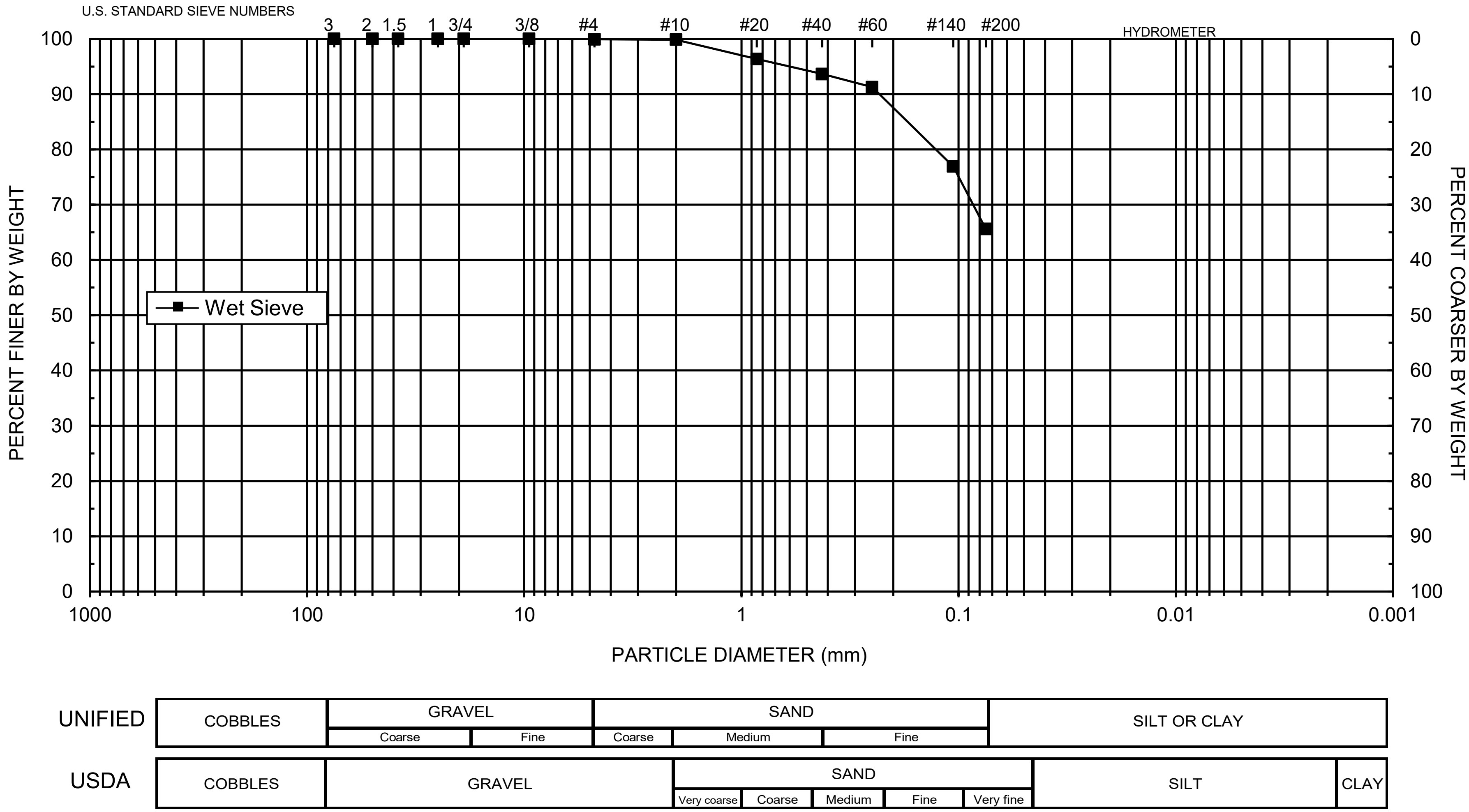
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): NA
d_{60} (mm): NA
d_{84} (mm): 0.16

Median Particle Diameter --d_{50} (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **NA**	d_{60} = **NA**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 1T	**233001076-DBS**	**NA**	**NA**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: SA-GM 2B
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 25-May-18

Initial Dry Weight of Sample (g): 632.00
Weight Passing #10 (g): 632.00
Weight Retained #10 (g): 0.00
Wt. of -10 Sieve Sample (g): 53.48
Calculated Weight of Sieve Sample (g): 53.48

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 calculated 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	

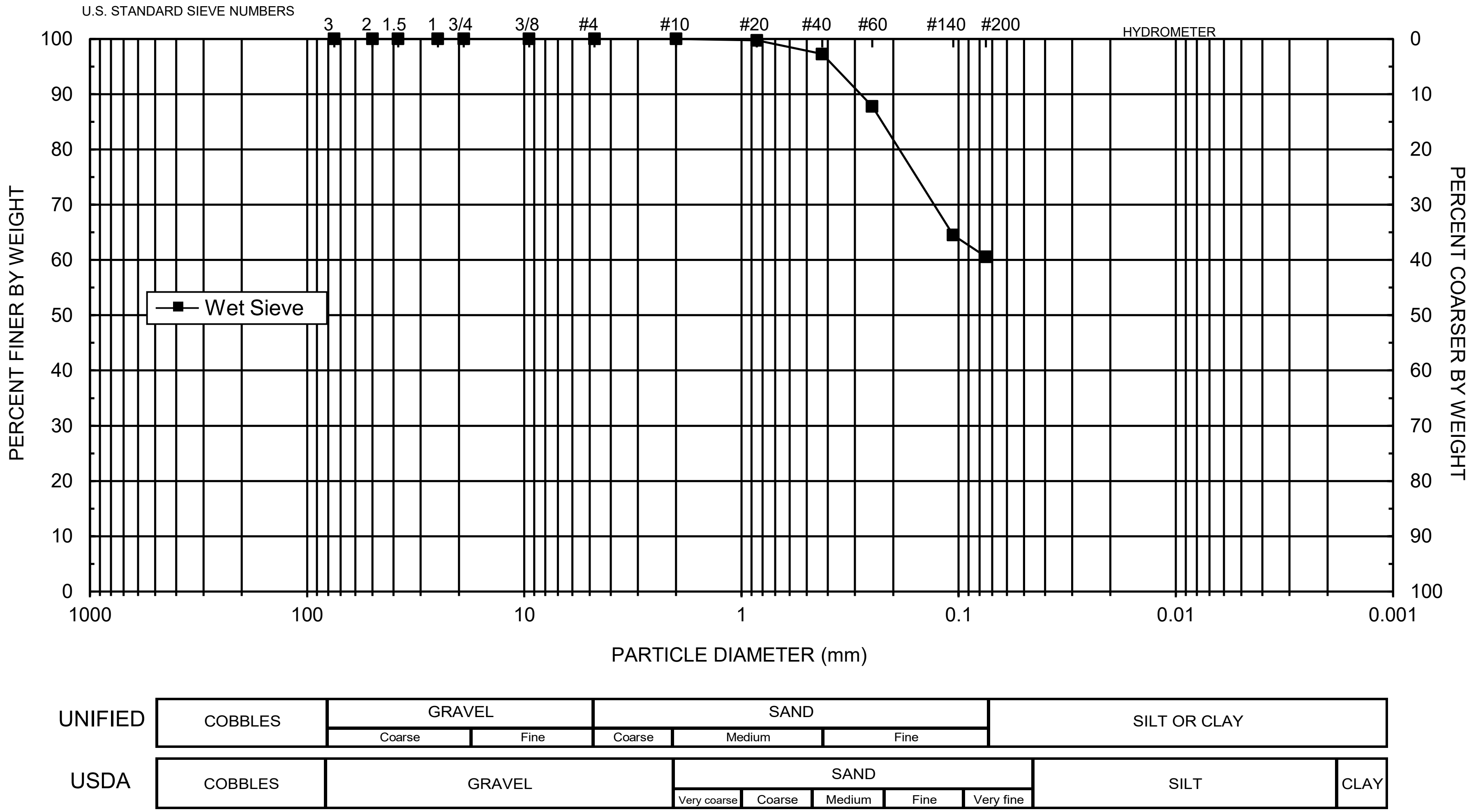
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): NA
d_{60} (mm): 0.071
d_{84} (mm): 0.22

Median Particle Diameter --d_{50} (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **NA**	d_{60} = **0.071**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 2B	**233001076-DBS**	**NA**	**NA**

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):*	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 calculated 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	

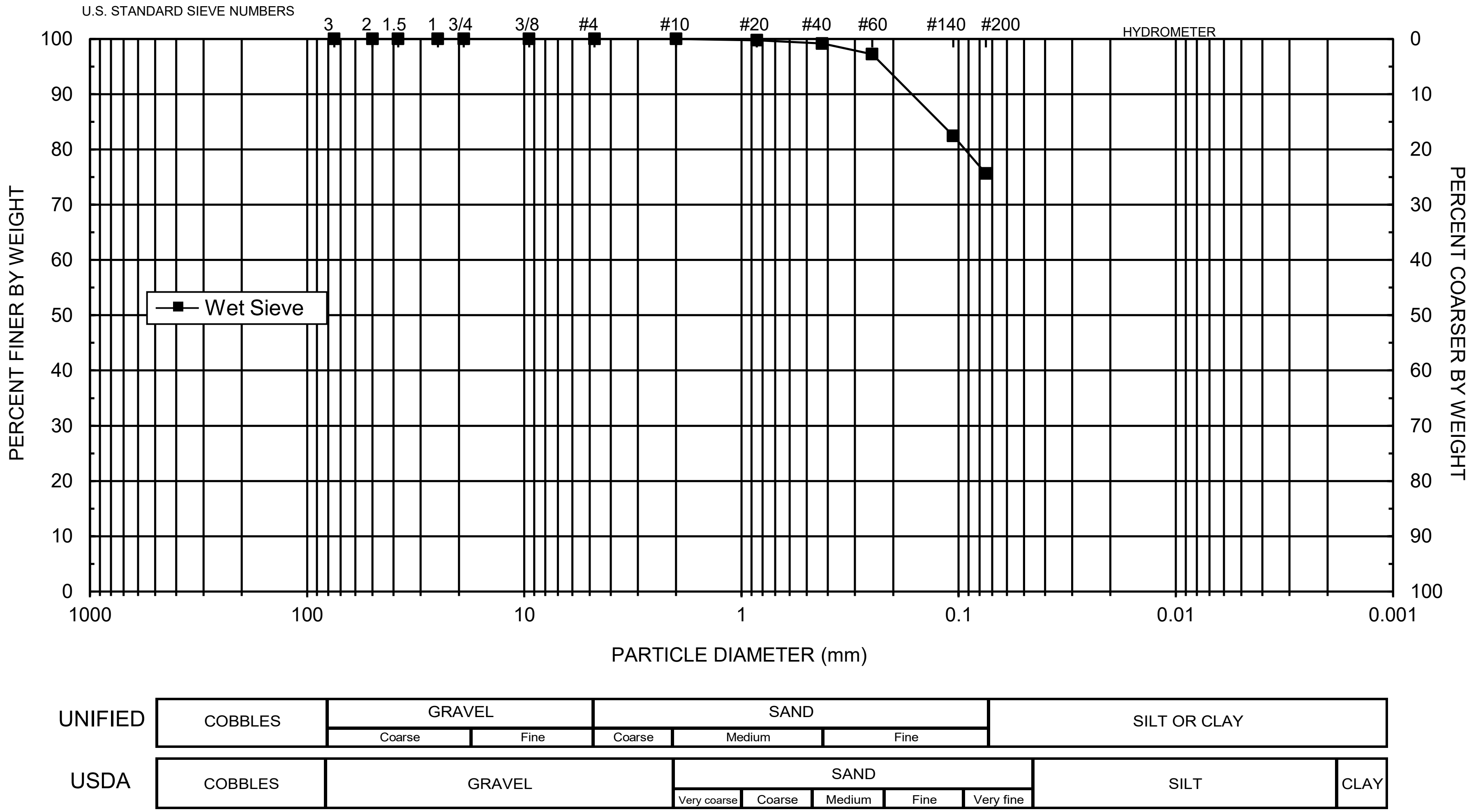
d_{10} (mm):	NA	d_{50} (mm):	NA
d_{16} (mm):	NA	d_{60} (mm):	NA
d_{30} (mm):	NA	d_{84} (mm):	0.12

Median Particle Diameter --d_{50} (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **NA**	d_{60} = **NA**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 2T	**233001076-DBS**	**NA**	**NA**

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
Job Number: DB18.1151.00
Sample Number: SA-GM 3B
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 23-May-18

Initial Dry Weight of Sample (g): 509.48
Weight Passing #10 (g): 509.48
Weight Retained #10 (g): 0.00
Wt. of -10 Sieve Sample (g): 90.13
Calculated Weight of Sieve Sample (g): 90.13

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	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 calculated 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	

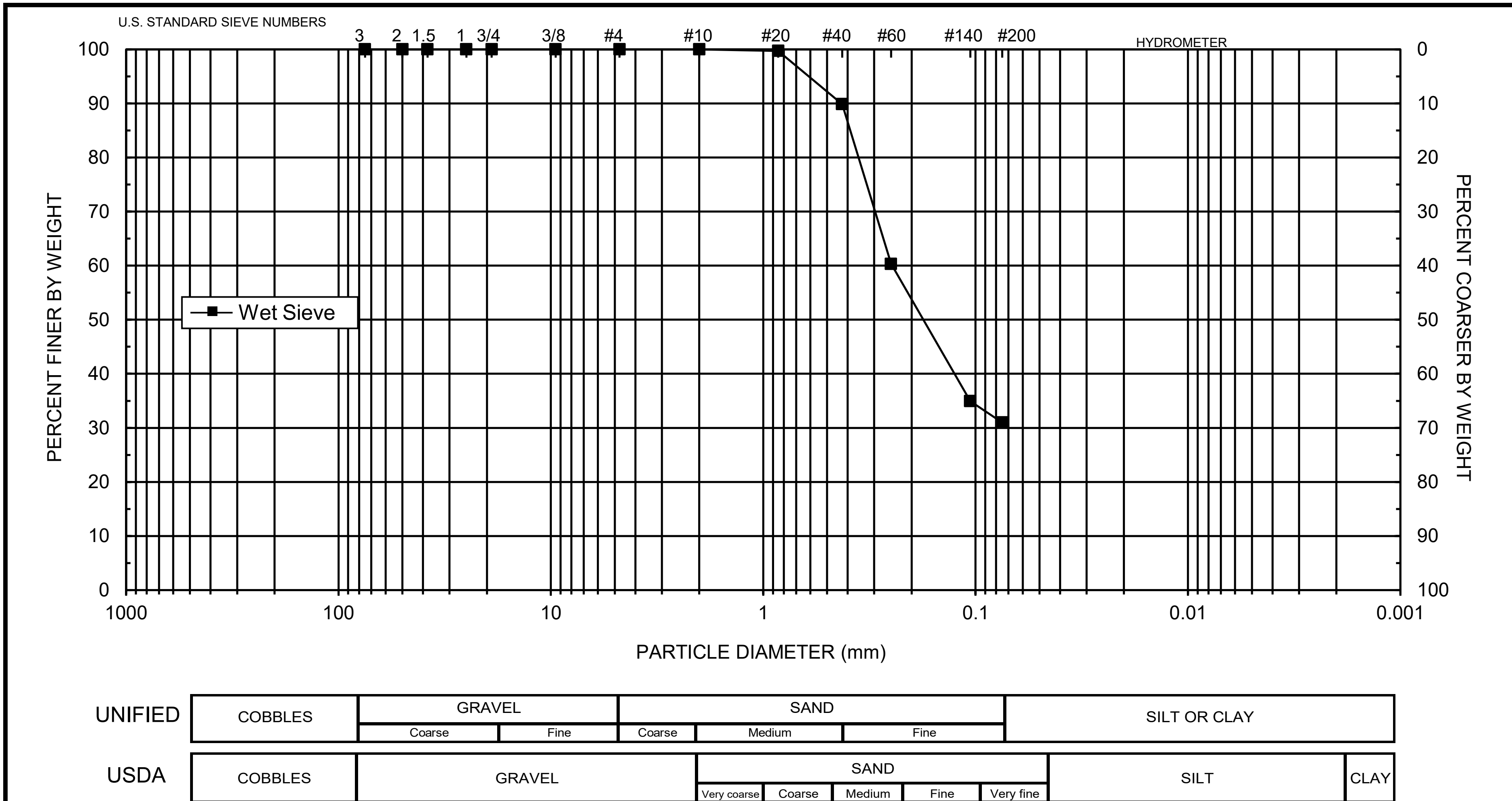
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): 0.18
d_{60} (mm): 0.25
d_{84} (mm): 0.38

Median Particle Diameter --d_{50} (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 --[$(d_{16}+d_{50}+d_{84})/3$] (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **0.18**	d_{60} = **0.25**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 3B	**233001076-DBS**	**NA**	**NA**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: SA-GM 3T
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 23-May-18

Initial Dry Weight of Sample (g): 787.33
Weight Passing #10 (g): 628.52
Weight Retained #10 (g): 158.81
Wt. of -10 Sieve Sample (g): 61.15
Calculated Weight of Sieve Sample (g): 76.60

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	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 calculated 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	

d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): 0.18
d_{60} (mm): 0.37
d_{84} (mm): 4.1

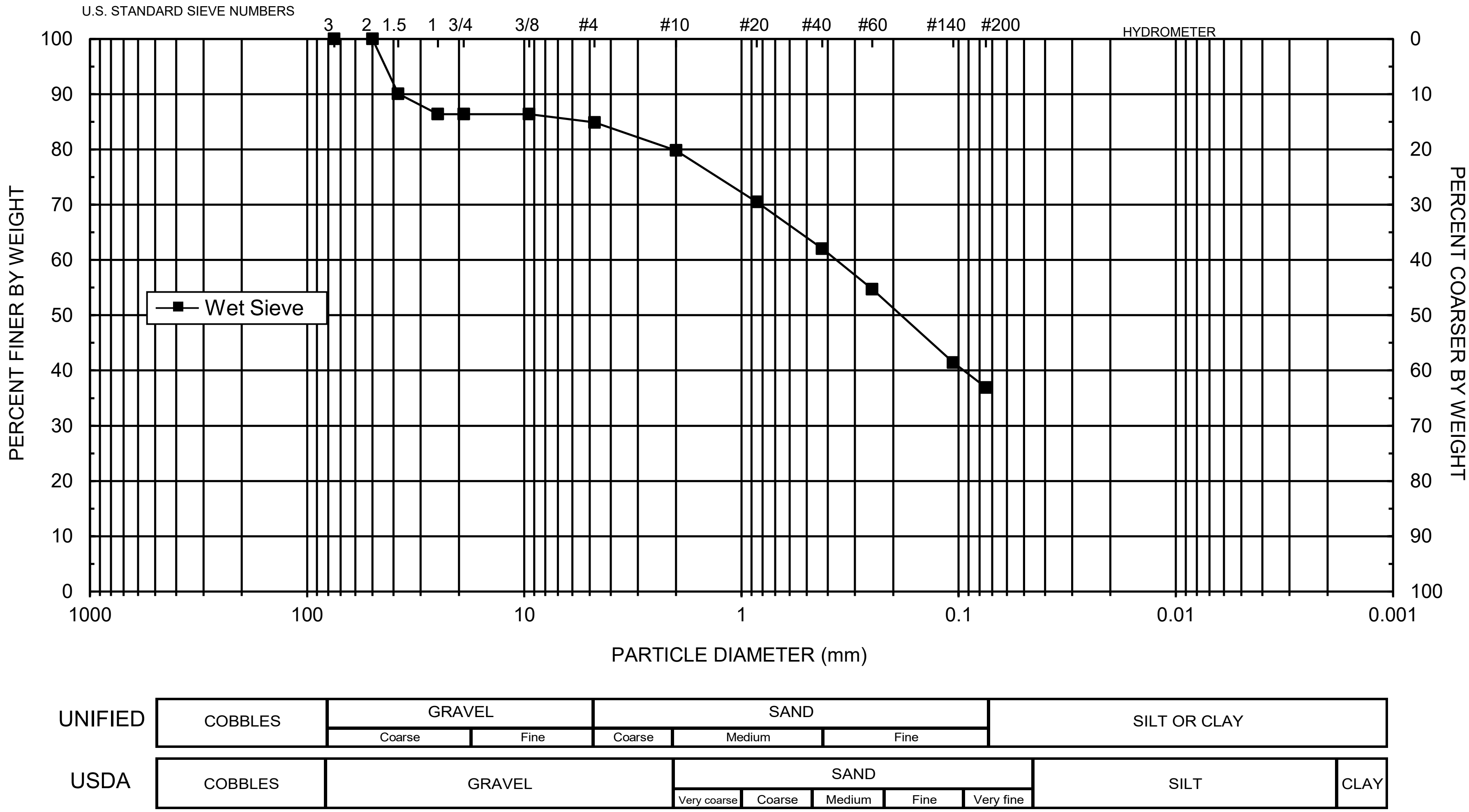
Median Particle Diameter --d_{50} (mm): 0.18
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): NA
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): NA
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): NA

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 †

† Greater than 10% of sample is coarse material

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **0.18**	d_{60} = **0.37**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 3T	**233001076-DBS**	**NA**	**NA †**

† Greater than 10% of sample is coarse material

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
Job Number: DB18.1151.00
Sample Number: SA-GM 4B
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 23-May-18

Initial Dry Weight of Sample (g): 587.80
Weight Passing #10 (g): 587.80
Weight Retained #10 (g): 0.00
Wt. of -10 Sieve Sample (g): 66.17
Calculated Weight of Sieve Sample (g): 66.17
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 calculated 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	

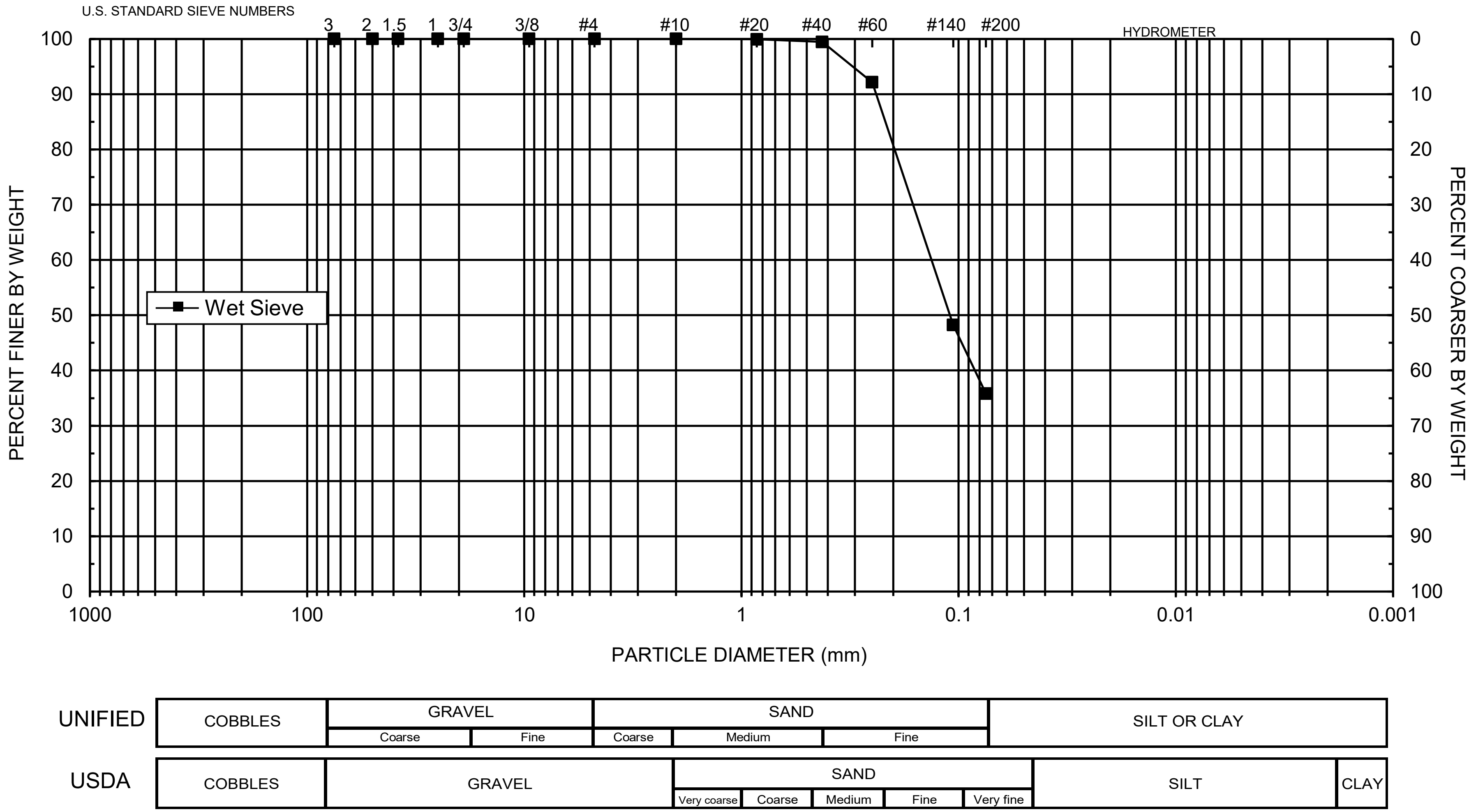
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): 0.11
d_{60} (mm): 0.13
d_{84} (mm): 0.21

Median Particle Diameter --d_{50} (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 --$[(d_{16}+d_{50}+d_{84})/3]$ (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **0.11**	d_{60} = **0.13**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 4B	**233001076-DBS**	**NA**	**NA**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: SA-GM 5B
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 23-May-18

Initial Dry Weight of Sample (g): 556.89
Weight Passing #10 (g): 456.92
Weight Retained #10 (g): 99.97
Wt. of -10 Sieve Sample (g): 65.29
Calculated Weight of Sieve Sample (g): 79.57

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

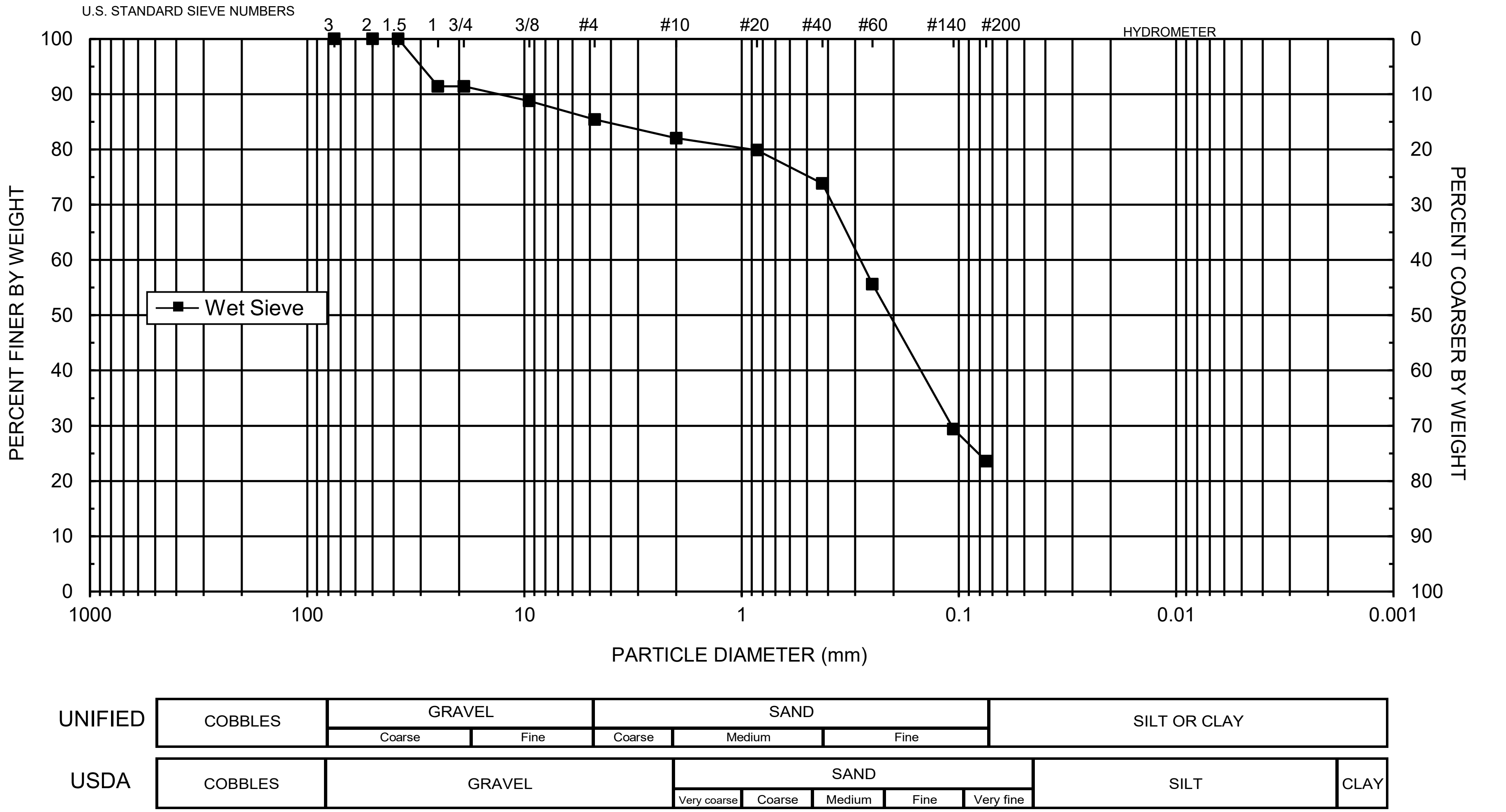
Median Particle Diameter --d_{50} (mm): 0.21
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): NA
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): NA
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): NA

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 †

† Greater than 10% of sample is coarse material

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **0.11**	d_{50} = **0.21**	d_{60} = **0.28**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 5B	**233001076-DBS**	**NA**	**NA †**

† Greater than 10% of sample is coarse material

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: SA-GM 5T
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 4-Jun-18

Initial Dry Weight of Sample (g): 1308.27
Weight Passing #10 (g): 1305.54
Weight Retained #10 (g): 2.73
Wt. of -10 Sieve Sample (g): 62.18
Calculated Weight of Sieve Sample (g): 62.31

Shape: Rounded
Hardness: Hard and durable

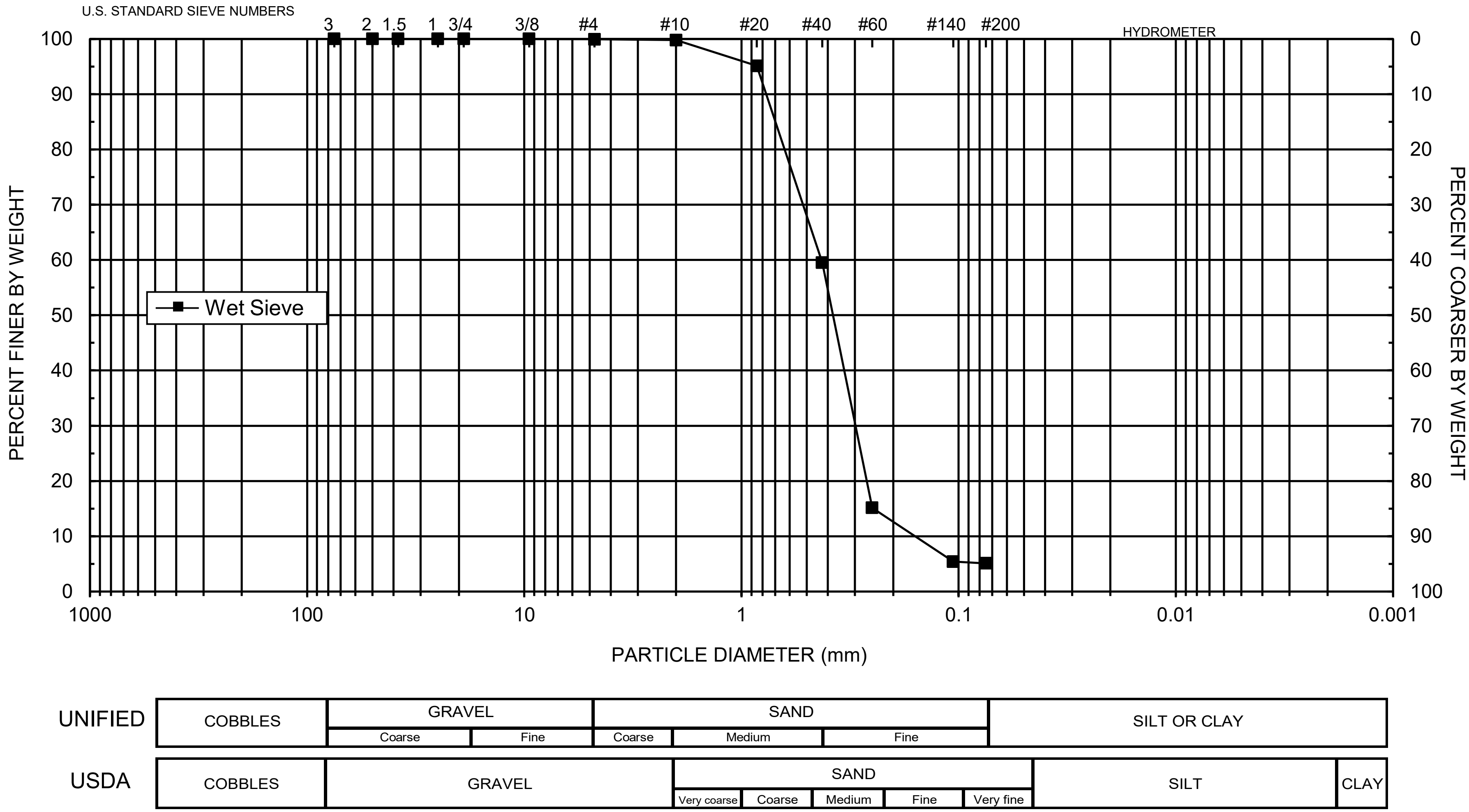
Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	1308.27	100.00
	2"	50	0.00	0.00	1308.27	100.00
	1.5"	38.1	0.00	0.00	1308.27	100.00
	1"	25	0.00	0.00	1308.27	100.00
	3/4"	19.0	0.00	0.00	1308.27	100.00
	3/8"	9.5	0.00	0.00	1308.27	100.00
	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 calculated 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_{16} (mm): 0.25
d_{30} (mm): 0.30
d_{50} (mm): 0.38
d_{60} (mm): 0.43
d_{84} (mm): 0.68

Median Particle Diameter --d_{50} (mm): 0.38
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 2.7
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 1.3
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.44

ASTM Soil Classification: NA
USDA Soil Classification: Sand

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



d_{10} = **0.16**	d_{30} = **0.30**	d_{50} = **0.38**	d_{60} = **0.43**	C_u = **2.7**	C_c = **1.3**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 5T	**233001076-DBS**	**NA**	**Sand**

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: SA-GM 6B
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 25-May-18

Initial Dry Weight of Sample (g): 641.27
Weight Passing #10 (g): 641.27
Weight Retained #10 (g): 0.00
Wt. of -10 Sieve Sample (g): 53.75
Calculated Weight of Sieve Sample (g): 53.75

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 calculated 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	

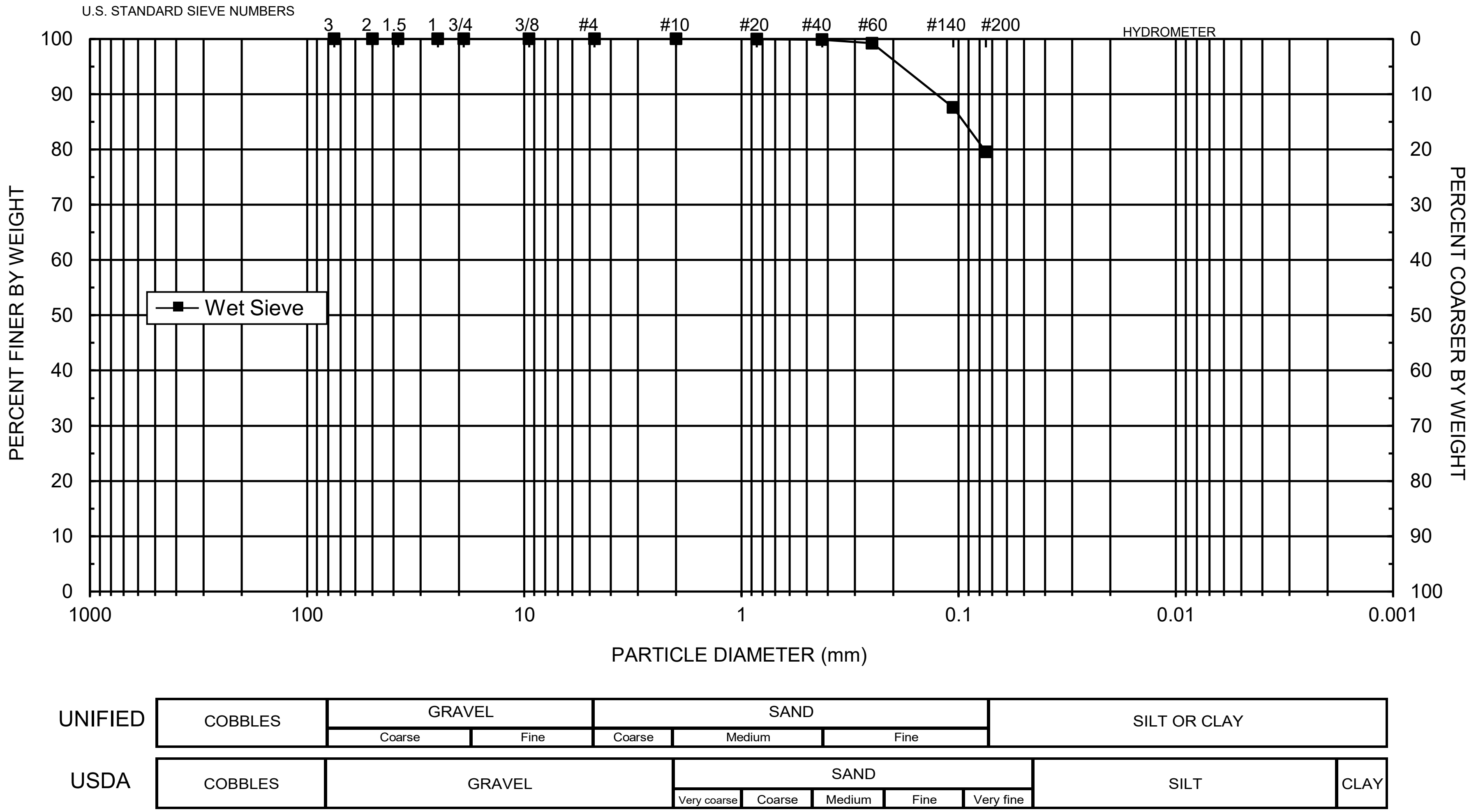
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): NA
d_{60} (mm): NA
d_{84} (mm): 0.091

Median Particle Diameter --d_{50} (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **NA**	d_{60} = **NA**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 6B	**233001076-DBS**	**NA**	**NA**

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
Job Number: DB18.1151.00
Sample Number: SA-GM 6T
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 23-May-18

Initial Dry Weight of Sample (g): 508.84
Weight Passing #10 (g): 508.84
Weight Retained #10 (g): 0.00
Wt. of -10 Sieve Sample (g): 60.17
Calculated Weight of Sieve Sample (g): 60.17

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 calculated 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	

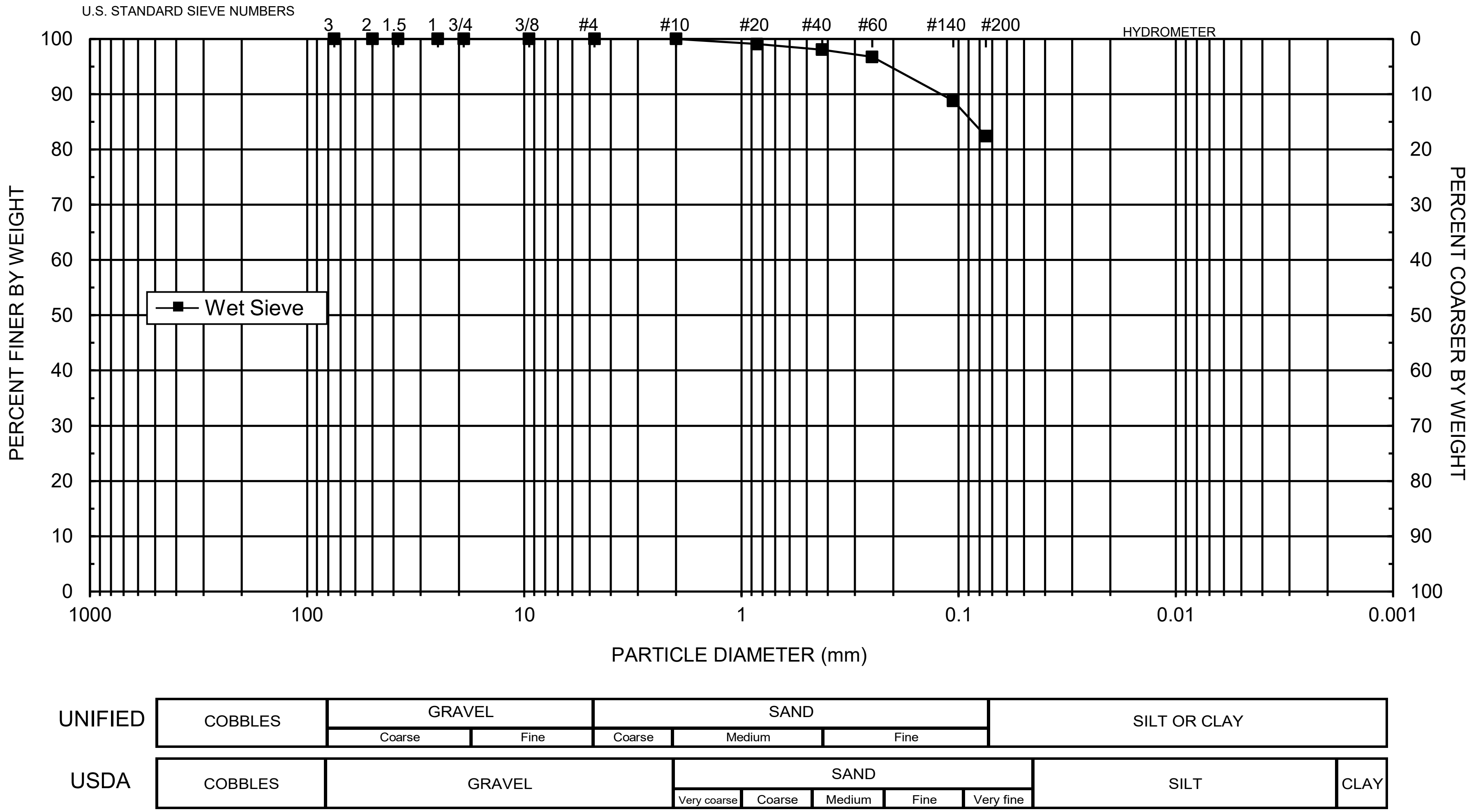
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): NA
d_{60} (mm): NA
d_{84} (mm): 0.082

Median Particle Diameter --d_{50} (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **NA**	d_{60} = **NA**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 6T	**233001076-DBS**	**NA**	**NA**

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
Job Number: DB18.1151.00
Sample Number: SA-GM 7B
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 25-May-18

Initial Dry Weight of Sample (g): 916.23
Weight Passing #10 (g): 916.23
Weight Retained #10 (g): 0.00
Wt. of -10 Sieve Sample (g): 54.29
Calculated Weight of Sieve Sample (g): 54.29

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 calculated 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	

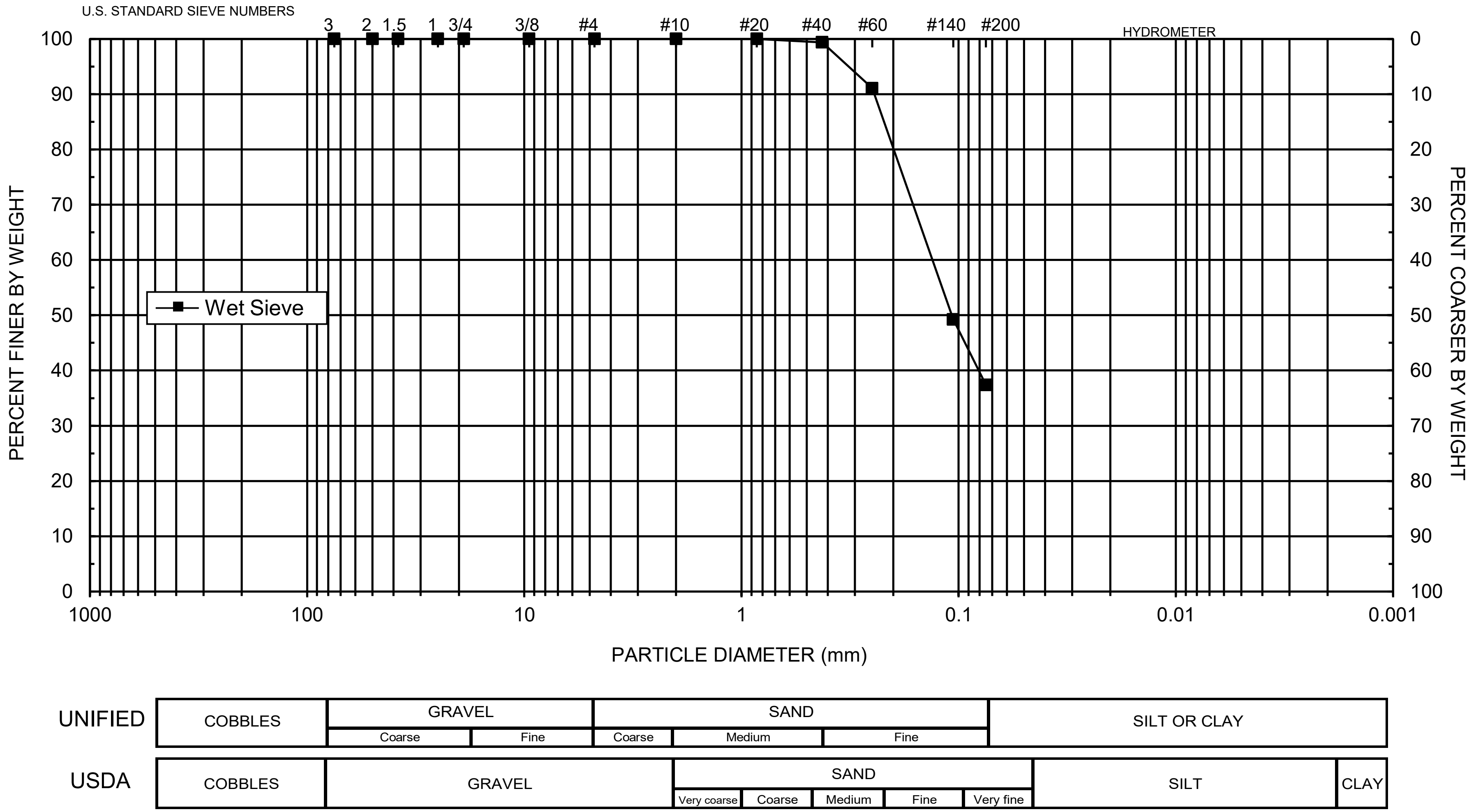
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): 0.11
d_{60} (mm): 0.13
d_{84} (mm): 0.22

Median Particle Diameter --d_{50} (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 --[$(d_{16}+d_{50}+d_{84})/3$] (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} =	d_{30} =	d_{50} =	d_{60} =	C_u =	C_c =
NA	**NA**	**0.11**	**0.13**	**NA**	**NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 7B	**233001076-DBS**	**NA**	**NA**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: SA-GM 8B
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 25-May-18

Initial Dry Weight of Sample (g): 1050.54
Weight Passing #10 (g): 1050.54
Weight Retained #10 (g): 0.00
Wt. of -10 Sieve Sample (g): 60.03
Calculated Weight of Sieve Sample (g): 60.03

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 calculated 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	

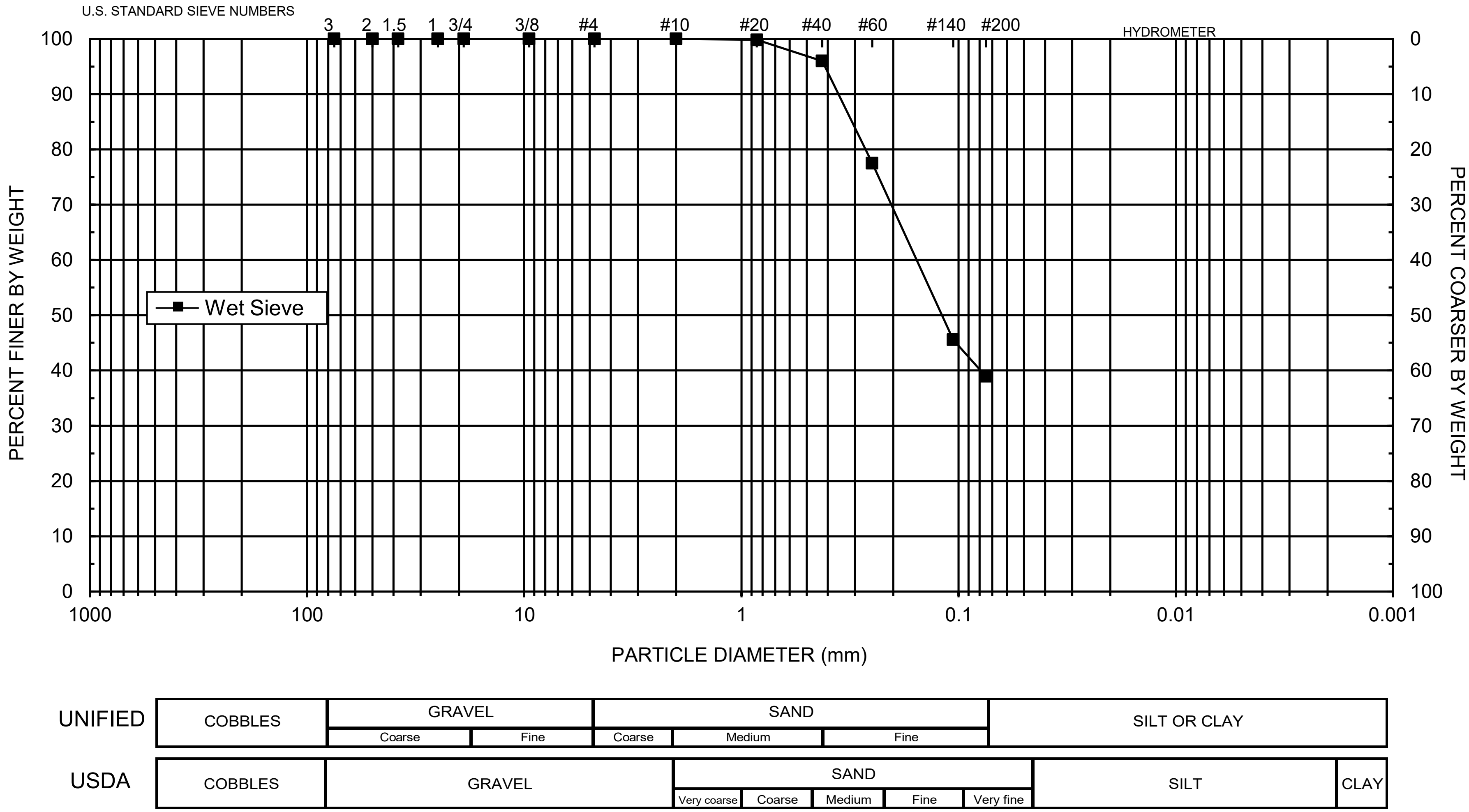
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): 0.12
d_{60} (mm): 0.16
d_{84} (mm): 0.30

Median Particle Diameter --d_{50} (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 --[$(d_{16}+d_{50}+d_{84})/3$] (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **0.12**	d_{60} = **0.16**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 8B	**233001076-DBS**	**NA**	**NA**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: SA-GM 8T
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 24-May-18

Initial Dry Weight of Sample (g): 1380.92
Weight Passing #10 (g): 1136.29
Weight Retained #10 (g): 244.63
Wt. of -10 Sieve Sample (g): 57.64
Calculated Weight of Sieve Sample (g): 70.05

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	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 calculated 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	
	wet pan			10.97	0.00	

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

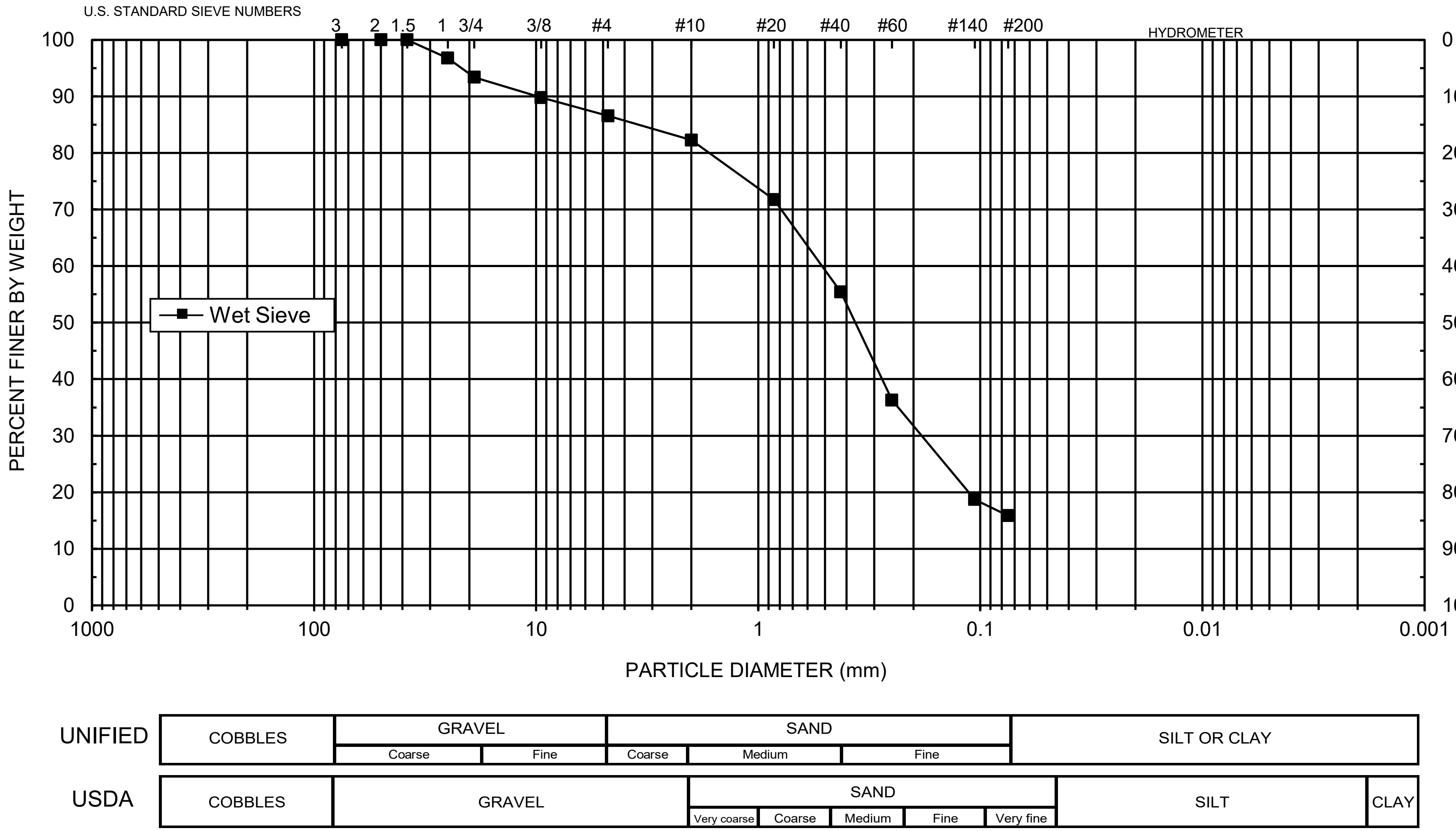
Median Particle Diameter --d_{50} (mm): 0.37
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): NA
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): NA
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 1.1

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 †

† Greater than 10% of sample is coarse material

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = NA	d_{30} = 0.18	d_{50} = 0.37	d_{60} = 0.52	C_u = NA	C_c = NA

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
SA-GM 8T	**233001076-DBS**	**NA**	**NA †**

† Greater than 10% of sample is coarse material

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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
Test Date: 17-May-18

Initial Dry Weight of Sample (g): 272.52
Weight Passing #10 (g): 272.52
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 56.68
Calculated Weight of Sieve Sample (g): 56.68

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	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 calculated 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	

d_{10} (mm): 2.2E-05
d_{16} (mm): 0.00016
d_{30} (mm): 0.0067
d_{50} (mm): 0.046
d_{60} (mm): 0.061
d_{84} (mm): 0.13

Median Particle Diameter --d_{50} (mm): 0.046
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 2773
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 33
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Loam

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 15-May-18
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

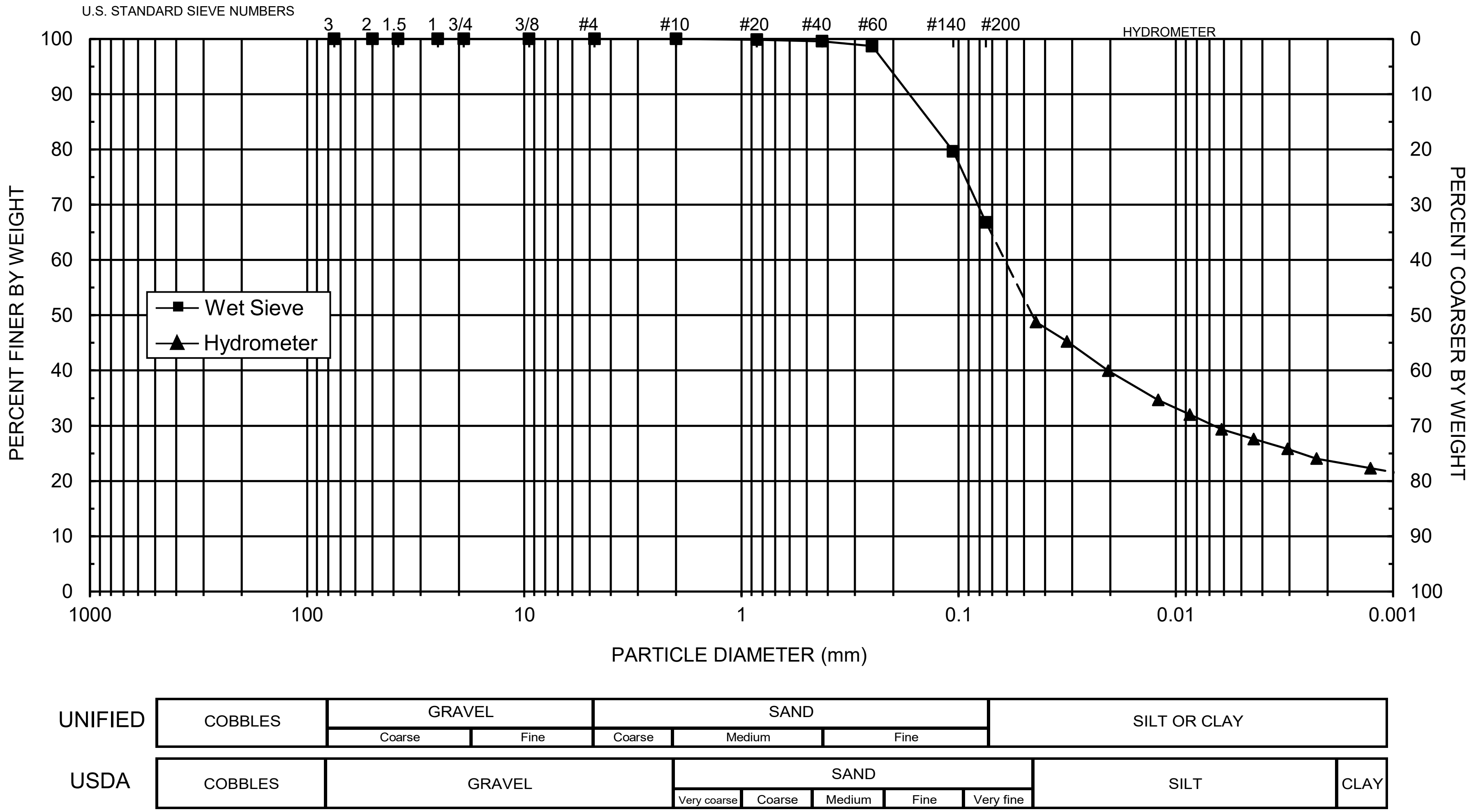
Initial Wt. (g): 56.68
Total Sample Wt. (g): 272.52
Wt. Passing #10 (g): 272.52

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **2.2E-05**	d_{30} = **0.0067**	d_{50} = **0.046**	d_{60} = **0.061**	C_u = **2773**	C_c = **33**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L1-1 (10'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam**

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
Job Number: DB18.1151.00
Sample Number: L1-2 (20'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 17-May-18

Initial Dry Weight of Sample (g): 491.56
Weight Passing #10 (g): 489.94
Weight Retained #10 (g): 1.62
Weight of Hydrometer Sample (g): 57.04
Calculated Weight of Sieve Sample (g): 57.23

Shape: Rounded
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	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 calculated 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_{16} (mm): 0.00010
d_{30} (mm): 0.0022
d_{50} (mm): 0.0092
d_{60} (mm): 0.015
d_{84} (mm): 0.044

Median Particle Diameter --d_{50} (mm): 0.0092
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 536
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 12
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.018

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: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Silty Clay Loam

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

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

Test Date: 15-May-18
Start Time: 9:06

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

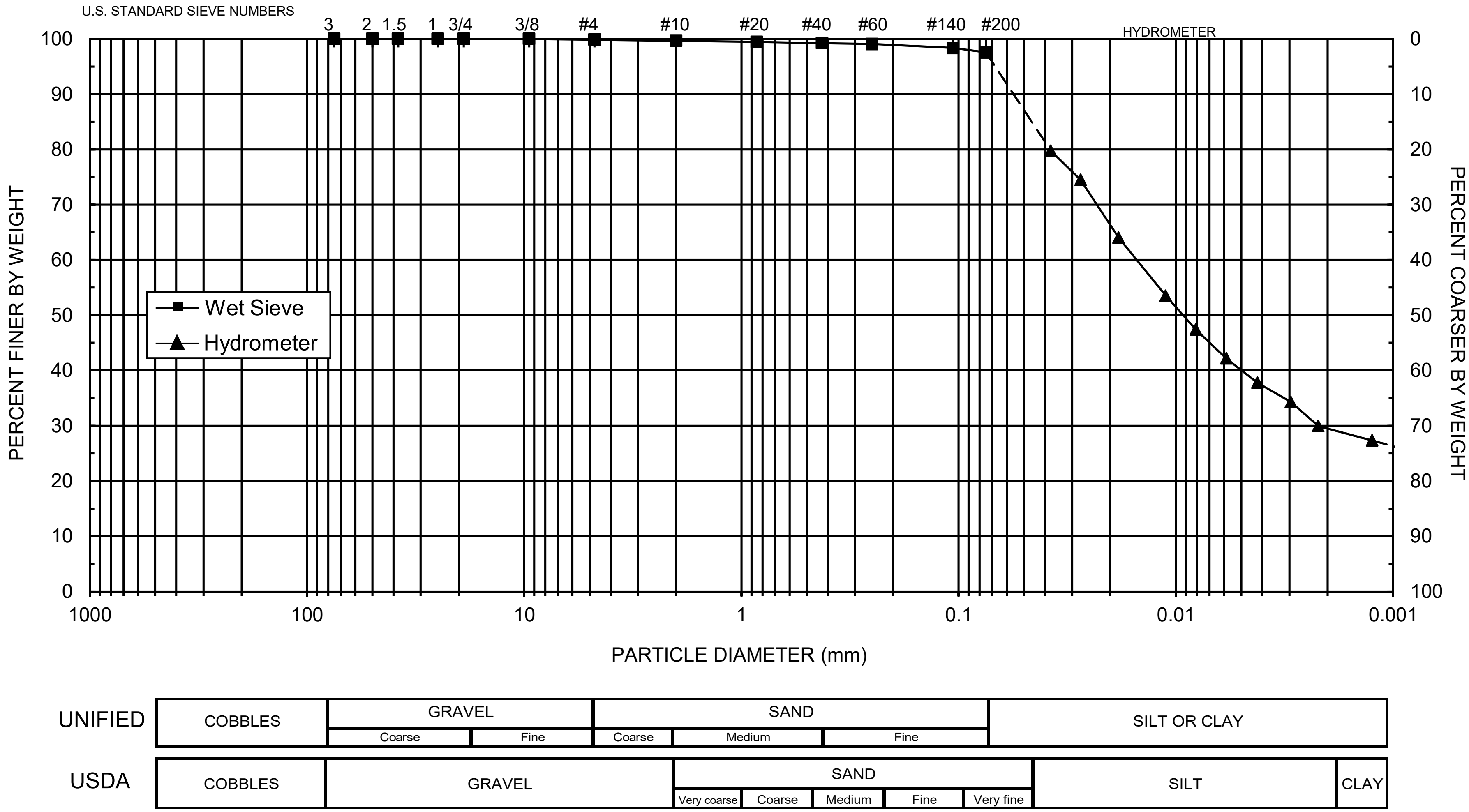
Initial Wt. (g): 57.04
Total Sample Wt. (g): 491.56
Wt. Passing #10 (g): 489.94

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **2.8E-05**	d_{30} = **0.0022**	d_{50} = **0.0092**	d_{60} = **0.015**	C_u = **536**	C_c = **12**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L1-2 (20'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Silty Clay Loam**

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.

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):*	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						
	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 calculated 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_{10} (mm):	6.4E-45	d_{50} (mm):	0.066
d_{16} (mm):	0.0031	d_{60} (mm):	0.088
d_{30} (mm):	0.034	d_{84} (mm):	0.17

Median Particle Diameter --d_{50} (mm): 0.066

Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 1.4E+43

Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 2.1E+42

Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: Z. Calhoun

Data entered by: M. Garcia

Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 15-May-18
Start Time: 9:12

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

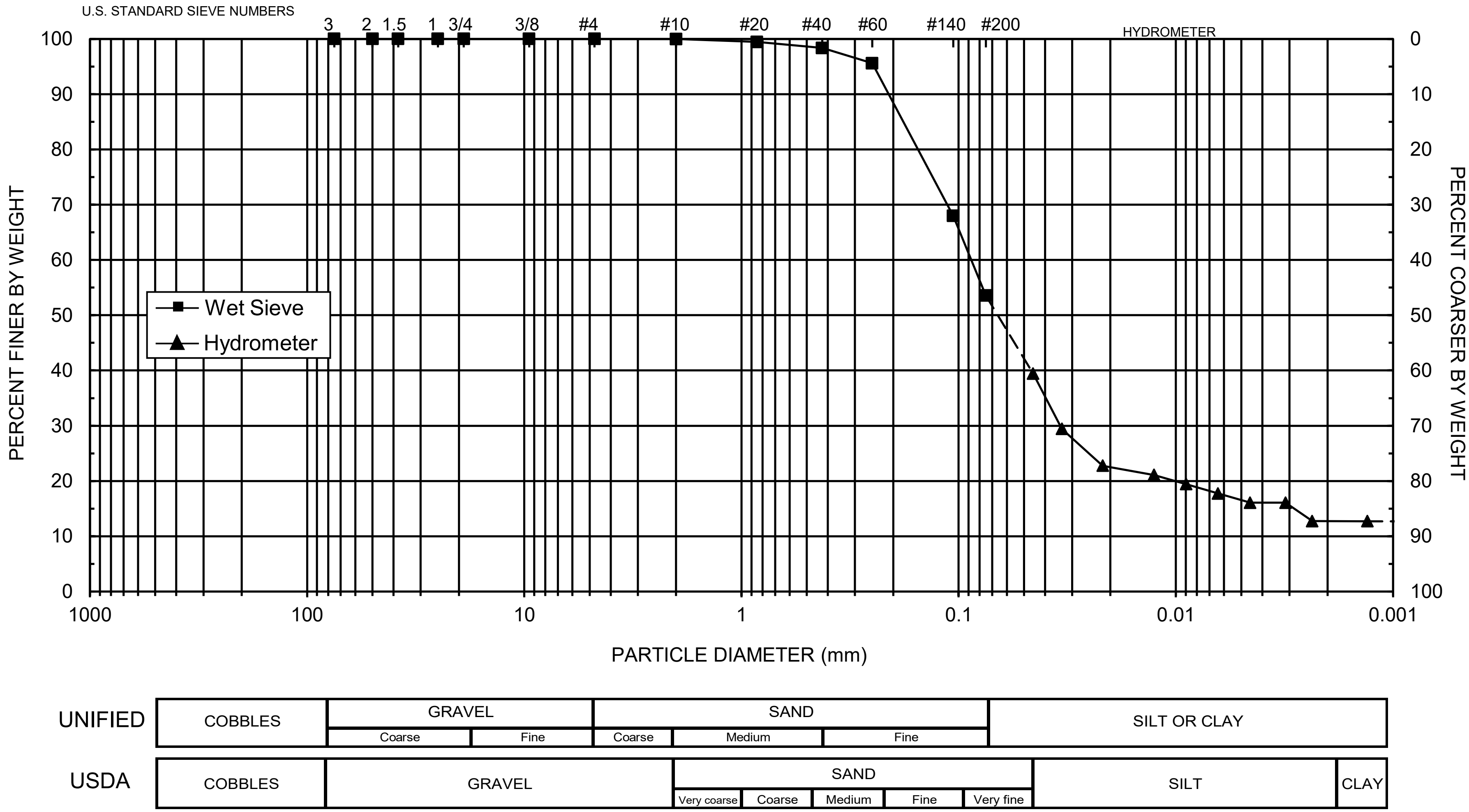
Initial Wt. (g): 59.96
Total Sample Wt. (g): 434.95
Wt. Passing #10 (g): 434.90

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **6.4E-45**	d_{30} = **0.034**	d_{50} = **0.066**	d_{60} = **0.088**	C_u = **1.4E+43**	C_c = **2.1E+42**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L1-3 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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
Job Number: DB18.1151.00
Sample Number: L1-5 (20'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 24-May-18

Initial Dry Weight of Sample (g): 419.21
Weight Passing #10 (g): 419.21
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 55.07
Calculated Weight of Sieve Sample (g): 55.07

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	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 calculated 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_{10} (mm): 0.0011
d_{16} (mm): 0.0045
d_{30} (mm): 0.042
d_{50} (mm): 0.074
d_{60} (mm): 0.093
d_{84} (mm): 0.17

Median Particle Diameter --d_{50} (mm): 0.074
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 85
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 17
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Sandy Loam

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L1-5 (20'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18
Start Time: 9:30

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

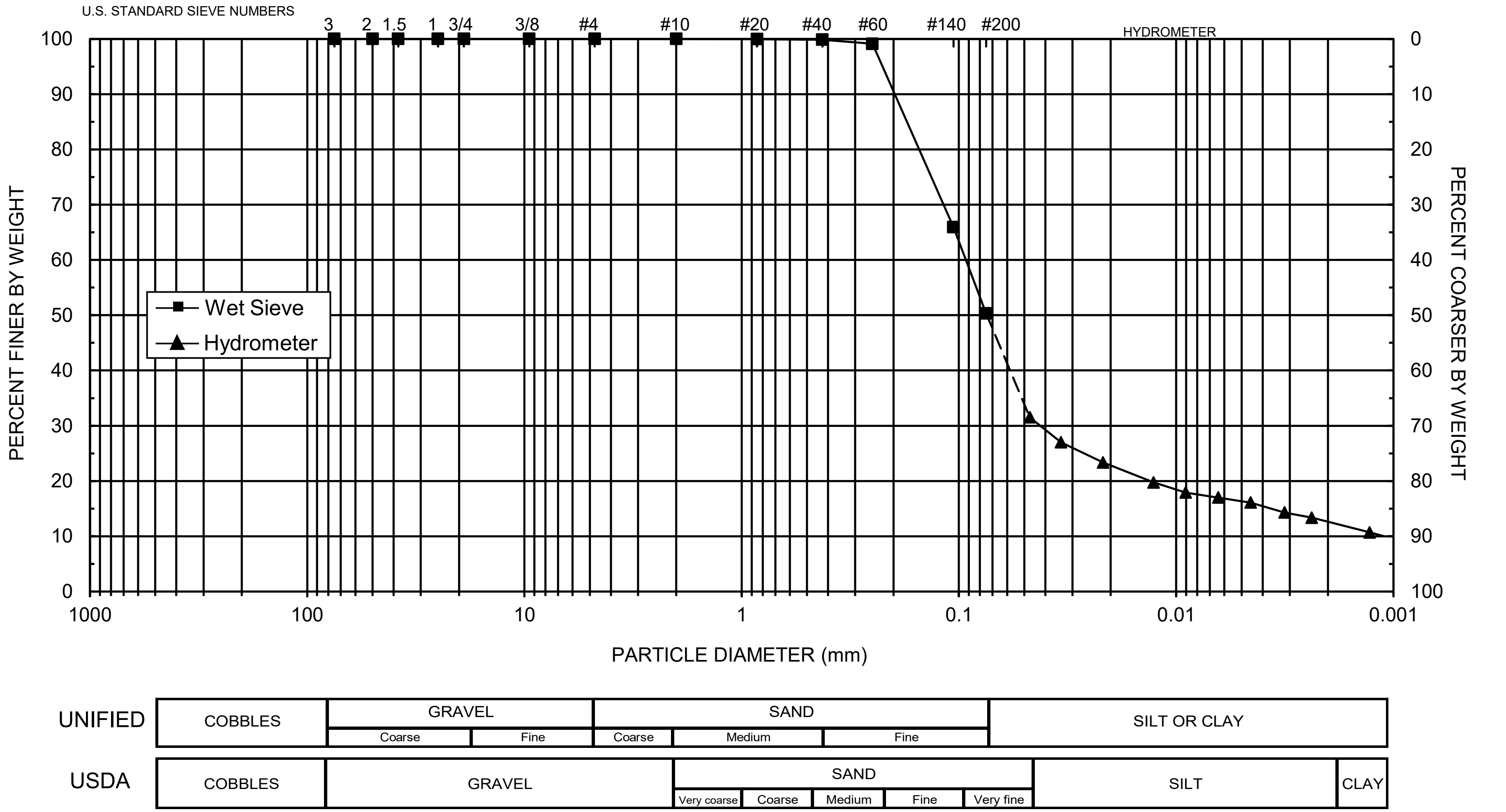
Initial Wt. (g): 55.07
Total Sample Wt. (g): 419.21
Wt. Passing #10 (g): 419.21

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0011**	d_{30} = **0.042**	d_{50} = **0.074**	d_{60} = **0.093**	C_u = **85**	C_c = **17**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L1-5 (20'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-1 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 17-May-18

Initial Dry Weight of Sample (g): 507.75
Weight Passing #10 (g): 507.75
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 65.87
Calculated Weight of Sieve Sample (g): 65.87

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 calculated 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	

d_{10} (mm): 0.00040
d_{16} (mm): 0.0013
d_{30} (mm): 0.015
d_{50} (mm): 0.045
d_{60} (mm): 0.060
d_{84} (mm): 0.12

Median Particle Diameter --d_{50} (mm): 0.045
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 150
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 9.4
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.055

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: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Loam

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

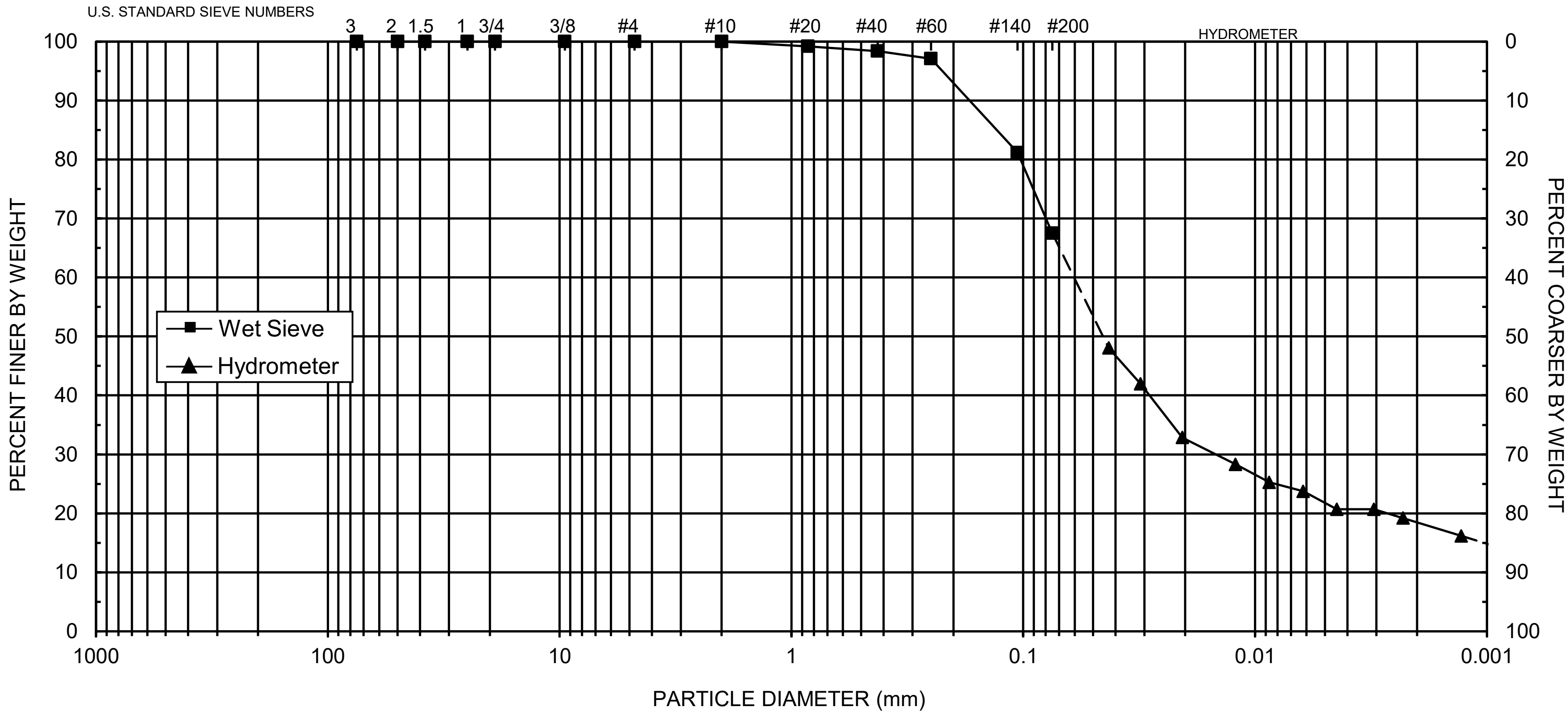
Job Name:	Stantec Consulting Services Inc	*Type of Water Used:*	DISTILLED
Job Number:	DB18.1151.00	*Reaction with H_2O_2:*	NA
Sample Number:	L2-1 (5'A)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	St. Anthony Geotech Investigation	*Assumed particle density:*	2.65
PO Number:	233001076-DBS	*Initial Wt. (g):*	65.87
Test Date:	15-May-18	*Total Sample Wt. (g):*	507.75
Start Time:	9:18	*Wt. Passing #10 (g):*	507.75

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY	
		Coarse	Fine	Coarse	Medium	Fine		

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.00040**	d_{30} = **0.015**	d_{50} = **0.045**	d_{60} = **0.060**	C_u = **150**	C_c = **9.4**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L2-1 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-1 (15'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 29-Jun-18

Initial Dry Weight of Sample (g): 371.36
Weight Passing #10 (g): 371.36
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 52.42
Calculated Weight of Sieve Sample (g): 52.42

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 calculated 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	

d_{10} (mm): 0.00024
d_{16} (mm): 0.0012
d_{30} (mm): 0.013
d_{50} (mm): 0.056
d_{60} (mm): 0.065
d_{84} (mm): 0.12

Median Particle Diameter --d_{50} (mm): 0.056
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 271
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 11
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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
Job Number: DB18.1151.00
Sample Number: L2-1 (15'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 27-Jun-18
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

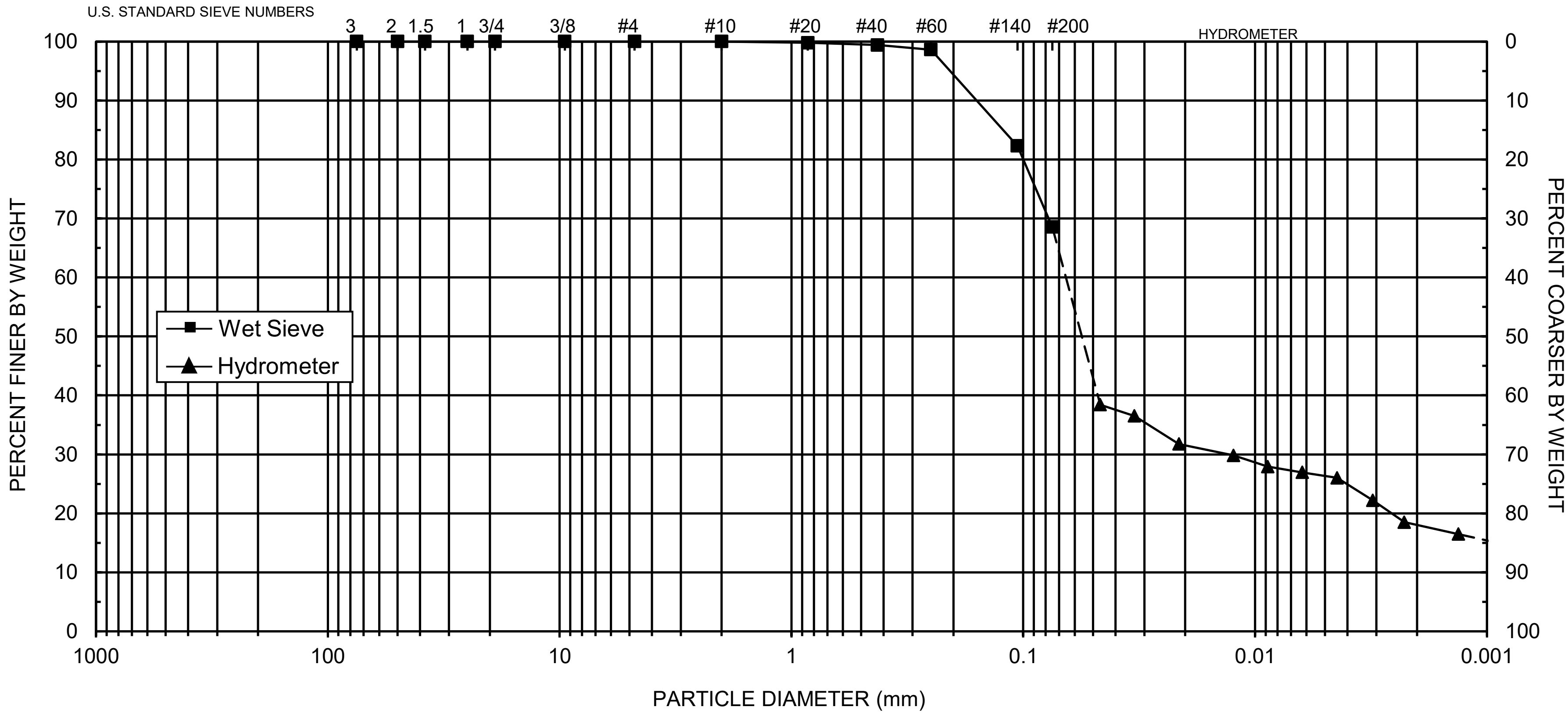
Initial Wt. (g)*:* 52.42
Total Sample Wt. (g)*:* 371.36
Wt. Passing #10 (g): 371.36

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



UNIFIED	COBBLES	GRAVEL Coarse	GRAVEL Fine	SAND Coarse	SAND Medium	SAND Fine	SILT OR CLAY

USDA	COBBLES	GRAVEL	SAND Very coarse	SAND Coarse	SAND Medium	SAND Fine	SAND Very fine	SILT	CLAY

d_{10} = **0.00024**	d_{30} = **0.013**	d_{50} = **0.056**	d_{60} = **0.065**	C_u = **271**	C_c = **11**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L2-1 (15'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-2 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 17-May-18

Initial Dry Weight of Sample (g): 483.31
Weight Passing #10 (g): 483.31
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 63.94
Calculated Weight of Sieve Sample (g): 63.94

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 calculated 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_{10} (mm): 0.00019
d_{16} (mm): 0.0018
d_{30} (mm): 0.031
d_{50} (mm): 0.067
d_{60} (mm): 0.085
d_{84} (mm): 0.16

Median Particle Diameter --d_{50} (mm): 0.067
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 447
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 60
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.076

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: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Sandy Loam

Laboratory analysis by: Z. Calhoun/L. Hill
Data entered by: M. Garcia
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-2 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 15-May-18
Start Time: 9:24

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

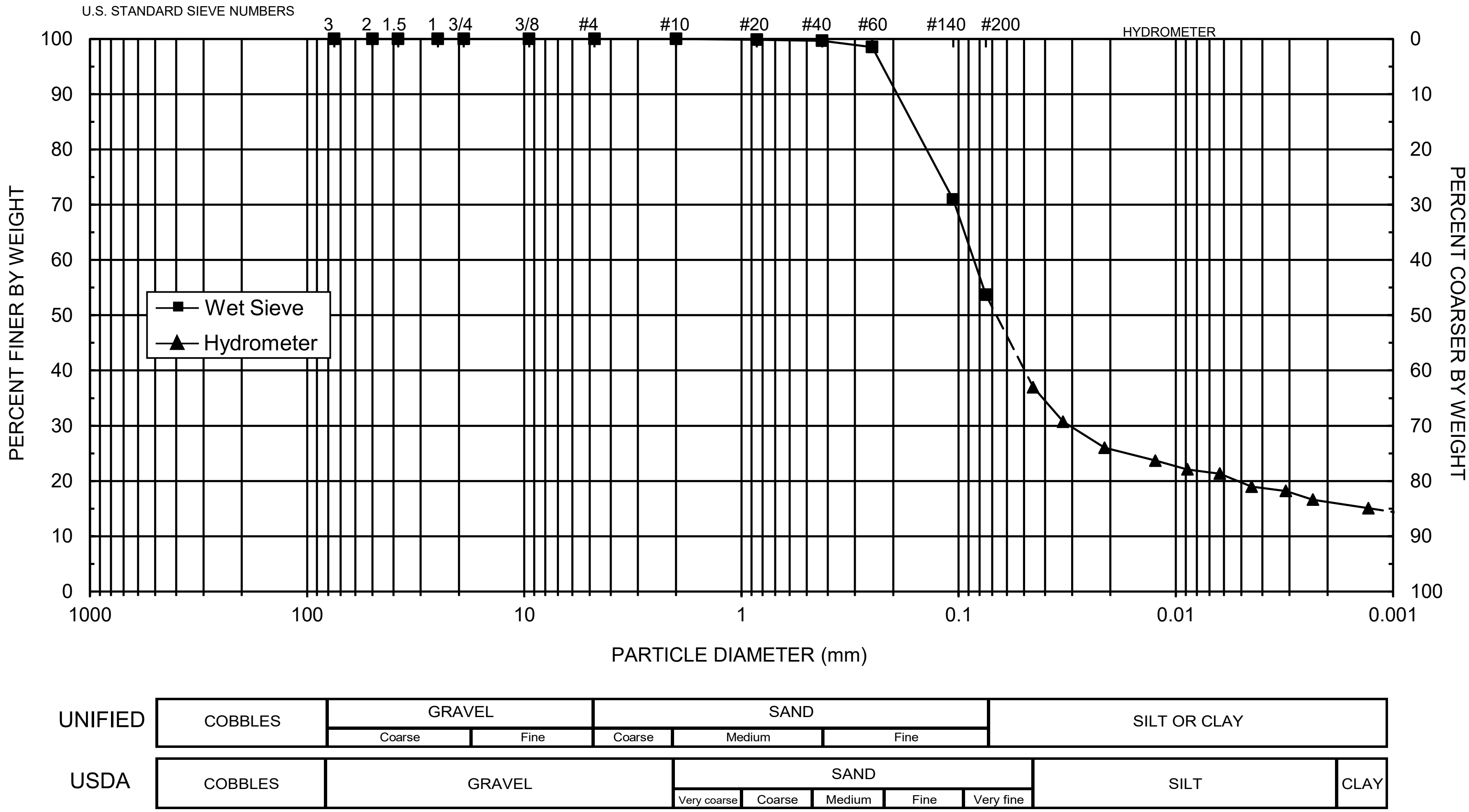
Initial Wt. (g): 63.94
Total Sample Wt. (g): 483.31
Wt. Passing #10 (g): 483.31

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00019**	d_{30} = **0.031**	d_{50} = **0.067**	d_{60} = **0.085**	C_u = **447**	C_c = **60**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L2-2 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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):*	469.13
Job Number:	DB18.1151.00	*Weight Passing #10 (g):*	469.13
Sample Number:	L2-3 (5'A)	*Weight Retained #10 (g):*	0.00
Project Name:	St. Anthony Geotech Investigation	*Weight of Hydrometer 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 calculated 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	

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

Median Particle Diameter --d_{50} (mm): 0.076

Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 95

Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 26

Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: Z. Calhoun

Data entered by: M. Garcia

Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 15-May-18
Start Time: 9:30

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

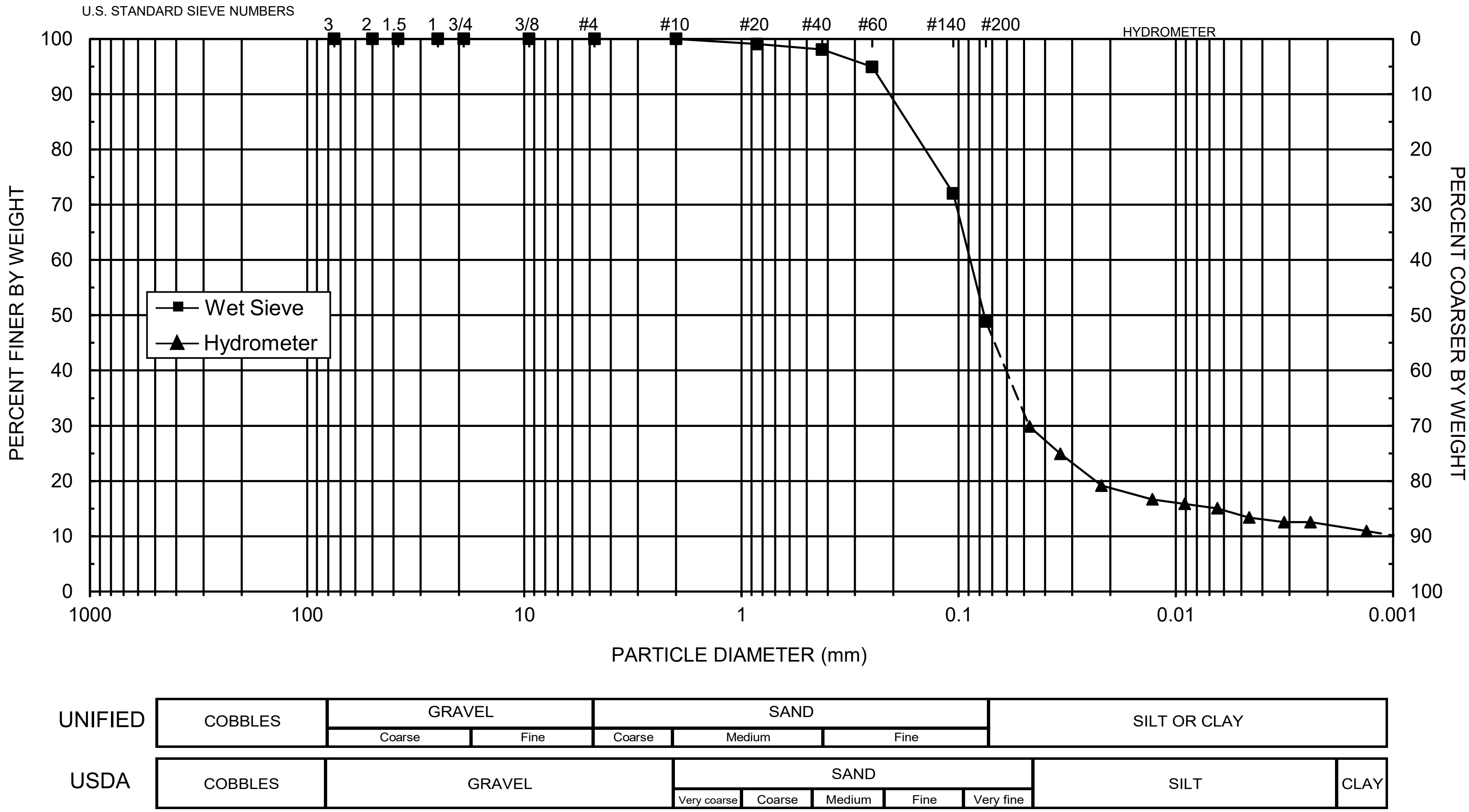
Initial Wt. (g): 60.77
Total Sample Wt. (g): 469.13
Wt. Passing #10 (g): 469.13

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00094**	d_{30} = **0.047**	d_{50} = **0.076**	d_{60} = **0.089**	C_u = **95**	C_c = **26**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L2-3 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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
Job Number: DB18.1151.00
Sample Number: L2-4 (10'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 17-May-18

Initial Dry Weight of Sample (g): 333.87
Weight Passing #10 (g): 333.87
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 58.28
Calculated Weight of Sieve Sample (g): 58.28

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 calculated 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	

d_{10} (mm): 3.9E-05
d_{16} (mm): 0.00032
d_{30} (mm): 0.012
d_{50} (mm): 0.045
d_{60} (mm): 0.057
d_{84} (mm): 0.10

Median Particle Diameter --d_{50} (mm): 0.045
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 1462
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 65
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Loam

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-4 (10'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 15-May-18
Start Time: 9:36

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

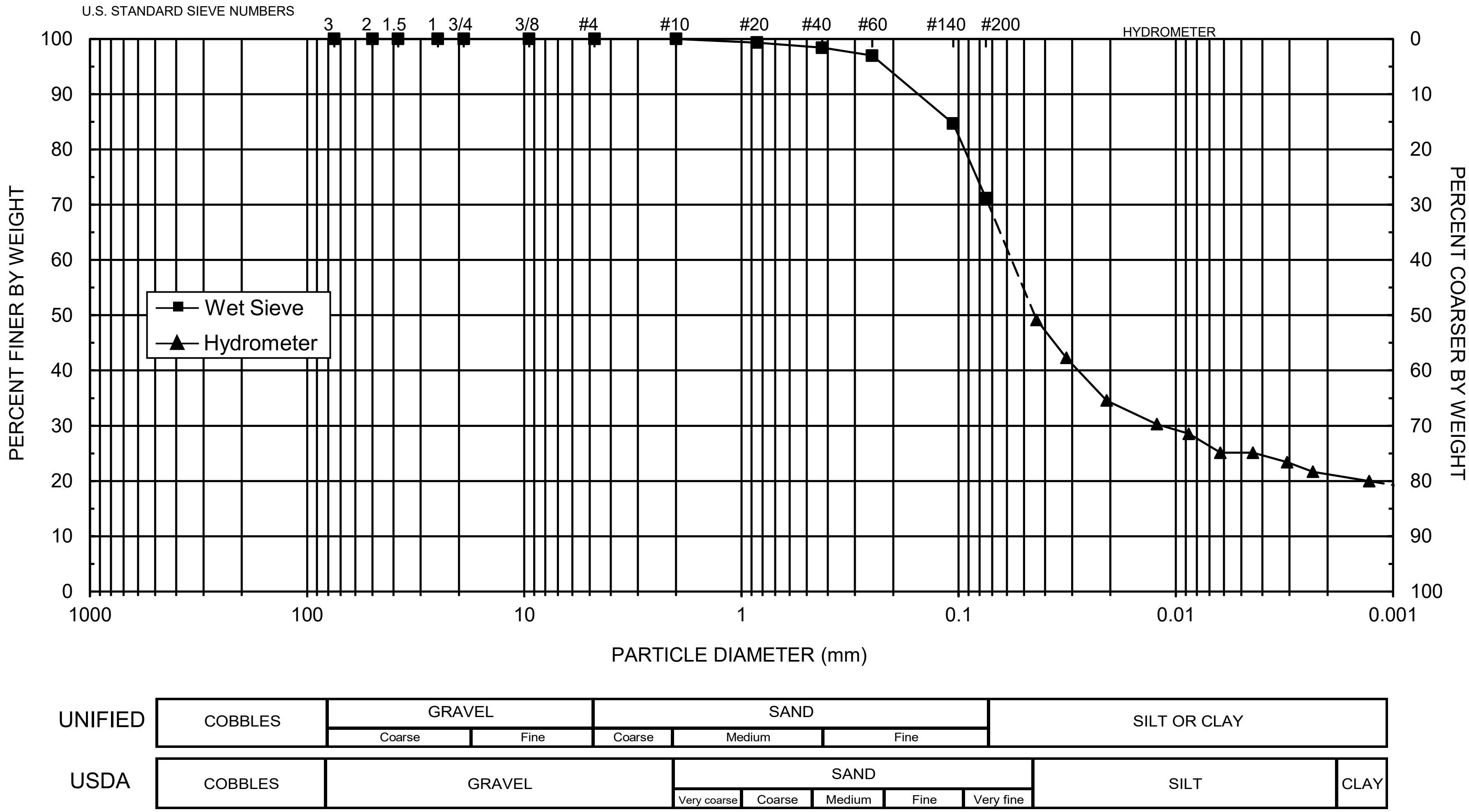
Initial Wt. (g): 58.28
Total Sample Wt. (g): 333.87
Wt. Passing #10 (g): 333.87

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **3.9E-05**	d_{30} = **0.012**	d_{50} = **0.045**	d_{60} = **0.057**	C_u = **1462**	C_c = **65**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L2-4 (10'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-5 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 17-May-18

Initial Dry Weight of Sample (g): 485.58
Weight Passing #10 (g): 485.58
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 59.33
Calculated Weight of Sieve Sample (g): 59.33

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 calculated 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_{16} (mm): 8.0E-05
d_{30} (mm): 0.00032
d_{50} (mm): 0.0022
d_{60} (mm): 0.0047
d_{84} (mm): 0.023

Median Particle Diameter --d_{50} (mm): 0.0022
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 107
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 0.50
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.0084

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: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Silty Clay

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

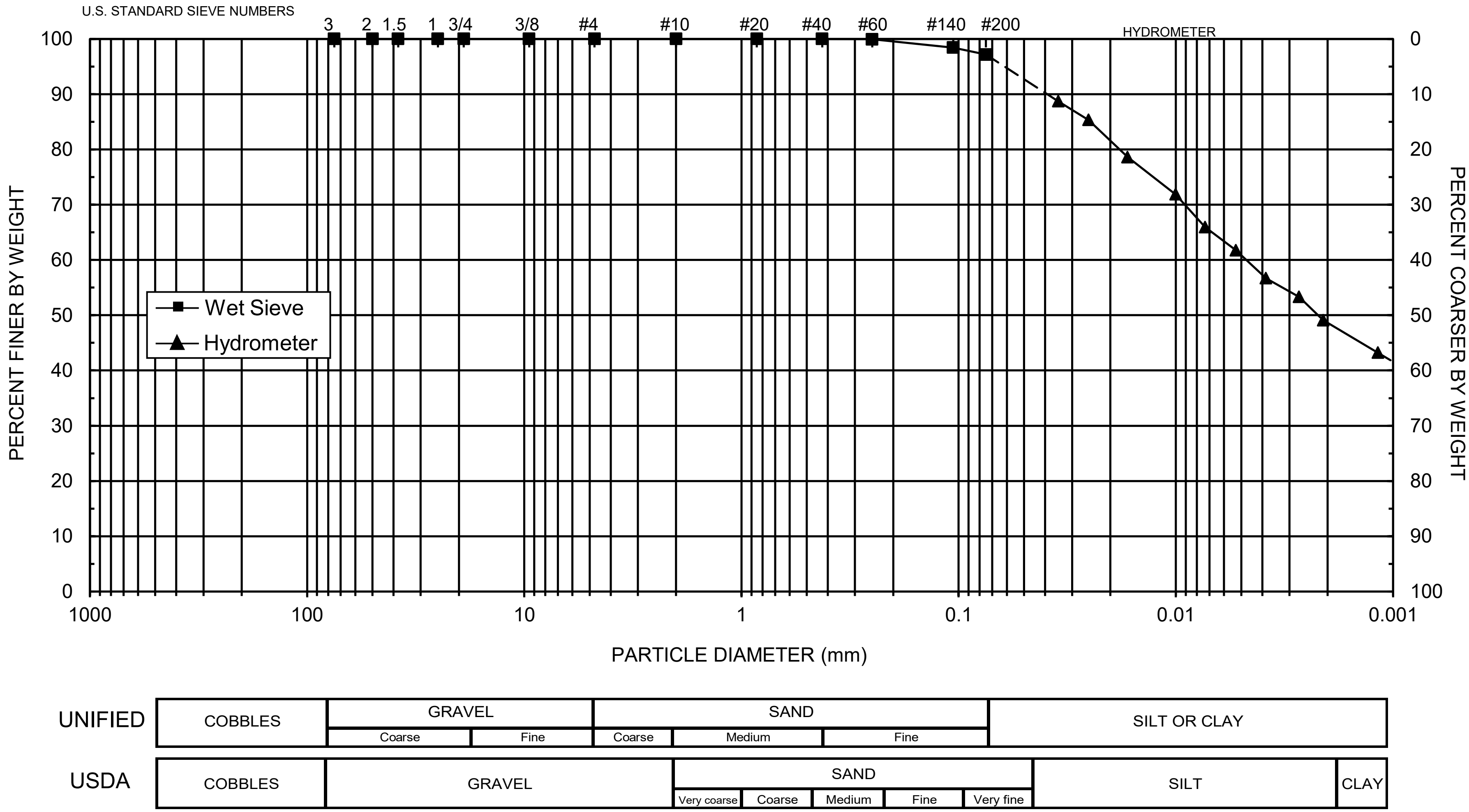
Job Name:	Stantec Consulting Services Inc	*Type of Water Used:*	DISTILLED
Job Number:	DB18.1151.00	*Reaction with* H_2O_2:	NA
Sample Number:	L2-5 (5'A)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	St. Anthony Geotech Investigation	*Assumed particle density:*	2.65
PO Number:	233001076-DBS	*Initial Wt. (g):*	59.33
Test Date:	15-May-18	*Total Sample Wt. (g):*	485.58
Start Time:	9:42	*Wt. Passing #10 (g):*	485.58

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **4.4E-05**	d_{30} = **0.00032**	d_{50} = **0.0022**	d_{60} = **0.0047**	C_u = **107**	C_c = **0.50**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L2-5 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Silty Clay**

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
Job Number: DB18.1151.00
Sample Number: L2-6 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 24-May-18

Initial Dry Weight of Sample (g): 230.60
Weight Passing #10 (g): 230.60
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 54.02
Calculated Weight of Sieve Sample (g): 54.02

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 calculated 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	

d_{10} (mm): 0.00031
d_{16} (mm): 0.00054
d_{30} (mm): 0.0020
d_{50} (mm): 0.013
d_{60} (mm): 0.030
d_{84} (mm): 0.072

Median Particle Diameter --d_{50} (mm): 0.013
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 97
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 0.43
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.029

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

Classification of fines: CL

ASTM Soil Classification: Lean clay (CL)
USDA Soil Classification: Clay Loam

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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: 18-May-18
Start Time: 9:36

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

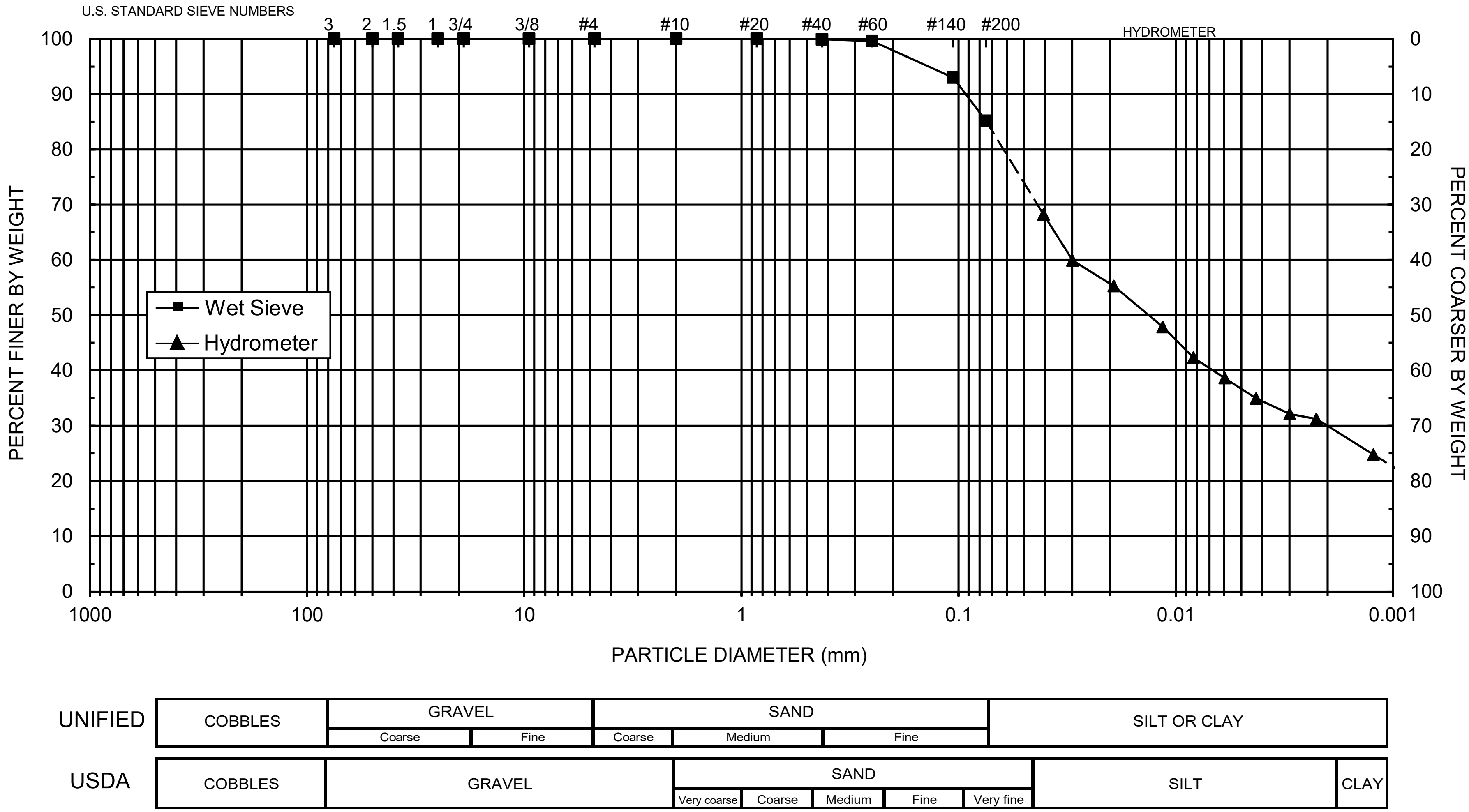
Initial Wt. (g)*:* 54.02
Total Sample Wt. (g)*:* 230.60
Wt. Passing #10 (g): 230.60

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00031**	d_{30} = **0.0020**	d_{50} = **0.013**	d_{60} = **0.030**	C_u = **97**	C_c = **0.43**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L2-6 (5'A)	**233001076-DBS**	**Lean clay (CL)**	**Clay Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-7 (10'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 30-May-18

Initial Dry Weight of Sample (g): 458.29
Weight Passing #10 (g): 458.15
Weight Retained #10 (g): 0.14
Weight of Hydrometer Sample (g): 59.02
Calculated Weight of Sieve Sample (g): 59.04

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 calculated 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_{10} (mm): 1.9E-09
d_{16} (mm): 0.0067
d_{30} (mm): 0.025
d_{50} (mm): 0.057
d_{60} (mm): 0.075
d_{84} (mm): 0.14

Median Particle Diameter --d_{50} (mm): 0.057
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 3.9E+07
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 4.4E+06
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-7 (10'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 23-May-18
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

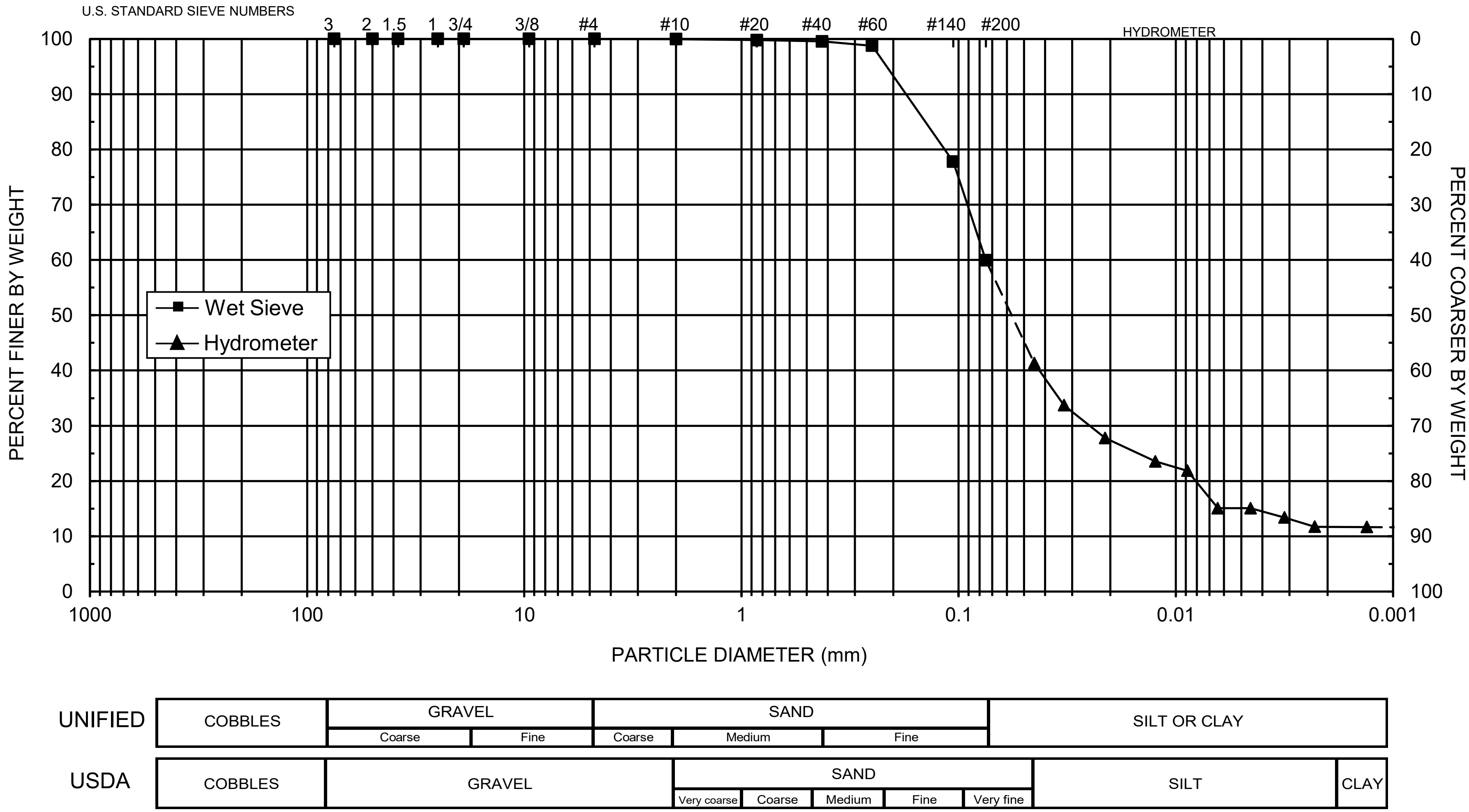
Initial Wt. (g): 59.02
Total Sample Wt. (g): 458.29
Wt. Passing #10 (g): 458.15

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **1.9E-09**	d_{30} = **0.025**	d_{50} = **0.057**	d_{60} = **0.075**	C_u = **3.9E+07**	C_c = **4.4E+06**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
L2-7 (10'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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):*	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	*Weight of Hydrometer Sample (g):*	54.86
PO Number:	233001076-DBS	*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 calculated 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	

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

Median Particle Diameter --d_{50} (mm): 0.0088

Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 53

Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 0.75

Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.017

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: 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

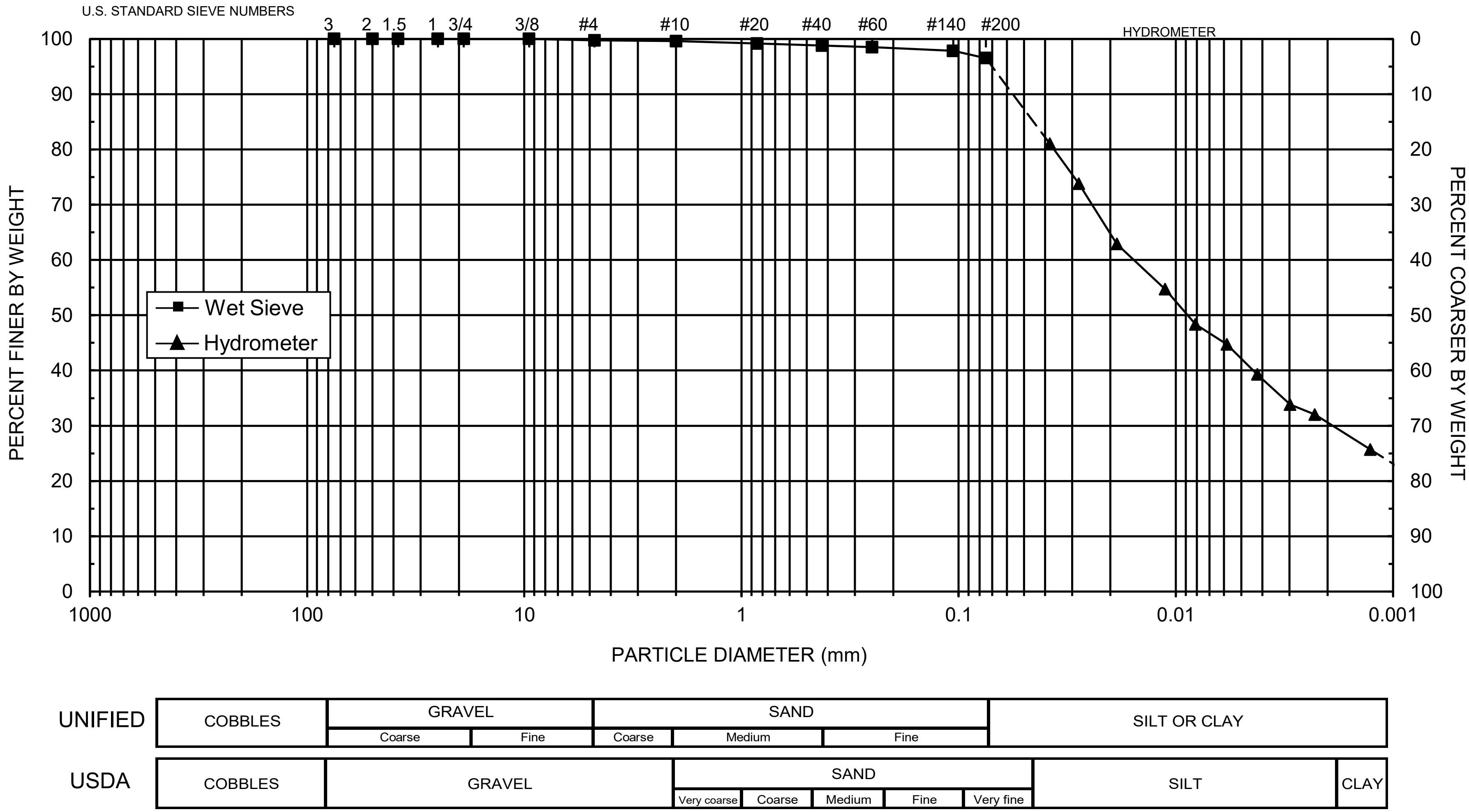
Job Name:	Stantec Consulting Services Inc	*Type of Water Used:*	DISTILLED
Job Number:	DB18.1151.00	*Reaction with* H_2O_2:	NA
Sample Number:	T/O-1 (20'A)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	St. Anthony Geotech Investigation	*Assumed particle density:*	2.65
PO Number:	233001076-DBS	*Initial Wt. (g):*	54.86
Test Date:	15-May-18	*Total Sample Wt. (g):*	451.54
Start Time:	9:48	*Wt. Passing #10 (g):*	449.76

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00030**	d_{30} = **0.0019**	d_{50} = **0.0088**	d_{60} = **0.016**	C_u = **53**	C_c = **0.75**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
T/O-1 (20'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Silty Clay Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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

Test Date: 17-May-18

Initial Dry Weight of Sample (g): 440.68
Weight Passing #10 (g): 440.68
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 53.68
Calculated Weight of Sieve Sample (g): 53.68

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	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 calculated 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	

d_{10} (mm): 5.1E-05
d_{16} (mm): 0.00037
d_{30} (mm): 0.016
d_{50} (mm): 0.070
d_{60} (mm): 0.099
d_{84} (mm): 0.18

Median Particle Diameter --d_{50} (mm): 0.070
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 1941
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 51
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Sandy Clay Loam

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

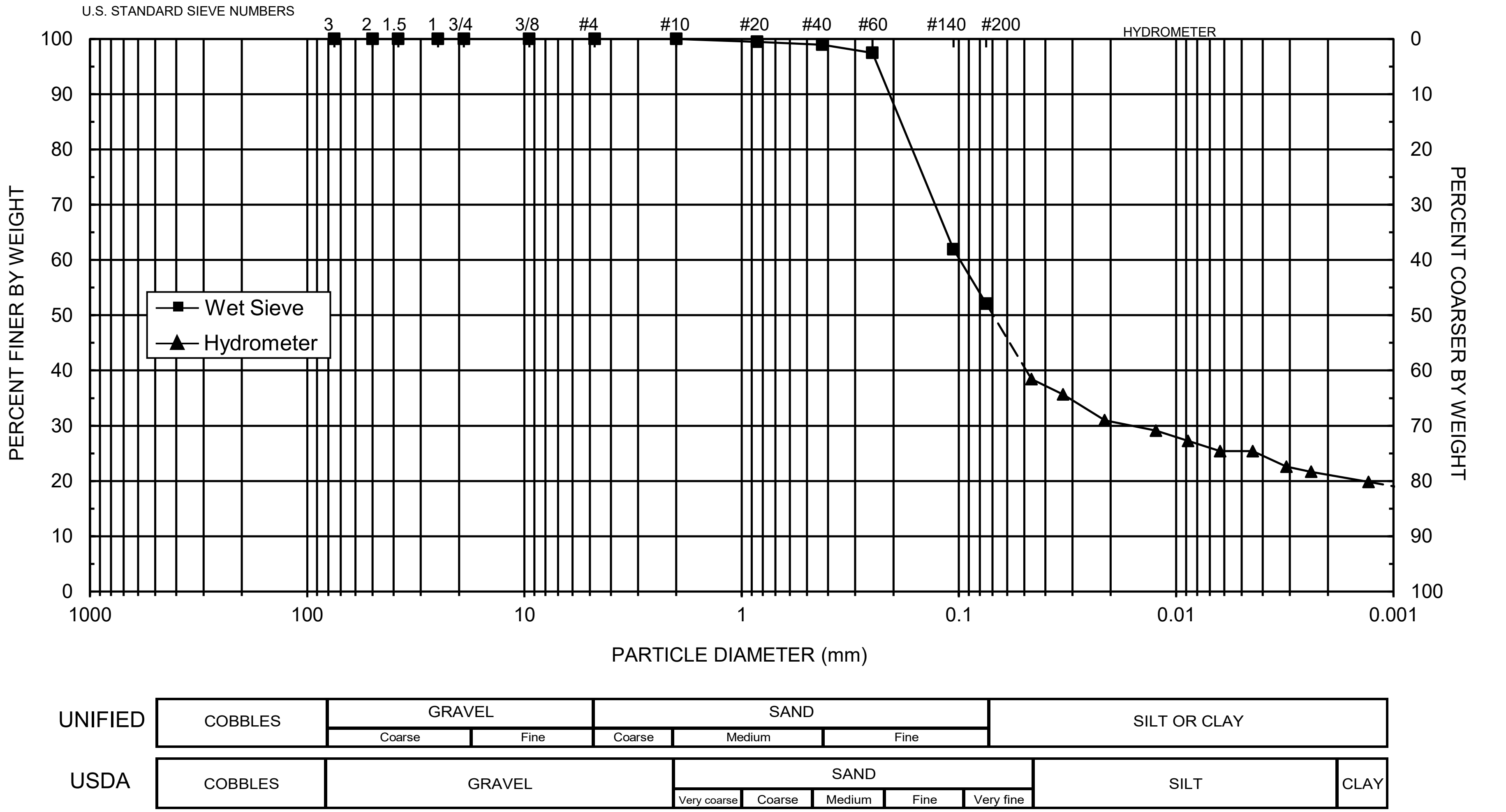
Job Name:	Stantec Consulting Services Inc	*Type of Water Used:*	DISTILLED
Job Number:	DB18.1151.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	T/O-1 (45'B)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	St. Anthony Geotech Investigation	*Assumed particle density:*	2.65
PO Number:	233001076-DBS	*Initial Wt. (g):*	53.68
Test Date:	15-May-18	*Total Sample Wt. (g):*	440.68
Start Time:	9:54	*Wt. Passing #10 (g):*	440.68

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **5.1E-05**	d_{30} = **0.016**	d_{50} = **0.070**	d_{60} = **0.099**	C_u = **1941**	C_c = **51**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
T/O-1 (45'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Clay Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: T/O-2 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 23-May-18

Initial Dry Weight of Sample (g): 502.66
Weight Passing #10 (g): 501.78
Weight Retained #10 (g): 0.88
Weight of Hydrometer Sample (g): 52.20
Calculated Weight of Sieve Sample (g): 52.29

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	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 calculated 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: T/O-2 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18
Start Time: 9:06

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

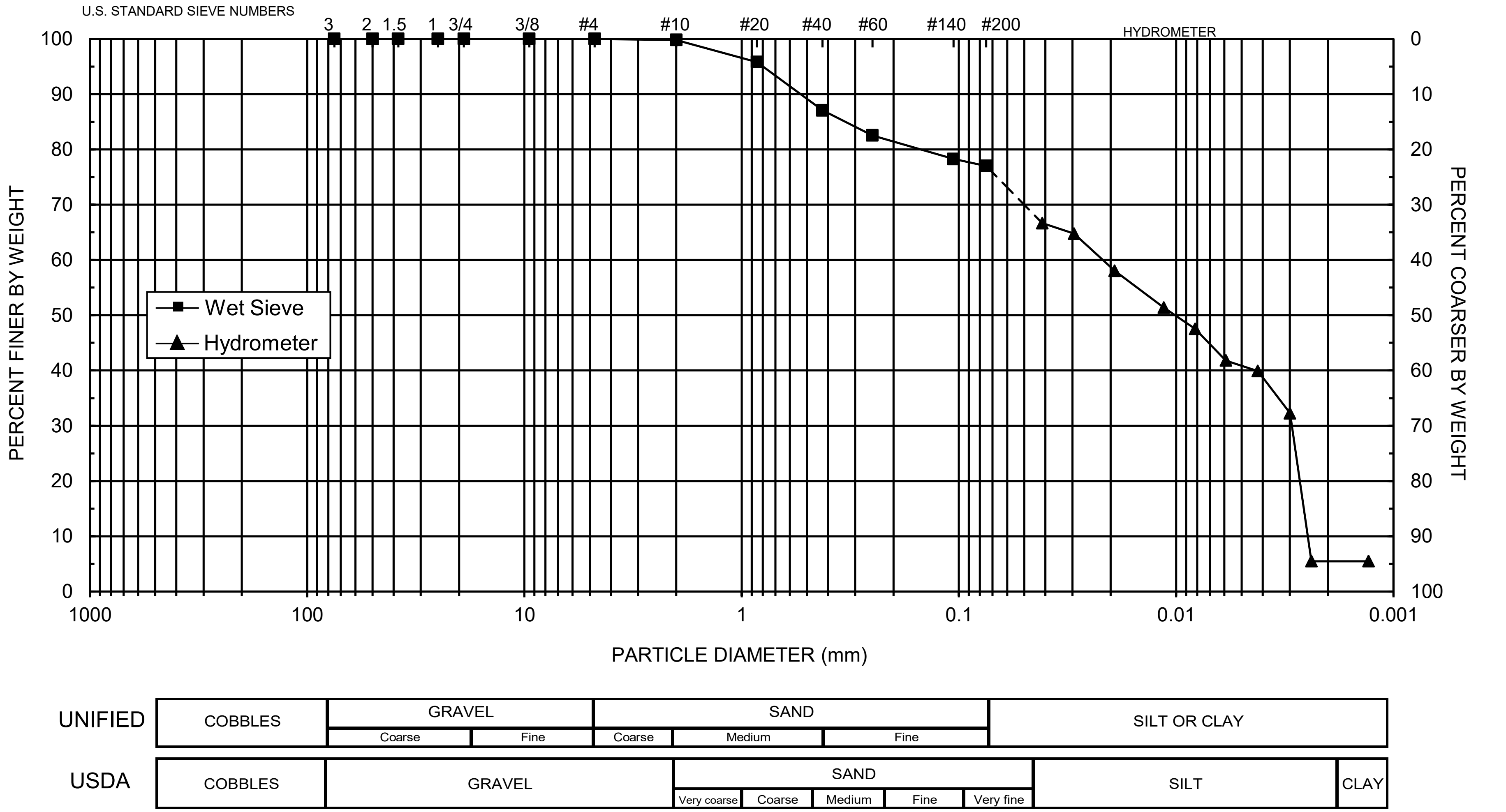
Initial Wt. (g): 52.20
Total Sample Wt. (g): 502.66
Wt. Passing #10 (g): 501.78

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0025**	d_{30} = **0.0029**	d_{50} = **0.010**	d_{60} = **0.022**	C_u = **8.8**	C_c = **0.15**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
T/O-2 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Silt Loam**

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: T/O-3 (40'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 24-May-18

Initial Dry Weight of Sample (g): 403.81
Weight Passing #10 (g): 403.64
Weight Retained #10 (g): 0.17
Weight of Hydrometer Sample (g): 53.27
Calculated Weight of Sieve Sample (g): 53.29

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 calculated 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	

d_{10} (mm): 0.00083
d_{16} (mm): 0.0036
d_{30} (mm): 0.041
d_{50} (mm): 0.078
d_{60} (mm): 0.10
d_{84} (mm): 0.18

Median Particle Diameter --d_{50} (mm): 0.078
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 120
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 20
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (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_{10} 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: T/O-3 (40'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18
Start Time: 9:12

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

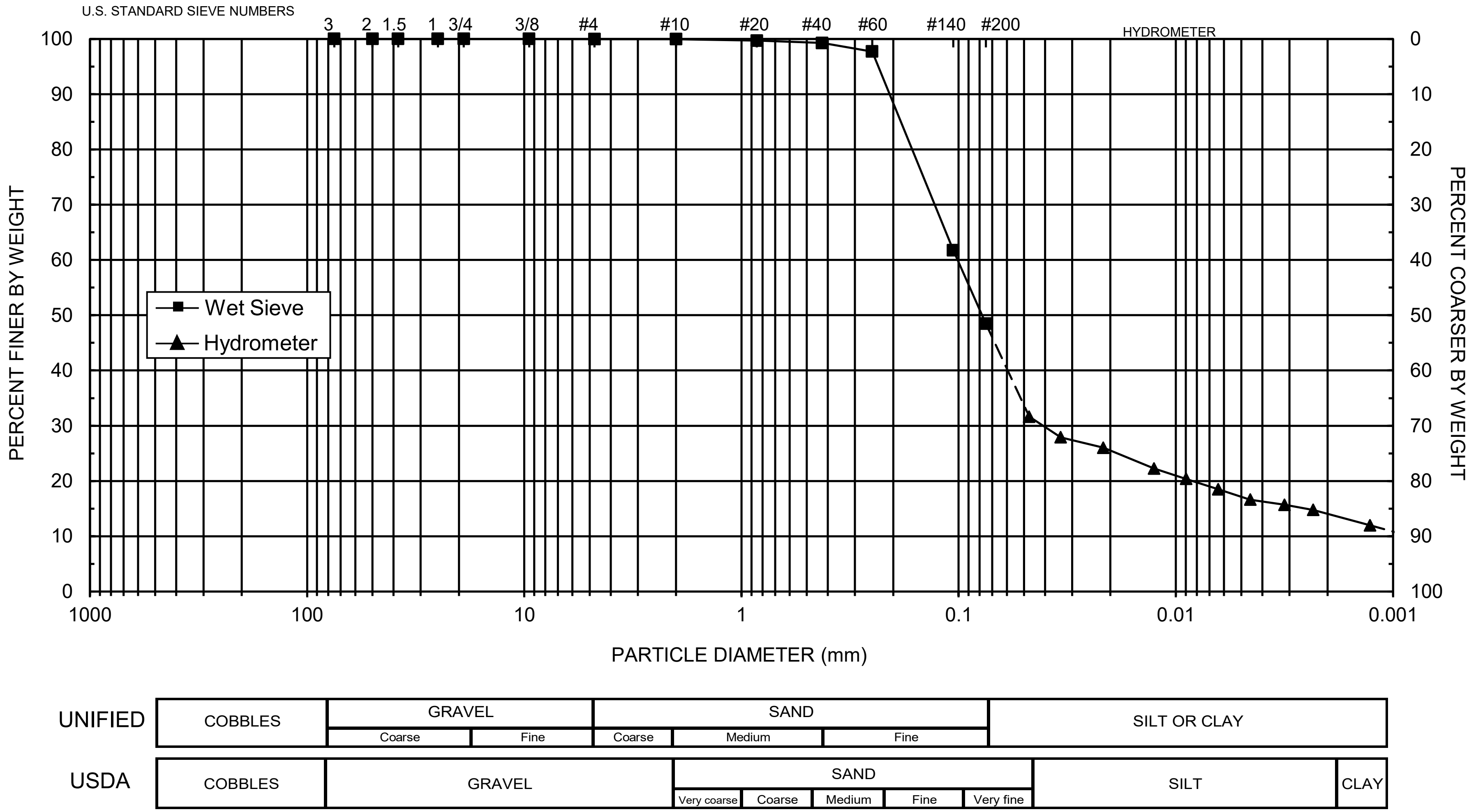
Initial Wt. (g): 53.27
Total Sample Wt. (g): 403.81
Wt. Passing #10 (g): 403.64

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00083**	d_{30} = **0.041**	d_{50} = **0.078**	d_{60} = **0.10**	C_u = **120**	C_c = **20**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
T/O-3 (40'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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
Job Number: DB18.1151.00
Sample Number: T/O-3 (70'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 22-May-18

Initial Dry Weight of Sample (g): 563.72
Weight Passing #10 (g): 558.38
Weight Retained #10 (g): 5.34
Weight of Hydrometer Sample (g): 49.58
Calculated Weight of Sieve Sample (g): 50.05

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 calculated 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	

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

Median Particle Diameter --d_{50} (mm): 0.034
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 141
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 8.4
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.034

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: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Loam

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

Particle Size Analysis
Hydrometer Data

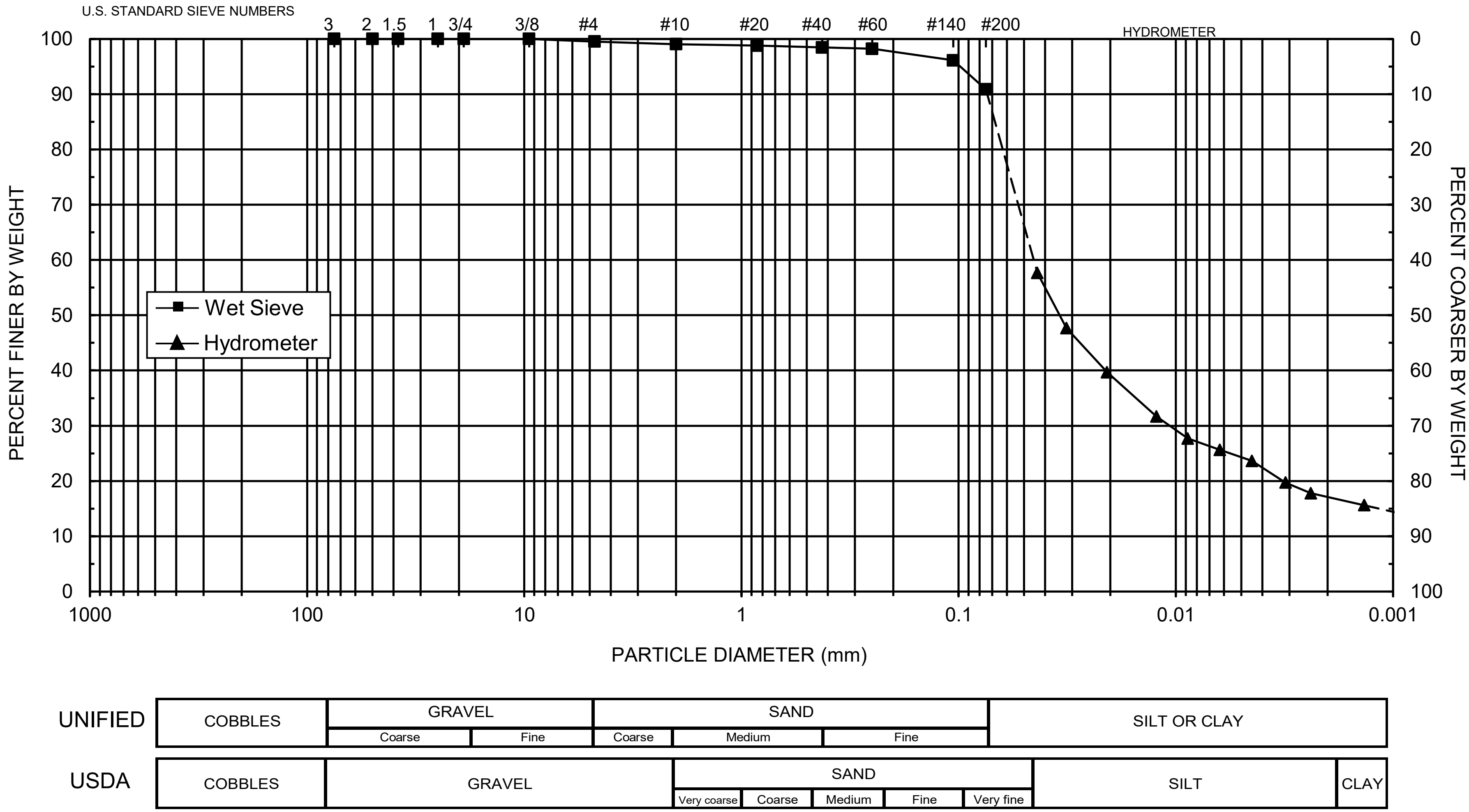
Job Name:	Stantec Consulting Services Inc	*Type of Water Used:*	DISTILLED
Job Number:	DB18.1151.00	*Reaction with H_2O_2:*	NA
Sample Number:	T/O-3 (70'B)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	St. Anthony Geotech Investigation	*Assumed particle density:*	2.65
PO Number:	233001076-DBS	*Initial Wt. (g):*	49.58
Test Date:	17-May-18	*Total Sample Wt. (g):*	563.72
Start Time:	9:48	*Wt. Passing #10 (g):*	558.38

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00032**	d_{30} = **0.011**	d_{50} = **0.034**	d_{60} = **0.045**	C_u = **141**	C_c = **8.4**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
T/O-3 (70'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: T/O-4 (20'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 24-May-18

Initial Dry Weight of Sample (g): 454.63
Weight Passing #10 (g): 454.63
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 53.65
Calculated Weight of Sieve Sample (g): 53.65

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 calculated 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	

d_{10} (mm): 0.00059
d_{16} (mm): 0.0016
d_{30} (mm): 0.011
d_{50} (mm): 0.034
d_{60} (mm): 0.050
d_{84} (mm): 0.11

Median Particle Diameter --d_{50} (mm): 0.034
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 85
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 4.1
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (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_{10} 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: T/O-4 (20'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18
Start Time: 9:18

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

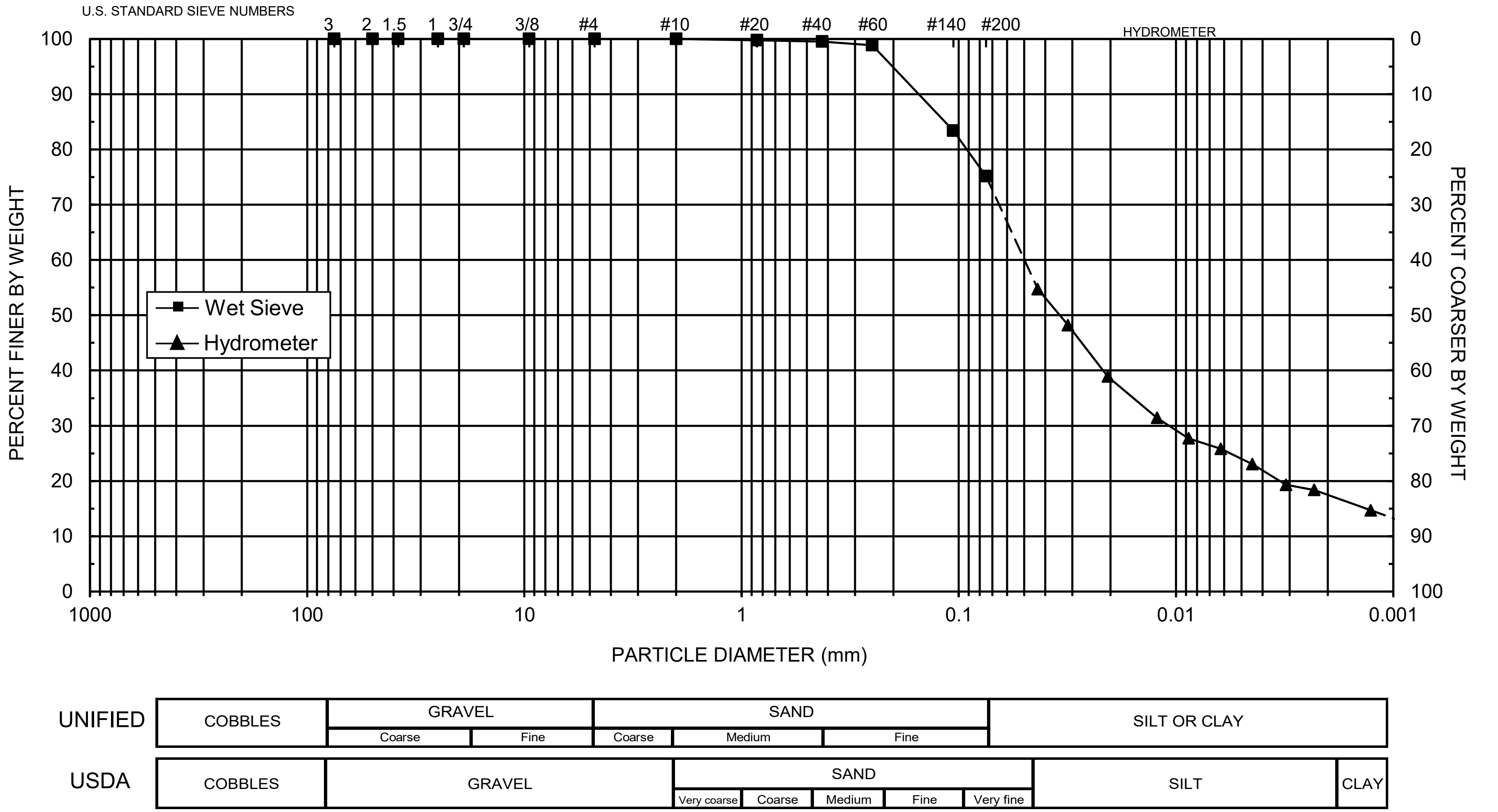
Initial Wt. (g): 53.65
Total Sample Wt. (g): 454.63
Wt. Passing #10 (g): 454.63

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00059**	d_{30} = **0.011**	d_{50} = **0.034**	d_{60} = **0.050**	C_u = **85**	C_c = **4.1**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
T/O-4 (20'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: T/O-5 (10'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 24-May-18

Initial Dry Weight of Sample (g): 402.66
Weight Passing #10 (g): 402.55
Weight Retained #10 (g): 0.11
Weight of Hydrometer Sample (g): 52.88
Calculated Weight of Sieve Sample (g): 52.89

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 calculated 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	

d_{10} (mm): 0.0011
d_{16} (mm): 0.0025
d_{30} (mm): 0.0100
d_{50} (mm): 0.028
d_{60} (mm): 0.039
d_{84} (mm): 0.066

Median Particle Diameter --d_{50} (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 --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: T/O-5 (10'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18
Start Time: 9:24

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

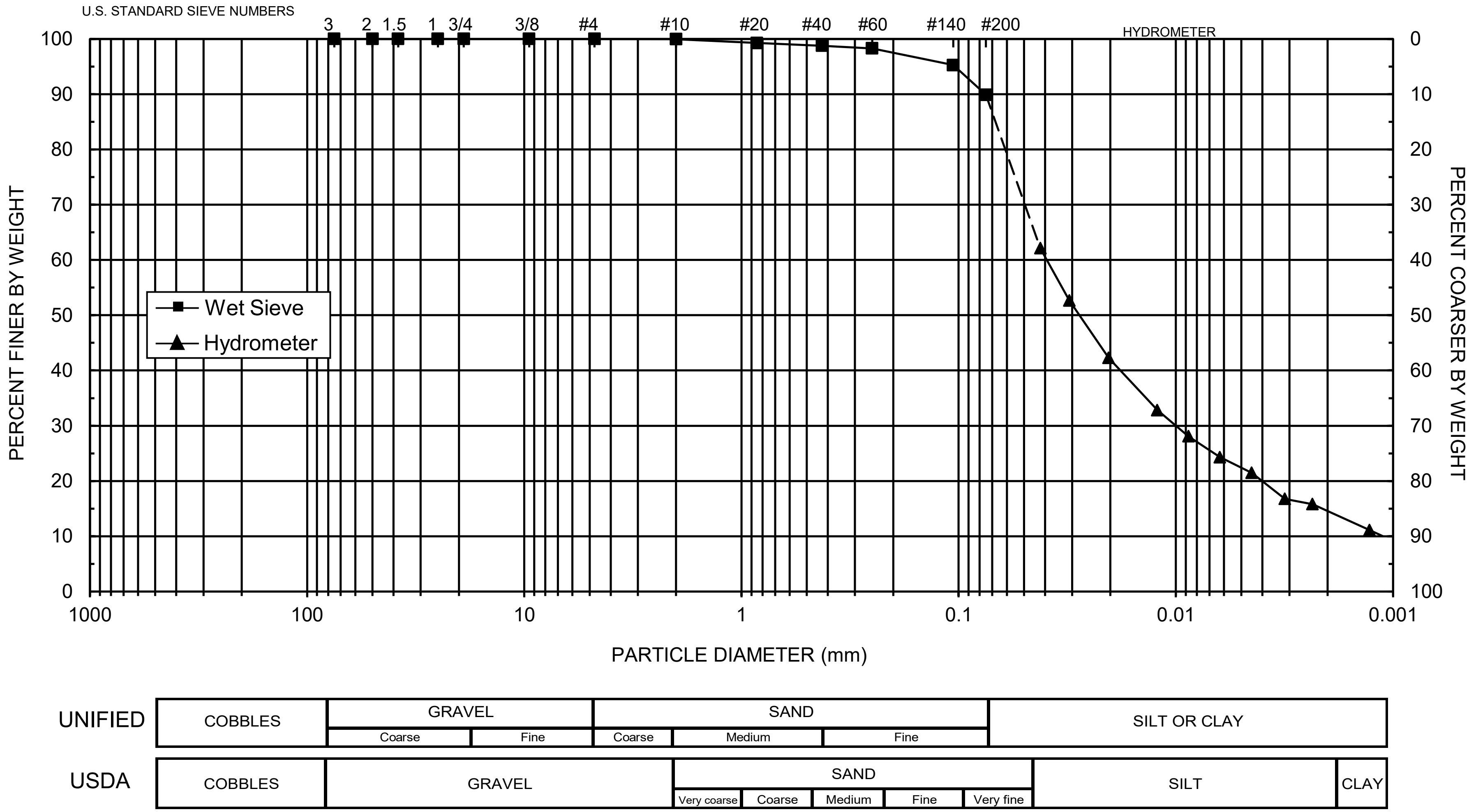
Initial Wt. (g): 52.88
Total Sample Wt. (g): 402.66
Wt. Passing #10 (g): 402.55

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0011**	d_{30} = **0.010**	d_{50} = **0.028**	d_{60} = **0.039**	C_u = **35**	C_c = **2.3**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
T/O-5 (10'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Silt Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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

Test Date: 18-May-18

Initial Dry Weight of Sample (g): 507.52
Weight Passing #10 (g): 507.52
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 49.32
Calculated Weight of Sieve Sample (g): 49.32

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 calculated 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	

d_{10} (mm): 0.00066
d_{16} (mm): 0.0020
d_{30} (mm): 0.018
d_{50} (mm): 0.043
d_{60} (mm): 0.054
d_{84} (mm): 0.099

Median Particle Diameter --d_{50} (mm): 0.043
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 82
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 9.1
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Loam

Laboratory analysis by: E. Bastien
Data entered by: M. Garcia
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 16-May-18
Start Time: 9:42

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

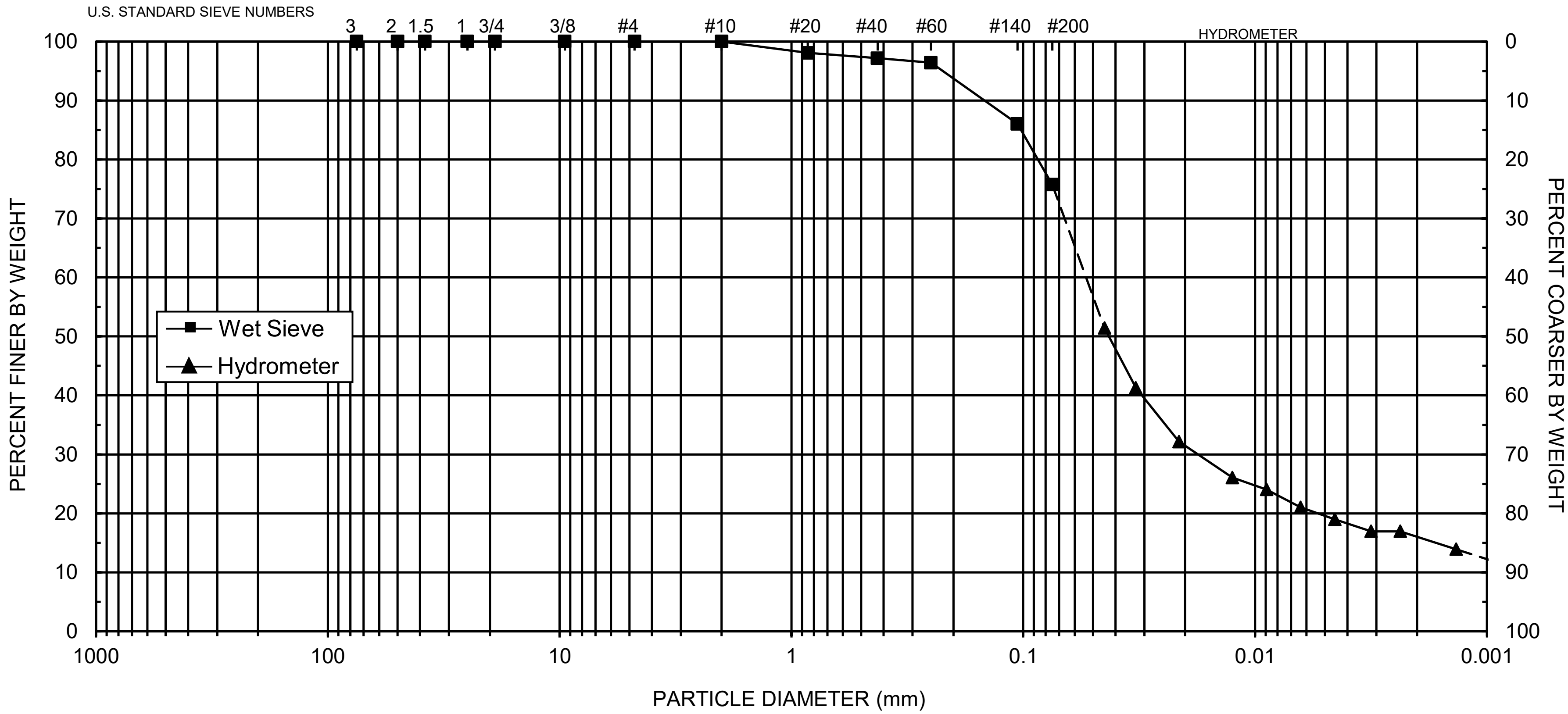
Initial Wt. (g): 49.32
Total Sample Wt. (g): 507.52
Wt. Passing #10 (g): 507.52

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY					
		Coarse	Fine	Coarse	Medium	Fine						
USDA	COBBLES	GRAVEL	SAND					SILT	CLAY			
			Very coarse	Coarse	Medium	Fine	Very fine					

d_{10} = **0.00066**	d_{30} = **0.018**	d_{50} = **0.043**	d_{60} = **0.054**	C_u = **82**	C_c = **9.1**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
T/O-6 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam**

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):*	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						
	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 calculated 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_{10} (mm):	0.00074	d_{50} (mm):	0.077
d_{16} (mm):	0.0022	d_{60} (mm):	0.097
d_{30} (mm):	0.035	d_{84} (mm):	0.18

Median Particle Diameter --d_{50} (mm): 0.077

Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 131

Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 17

Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.086

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: 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: TN-1 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

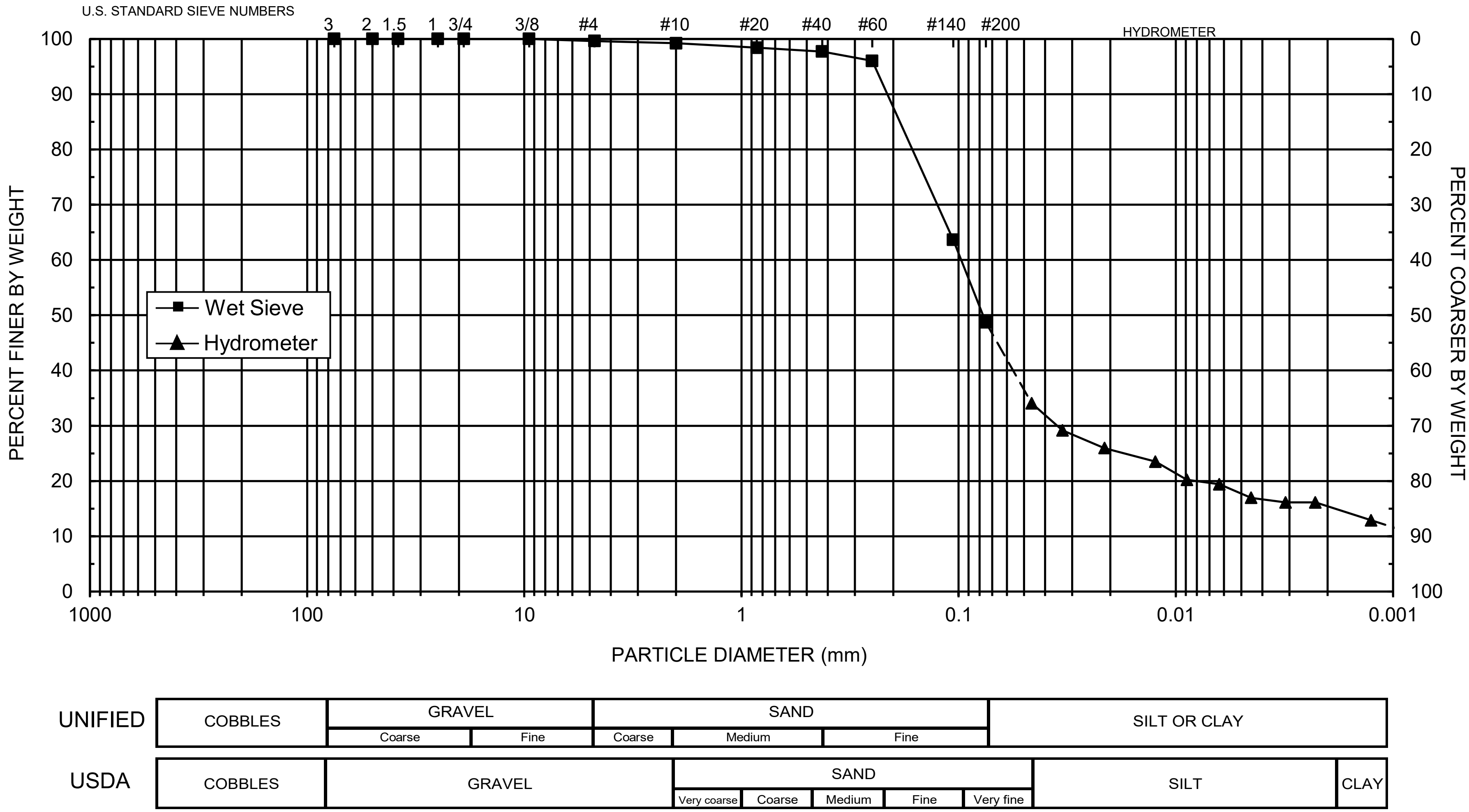
Initial Wt. (g): 60.67
Total Sample Wt. (g): 489.48
Wt. Passing #10 (g): 485.66

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00074**	d_{30} = **0.035**	d_{50} = **0.077**	d_{60} = **0.097**	C_u = **131**	C_c = **17**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
TN-1 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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
Job Number: DB18.1151.00
Sample Number: TN-2 (20'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18

Initial Dry Weight of Sample (g): 276.75
Weight Passing #10 (g): 276.75
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 68.55
Calculated Weight of Sieve Sample (g): 68.55

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	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 calculated 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	

d_{10} (mm): 0.00077
d_{16} (mm): 0.0036
d_{30} (mm): 0.037
d_{50} (mm): 0.079
d_{60} (mm): 0.10
d_{84} (mm): 0.18

Median Particle Diameter --d_{50} (mm): 0.079
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 130
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 18
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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
Job Number: DB18.1151.00
Sample Number: TN-2 (20'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 16-May-18
Start Time: 9:36

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

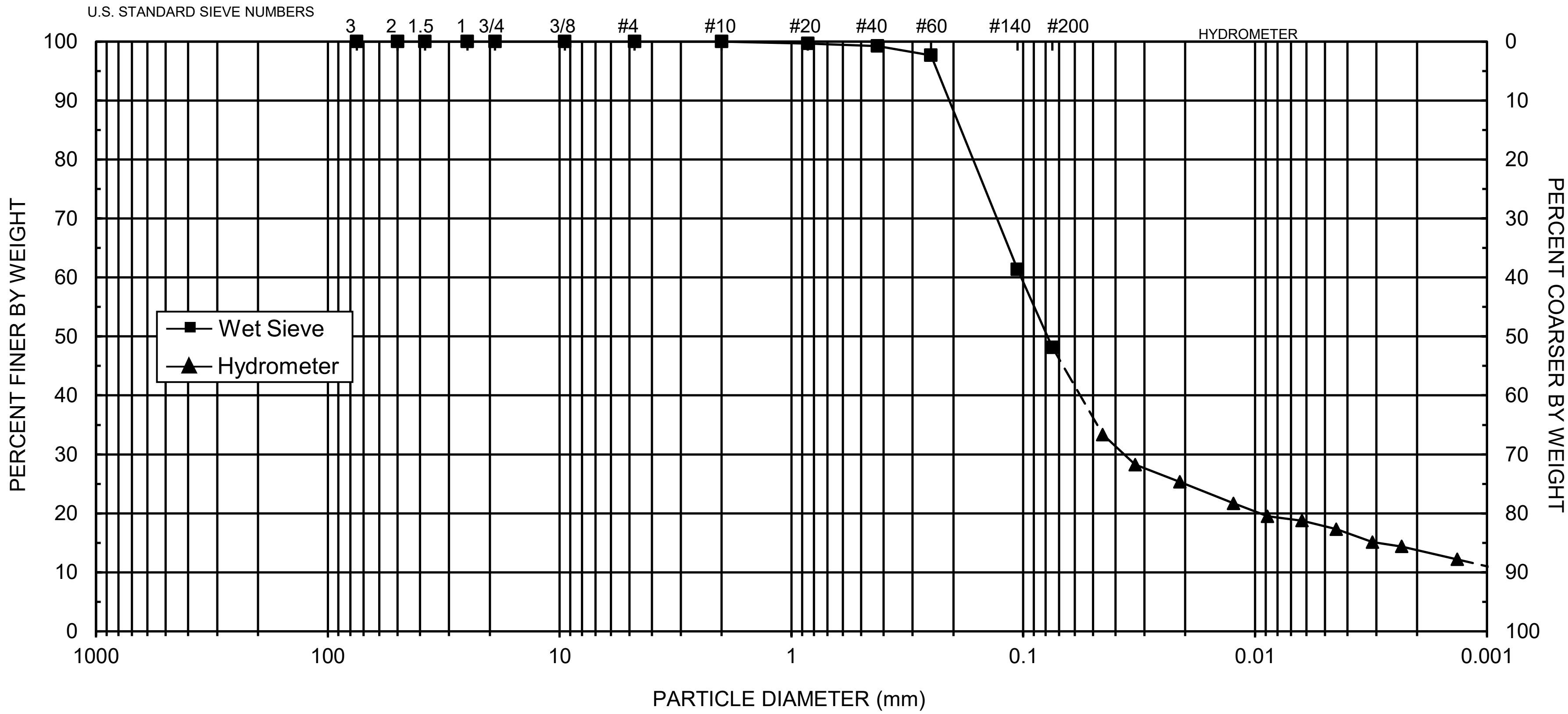
Initial Wt. (g): 68.55
Total Sample Wt. (g): 276.75
Wt. Passing #10 (g): 276.75

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



UNIFIED	COBBLES	GRAVEL Coarse	GRAVEL Fine	SAND Coarse	SAND Medium	SAND Fine	SILT OR CLAY	
USDA	COBBLES	GRAVEL	SAND Very coarse	SAND Coarse	SAND Medium	SAND Fine	SAND Very fine	SILT / CLAY

d_{10} = **0.00077**	d_{30} = **0.037**	d_{50} = **0.079**	d_{60} = **0.10**	C_u = **130**	C_c = **18**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
TN-2 (20'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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
Test Date: 18-May-18

Initial Dry Weight of Sample (g): 426.30
Weight Passing #10 (g): 426.30
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 56.34
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 calculated 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	

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

Median Particle Diameter --d_{50} (mm): 0.052
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 262
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 4.4
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Sandy Clay 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
Job Number: DB18.1151.00
Sample Number: BS-1 (10'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 16-May-18
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

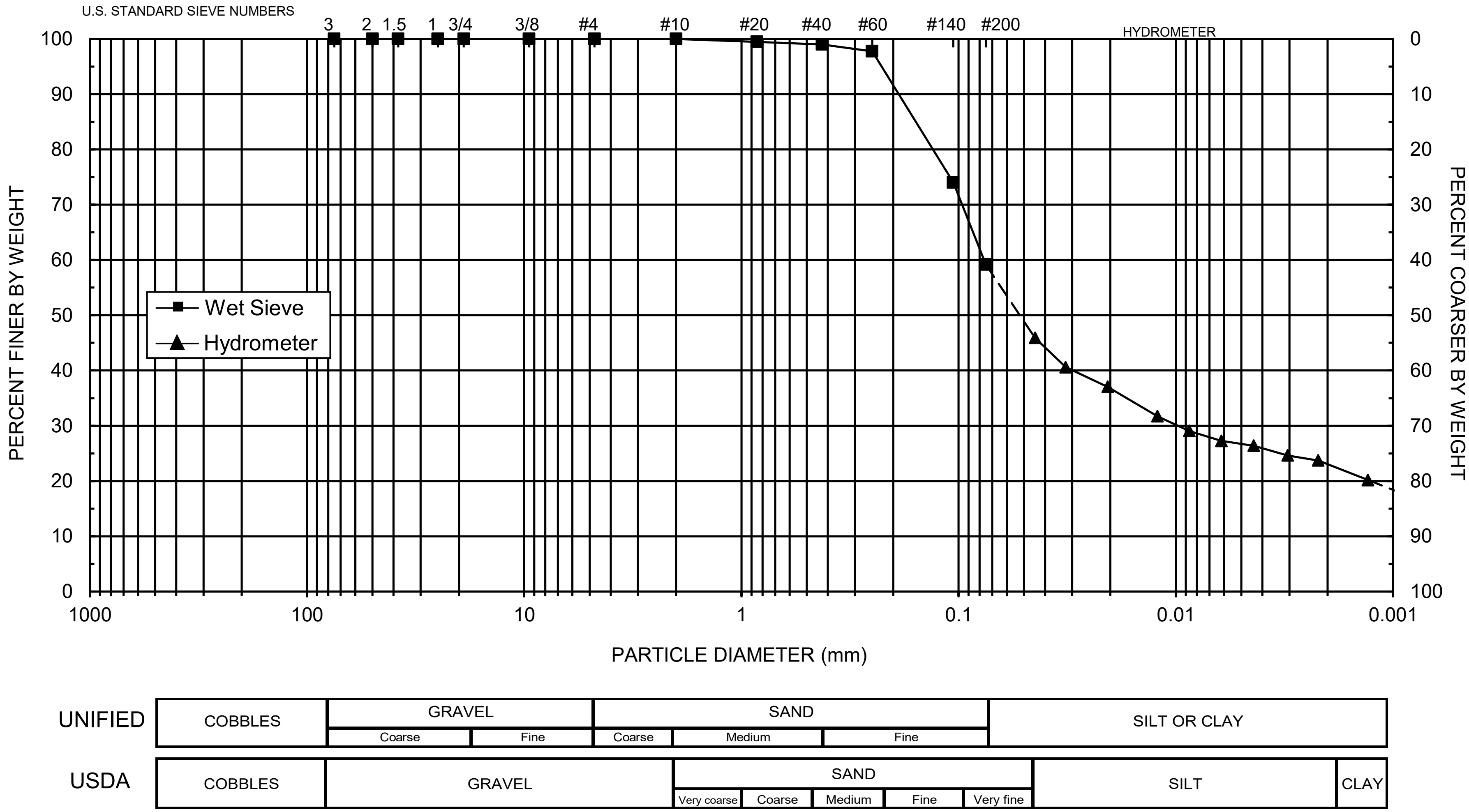
Initial Wt. (g): 56.34
Total Sample Wt. (g): 426.30
Wt. Passing #10 (g): 426.30

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00029**	d_{30} = **0.0098**	d_{50} = **0.052**	d_{60} = **0.076**	C_u = **262**	C_c = **4.4**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
BS-1 (10'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Clay Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: BS-2 (15'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 18-May-18

Initial Dry Weight of Sample (g): 413.95
Weight Passing #10 (g): 413.95
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 53.66
Calculated Weight of Sieve Sample (g): 53.66

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	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 calculated 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_{10} (mm): 0.0039 d_{50} (mm): 0.061
d_{16} (mm): 0.0048 d_{60} (mm): 0.082
d_{30} (mm): 0.014 d_{84} (mm): 0.18

Median Particle Diameter --d_{50} (mm): 0.061
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 21
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 0.61
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: BS-2 (15'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 16-May-18
Start Time: 9:06

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

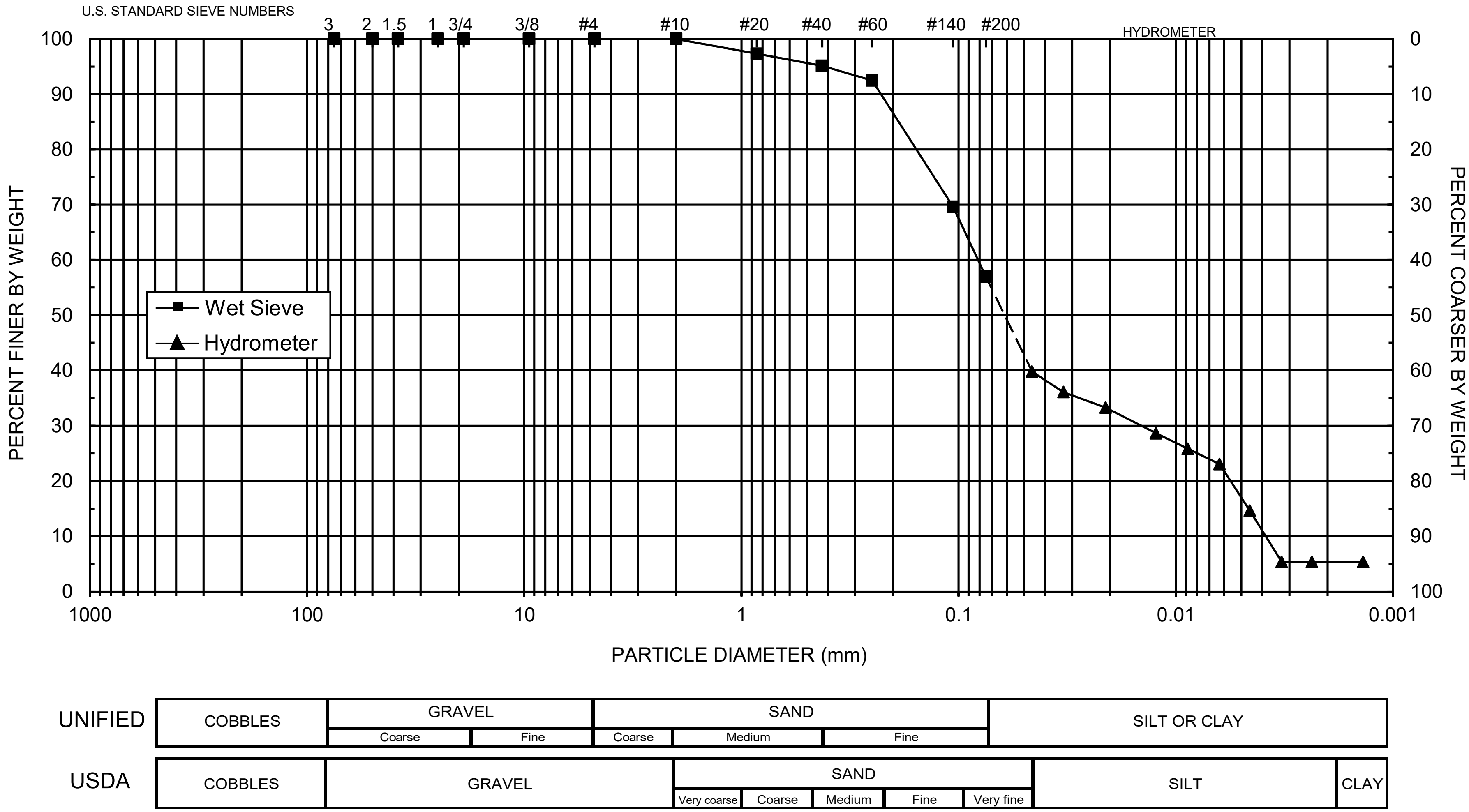
Initial Wt. (g): 53.66
Total Sample Wt. (g): 413.95
Wt. Passing #10 (g): 413.95

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0039**	d_{30} = **0.014**	d_{50} = **0.061**	d_{60} = **0.082**	C_u = **21**	C_c = **0.61**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
BS-2 (15'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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
Test Date: 18-May-18

Initial Dry Weight of Sample (g): 371.11
Weight Passing #10 (g): 371.11
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 56.55
Calculated Weight of Sieve Sample (g): 56.55

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 calculated 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	

d_{10} (mm): 0.00018
d_{16} (mm): 0.0011
d_{30} (mm): 0.022
d_{50} (mm): 0.054
d_{60} (mm): 0.062
d_{84} (mm): 0.097

Median Particle Diameter --d_{50} (mm): 0.054
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 344
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 43
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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
Job Number: DB18.1151.00
Sample Number: BS-6 (20'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 16-May-18
Start Time: 9:12

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

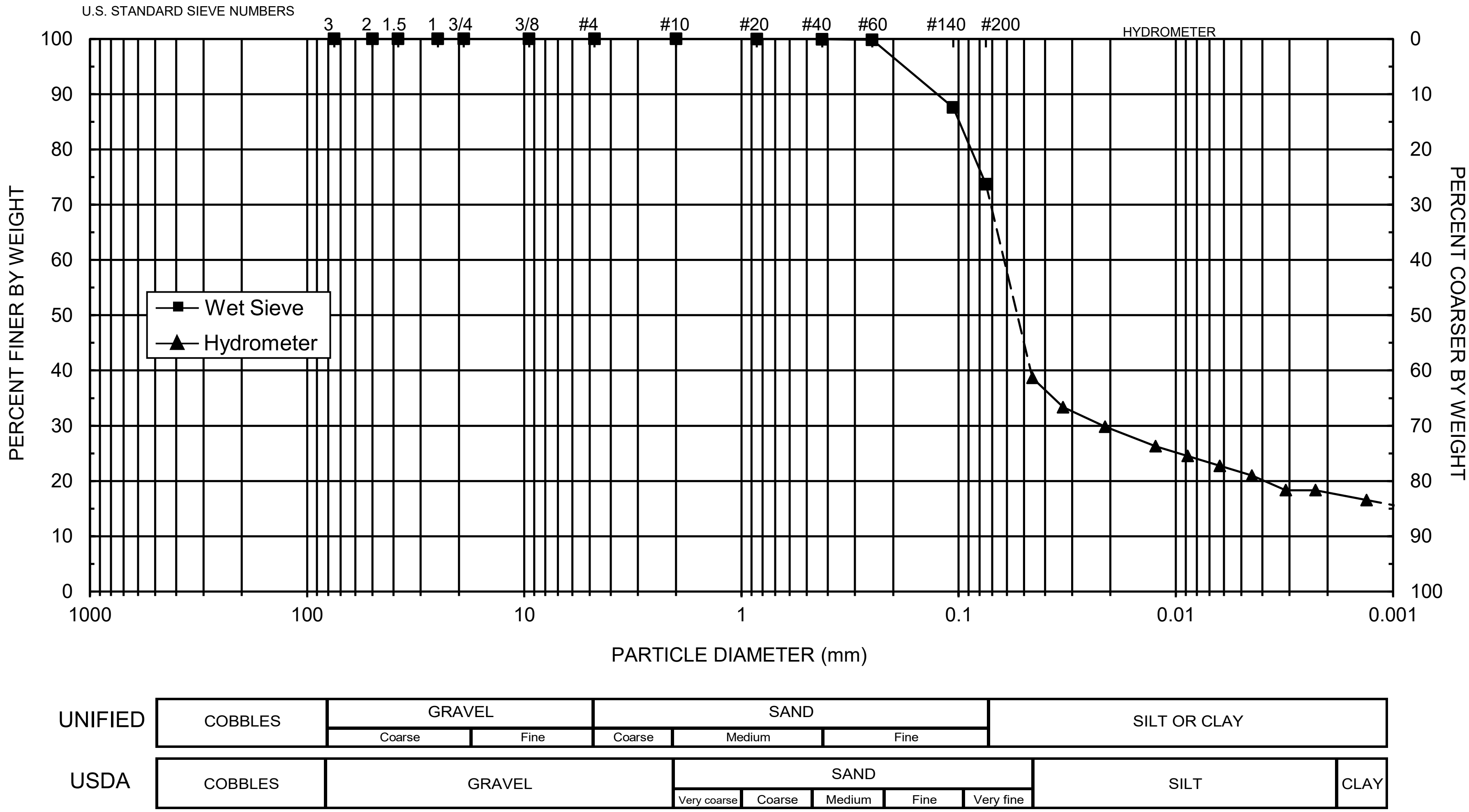
Initial Wt. (g): 56.55
Total Sample Wt. (g): 371.11
Wt. Passing #10 (g): 371.11

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00018**	d_{30} = **0.022**	d_{50} = **0.054**	d_{60} = **0.062**	C_u = **344**	C_c = **43**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
BS-6 (20'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: TS-1 (20'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 24-May-18

Initial Dry Weight of Sample (g): 512.99
Weight Passing #10 (g): 510.37
Weight Retained #10 (g): 2.62
Weight of Hydrometer Sample (g): 56.02
Calculated Weight of Sieve Sample (g): 56.31

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	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 calculated 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	

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

Median Particle Diameter --d_{50} (mm): 0.035
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 48
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 2.0
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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
Job Number: DB18.1151.00
Sample Number: TS-1 (20'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18
Start Time: 9:48

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

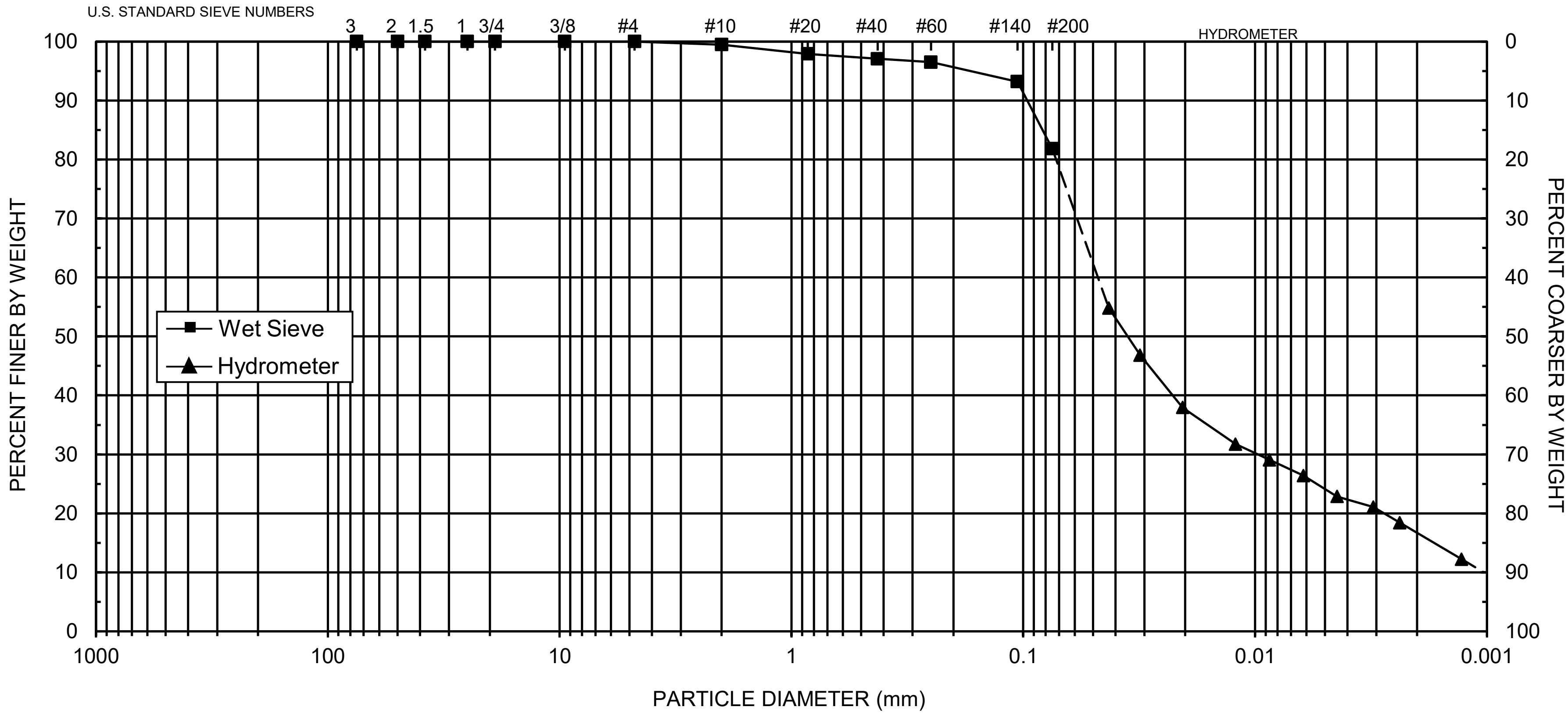
Initial Wt. (g): 56.02
Total Sample Wt. (g): 512.99
Wt. Passing #10 (g): 510.37

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine	

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.0010**	d_{30} = **0.0098**	d_{50} = **0.035**	d_{60} = **0.048**	C_u = **48**	C_c = **2.0**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
TS-1 (20'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: TS-2 (10'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18

Initial Dry Weight of Sample (g): 343.53
Weight Passing #10 (g): 343.53
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 57.64
Calculated Weight of Sieve Sample (g): 57.64

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	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 calculated 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_{10} (mm): 0.0019
d_{16} (mm): 0.0027
d_{30} (mm): 0.026
d_{50} (mm): 0.087
d_{60} (mm): 0.12
d_{84} (mm): 0.20

Median Particle Diameter --d_{50} (mm): 0.087
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 63
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 3.0
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: TS-2 (10'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 16-May-18
Start Time: 9:48

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

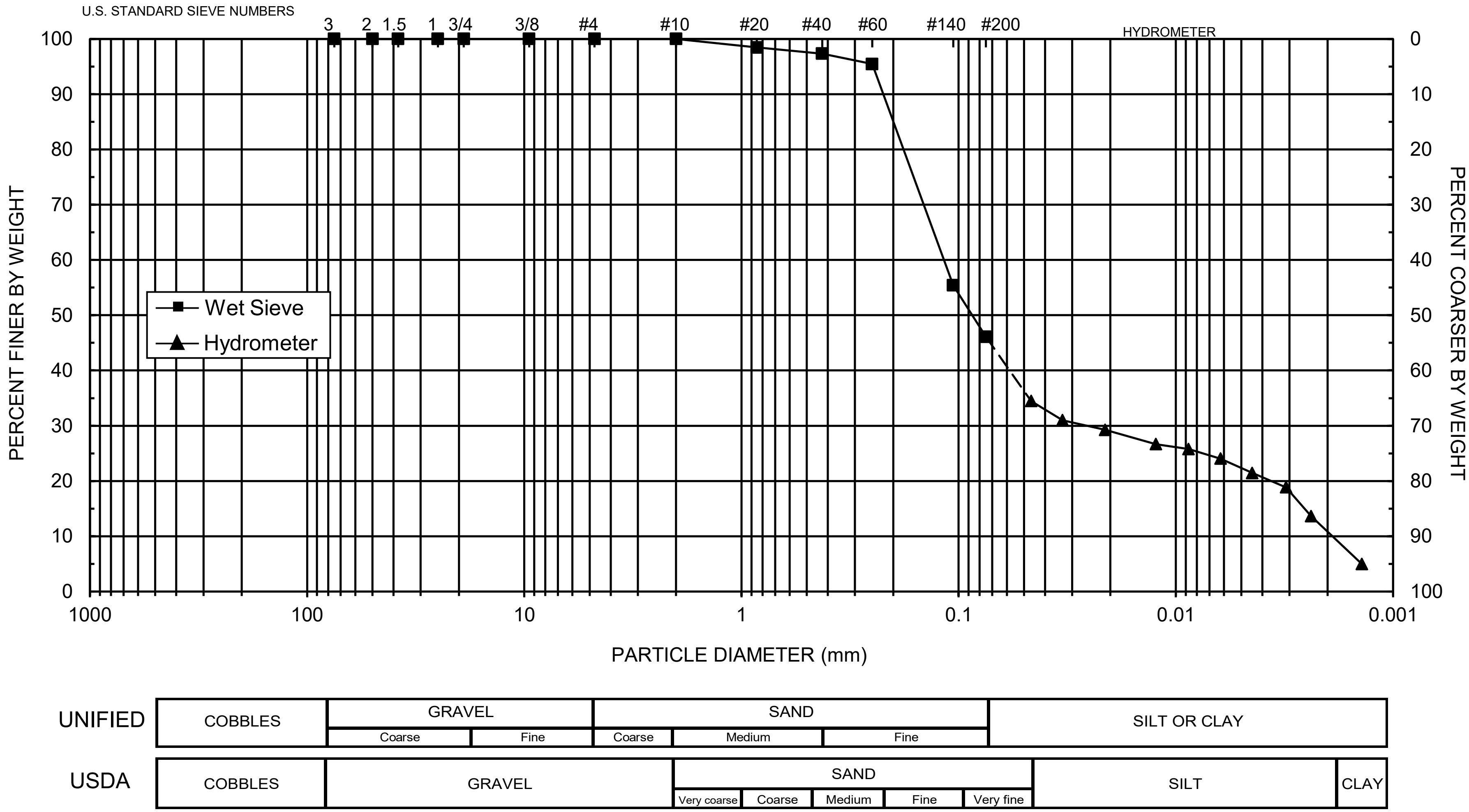
Initial Wt. (g): 57.64
Total Sample Wt. (g): 343.53
Wt. Passing #10 (g): 343.53

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0019**	d_{30} = **0.026**	d_{50} = **0.087**	d_{60} = **0.12**	C_u = **63**	C_c = **3.0**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
TS-2 (10'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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
Test Date: 18-May-18

Initial Dry Weight of Sample (g): 470.01
Weight Passing #10 (g): 469.83
Weight Retained #10 (g): 0.18
Weight of Hydrometer Sample (g): 57.40
Calculated Weight of Sieve Sample (g): 57.42

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	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 calculated 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	

d_{10} (mm): 0.00086
d_{16} (mm): 0.0023
d_{30} (mm): 0.013
d_{50} (mm): 0.043
d_{60} (mm): 0.051
d_{84} (mm): 0.075

Median Particle Diameter --d_{50} (mm): 0.043
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 59
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 3.9
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 16-May-18
Start Time: 9:54

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

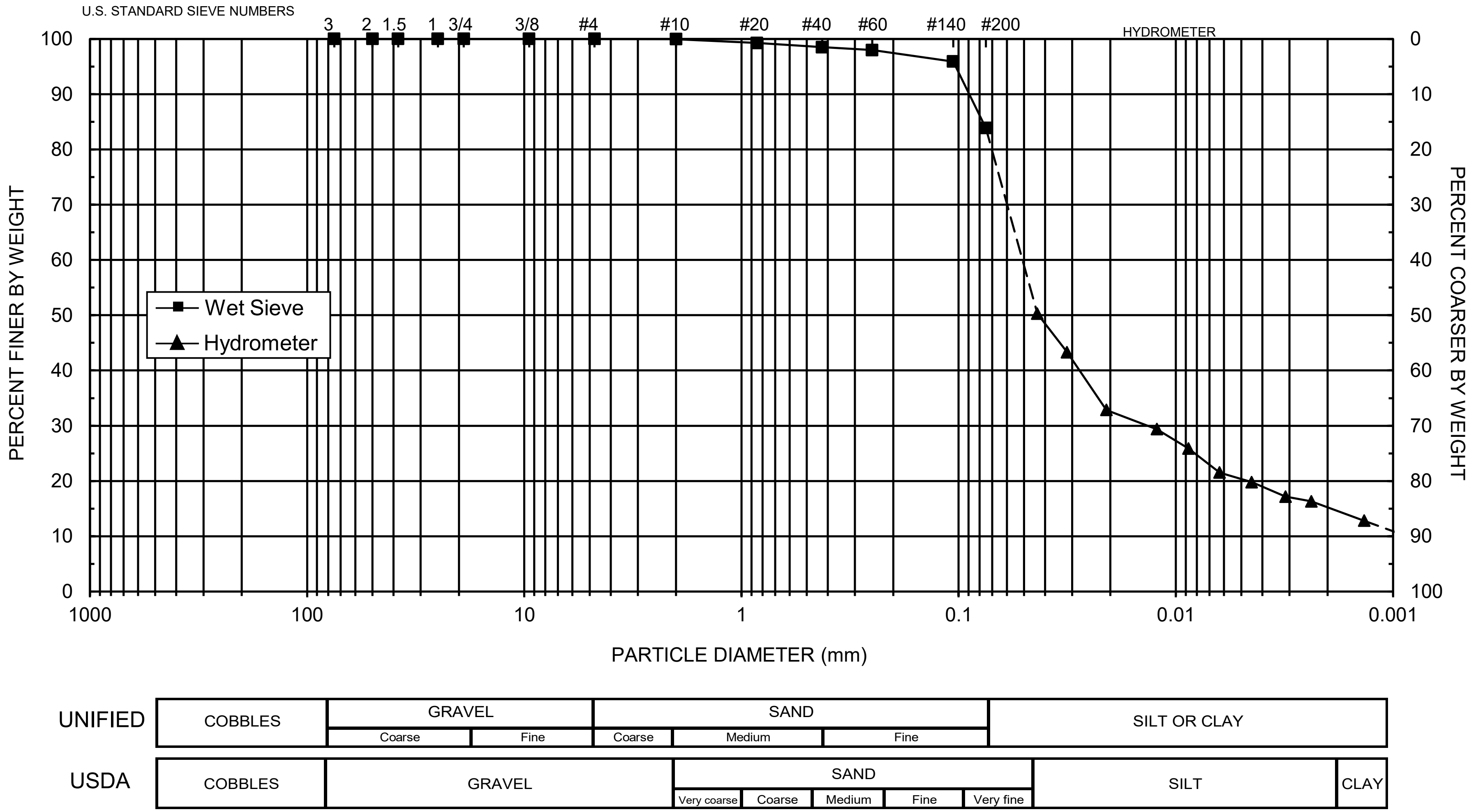
Initial Wt. (g): 57.40
Total Sample Wt. (g): 470.01
Wt. Passing #10 (g): 469.83

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00086**	d_{30} = **0.013**	d_{50} = **0.043**	d_{60} = **0.051**	C_u = **59**	C_c = **3.9**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
TS-3 (10'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: TS-4 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 24-May-18

Initial Dry Weight of Sample (g): 536.95
Weight Passing #10 (g): 522.77
Weight Retained #10 (g): 14.18
Weight of Hydrometer Sample (g): 52.41
Calculated Weight of Sieve Sample (g): 53.83

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 calculated 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	

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

Median Particle Diameter --d_{50} (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 --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.11

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: 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: TS-4 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18
Start Time: 9:54

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

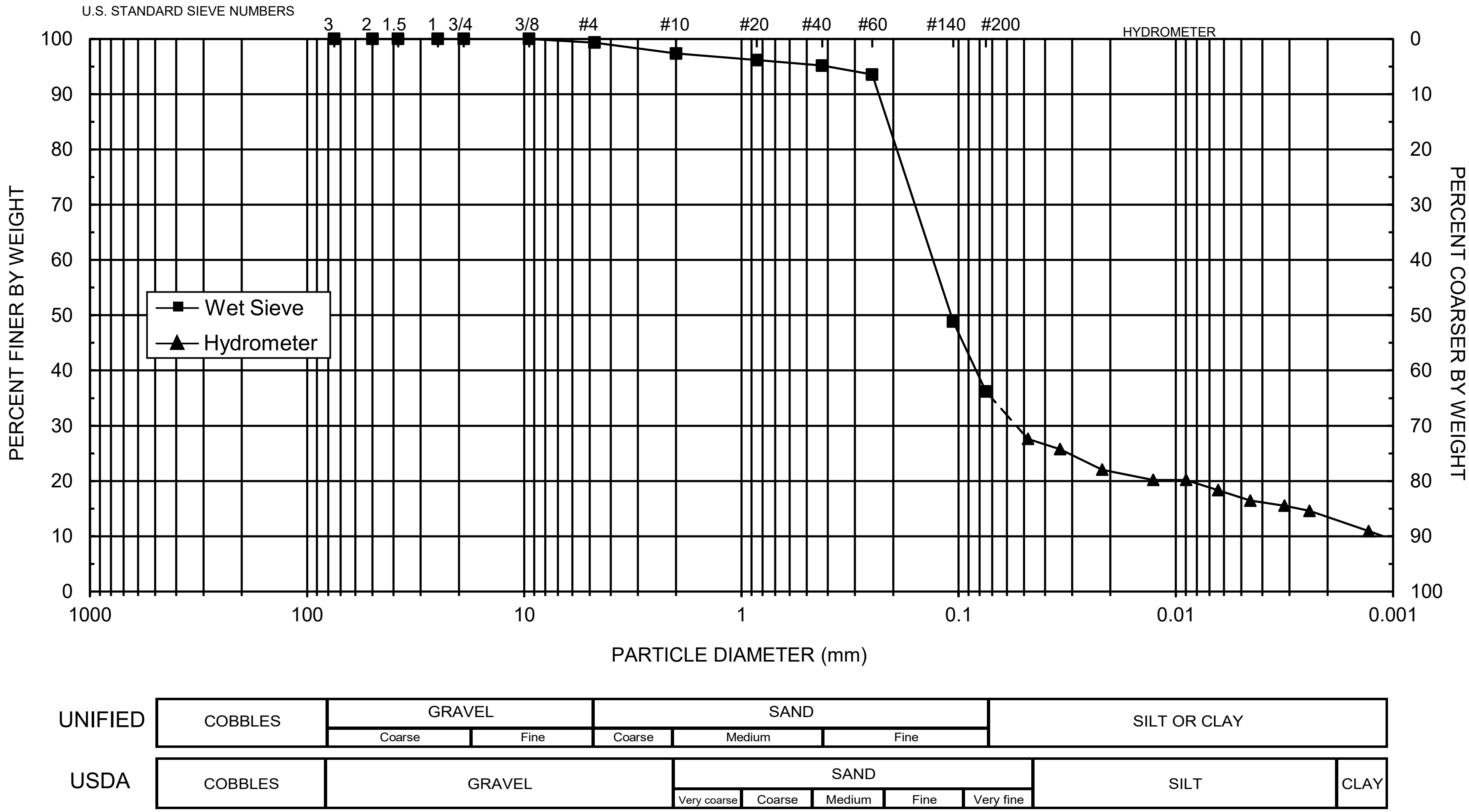
Initial Wt. (g): 52.41
Total Sample Wt. (g): 536.95
Wt. Passing #10 (g): 522.77

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0011**	d_{30} = **0.054**	d_{50} = **0.11**	d_{60} = **0.13**	C_u = **118**	C_c = **20**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
TS-4 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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
Job Number: DB18.1151.00
Sample Number: P1-1 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 21-May-18

Initial Dry Weight of Sample (g): 323.18
Weight Passing #10 (g): 254.78
Weight Retained #10 (g): 68.40
Weight of Hydrometer Sample (g): 68.64
Calculated Weight of Sieve Sample (g): 87.07

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	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 calculated 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_{50} (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 --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

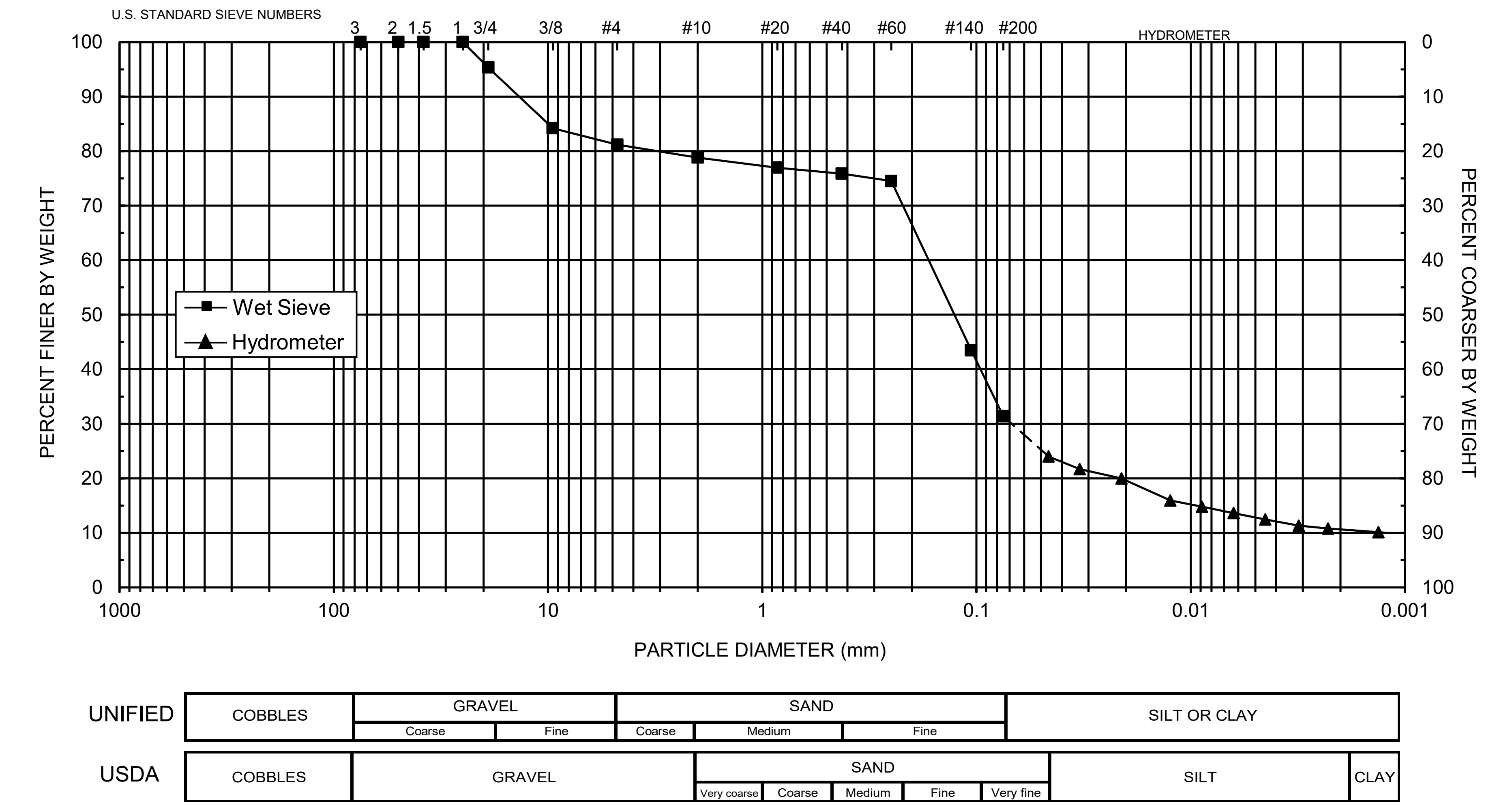
Job Name:	Stantec Consulting Services Inc	*Type of Water Used:*	DISTILLED
Job Number:	DB18.1151.00	*Reaction with H_2O_2:*	NA
Sample Number:	P1-1 (5'A)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	St. Anthony Geotech Investigation	*Assumed particle density:*	2.65
PO Number:	233001076-DBS	*Initial Wt. (g):*	68.64
Test Date:	17-May-18	*Total Sample Wt. (g):*	323.18
Start Time:	9:00	*Wt. Passing #10 (g):*	254.78

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0012**	d_{30} = **0.069**	d_{50} = **0.13**	d_{60} = **0.17**	C_u = **142**	C_c = **23**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P1-1 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam** †

† Greater than 10% of sample is coarse material

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: P1-2 (30'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 21-May-18

Initial Dry Weight of Sample (g): 268.32
Weight Passing #10 (g): 210.98
Weight Retained #10 (g): 57.34
Weight of Hydrometer Sample (g): 57.55
Calculated Weight of Sieve Sample (g): 73.19

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 calculated 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_{16} (mm): 0.0071
d_{30} (mm): 0.058
d_{50} (mm): 0.11
d_{60} (mm): 0.16
d_{84} (mm): 12

Median Particle Diameter --d_{50} (mm): 0.11
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 160
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 21
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: P1-2 (30'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 17-May-18
Start Time: 9:06

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

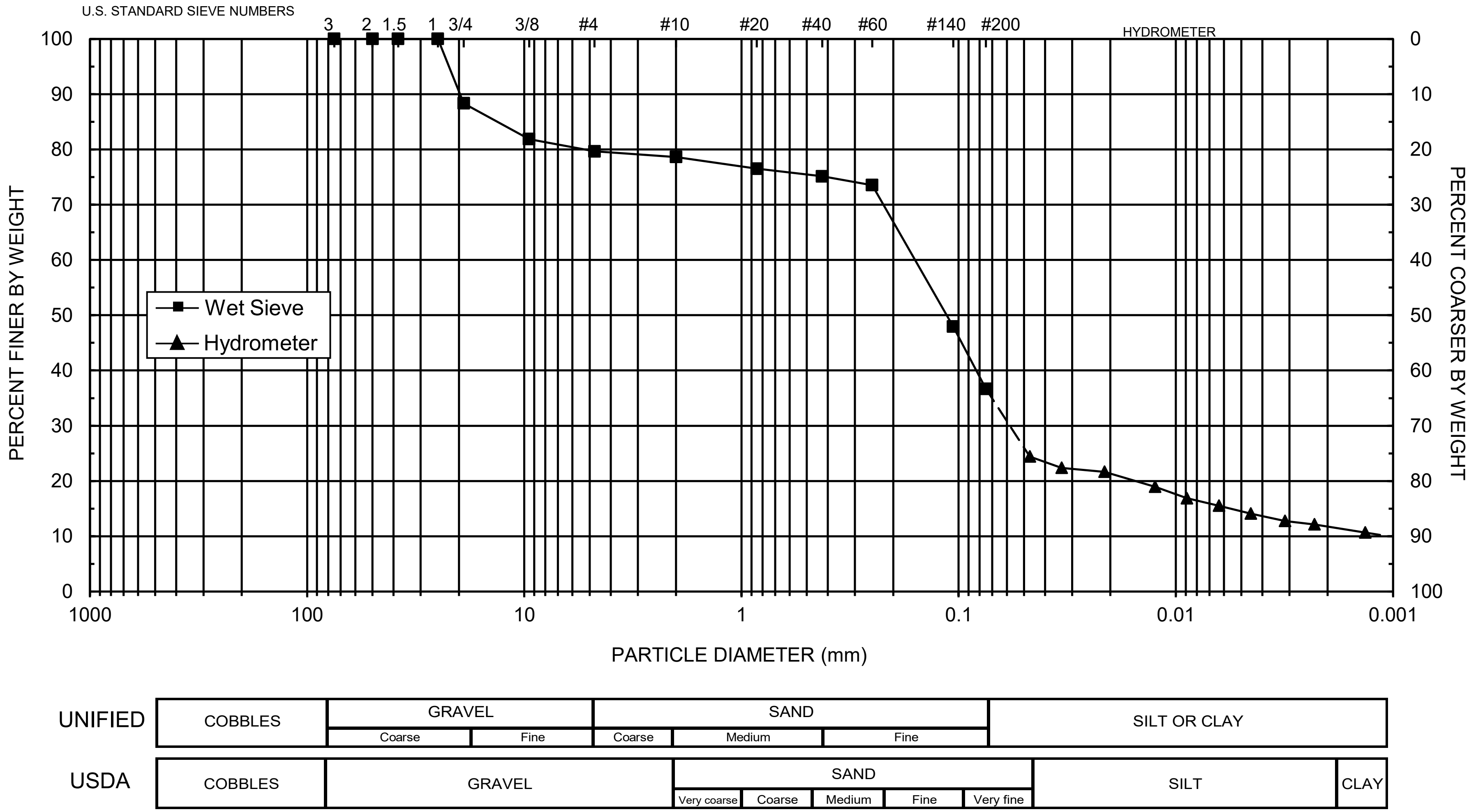
Initial Wt. (g): 57.55
Total Sample Wt. (g): 268.32
Wt. Passing #10 (g): 210.98

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0010**	d_{30} = **0.058**	d_{50} = **0.11**	d_{60} = **0.16**	C_u = **160**	C_c = **21**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P1-2 (30'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam †**

† Greater than 10% of sample is coarse material

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
Job Number: DB18.1151.00
Sample Number: P2-1 (25'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 21-May-18

Initial Dry Weight of Sample (g): 487.96
Weight Passing #10 (g): 485.94
Weight Retained #10 (g): 2.02
Weight of Hydrometer Sample (g): 59.29
Calculated Weight of Sieve Sample (g): 59.54

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	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 calculated 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	

d_{10} (mm): 0.00071
d_{16} (mm): 0.0025
d_{30} (mm): 0.030
d_{50} (mm): 0.087
d_{60} (mm): 0.12
d_{84} (mm): 0.21

Median Particle Diameter --d_{50} (mm): 0.087
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 169
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 11
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: P2-1 (25'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 17-May-18
Start Time: 9:12

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

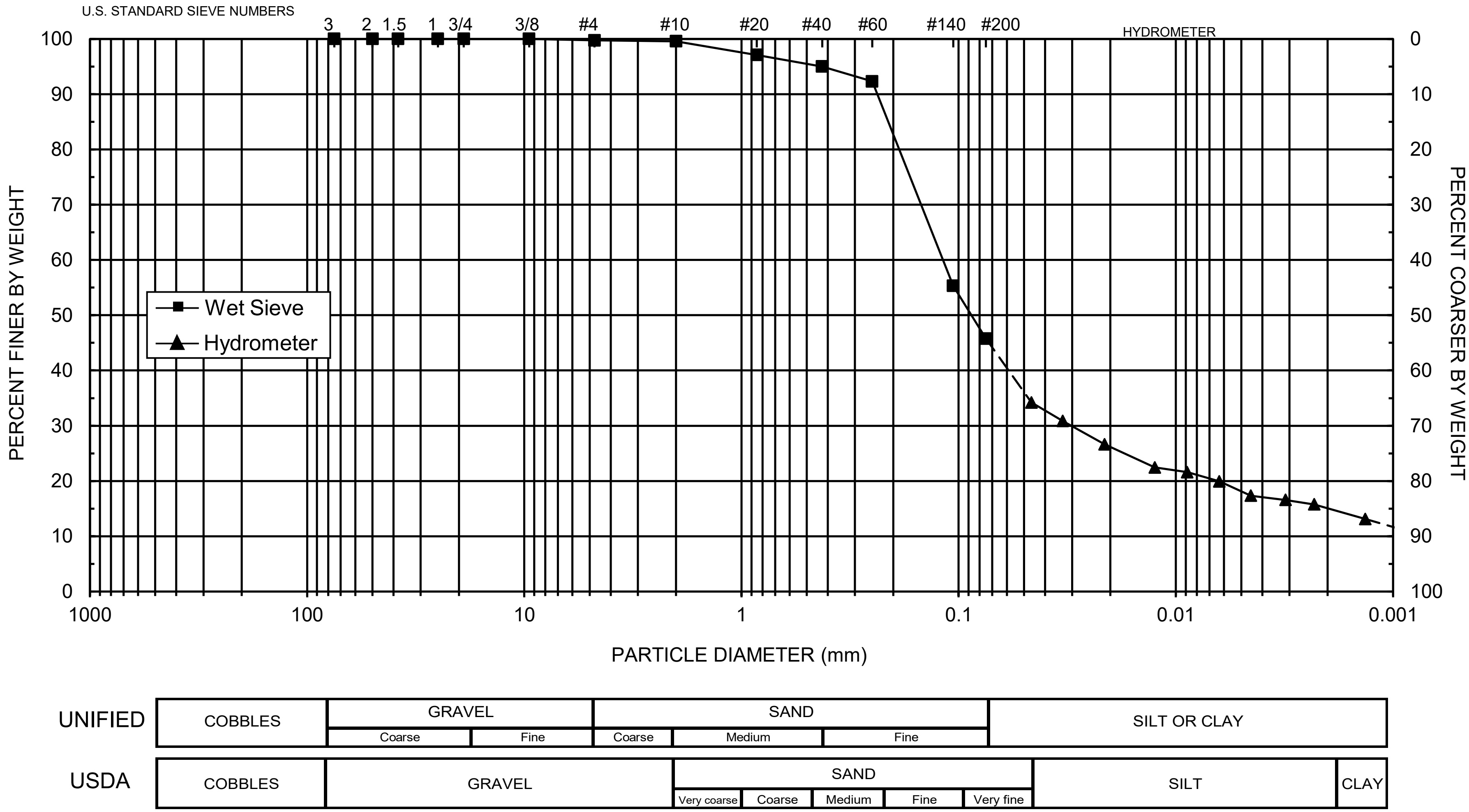
Initial Wt. (g): 59.29
Total Sample Wt. (g): 487.96
Wt. Passing #10 (g): 485.94

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00071**	d_{30} = **0.030**	d_{50} = **0.087**	d_{60} = **0.12**	C_u = **169**	C_c = **11**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P2-1 (25'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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
Job Number: DB18.1151.00
Sample Number: P2-2 (5'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 21-May-18

Initial Dry Weight of Sample (g): 509.13
Weight Passing #10 (g): 474.49
Weight Retained #10 (g): 34.64
Weight of Hydrometer Sample (g): 72.59
Calculated Weight of Sieve Sample (g): 77.89

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 calculated 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_{10} (mm): 0.00078
d_{16} (mm): 0.0027
d_{30} (mm): 0.049
d_{50} (mm): 0.089
d_{60} (mm): 0.11
d_{84} (mm): 0.21

Median Particle Diameter --d_{50} (mm): 0.089
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 141
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 28
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.10

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: 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

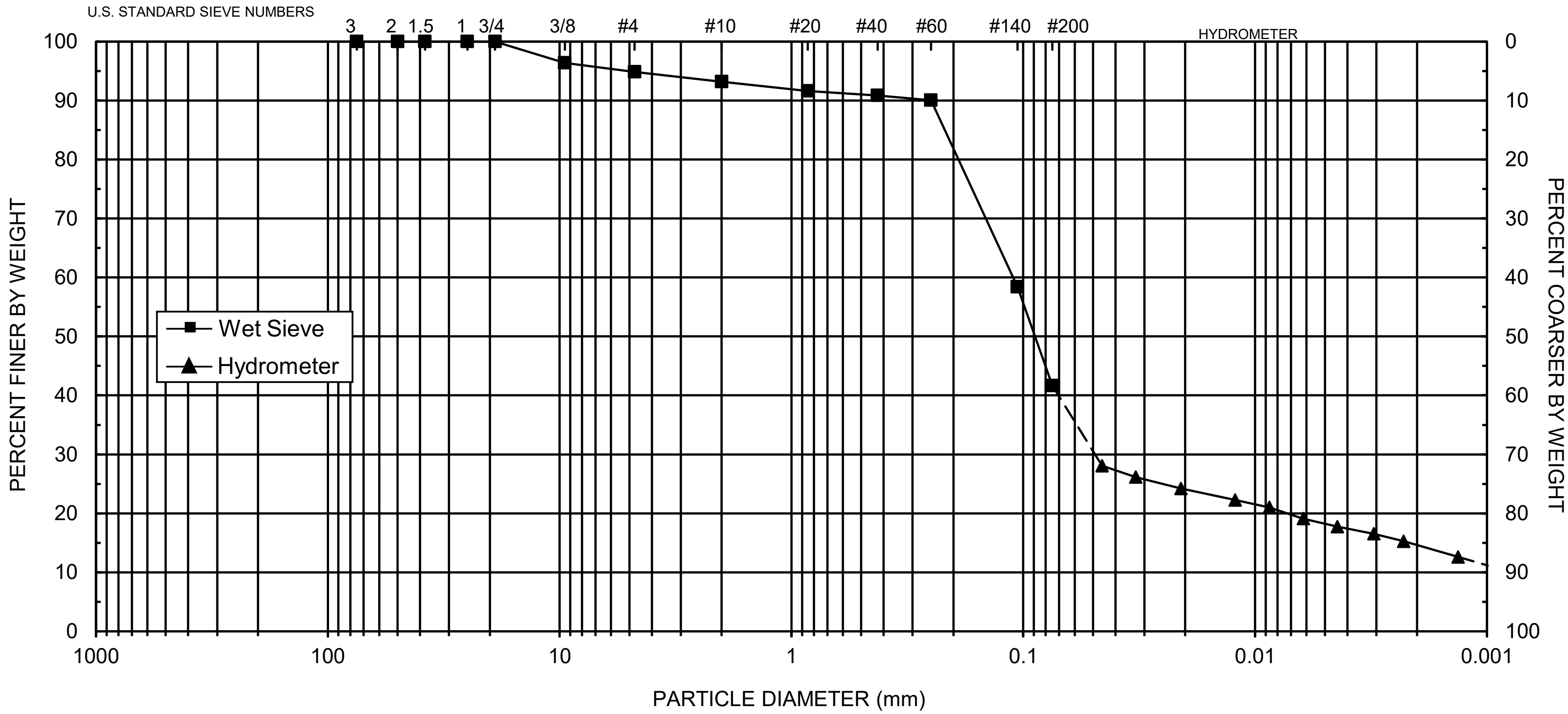
Job Name:	Stantec Consulting Services Inc	*Type of Water Used:*	DISTILLED
Job Number:	DB18.1151.00	*Reaction with H_2O_2:*	NA
Sample Number:	P2-2 (5'B)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	St. Anthony Geotech Investigation	*Assumed particle density:*	2.65
PO Number:	233001076-DBS	*Initial Wt. (g):*	72.59
Test Date:	17-May-18	*Total Sample Wt. (g):*	509.13
Start Time:	9:18	*Wt. Passing #10 (g):*	474.49

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY		
		Coarse	Fine	Coarse	Medium	Fine			
USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.00078**	d_{30} = **0.049**	d_{50} = **0.089**	d_{60} = **0.11**	C_u = **141**	C_c = **28**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P2-2 (5'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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
Job Number: DB18.1151.00
Sample Number: P3-1 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 23-May-18

Initial Dry Weight of Sample (g): 541.45
Weight Passing #10 (g): 418.25
Weight Retained #10 (g): 123.20
Wt. of -10 Sieve Sample (g): 57.93
Calculated Weight of Sieve Sample (g): 74.99

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	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 calculated 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	

d_{10} (mm): NA
d_{16} (mm): 0.078
d_{30} (mm): 0.13
d_{50} (mm): 0.23
d_{60} (mm): 0.33
d_{84} (mm): 7.3

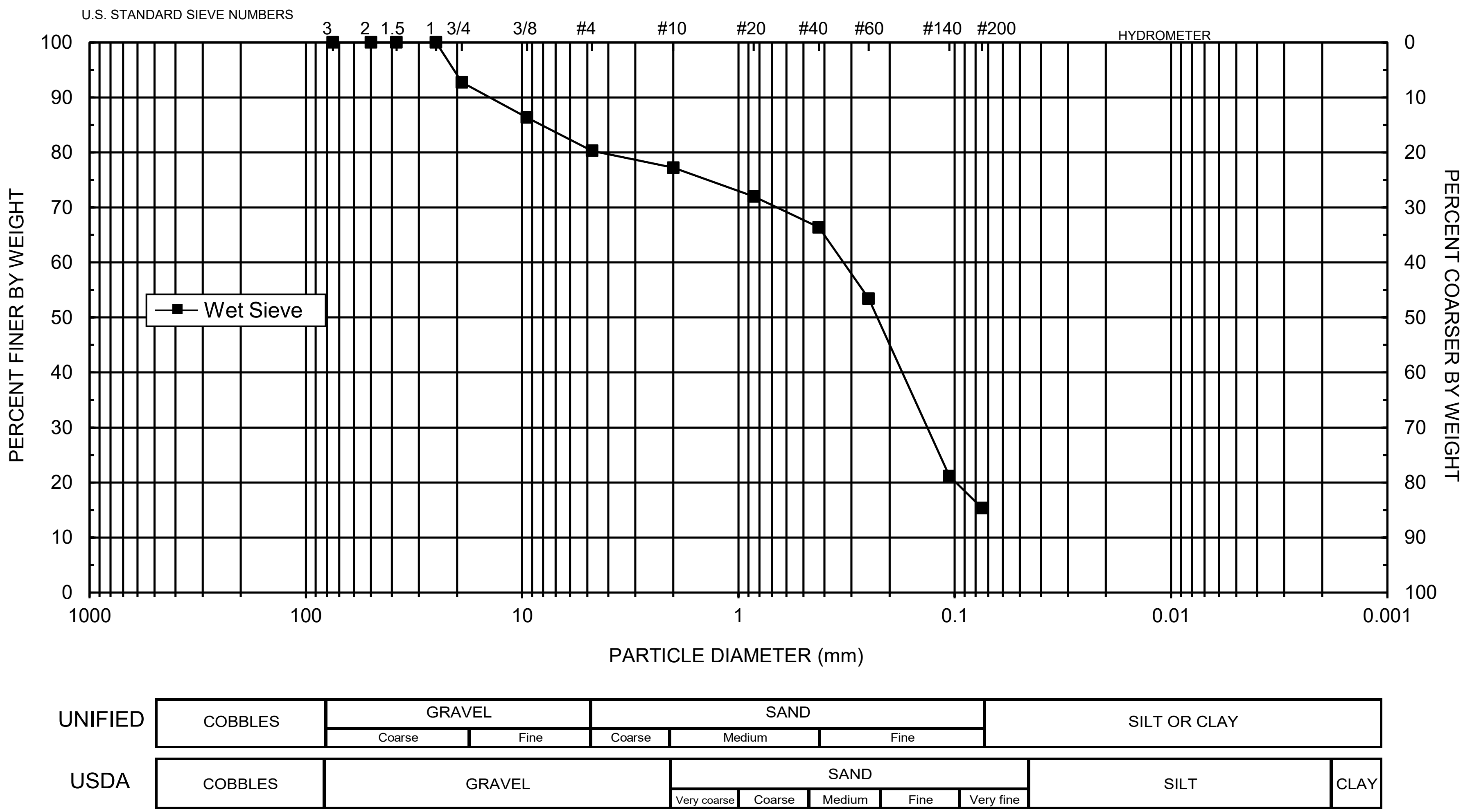
Median Particle Diameter --d_{50} (mm): 0.23
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): NA
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): NA
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 2.5

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 †

† Greater than 10% of sample is coarse material

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **0.13**	d_{50} = **0.23**	d_{60} = **0.33**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-1 (5'A)	**233001076-DBS**	**NA**	**NA †**

† Greater than 10% of sample is coarse material
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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: P3-2 (15'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 23-May-18

Initial Dry Weight of Sample (g): 410.00
Weight Passing #10 (g): 410.00
Weight Retained #10 (g): 0.00
Wt. of -10 Sieve Sample (g): 58.51
Calculated Weight of Sieve Sample (g): 58.51

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 calculated 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	

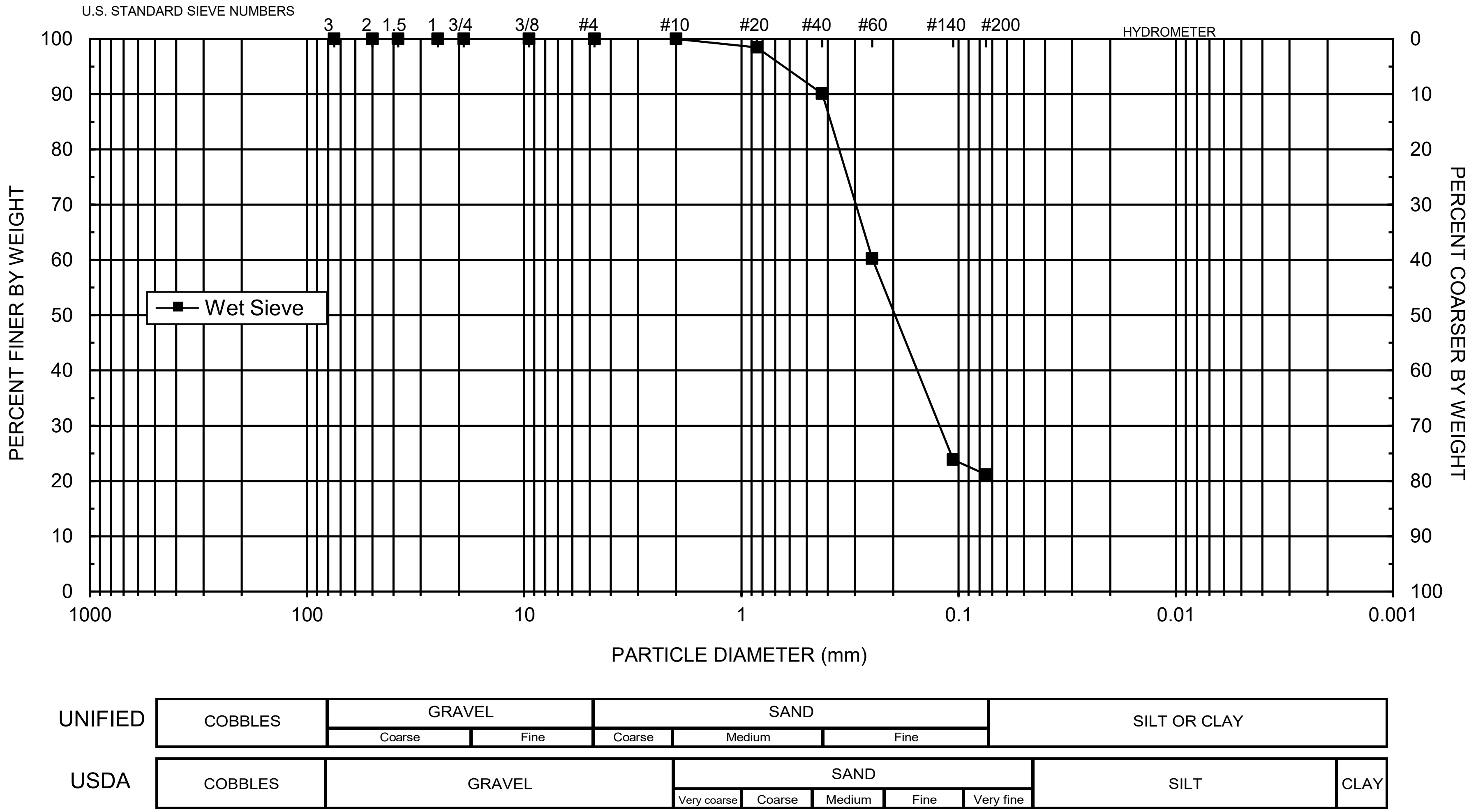
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): 0.12
d_{50} (mm): 0.20
d_{60} (mm): 0.25
d_{84} (mm): 0.38

Median Particle Diameter --d_{50} (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 --[$(d_{16}+d_{50}+d_{84})/3$] (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = NA	d_{30} = 0.12	d_{50} = 0.20	d_{60} = 0.25	C_u = NA	C_c = NA

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-2 (15'B)	**233001076-DBS**	**NA**	**NA**

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
Job Number: DB18.1151.00
Sample Number: P3-2 (35'B)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 23-May-18

Initial Dry Weight of Sample (g): 426.94
Weight Passing #10 (g): 422.32
Weight Retained #10 (g): 4.62
Wt. of -10 Sieve Sample (g): 58.70
Calculated Weight of Sieve Sample (g): 59.34

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 calculated 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	

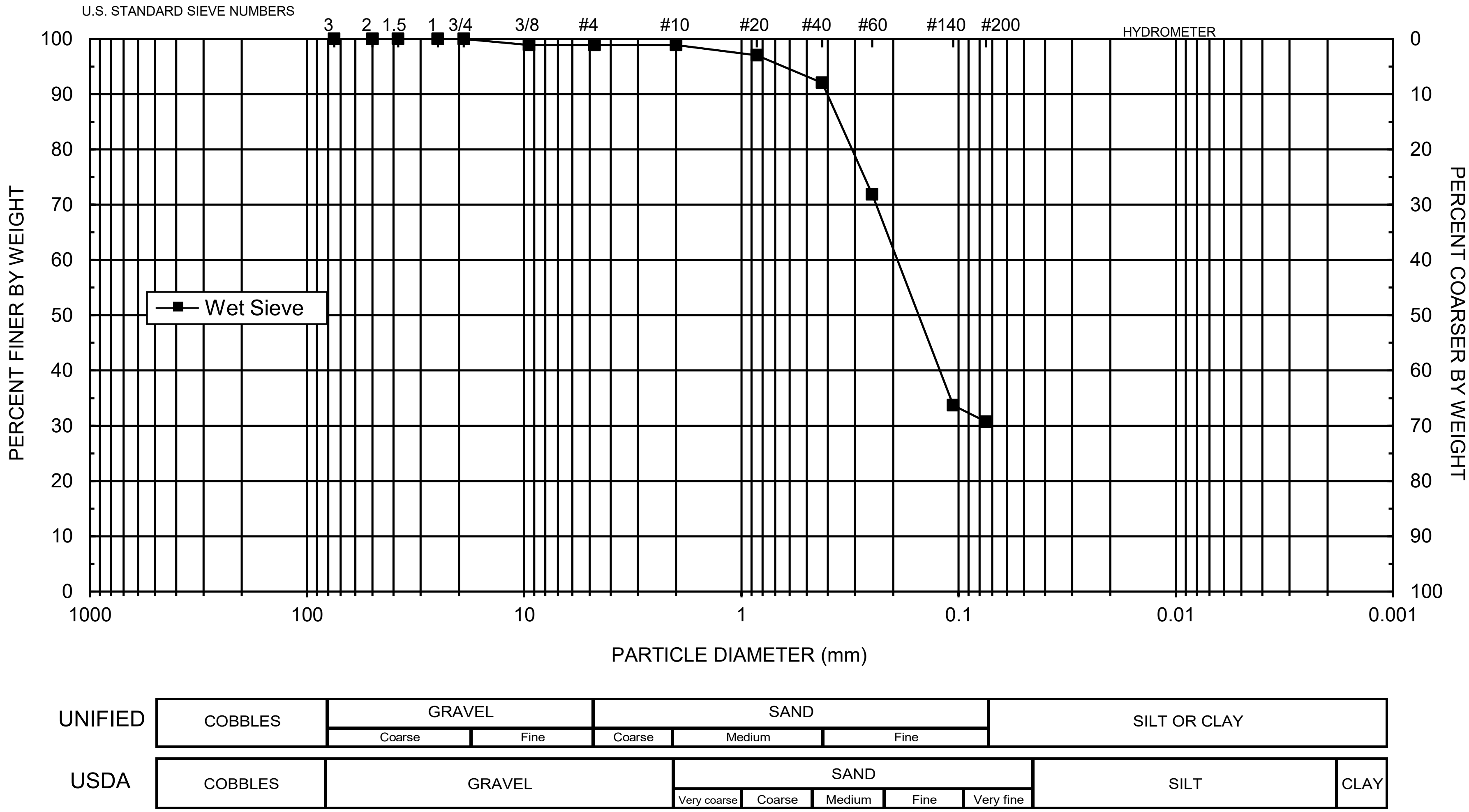
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): 0.15
d_{60} (mm): 0.19
d_{84} (mm): 0.34

Median Particle Diameter --d_{50} (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 --[$(d_{16}+d_{50}+d_{84})/3$] (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **0.15**	d_{60} = **0.19**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-2 (35'B)	**233001076-DBS**	**NA**	**NA**

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.

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: P3-3 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 23-May-18

Initial Dry Weight of Sample (g): 492.77
Weight Passing #10 (g): 489.86
Weight Retained #10 (g): 2.91
Wt. of -10 Sieve Sample (g): 65.64
Calculated Weight of Sieve Sample (g): 66.03
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	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 calculated 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	

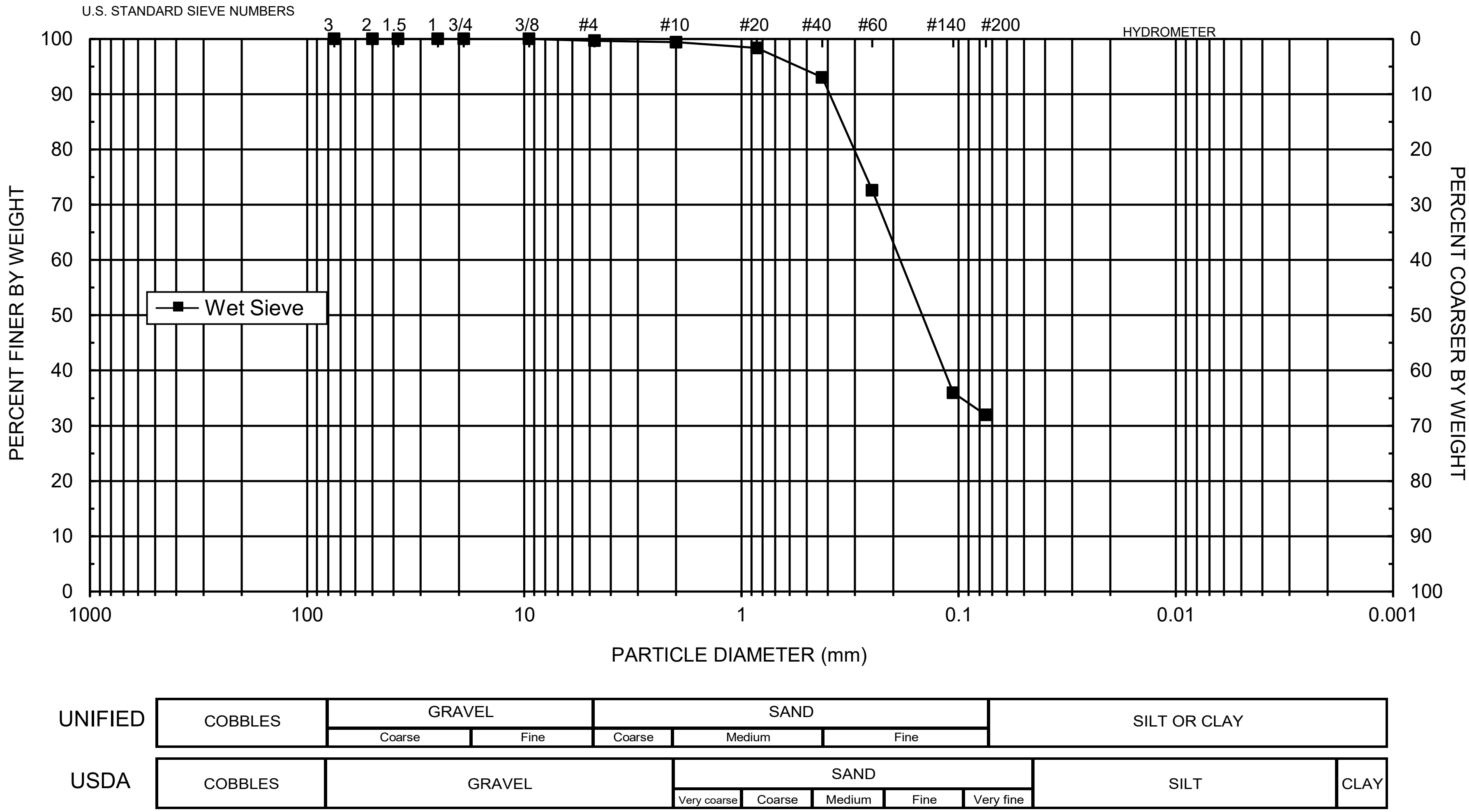
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): 0.15
d_{60} (mm): 0.19
d_{84} (mm): 0.34

Median Particle Diameter --d_{50} (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 --[$(d_{16}+d_{50}+d_{84})/3$] (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **0.15**	d_{60} = **0.19**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-3 (5'A)	**233001076-DBS**	**NA**	**NA**

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

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name:	Stantec Consulting Services Inc	*Initial Dry Weight of Sample (g):*	501.86
Job Number:	DB18.1151.00	*Weight Passing #10 (g):*	478.89
Sample Number:	P3-3 (40'B)	*Weight Retained #10 (g):*	22.97
Project Name:	St. Anthony Geotech Investigation	*Wt. of -10 Sieve Sample (g):*	53.69
PO Number:	233001076-DBS	*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						
	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 calculated 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_{50} (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

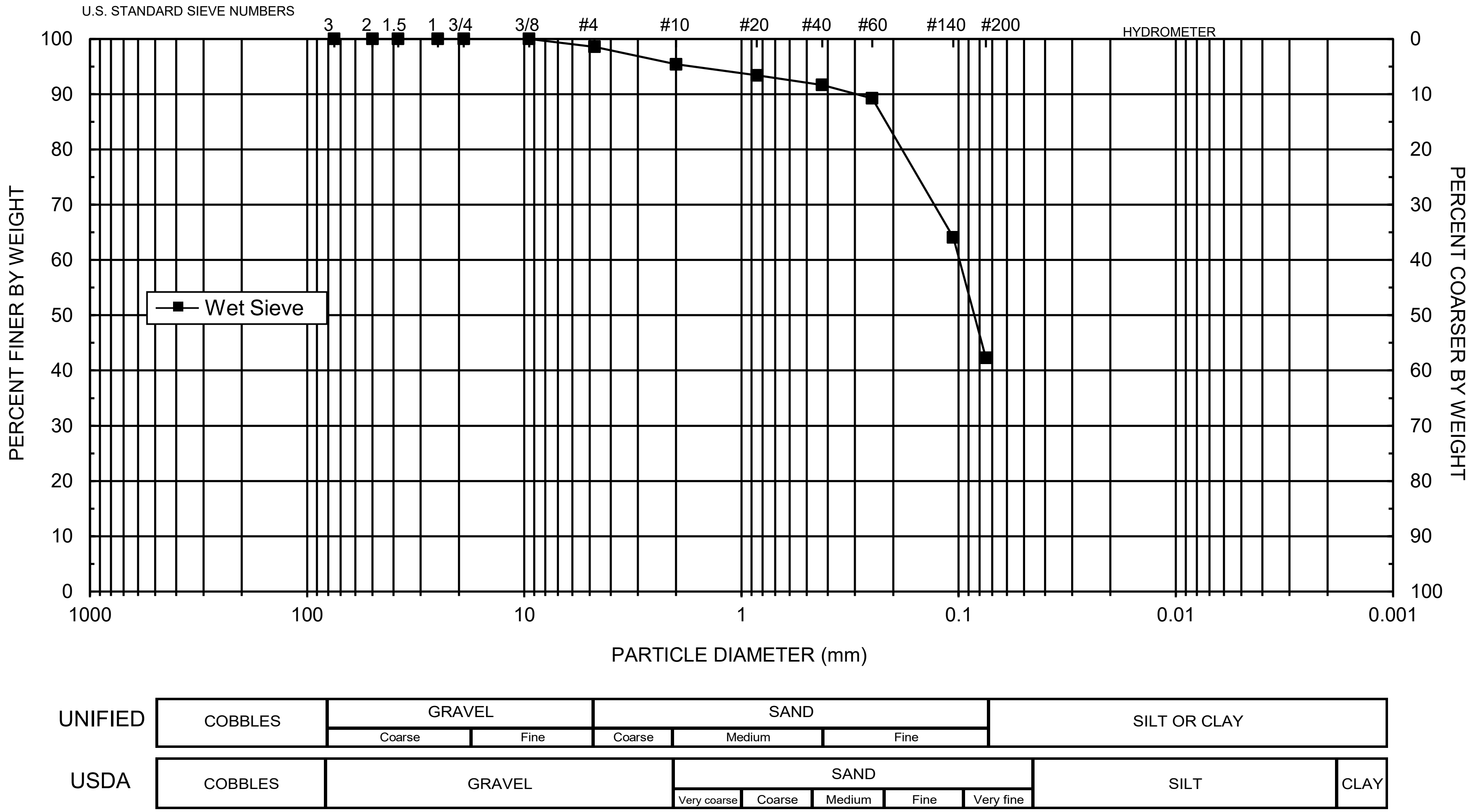
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): NA

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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **0.085**	d_{60} = **0.099**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-3 (40'B)	**233001076-DBS**	**NA**	**NA**

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.

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: P3-4 (20'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 23-May-18

Initial Dry Weight of Sample (g): 489.96
Weight Passing #10 (g): 489.74
Weight Retained #10 (g): 0.22
Wt. of -10 Sieve Sample (g): 64.28
Calculated Weight of Sieve Sample (g): 64.31

Shape: Rounded
Hardness: Soft

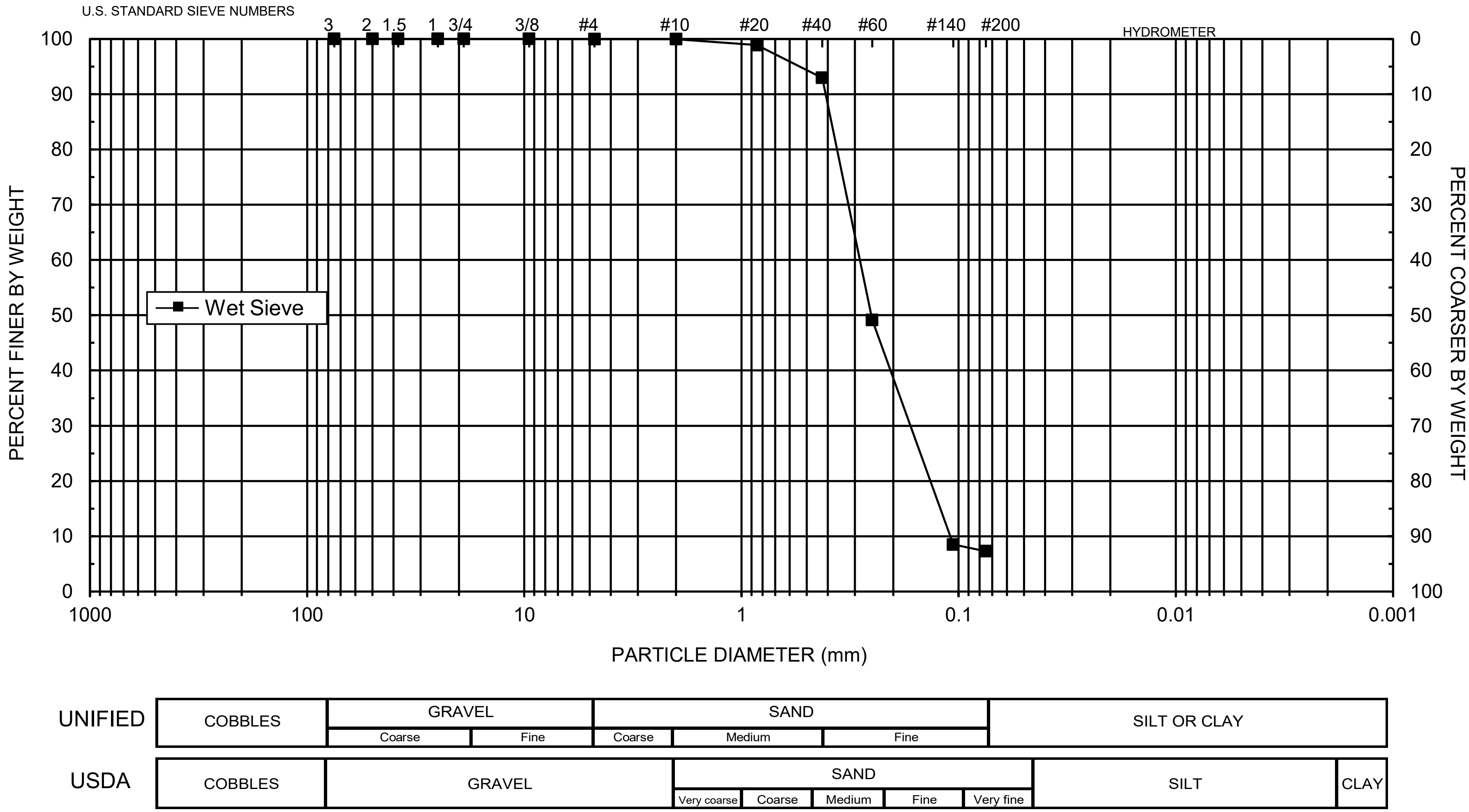
Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	489.96	100.00
	2"	50	0.00	0.00	489.96	100.00
	1.5"	38.1	0.00	0.00	489.96	100.00
	1"	25	0.00	0.00	489.96	100.00
	3/4"	19.0	0.00	0.00	489.96	100.00
	3/8"	9.5	0.00	0.00	489.96	100.00
	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 calculated 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_{10} (mm): 0.11 d_{50} (mm): 0.25
d_{16} (mm): 0.12 d_{60} (mm): 0.29
d_{30} (mm): 0.17 d_{84} (mm): 0.38

Median Particle Diameter --d_{50} (mm): 0.25
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 2.6
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 0.91
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.25

ASTM Soil Classification: NA
USDA Soil Classification: Sand

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **0.11**	d_{30} = **0.17**	d_{50} = **0.25**	d_{60} = **0.29**	C_u = **2.6**	C_c = **0.91**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-4 (20'A)	**233001076-DBS**	**NA**	**Sand**

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):*	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
Project Name:	St. Anthony Geotech Investigation	*Wt. of -10 Sieve Sample (g):*	76.13
PO Number:	233001076-DBS	*Calculated Weight of Sieve Sample (g):*	76.13
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	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 calculated 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_{50} (mm):	0.19
d_{16} (mm):	0.12	d_{60} (mm):	0.22
d_{30} (mm):	0.14	d_{84} (mm):	0.34

Median Particle Diameter --d_{50} (mm): 0.19

Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 2.2

Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 0.89

Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.22

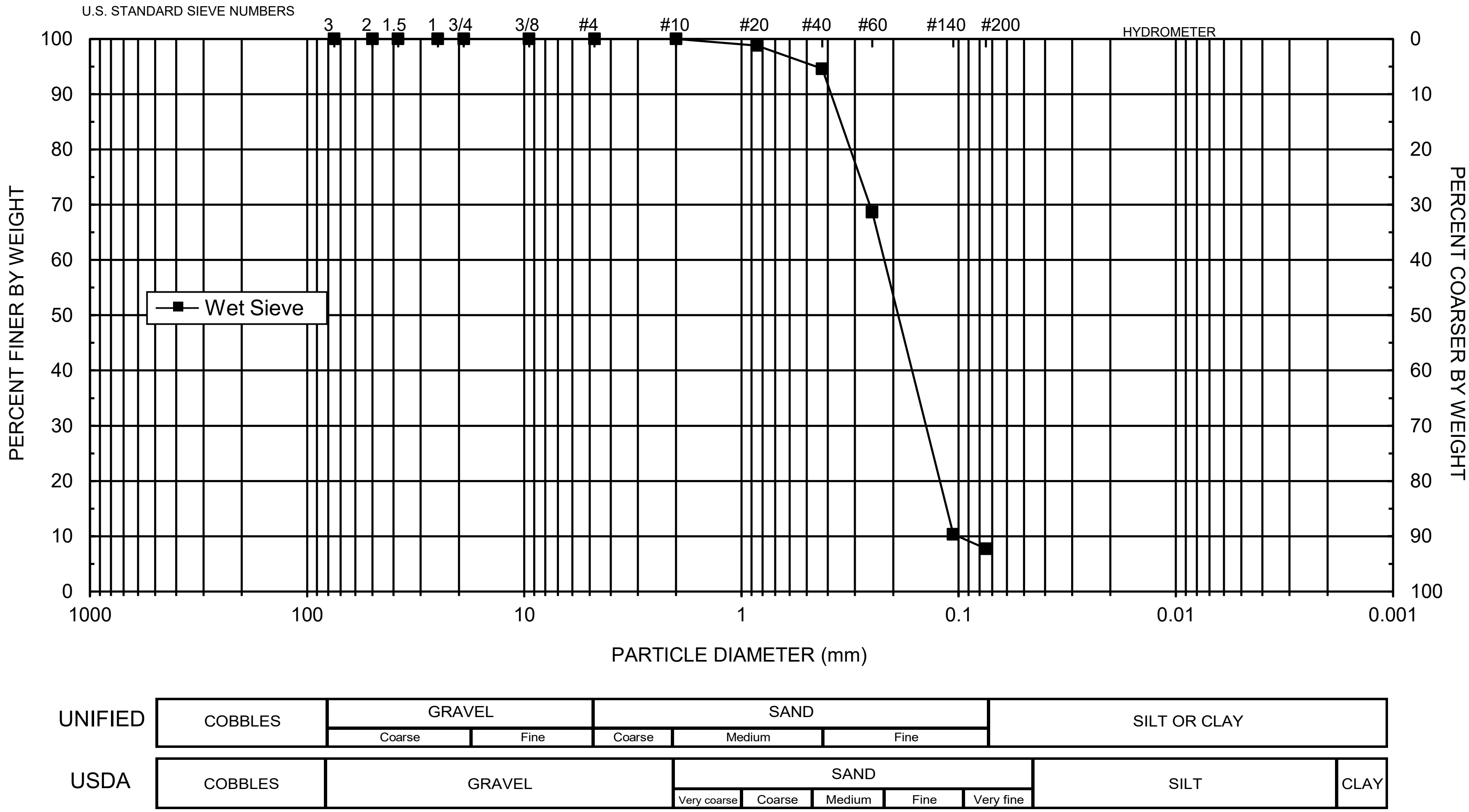
ASTM Soil Classification: NA

USDA Soil Classification: Sand

Laboratory analysis by: Z. Calhoun

Data entered by: M. Garcia

Checked by: J. Hines



d_{10} = **0.10**	d_{30} = **0.14**	d_{50} = **0.19**	d_{60} = **0.22**	C_u = **2.2**	C_c = **0.89**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-4 (30'A)	**233001076-DBS**	**NA**	**Sand**

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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

Test Date: 24-May-18

Initial Dry Weight of Sample (g): 546.30
Weight Passing #10 (g): 546.30
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 54.62
Calculated Weight of Sieve Sample (g): 54.62

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 calculated 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_{10} (mm): 0.0029
d_{16} (mm): 0.0099
d_{30} (mm): 0.044
d_{50} (mm): 0.072
d_{60} (mm): 0.087
d_{84} (mm): 0.16

Median Particle Diameter --d_{50} (mm): 0.072
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 30
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 7.7
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.081

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Sandy Loam

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 18-May-18
Start Time: 9:42

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

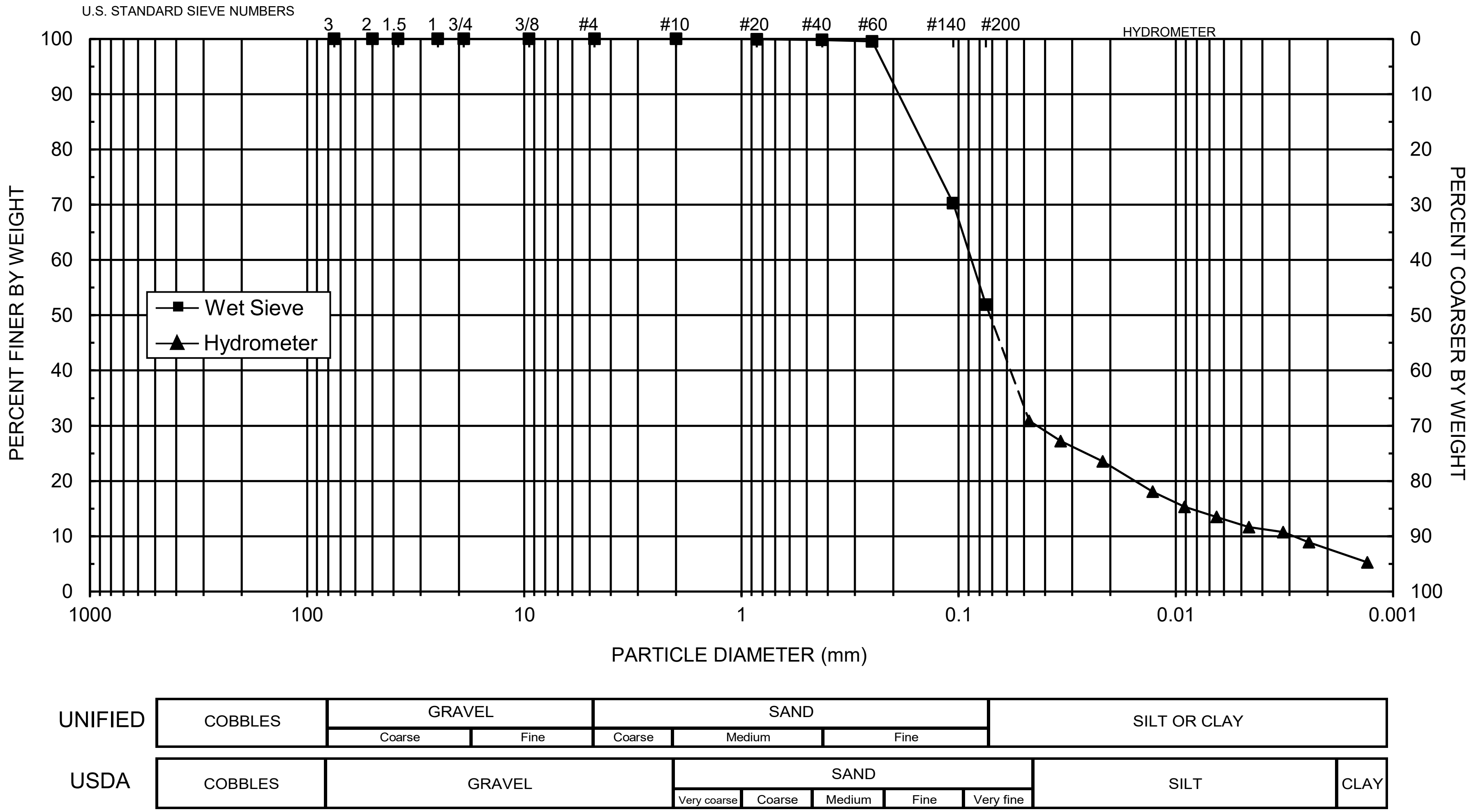
Initial Wt. (g): 54.62
Total Sample Wt. (g): 546.30
Wt. Passing #10 (g): 546.30

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0029**	d_{30} = **0.044**	d_{50} = **0.072**	d_{60} = **0.087**	C_u = **30**	C_c = **7.7**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-4 (40'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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

Test Date: 21-May-18

Initial Dry Weight of Sample (g): 530.27
Weight Passing #10 (g): 530.27
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 51.69
Calculated Weight of Sieve Sample (g): 51.69

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 calculated 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_{16} (mm): 0.040
d_{30} (mm): 0.072
d_{50} (mm): 0.099
d_{60} (mm): 0.12
d_{84} (mm): 0.19

Median Particle Diameter --d_{50} (mm): 0.099
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 6.0
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 2.2
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.11

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Loamy Sand

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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 17-May-18
Start Time: 9:24

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

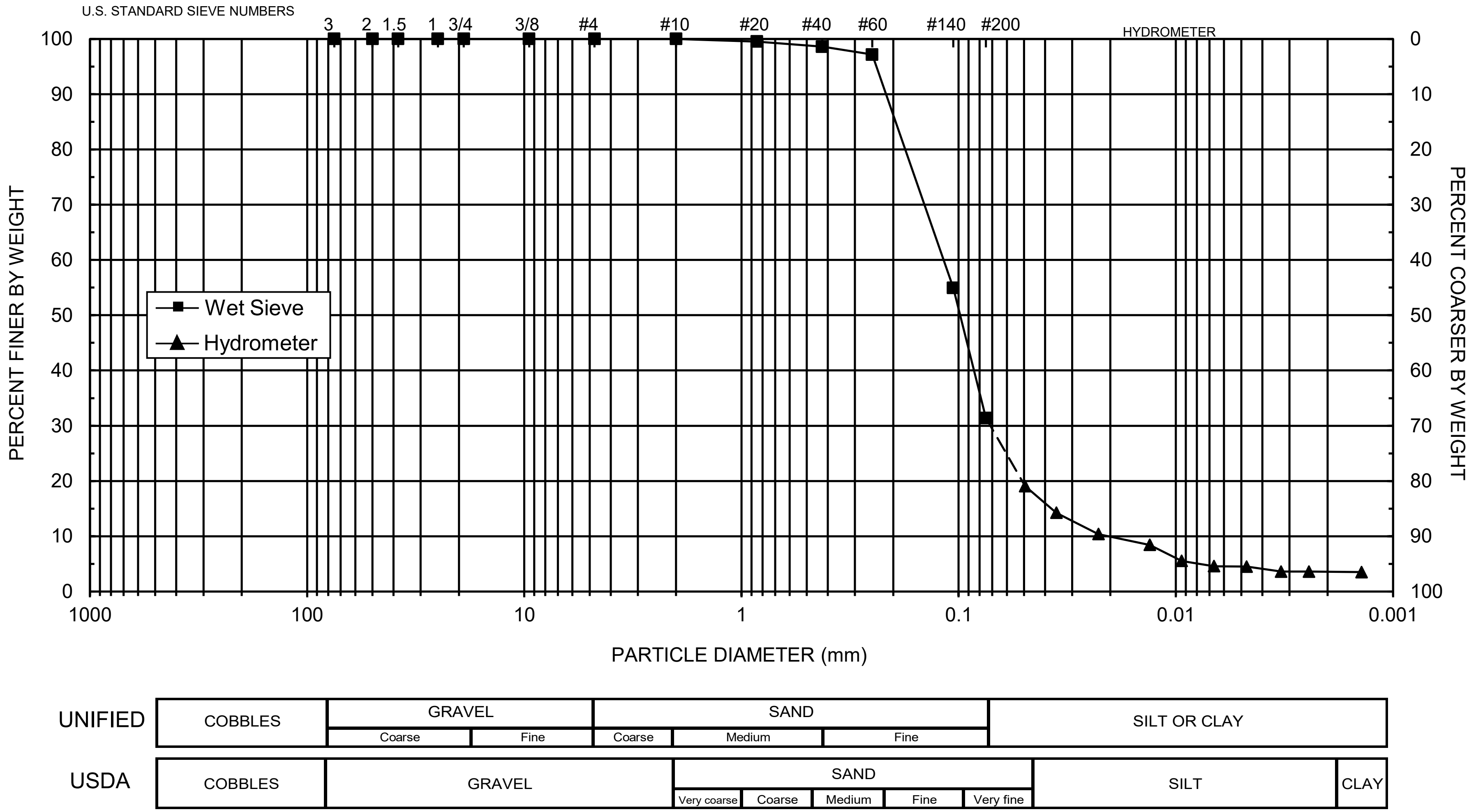
Initial Wt. (g): 51.69
Total Sample Wt. (g): 530.27
Wt. Passing #10 (g): 530.27

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.020**	d_{30} = **0.072**	d_{50} = **0.099**	d_{60} = **0.12**	C_u = **6.0**	C_c = **2.2**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-5 (10'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loamy Sand**

Daniel B. Stephens & Associates, Inc.

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):*	504.36
Job Number:	DB18.1151.00	*Weight 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 calculated 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_{50} (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 --$[(d_{16}+d_{50}+d_{84})/3]$ (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

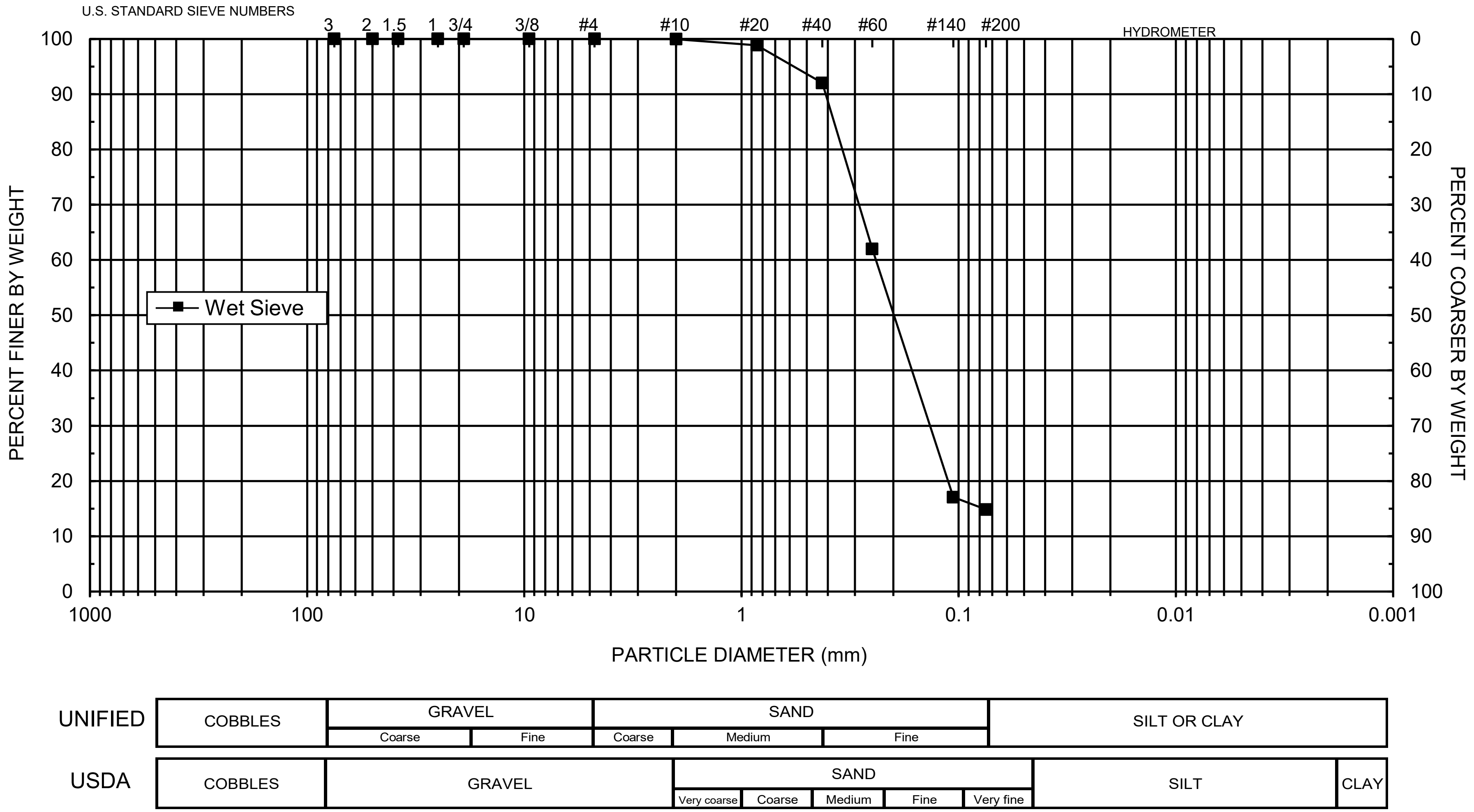
ASTM Soil Classification: NA

USDA Soil Classification: NA

Laboratory analysis by: Z. Calhoun

Data entered by: M. Garcia

Checked by: J. Hines



d_{10} = **NA**	d_{30} = **0.14**	d_{50} = **0.20**	d_{60} = **0.24**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-6 (20'A)	**233001076-DBS**	**NA**	**NA**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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

Test Date: 23-May-18

Initial Dry Weight of Sample (g): 516.43
Weight Passing #10 (g): 478.59
Weight Retained #10 (g): 37.84
Wt. of -10 Sieve Sample (g): 53.46
Calculated Weight of Sieve Sample (g): 57.69

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	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 calculated 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	

d_{10} (mm): NA
d_{16} (mm): 0.073
d_{30} (mm): 0.14
d_{50} (mm): 0.23
d_{60} (mm): 0.30
d_{84} (mm): 0.76

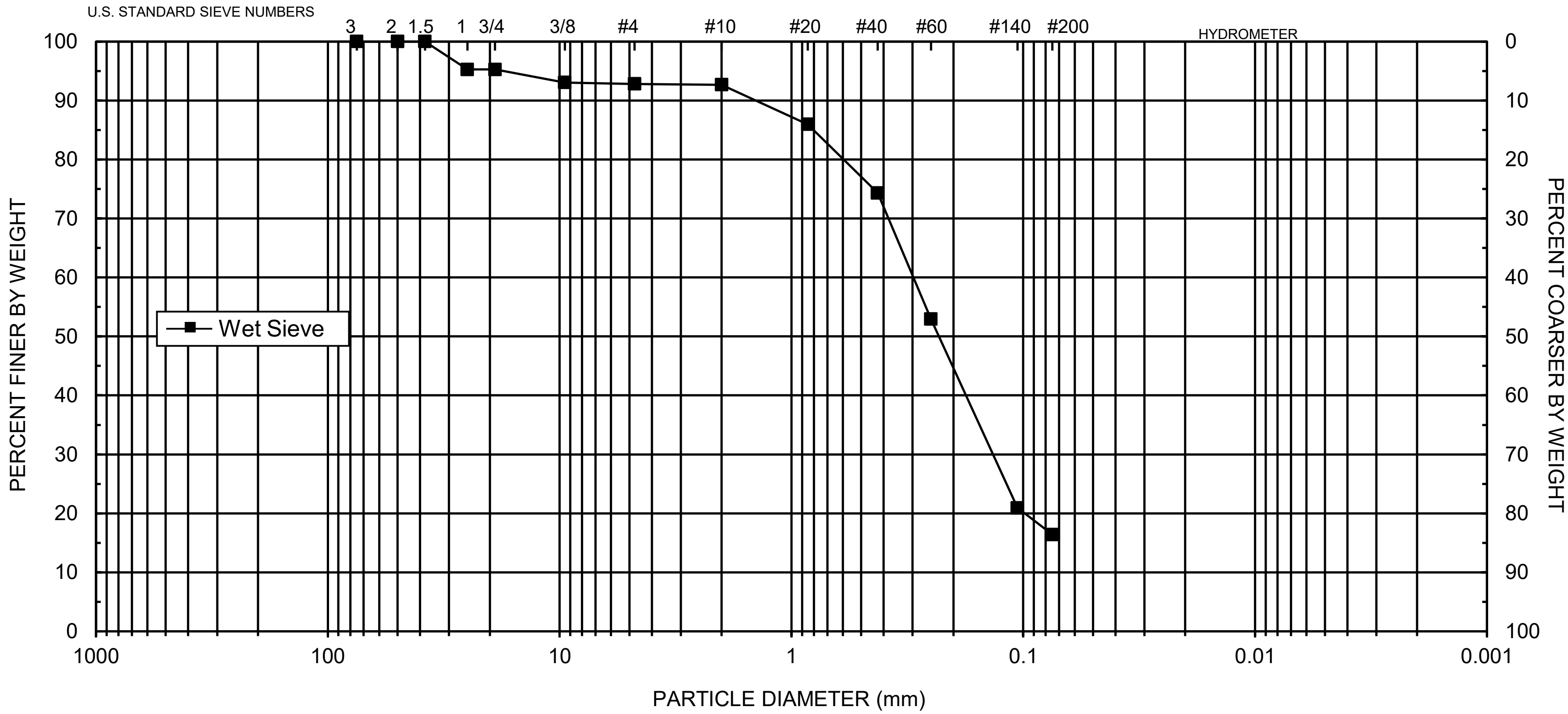
Median Particle Diameter --d_{50} (mm): 0.23
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): NA
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): NA
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.35

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

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



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine	

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **NA**	d_{30} = **0.14**	d_{50} = **0.23**	d_{60} = **0.30**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P3-6 (50'A)	**233001076-DBS**	**Silty sand (SM)**	**NA**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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

Test Date: 23-May-18

Initial Dry Weight of Sample (g): 466.53
Weight Passing #10 (g): 348.80
Weight Retained #10 (g): 117.73
Wt. of -10 Sieve Sample (g): 79.83
Calculated Weight of Sieve Sample (g): 106.77

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 calculated 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_{16} (mm): 0.094
d_{30} (mm): 0.16
d_{50} (mm): 0.30
d_{60} (mm): 0.39
d_{84} (mm): 21

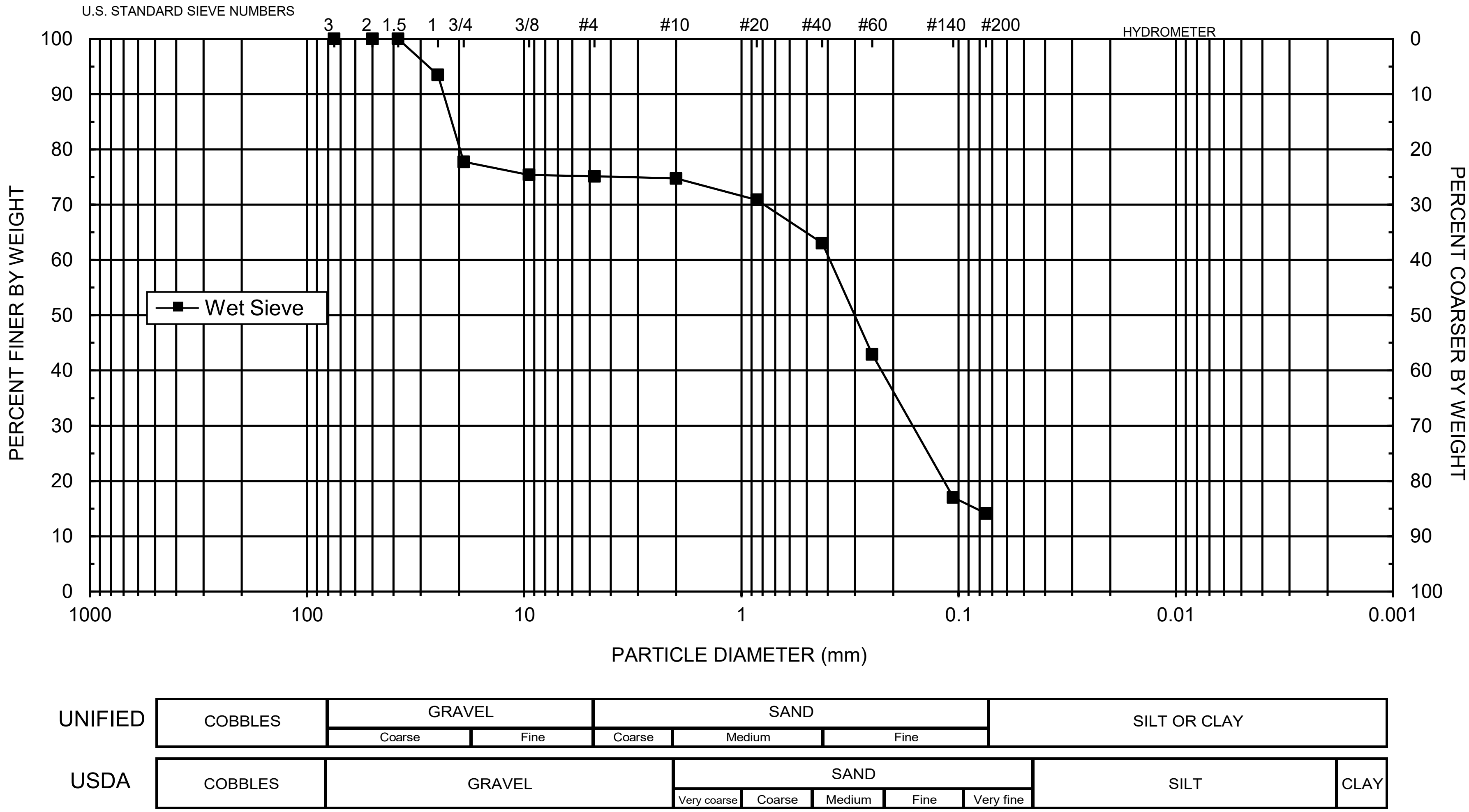
Median Particle Diameter --d_{50} (mm): 0.30
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): NA
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): NA
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 7.1

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 †

† Greater than 10% of sample is coarse material

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = NA	d_{30} = 0.16	d_{50} = 0.30	d_{60} = 0.39	C_u = NA	C_c = NA

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P4-5 (20'A)	**233001076-DBS**	**NA**	**NA †**

† Greater than 10% of sample is coarse material

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
Job Number: DB18.1151.00
Sample Number: P4-6 (10'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 21-May-18

Initial Dry Weight of Sample (g): 462.06
Weight Passing #10 (g): 462.06
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 51.81
Calculated Weight of Sieve Sample (g): 51.81

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 calculated 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	

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

Median Particle Diameter --d_{50} (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 --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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
Job Number: DB18.1151.00
Sample Number: P4-6 (10'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 17-May-18
Start Time: 9:30

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

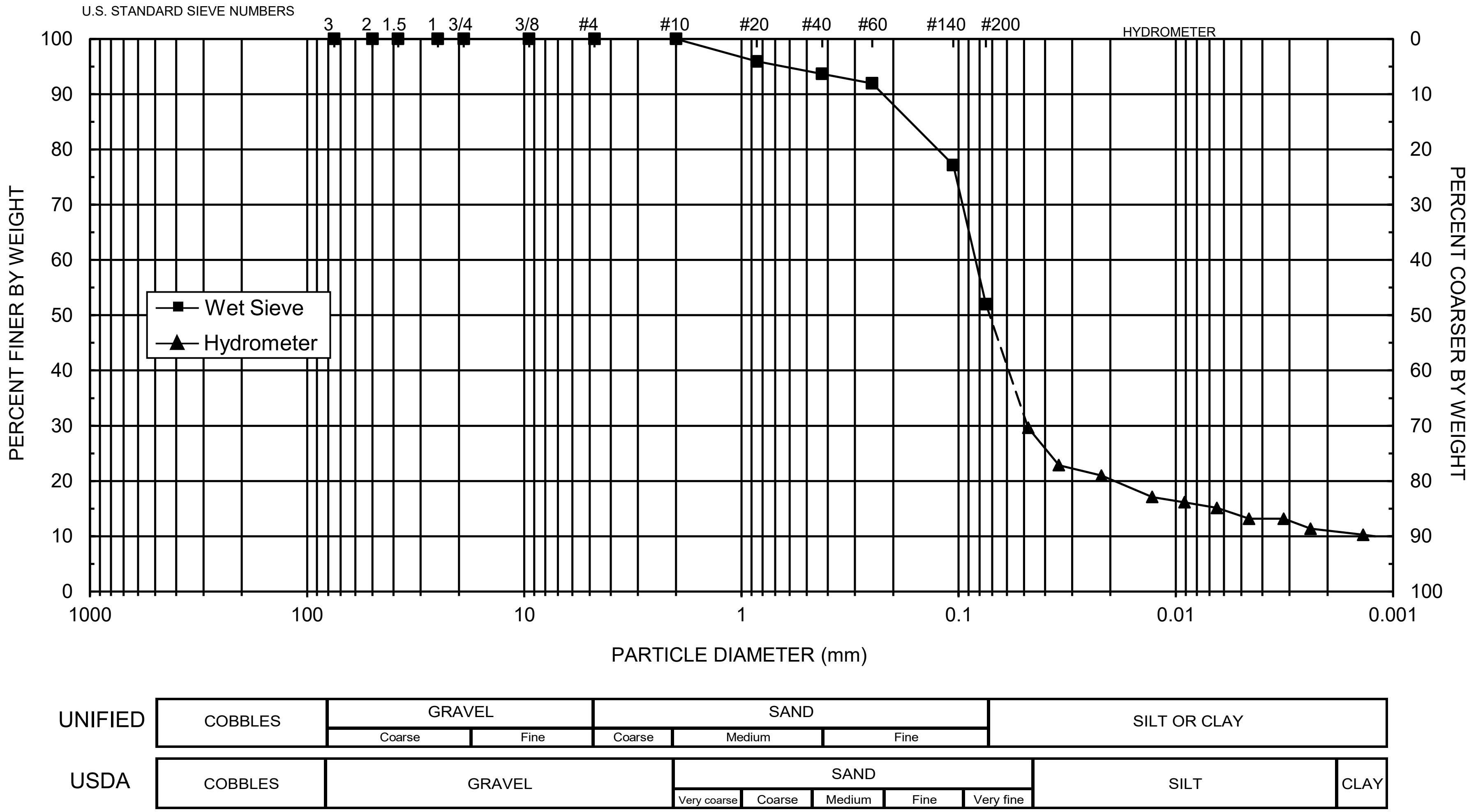
Initial Wt. (g): 51.81
Total Sample Wt. (g): 462.06
Wt. Passing #10 (g): 462.06

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0012**	d_{30} = **0.048**	d_{50} = **0.072**	d_{60} = **0.084**	C_u = **70**	C_c = **23**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P4-6 (10'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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
Job Number: DB18.1151.00
Sample Number: P4-7 (5'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 23-May-18

Initial Dry Weight of Sample (g): 392.69
Weight Passing #10 (g): 363.52
Weight Retained #10 (g): 29.17
Wt. of -10 Sieve Sample (g): 70.76
Calculated Weight of Sieve Sample (g): 76.44

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 calculated 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	

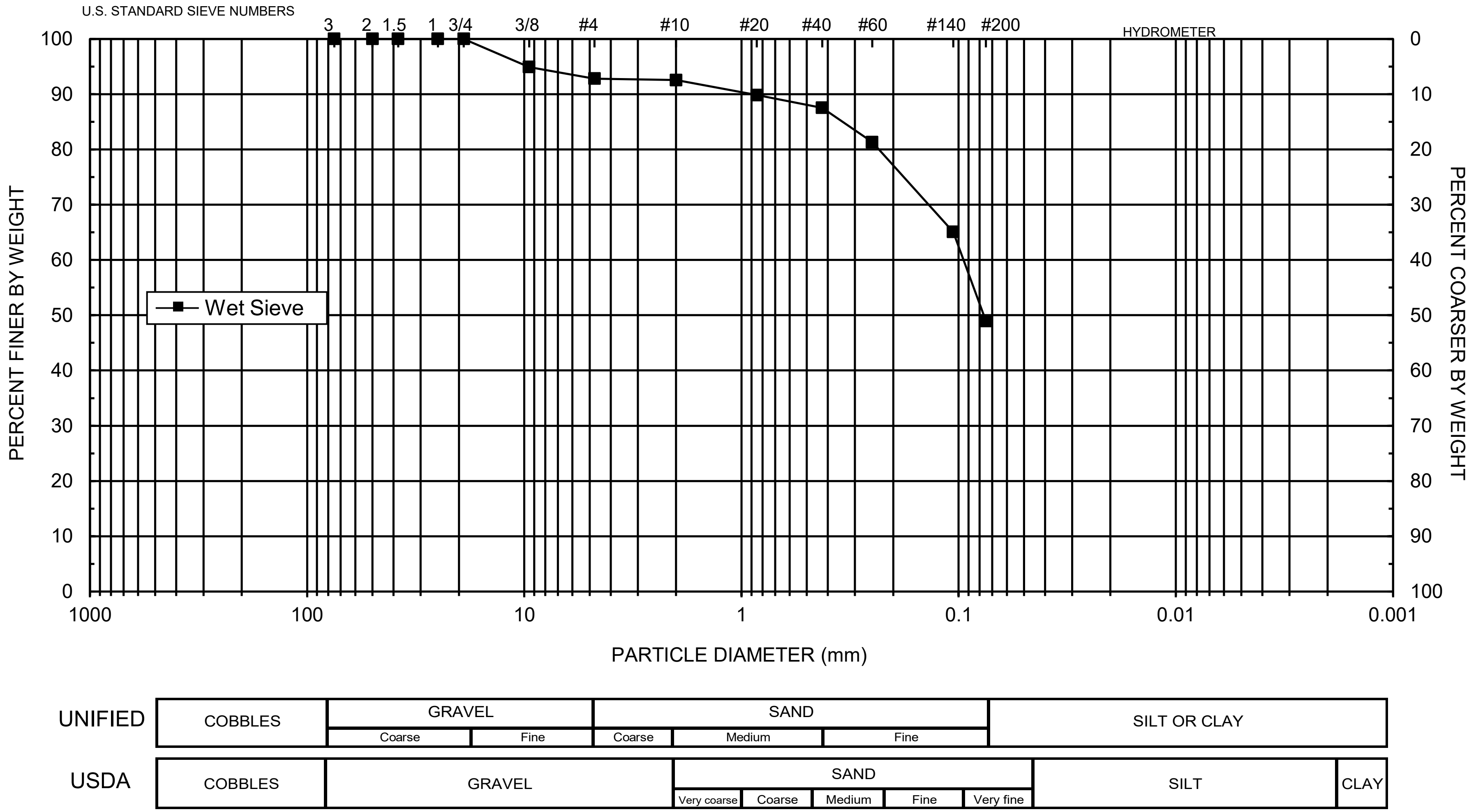
d_{10} (mm): NA
d_{16} (mm): NA
d_{30} (mm): NA
d_{50} (mm): 0.077
d_{60} (mm): 0.095
d_{84} (mm): 0.31

Median Particle Diameter --d_{50} (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 --[$(d_{16}+d_{50}+d_{84})/3$] (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

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines



d_{10} = **NA**	d_{30} = **NA**	d_{50} = **0.077**	d_{60} = **0.095**	C_u = **NA**	C_c = **NA**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P4-7 (5'A)	**233001076-DBS**	**NA**	**NA**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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

Test Date: 21-May-18

Initial Dry Weight of Sample (g): 512.00
Weight Passing #10 (g): 512.00
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 63.98
Calculated Weight of Sieve Sample (g): 63.98

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 calculated 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_{10} (mm): 0.0052
d_{16} (mm): 0.026
d_{30} (mm): 0.13
d_{50} (mm): 0.28
d_{60} (mm): 0.34
d_{84} (mm): 0.58

Median Particle Diameter --d_{50} (mm): 0.28
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 65
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 9.6
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 17-May-18
Start Time: 9:36

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

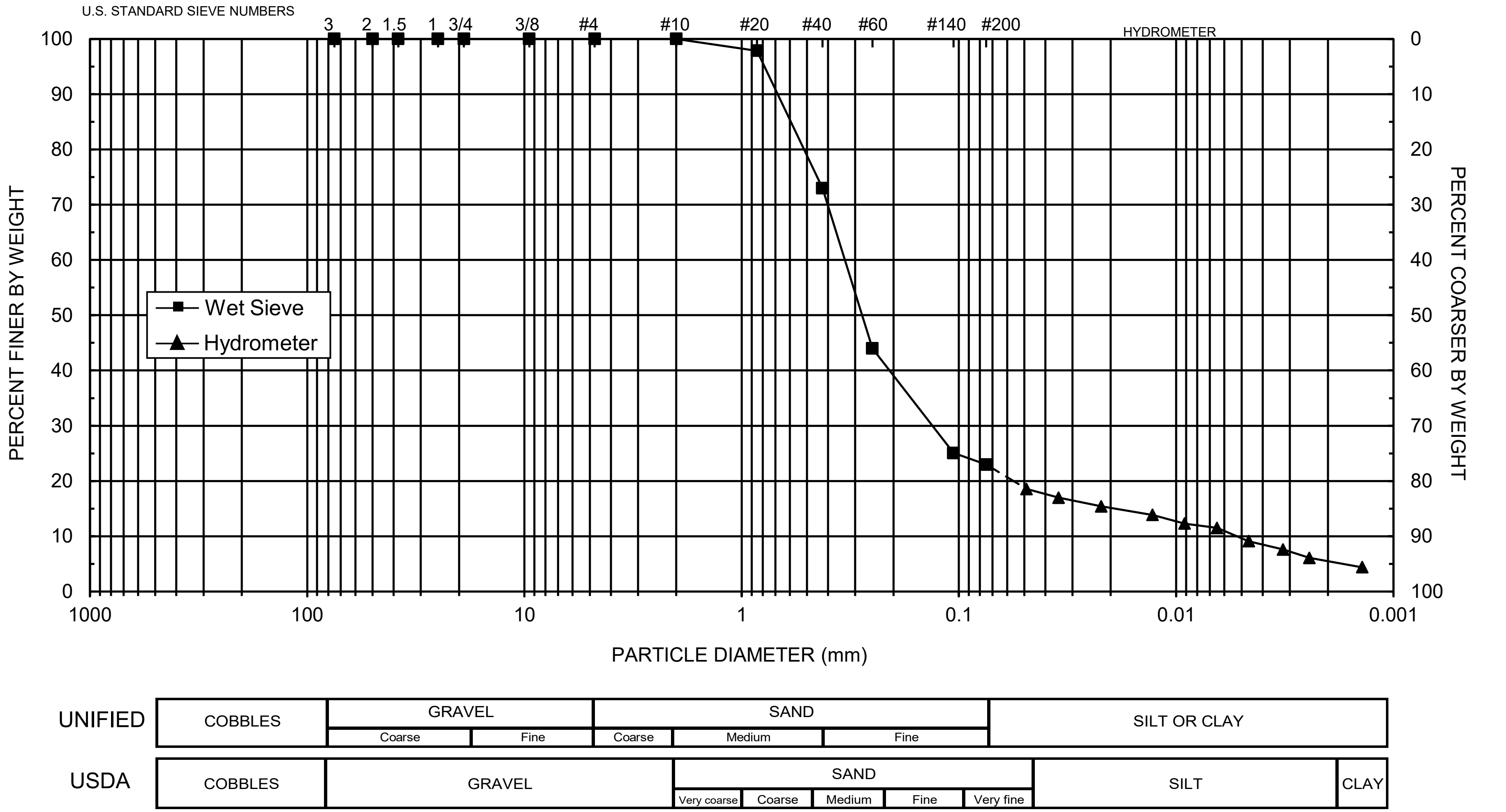
Initial Wt. (g): 63.98
Total Sample Wt. (g): 512.00
Wt. Passing #10 (g): 512.00

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0052**	d_{30} = **0.13**	d_{50} = **0.28**	d_{60} = **0.34**	C_u = **65**	C_c = **9.6**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P4-7 (25'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loamy Sand**

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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

Test Date: 22-May-18

Initial Dry Weight of Sample (g): 447.92
Weight Passing #10 (g): 441.77
Weight Retained #10 (g): 6.15
Weight of Hydrometer Sample (g): 53.46
Calculated Weight of Sieve Sample (g): 54.20

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 calculated 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	

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

Median Particle Diameter --d_{50} (mm): 0.085
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (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_{10} 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 17-May-18
Start Time: 9:42

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

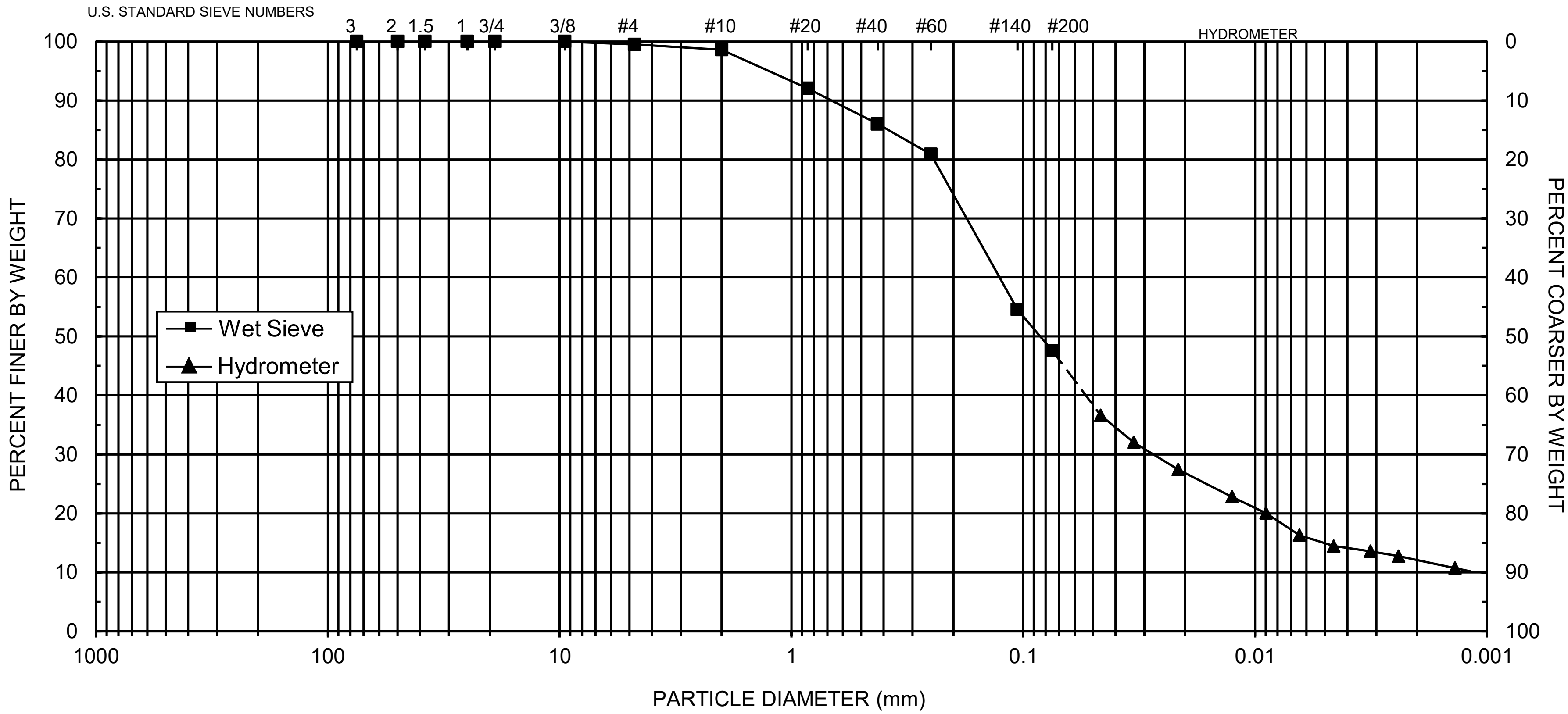
Initial Wt. (g): 53.46
Total Sample Wt. (g): 447.92
Wt. Passing #10 (g): 441.77

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



UNIFIED	COBBLES	GRAVEL: Coarse	GRAVEL: Fine	SAND: Coarse	SAND: Medium	SAND: Fine	SILT OR CLAY		
USDA	COBBLES	GRAVEL	SAND: Very coarse	SAND: Coarse	SAND: Medium	SAND: Fine	SAND: Very fine	SILT	CLAY

d_{10} = **0.0011**	d_{30} = **0.027**	d_{50} = **0.085**	d_{60} = **0.13**	C_u = **118**	C_c = **5.1**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P4-8 (15'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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
Test Date: 21-May-18

Initial Dry Weight of Sample (g): 471.98
Weight Passing #10 (g): 382.23
Weight Retained #10 (g): 89.75
Weight of Hydrometer Sample (g): 52.47
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 calculated 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_{10} (mm): 6.7E-06
d_{16} (mm): 0.0035
d_{30} (mm): 0.026
d_{50} (mm): 0.061
d_{60} (mm): 0.087
d_{84} (mm): 4.4

Median Particle Diameter --d_{50} (mm): 0.061
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 1.3E+04
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 1160
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 1.5

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: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: M. Garcia/Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 17-May-18
Start Time: 9:54

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

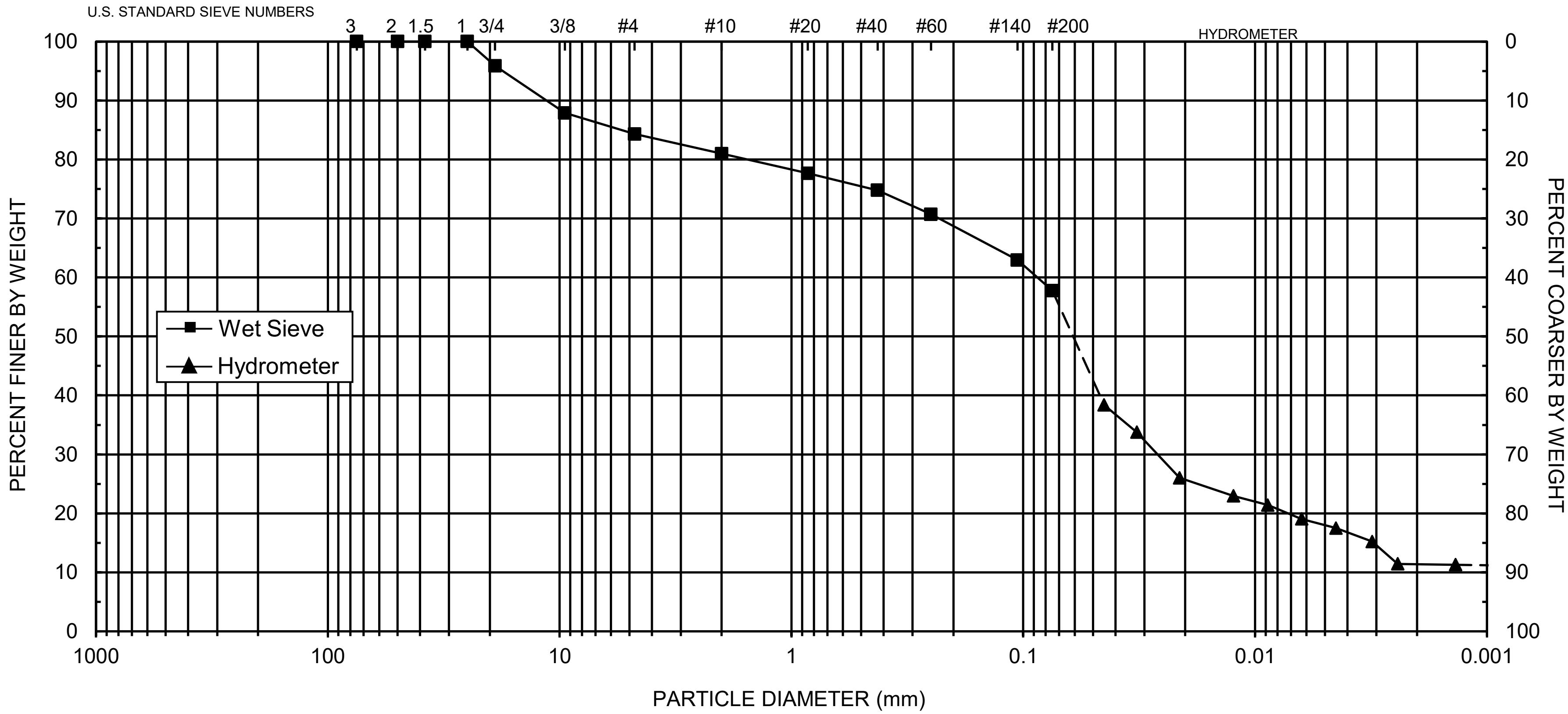
Initial Wt. (g): 52.47
Total Sample Wt. (g): 471.98
Wt. Passing #10 (g): 382.23

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine	

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **6.7E-06**	d_{30} = **0.026**	d_{50} = **0.061**	d_{60} = **0.087**	C_u = **1.3E+04**	C_c = **1160**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
P4-9 (35'B)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam †**

† Greater than 10% of sample is coarse material

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: BW-1 (20'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 18-May-18

Initial Dry Weight of Sample (g): 400.84
Weight Passing #10 (g): 400.84
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 53.41
Calculated Weight of Sieve Sample (g): 53.41

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 calculated 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	

d_{10} (mm): 0.0012
d_{16} (mm): 0.0017
d_{30} (mm): 0.011
d_{50} (mm): 0.047
d_{60} (mm): 0.083
d_{84} (mm): 0.16

Median Particle Diameter --d_{50} (mm): 0.047
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 69
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 1.2
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Loam

Laboratory analysis by: Z. Calhoun
Data entered by: M. Garcia
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: BW-1 (20'A)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 16-May-18
Start Time: 9:18

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

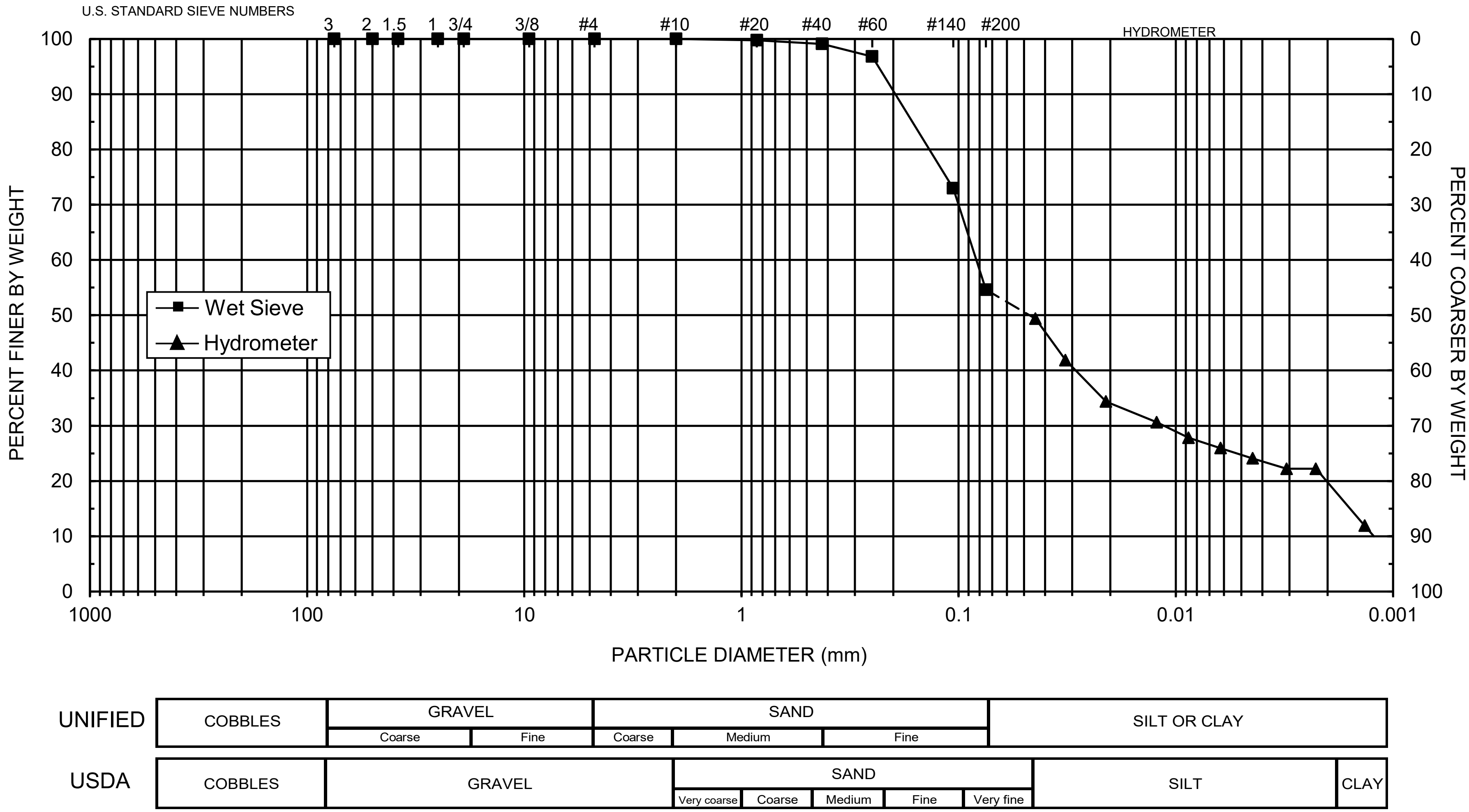
Initial Wt. (g): 53.41
Total Sample Wt. (g): 400.84
Wt. Passing #10 (g): 400.84

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.0012**	d_{30} = **0.011**	d_{50} = **0.047**	d_{60} = **0.083**	C_u = **69**	C_c = **1.2**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
BW-1 (20'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Loam**

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.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

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
Test Date: 18-May-18

Initial Dry Weight of Sample (g): 441.31
Weight Passing #10 (g): 441.31
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 61.69
Calculated Weight of Sieve Sample (g): 61.69

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 calculated 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	

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

Median Particle Diameter --d_{50} (mm): 0.062
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 240
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 18
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (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_{10} 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

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

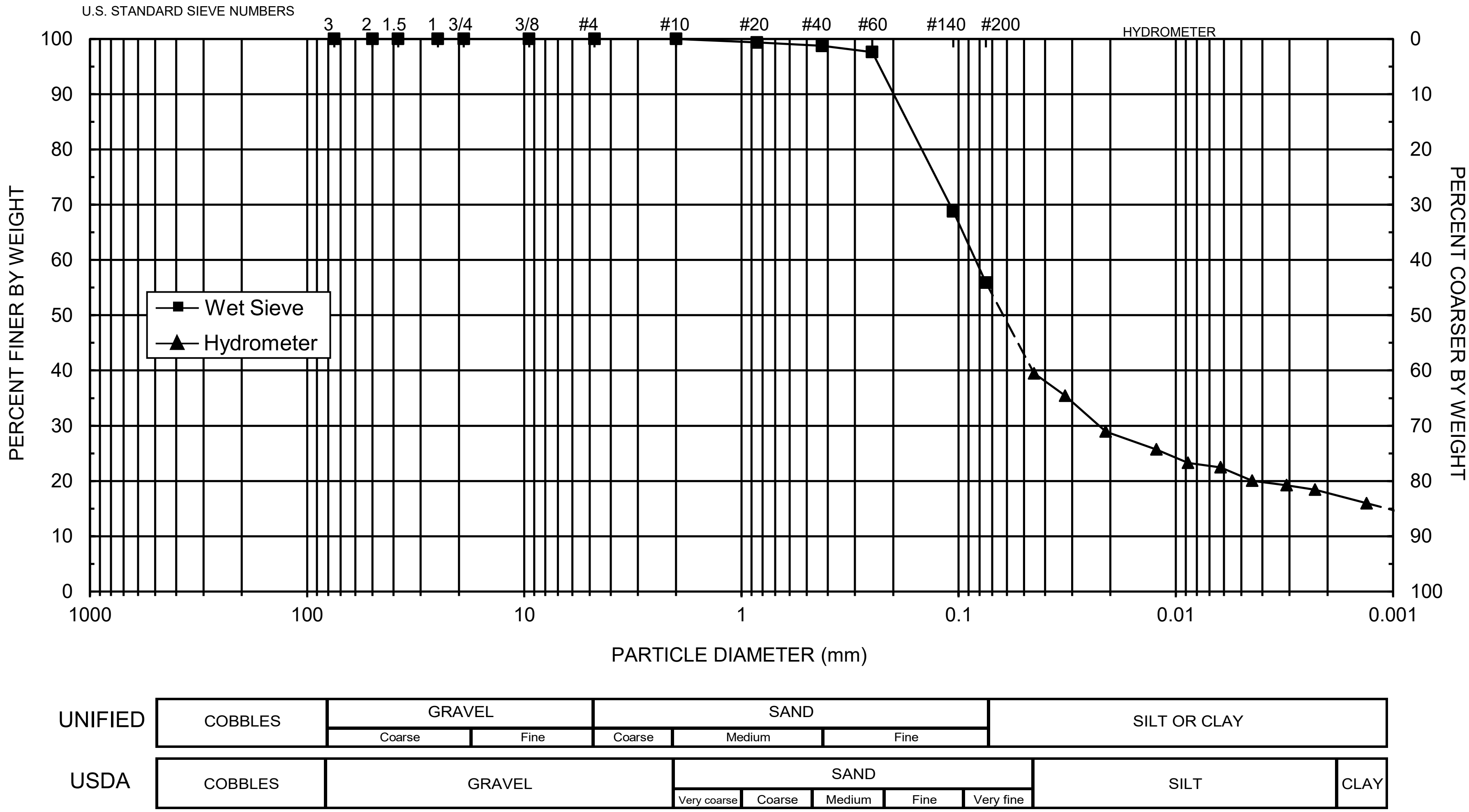
Job Name:	Stantec Consulting Services Inc	*Type of Water Used:*	DISTILLED
Job Number:	DB18.1151.00	*Reaction with H_2O_2:*	NA
Sample Number:	BW-2 (10'A)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	St. Anthony Geotech Investigation	*Assumed particle density:*	2.65
PO Number:	233001076-DBS	*Initial Wt. (g):*	61.69
Test Date:	16-May-18	*Total Sample Wt. (g):*	441.31
Start Time:	9:24	*Wt. Passing #10 (g):*	441.31

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



d_{10} = **0.00035**	d_{30} = **0.023**	d_{50} = **0.062**	d_{60} = **0.084**	C_u = **240**	C_c = **18**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
BW-2 (10'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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.

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 calculated 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	

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

Median Particle Diameter --d_{50} (mm): 0.080

Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 90

Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 23

Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.091

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: Classification by ASTM 2487 requires Atterberg test

USDA Soil Classification: Sandy Loam

Laboratory analysis by: Z. Calhoun

Data entered by: M. Garcia

Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

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

Test Date: 16-May-18
Start Time: 9:30

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

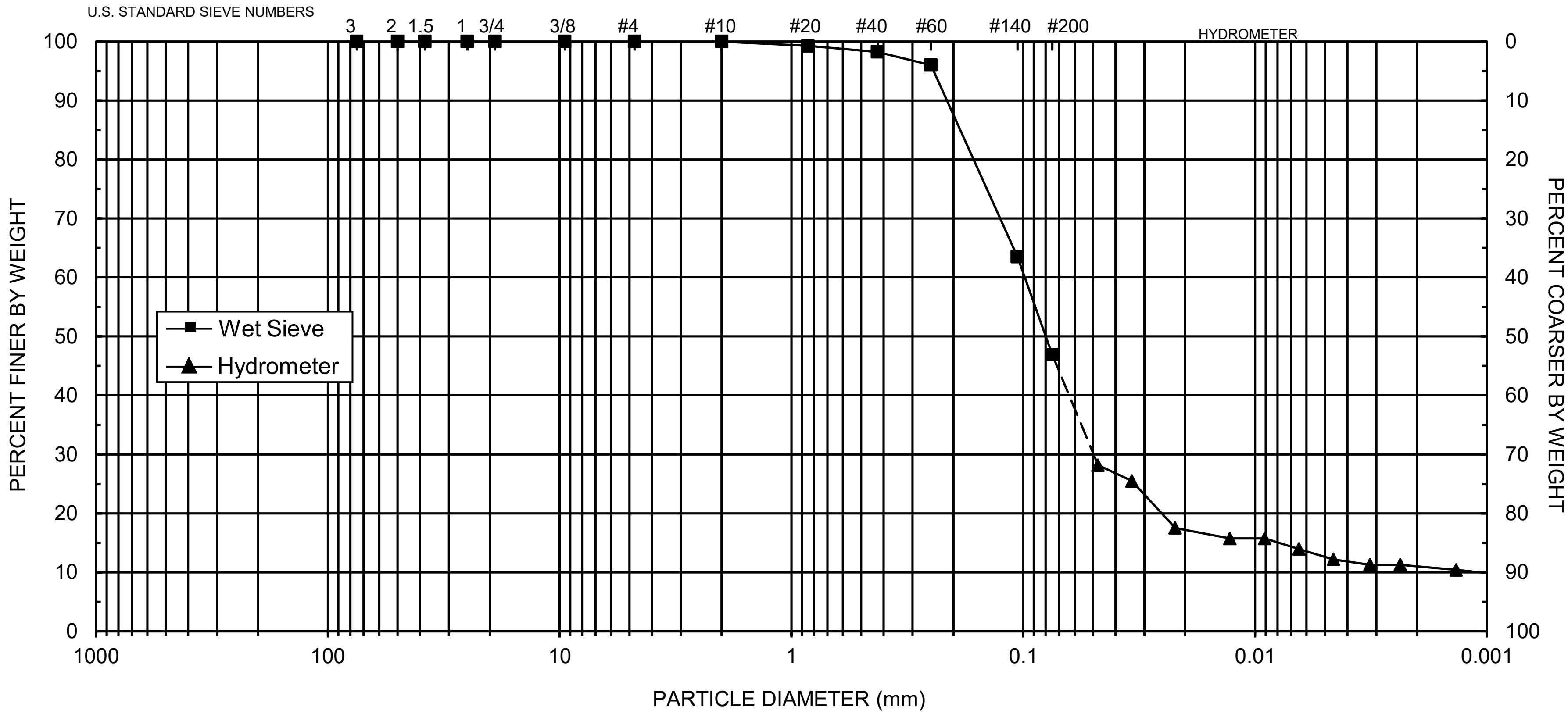
Initial Wt. (g): 56.32
Total Sample Wt. (g): 470.38
Wt. Passing #10 (g): 470.38

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% 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:

* Dispersion device: mechanically operated stirring device

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



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine	

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.0011**	d_{30} = **0.050**	d_{50} = **0.080**	d_{60} = **0.099**	C_u = **90**	C_c = **23**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
BW-3 (5'A)	**233001076-DBS**	**Classification by ASTM 2487 requires Atterberg test**	**Sandy Loam**

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

--- = Soil requires visual-manual classification due to non-plasticity

Daniel B. Stephens & Associates, Inc.

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

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:	L2-2 (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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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
HCl 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

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:	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

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:	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
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	124.49	122.16
Weight of pan plus dry soil (g)	122.97	120.57
Weight of pan (g):	116.26	113.70
Gravimetric moisture content (% g/g):	22.65	23.14
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

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:	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):	---	---
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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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
HCl 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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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

Daniel B. Stephens & Associates, Inc.

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

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:	P3-1 (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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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
HCl 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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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

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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):	---	---
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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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
HCl 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):	---	---	---
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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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
HCl 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

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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 (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

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

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
HCl 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^3)	Optimum Moisture Content (% g/g)	Maximum Dry Bulk Density (g/cm^3)
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

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

NR = Not requested

NA = Not applicable

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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
PO Number:	233001076-DBS	*Mold volume (cm^3):*	942.46
Test Date:	17-May-18	*Compaction Method:*	Standard A
		Preparation Method:	Dry
As Received Moisture Content (% g/g):	NA	*Type of Rammer:*	Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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

Coarse Fraction (% g/g): 3.8

Fines Fraction (% g/g): 96.2

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---

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

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia

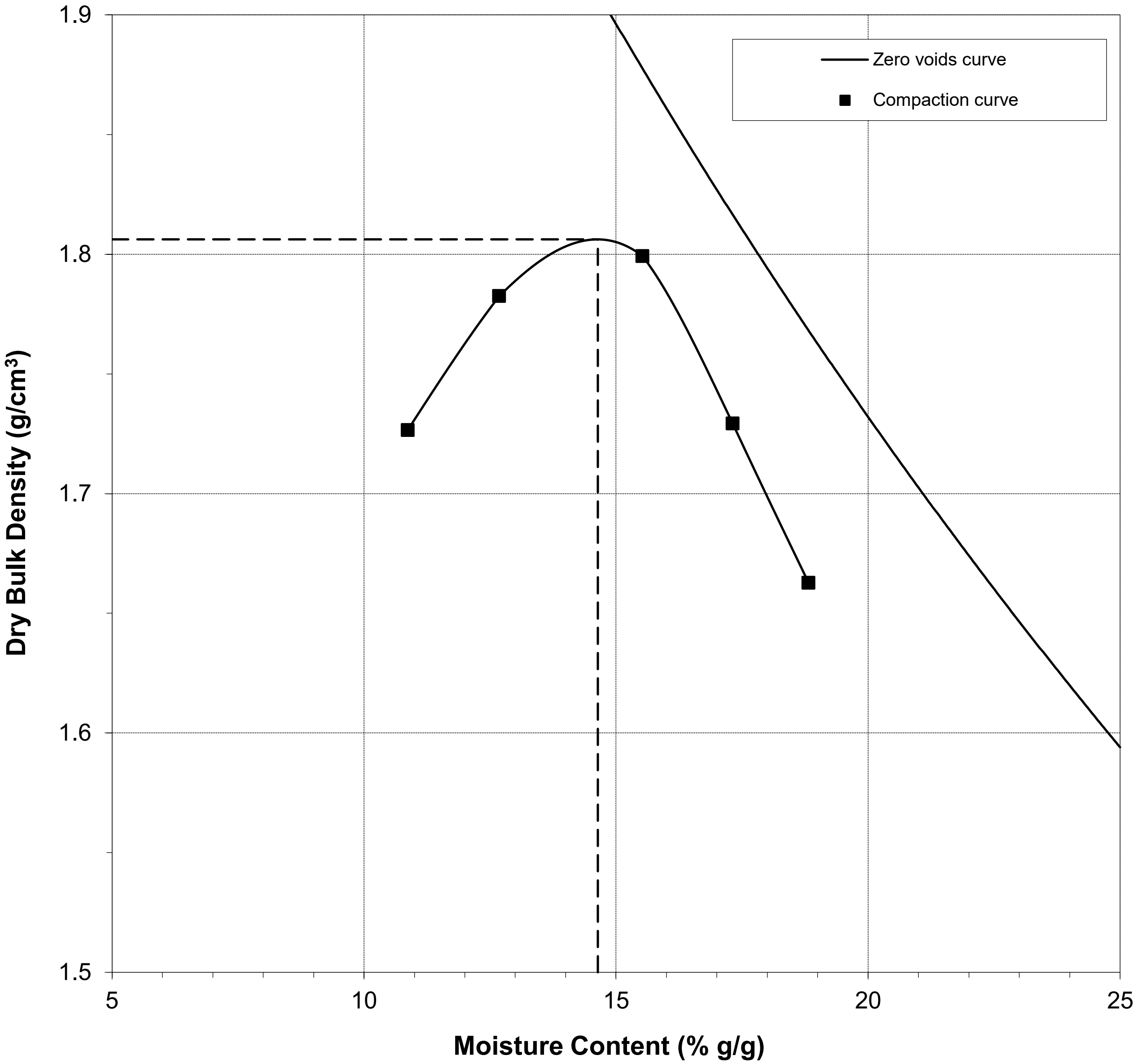
Checked by: J. Hines

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^3):	1.81	---

Test Date: 17-May-18



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

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

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
Sample Number:	L2 Auger Cuttings (1 & 2)	*Mass of fines material (g):*	47420.00
Project Name:	St. Anthony Geotech Investigation	*Mold weight (g):*	4226
PO Number:	233001076-DBS	*Mold volume (cm^3):*	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

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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

Coarse Fraction (% g/g): 1.8
Fines Fraction (% g/g): 98.2

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---

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

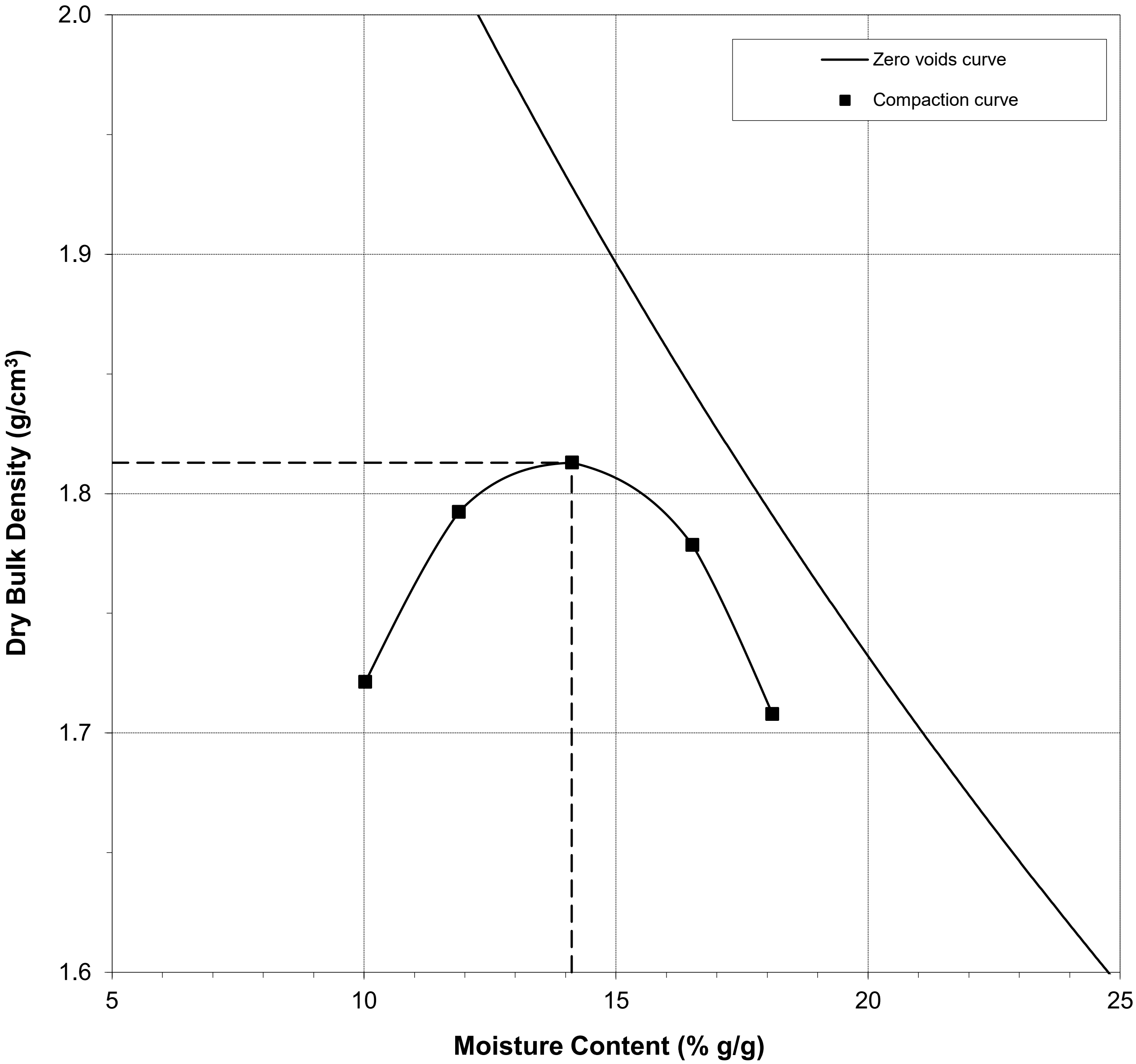
Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

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^3):	1.81	---

Test Date: 16-May-18



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

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

Proctor Compaction Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: T/O Auger Cuttings (1 & 2) (T/O-1 & T/O-2/4)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS
Test Date: 16-May-18
As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): #4
Mass of coarse material (g): 2357.50
Mass of fines material (g): 45348.00
Mold weight (g): 4226
Mold volume (cm^3): 942.46
Compaction Method: Standard A
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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

Coarse Fraction (% g/g): 4.9
Fines Fraction (% g/g): 95.1

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---

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

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

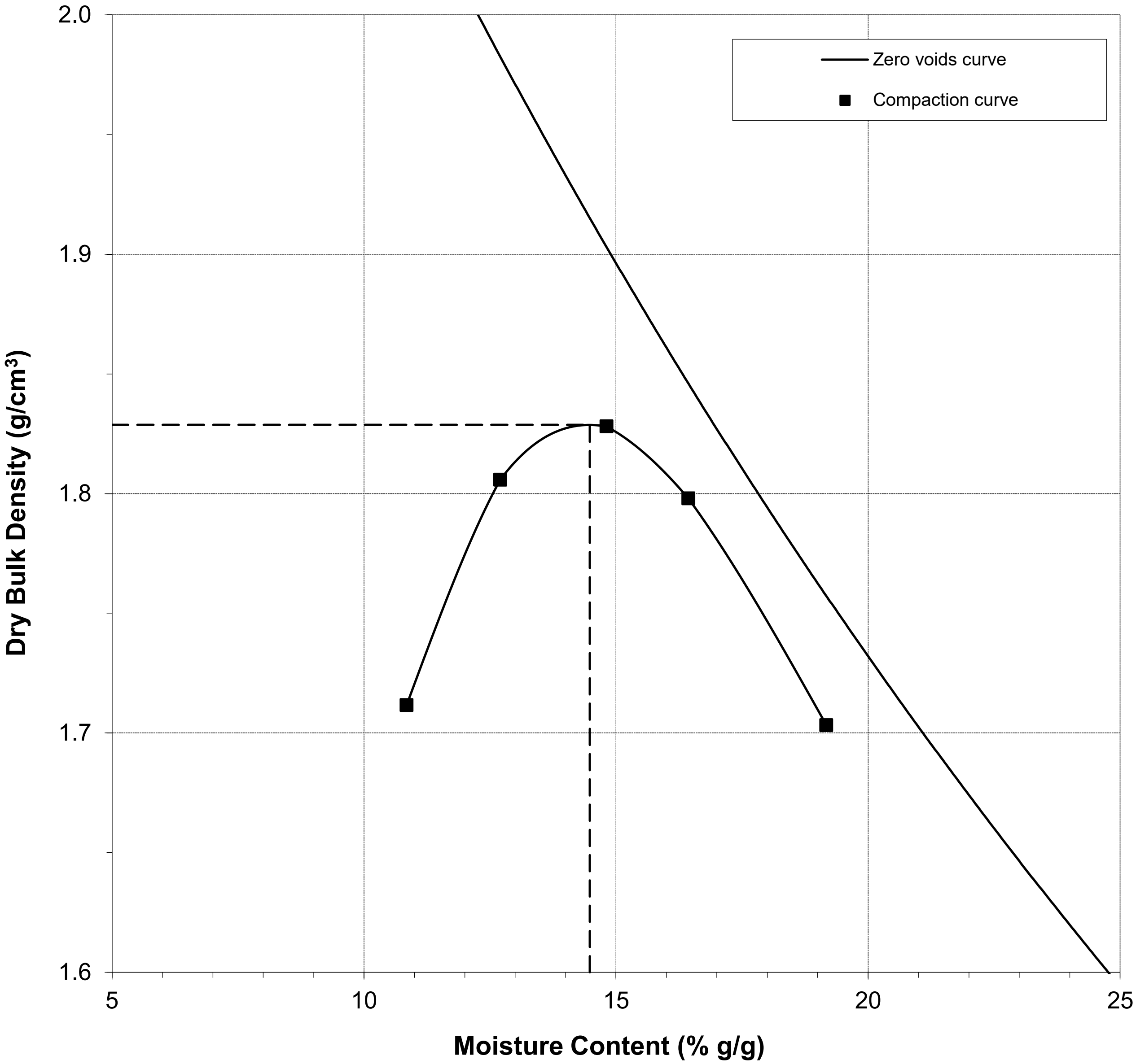
Daniel B. Stephens & Associates, Inc.

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^3):	1.83	---

Test Date: *16-May-18*



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

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

Daniel B. Stephens & Associates, Inc.

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):*	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 (cm^3):*	942.46
Test Date:	17-May-18	*Compaction Method:*	Standard A
		Preparation Method:	Dry
As Received Moisture Content (% g/g):	NA	*Type of Rammer:*	Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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

Coarse Fraction (% g/g): 1.7

Fines Fraction (% g/g): 98.3

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---

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

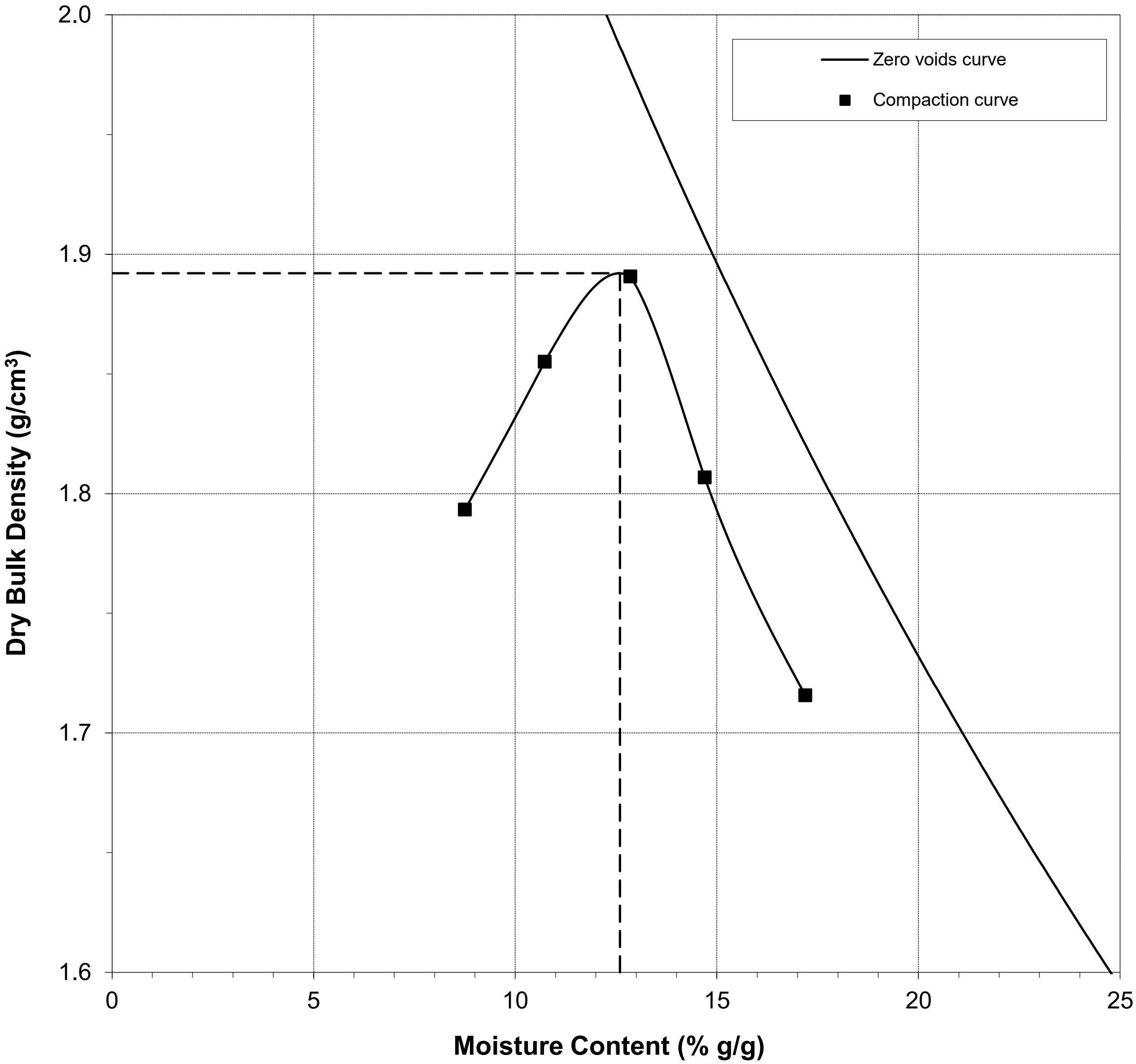
Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

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^3):	1.89	---

Test Date: 17-May-18



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

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

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):	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 volume* (cm^3):	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

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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
4	6197	1059.23	959.03	283.30	1.82	14.83
5	6143	1147.62	1022.92	289.53	1.74	17.00

Soil Fractions

Coarse Fraction (% g/g): 0.7
Fines Fraction (% g/g): 99.3

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---

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

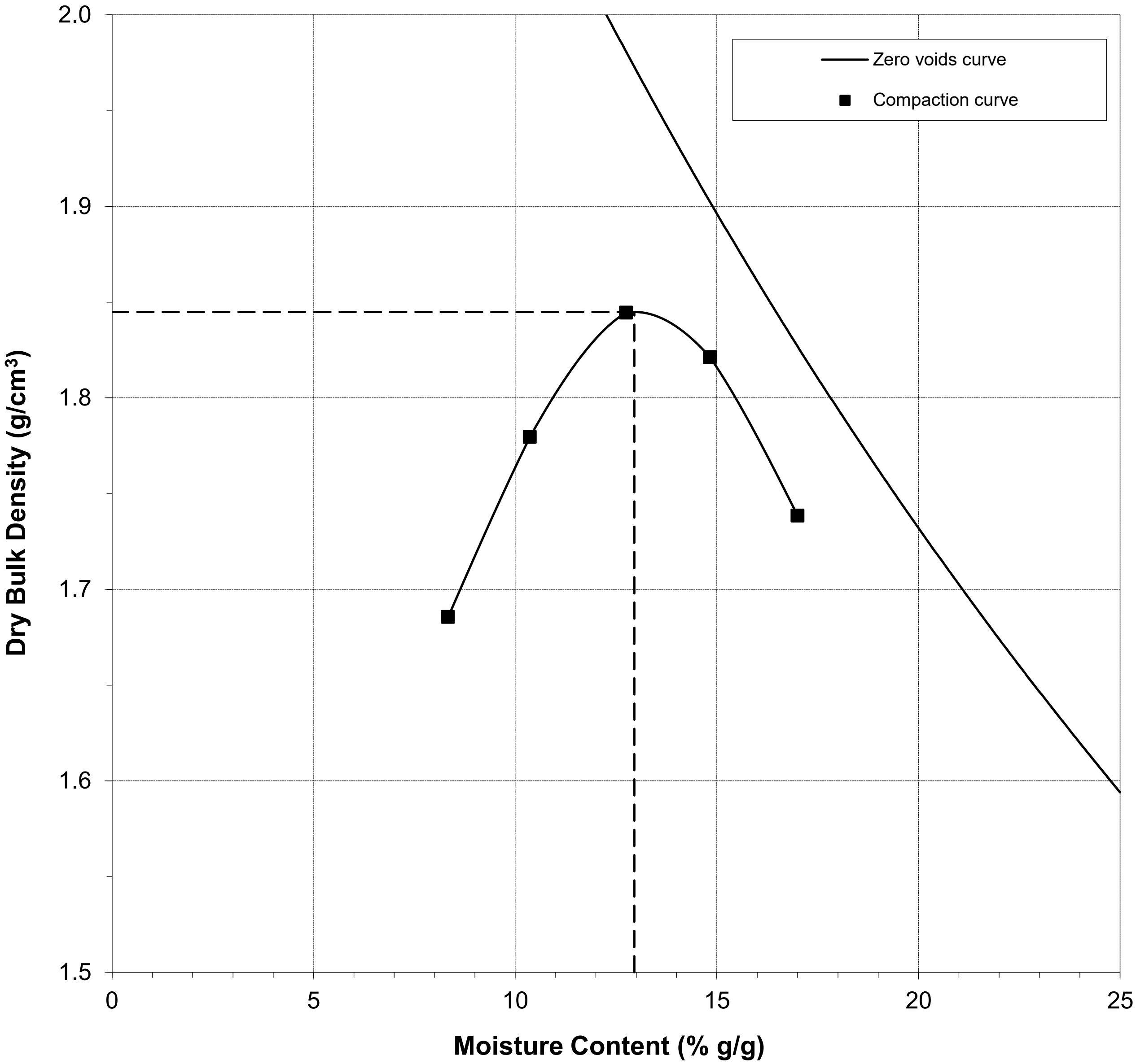
Laboratory analysis by: D. O'Dowd
Data entered by: M. Garcia
Checked by: J. Hines

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^3):	1.84	---

Test Date: 23-May-18



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

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

Daniel B. Stephens & Associates, Inc.

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 & TS-3,4)	*Mass of fines material (g):*	24015.18
Project Name:	St. Anthony Geotech Investigation	*Mold weight (g):*	4226
PO Number:	233001076-DBS	*Mold volume (cm^3):*	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

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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

Coarse Fraction (% g/g): 19.2

Fines Fraction (% g/g): 80.8

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% 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

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

Laboratory analysis by: D. O'Dowd

Data entered by: M. Garcia

Checked by: J. Hines

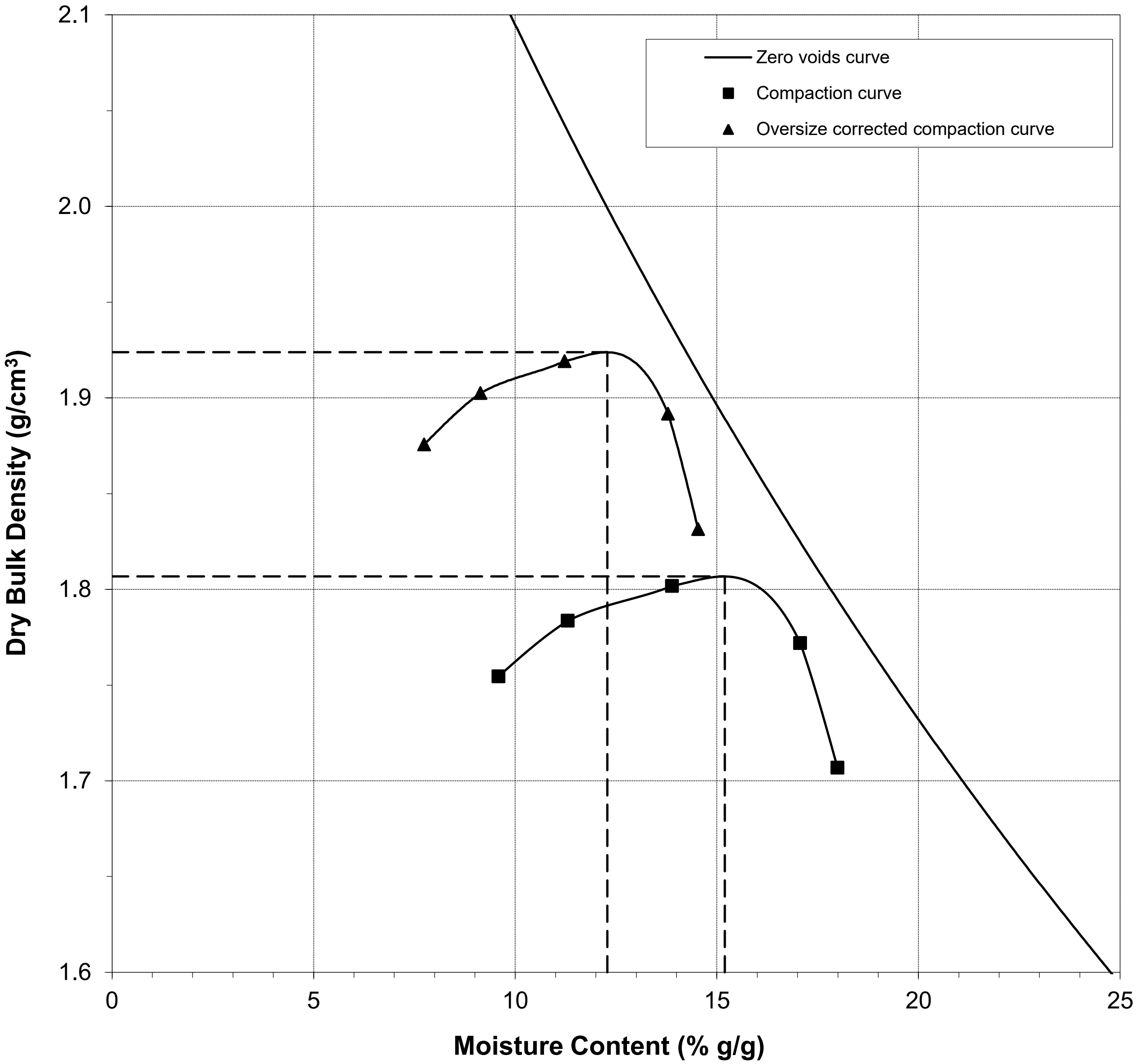
Daniel B. Stephens & Associates, Inc.

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^3):	1.81	1.92

Test Date: 16-May-18



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

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

Daniel B. Stephens & Associates, Inc.

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
Sample Number:	Borrow West Auger Cuttings (1 & 2)	*Mass of fines material (g):*	44700.00
Project Name:	St. Anthony Geotech Investigation	*Mold weight (g):*	4226
PO Number:	233001076-DBS	*Mold volume (cm^3):*	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

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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

Coarse Fraction (% g/g): 1.5

Fines Fraction (% g/g): 98.5

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65

Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---

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

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

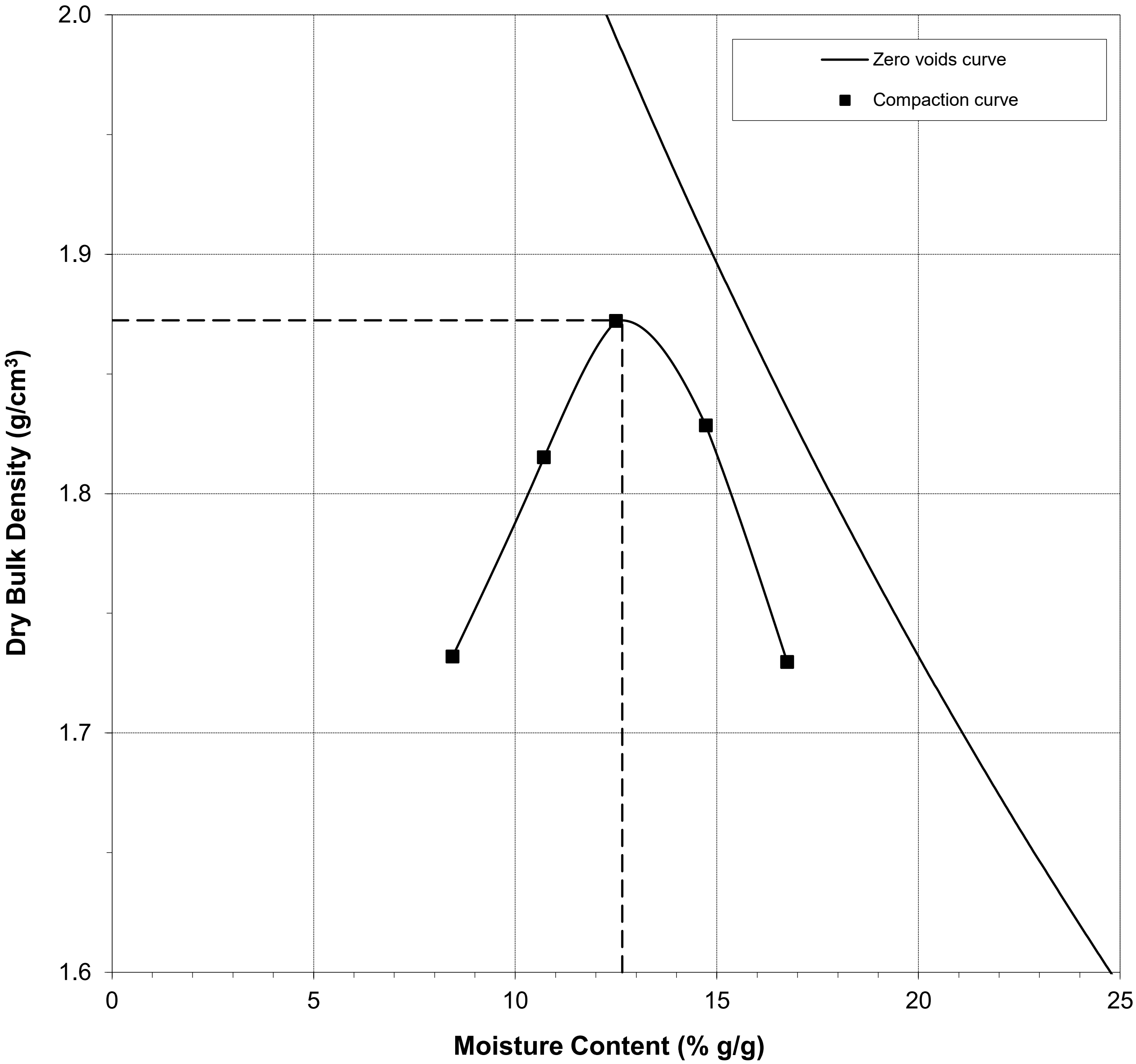
Daniel B. Stephens & Associates, Inc.

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^3):	1.87	---

Test Date: 23-May-18



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

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

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
PO Number:	233001076-DBS	*Mold volume (cm^3):*	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

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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

Coarse Fraction (% g/g): 3.7
Fines Fraction (% g/g): 96.3

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---

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

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

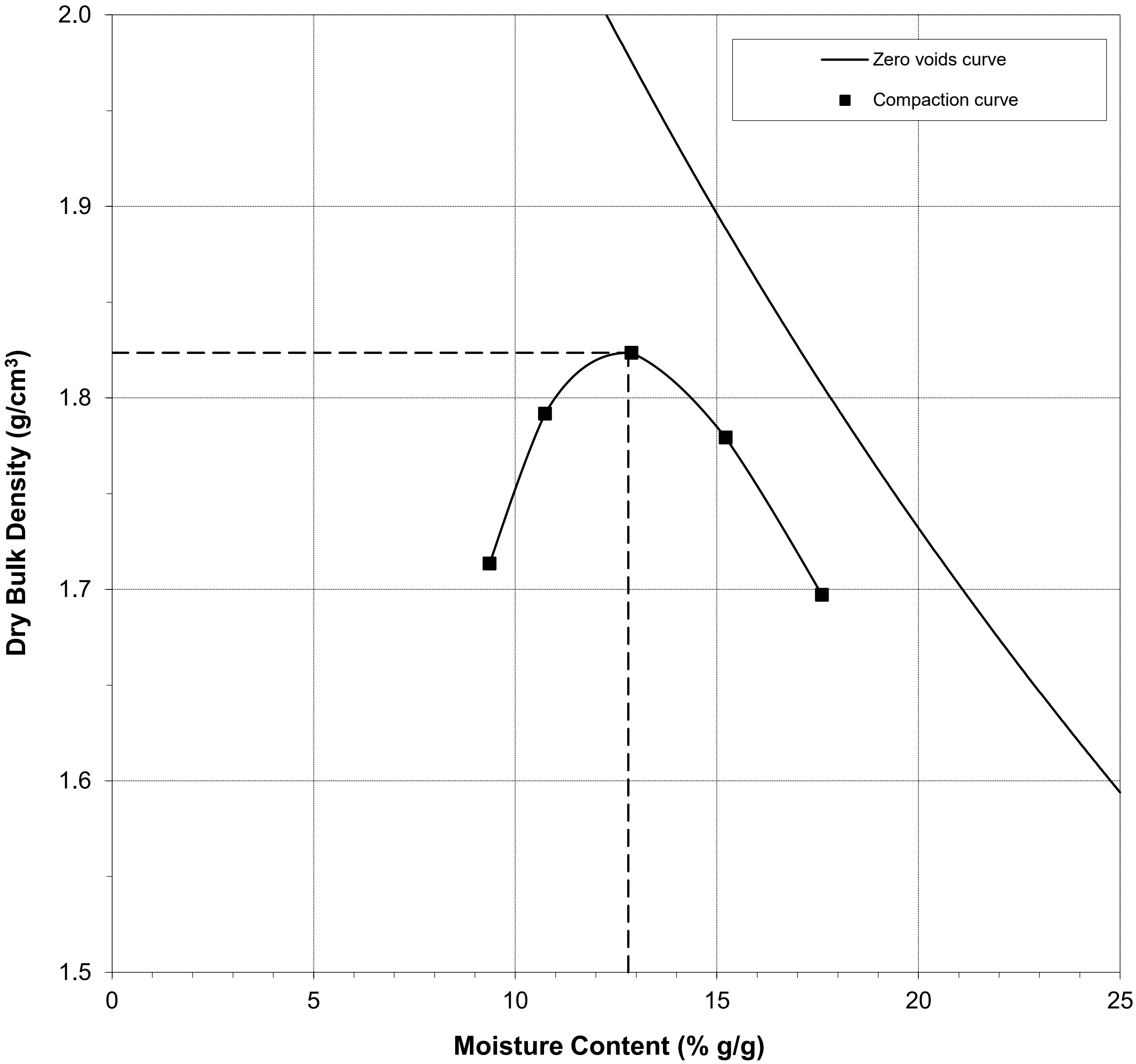
Daniel B. Stephens & Associates, Inc.

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^3):	1.82	---

Test Date: 23-May-18



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

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

Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: P3 Auger Cuttings (1 & 2)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Test Date: 17-May-18

As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): #4
Mass of coarse material (g): 2644.40
Mass of fines material (g): 36609.20
Mold weight (g): 4226
Mold volume (cm^3): 942.46

Compaction Method: Standard A
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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

Coarse Fraction (% g/g): 6.7
Fines Fraction (% g/g): 93.3

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% 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

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

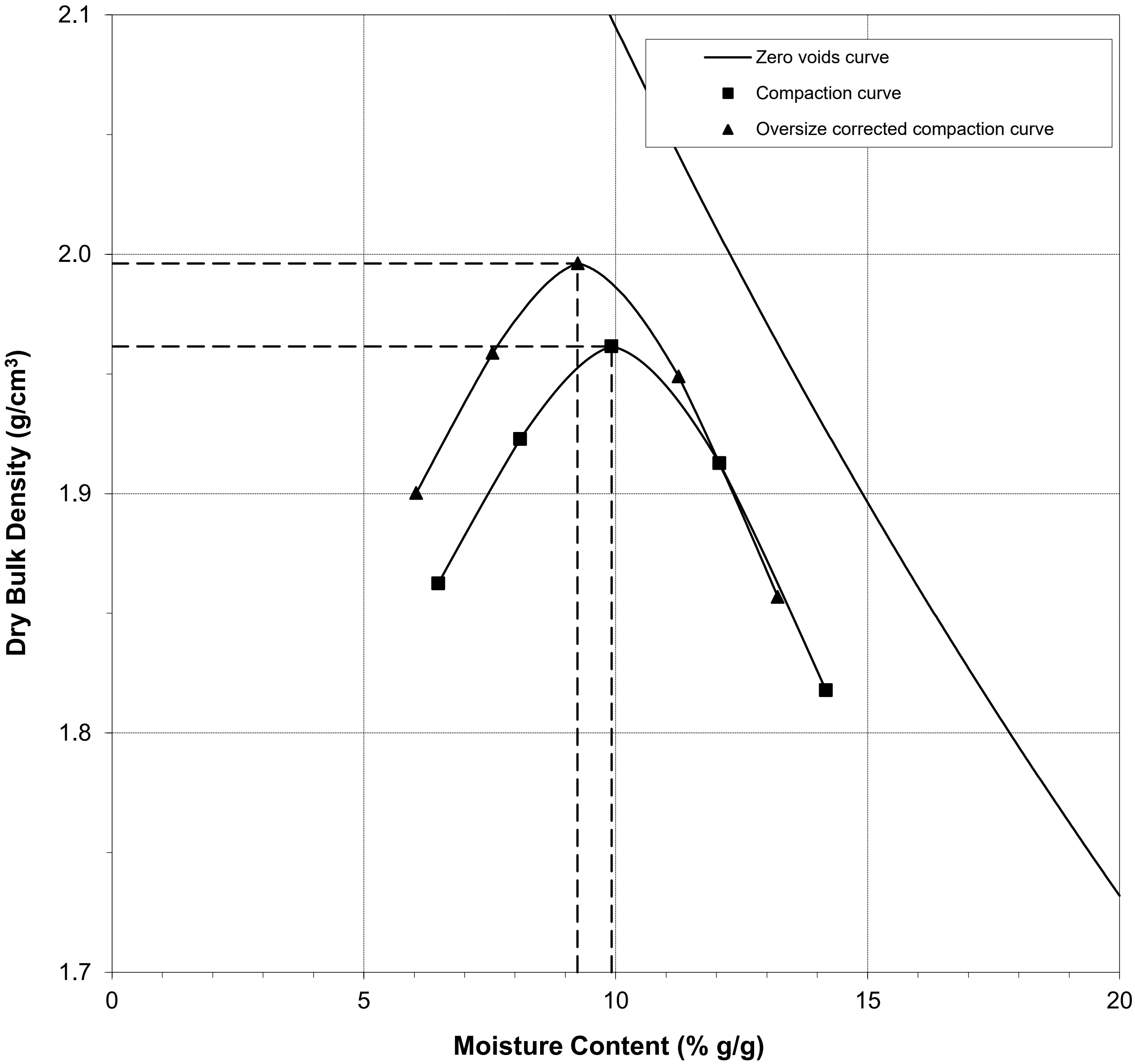
Laboratory analysis by: D. O' Dowd
Data entered by: M. Garcia
Checked by: J. Hines

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^3):	1.96	2.00

Test Date: 17-May-18



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

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

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 (cm^3):*	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

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% 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

Coarse Fraction (% g/g): 19.4
Fines Fraction (% g/g): 80.6

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% 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

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

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

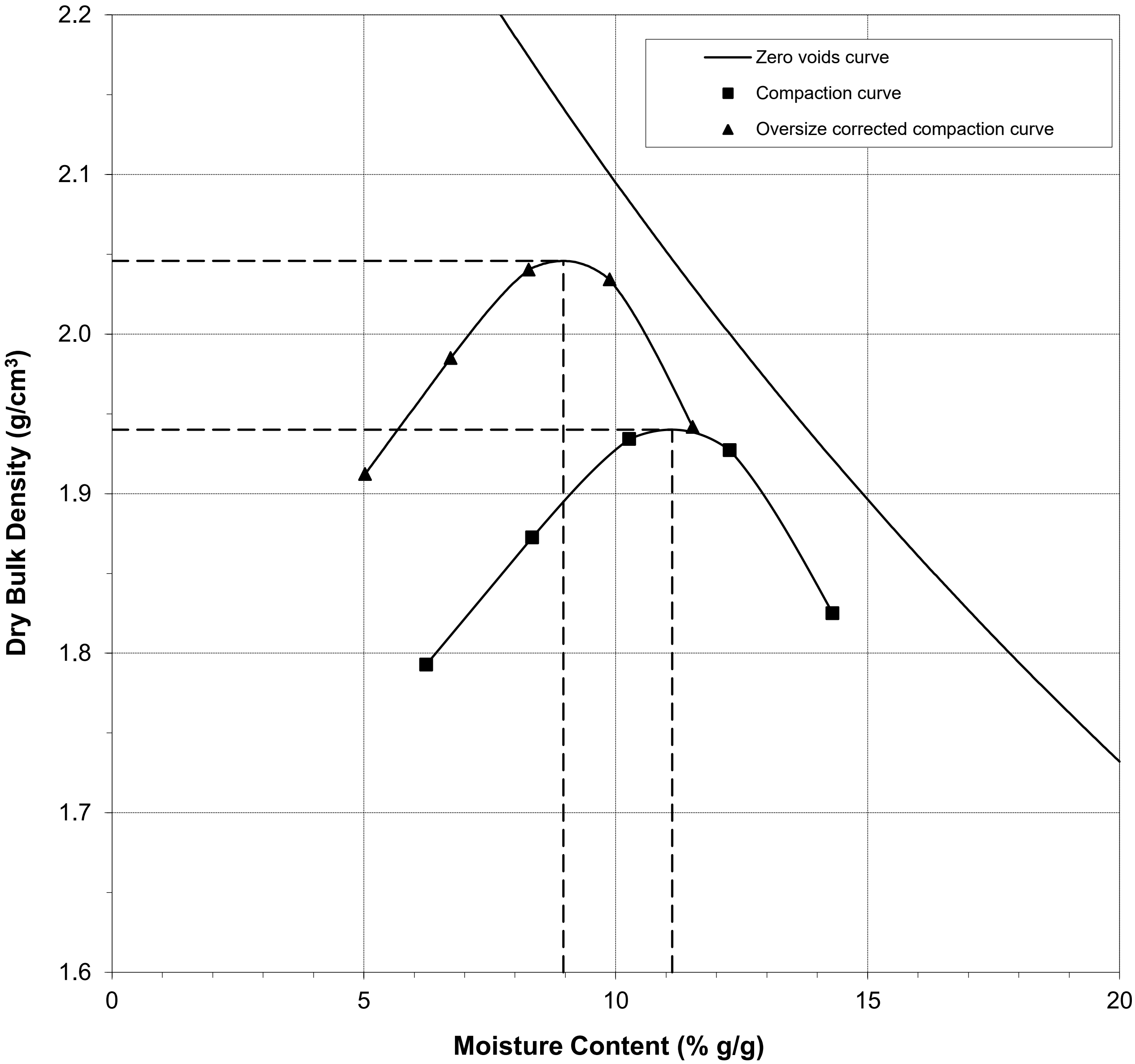
Daniel B. Stephens & Associates, Inc.

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^3):	1.94	2.05

Test Date: 23-May-18



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

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

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

*Noted percent strain used as failure criterion.

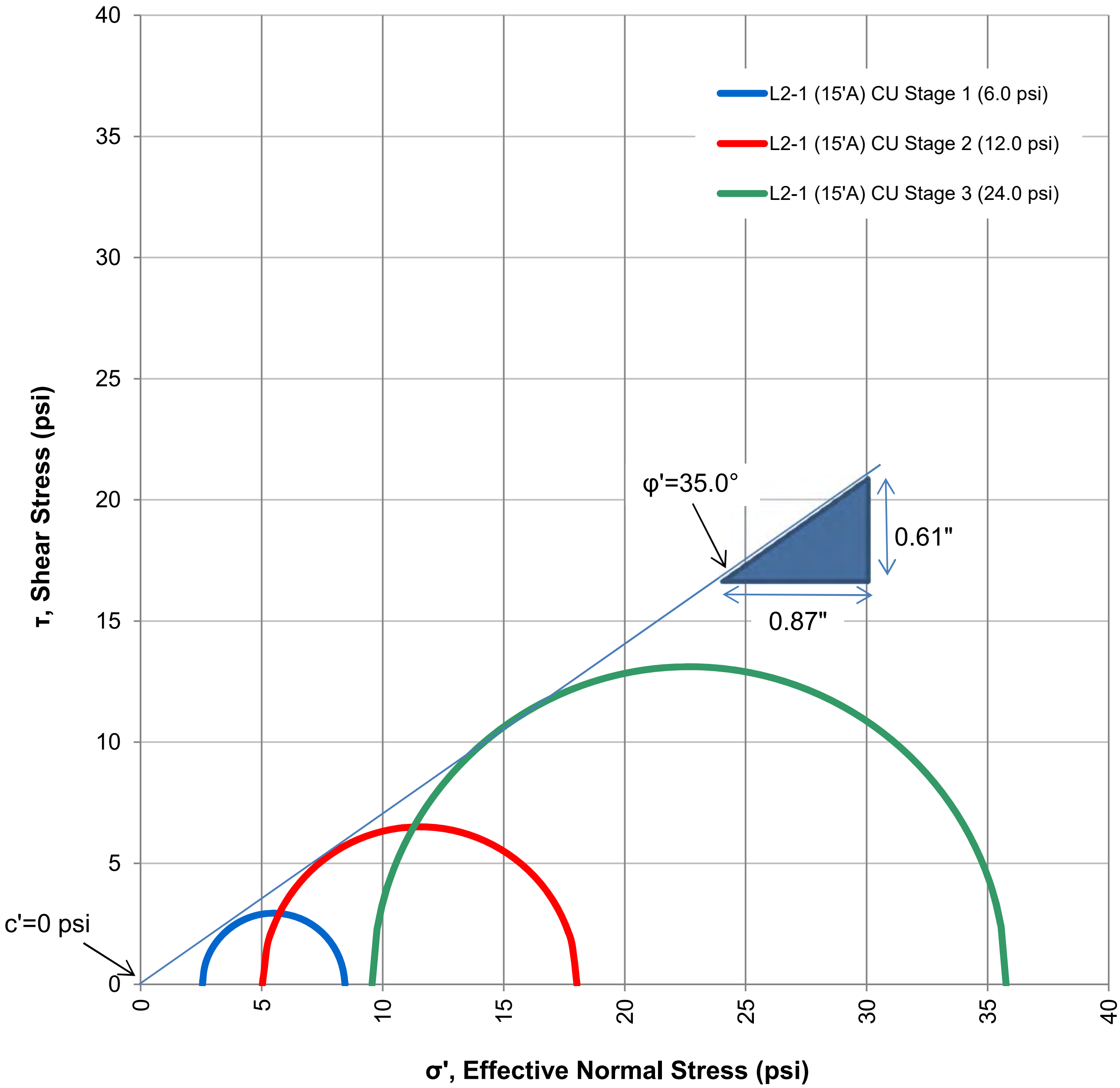
Summary of Consolidated Undrained Estimated Effective Friction Angle and Cohesion

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

[1]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



Estimated Effective Mohr-Coulomb Failure Parameters[1]:
cohesion (c')(psi) = 0
friction angle (ϕ')(°) = 35.0

[1]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.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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^2):	18.80
Volume (cm^3):	213.46
Dry Mass (g):	371.07
Dry Density (g/cm^3):	1.74
Dry Unit Weight (lbf/ft^3):	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:	☑ In situ sample, extruded ☐ Remolded Sample
Trimming Procedure:	NA
Split:	NA
Percent Coarse Material (%):	<5%
Particle Density (g/cm^3):	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

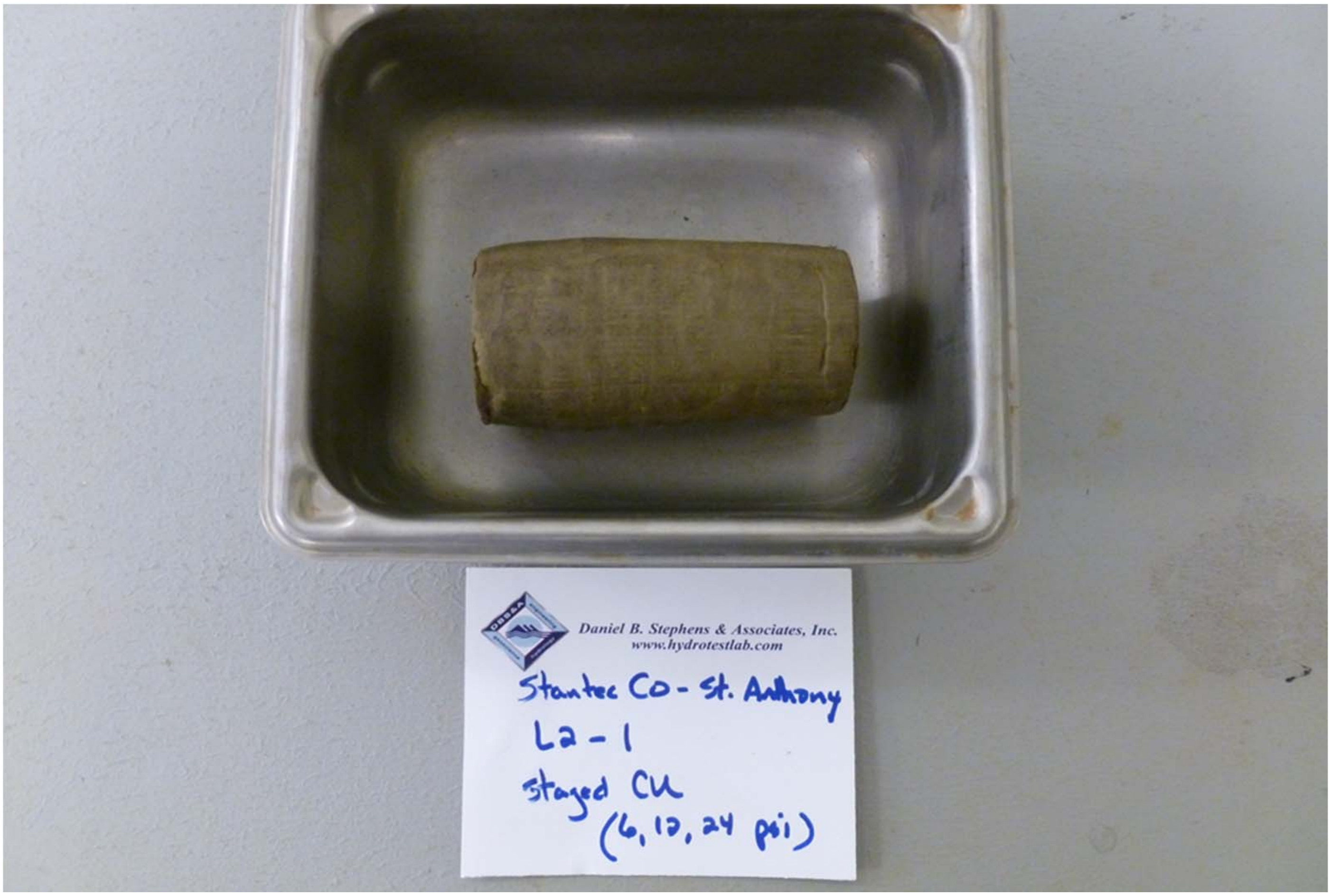
Data for Consolidated Undrained (CU) Triaxial Shear Testing

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



Data for Consolidated Undrained (CU) Triaxial Shear Testing

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^3):	5.04
Area (cm^2):	18.80
Area Determined by Method:	☑ A ☐ B
Volume (cm^3):	208.42
Dry Density (g/cm^3):	1.78
Dry Unit Weight (lbf/ft^3):	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.

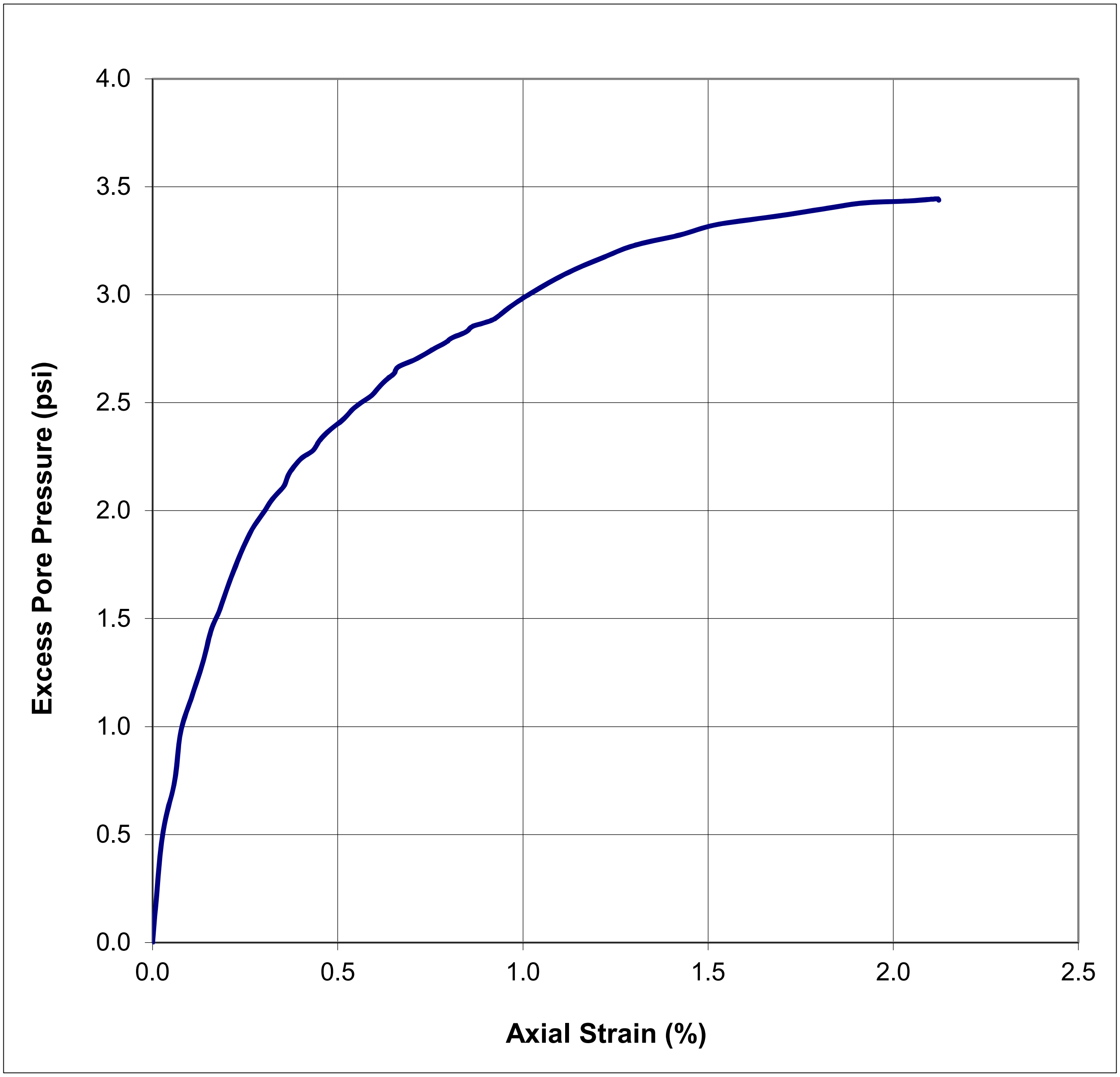
Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

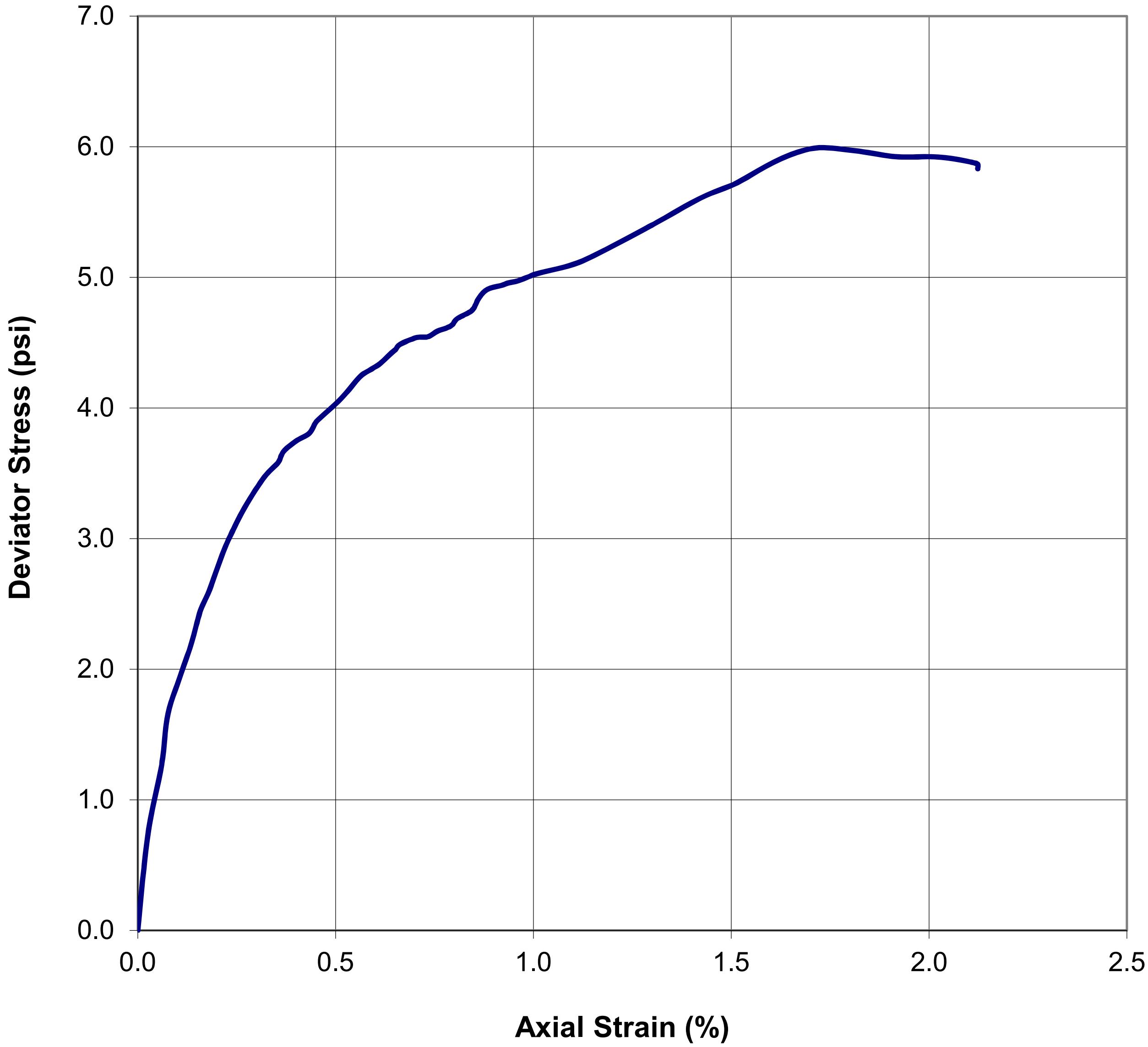
Plot of Excess Pore Pressure vs. Axial Strain



Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

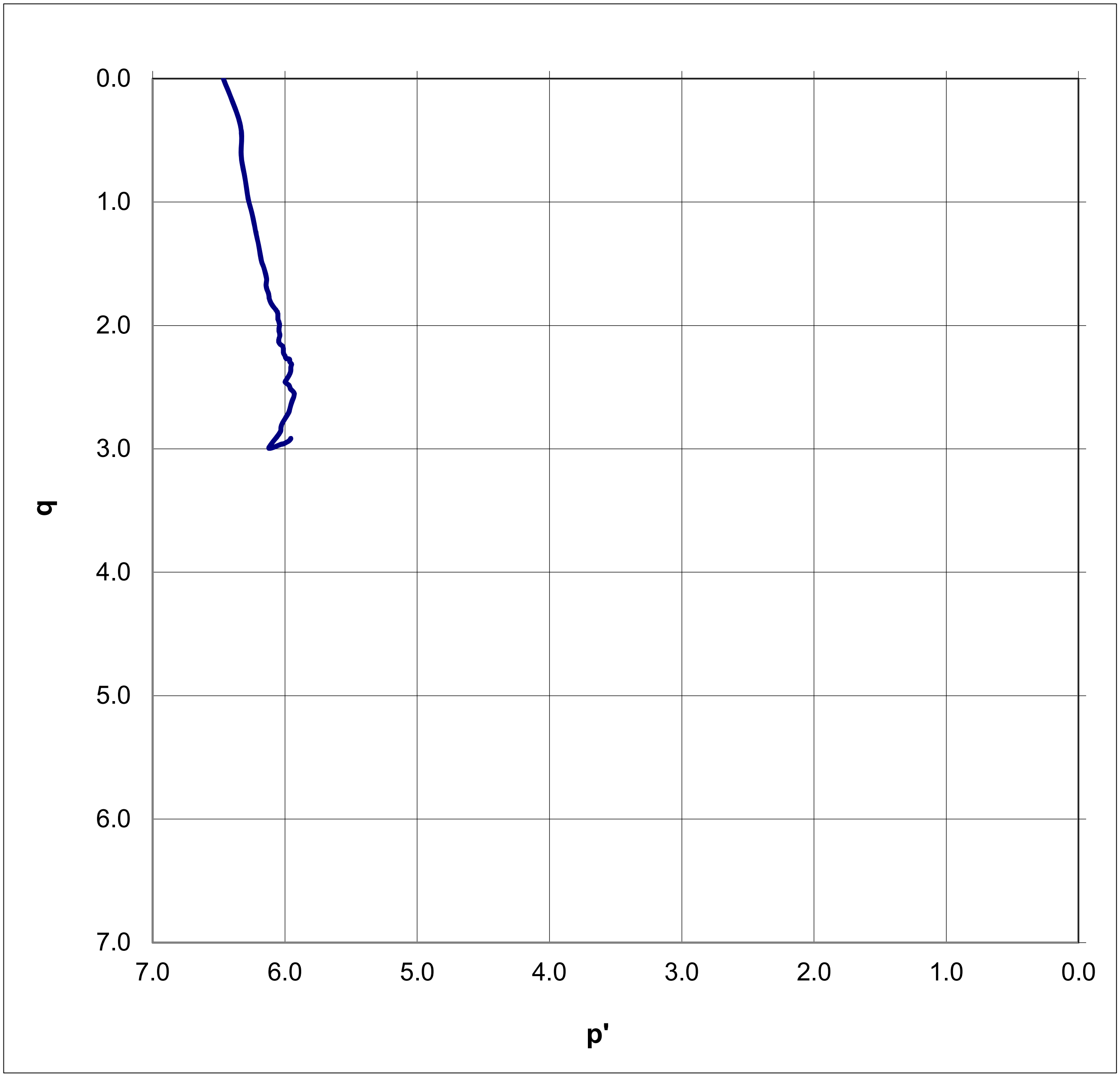


Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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 q vs.p'



Data for Consolidated Undrained (CU) Triaxial Shear Testing

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 (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)	Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)
71.58	0.00	5.98	5.98				
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				
72.88	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				
73.96	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	7.73	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				
74.52	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				
75.02	2.12	8.39	2.55				

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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^3):	3.39
Area (cm^2):	18.80
Area Determined by Method:	☑ A ☐ B
Volume (cm^3):	210.07
Dry Density (g/cm^3):	1.77
Dry Unit Weight (lbf/ft^3):	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
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.

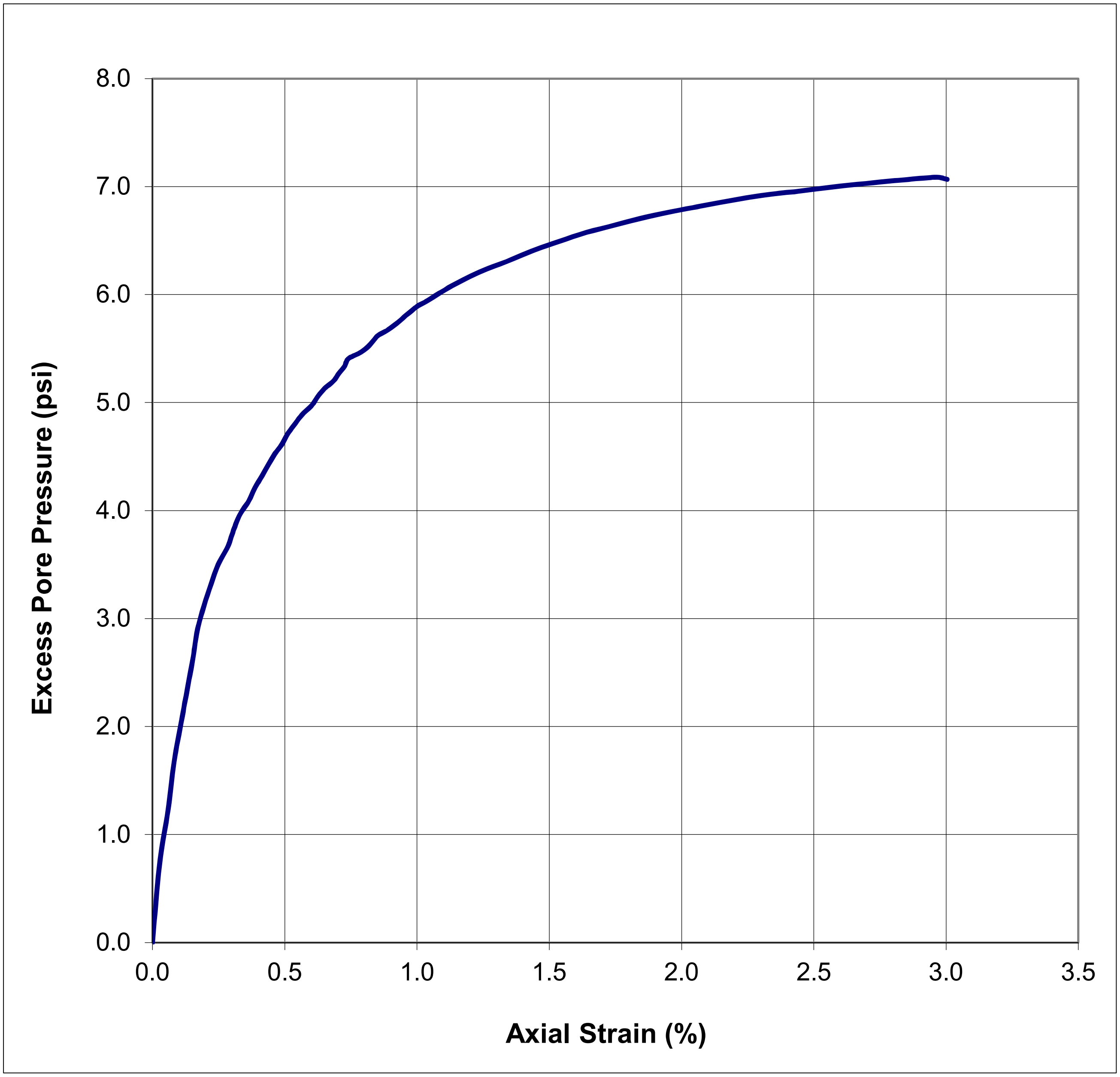
Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

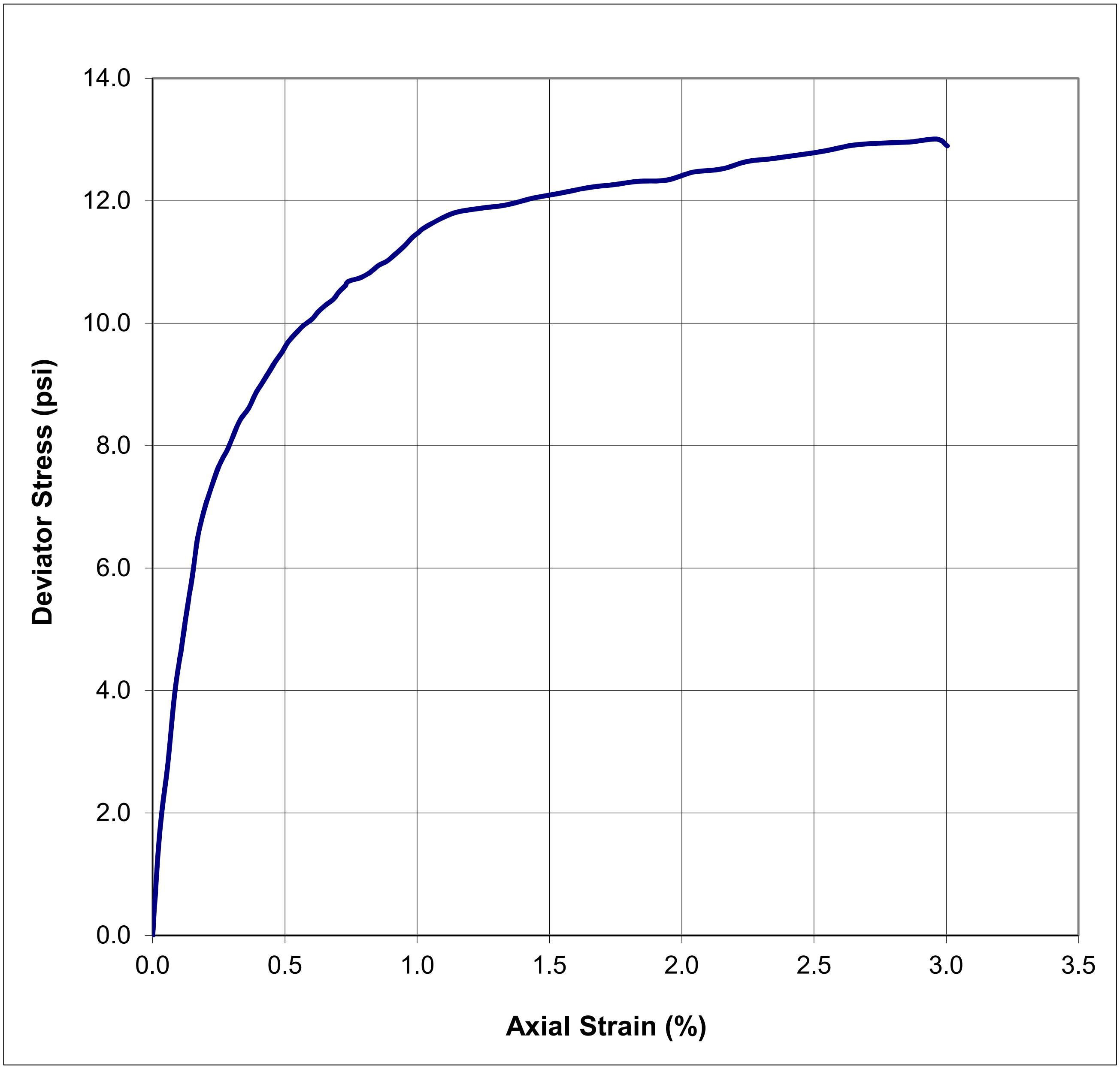


Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

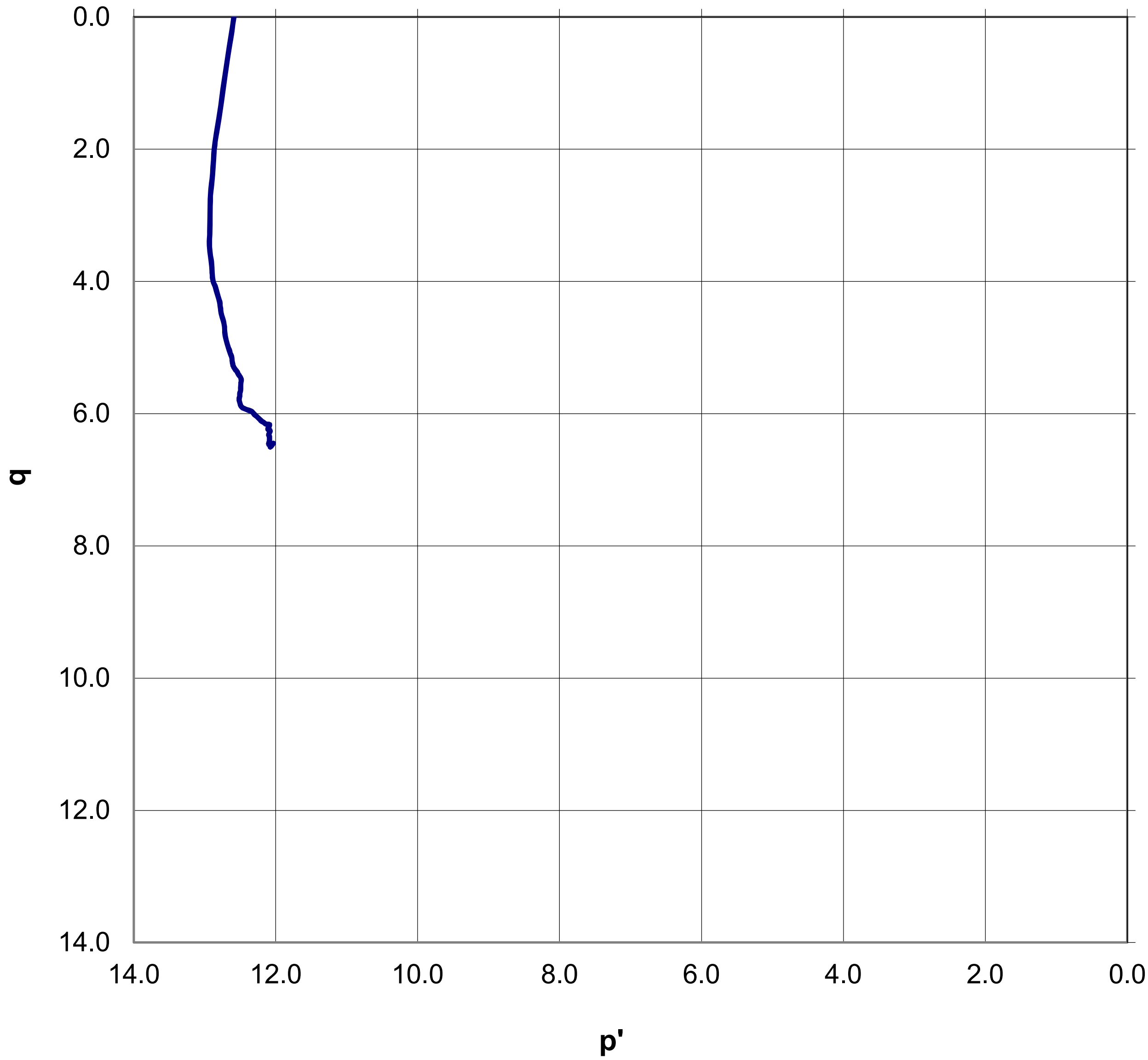


Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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'



Data for Consolidated Undrained (CU) Triaxial Shear Testing

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)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)	Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)
71.48	0.00	12.05	12.05				
72.21	0.03	13.02	11.32				
72.71	0.06	13.67	10.81				
73.15	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	16.94	7.41				
76.20	0.51	17.01	7.32				
76.29	0.54	17.06	7.23				
76.37	0.57	17.11	7.16				
76.45	0.60	17.15	7.08				
76.53	0.62	17.19	7.01				
76.61	0.65	17.22	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	2.75	18.02	5.08				
78.55	2.86	18.01	5.05				
78.57	2.96	18.04	5.03				
78.55	3.00	17.94	5.04				

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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^3): 2.78
Area (cm^2): 18.80
Area Determined by Method: ☑ A ☐ B
Volume (cm^3): 210.68
Dry Density (g/cm^3): 1.76
Dry Unit Weight (lbf/ft^3): 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

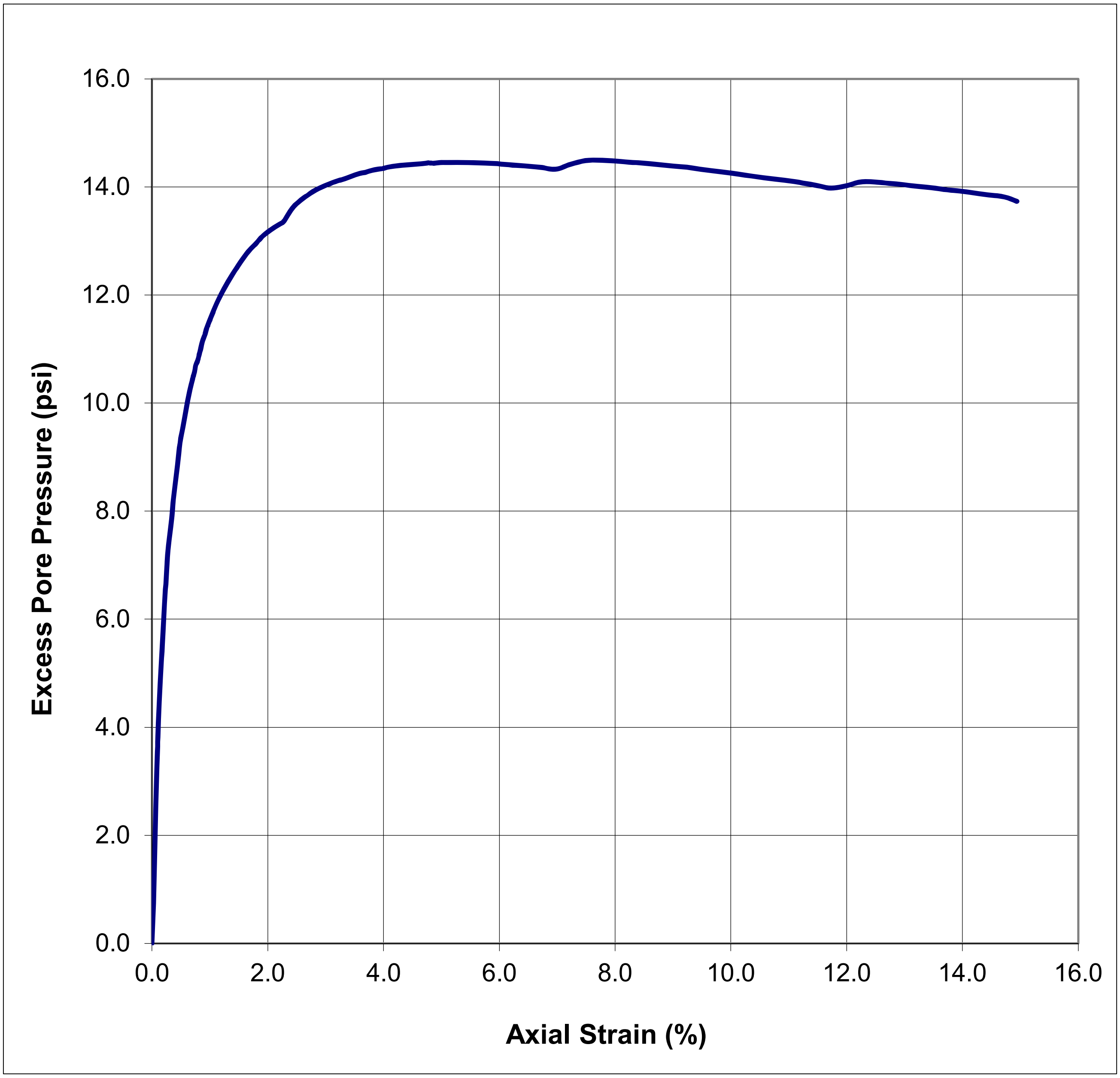
Test Notes:
Test was halted after reaching the target of 15% strain. Failure was interpreted as the peak deviator stress achieved.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

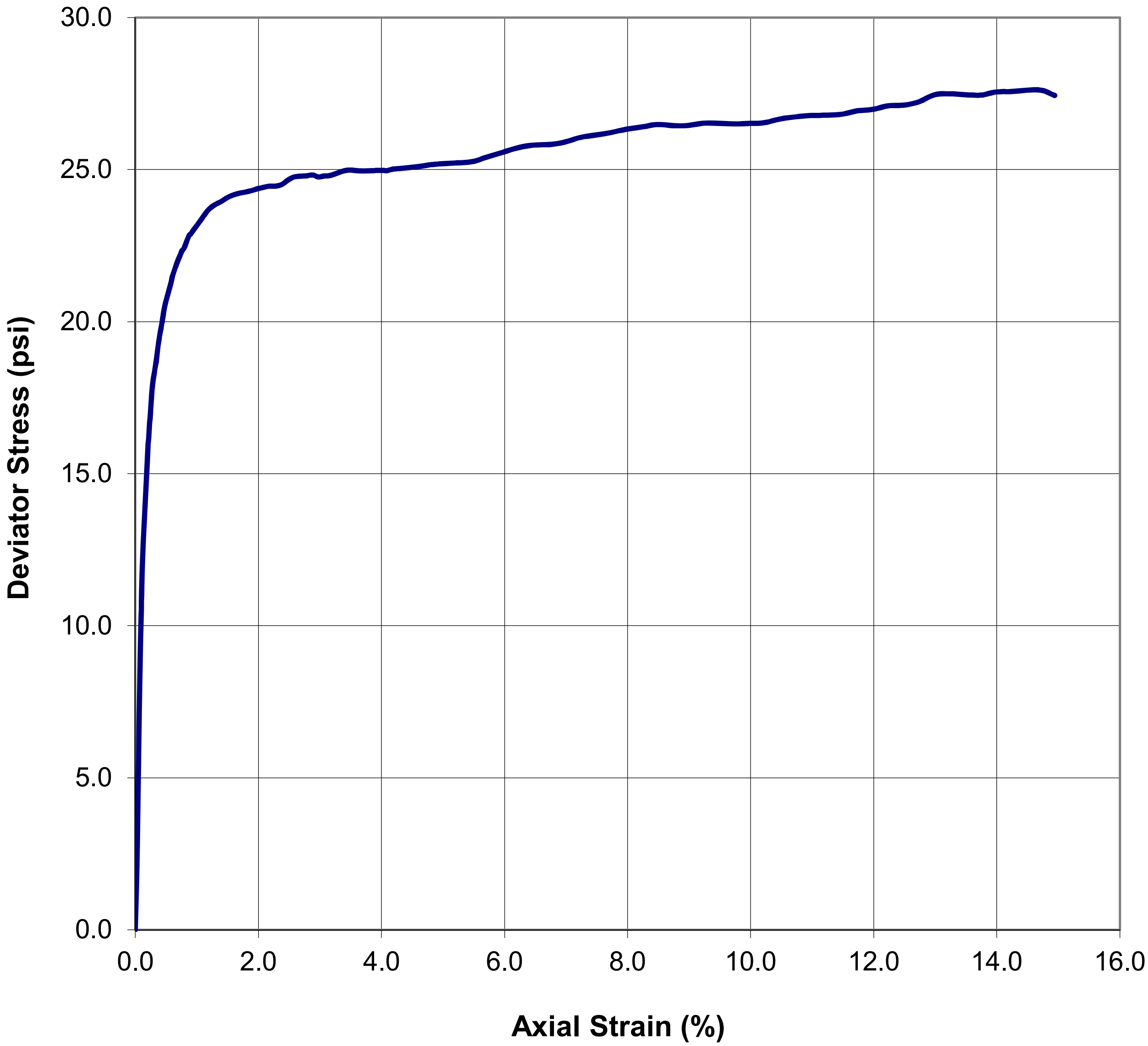
Plot of Excess Pore Pressure vs. Axial Strain



Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

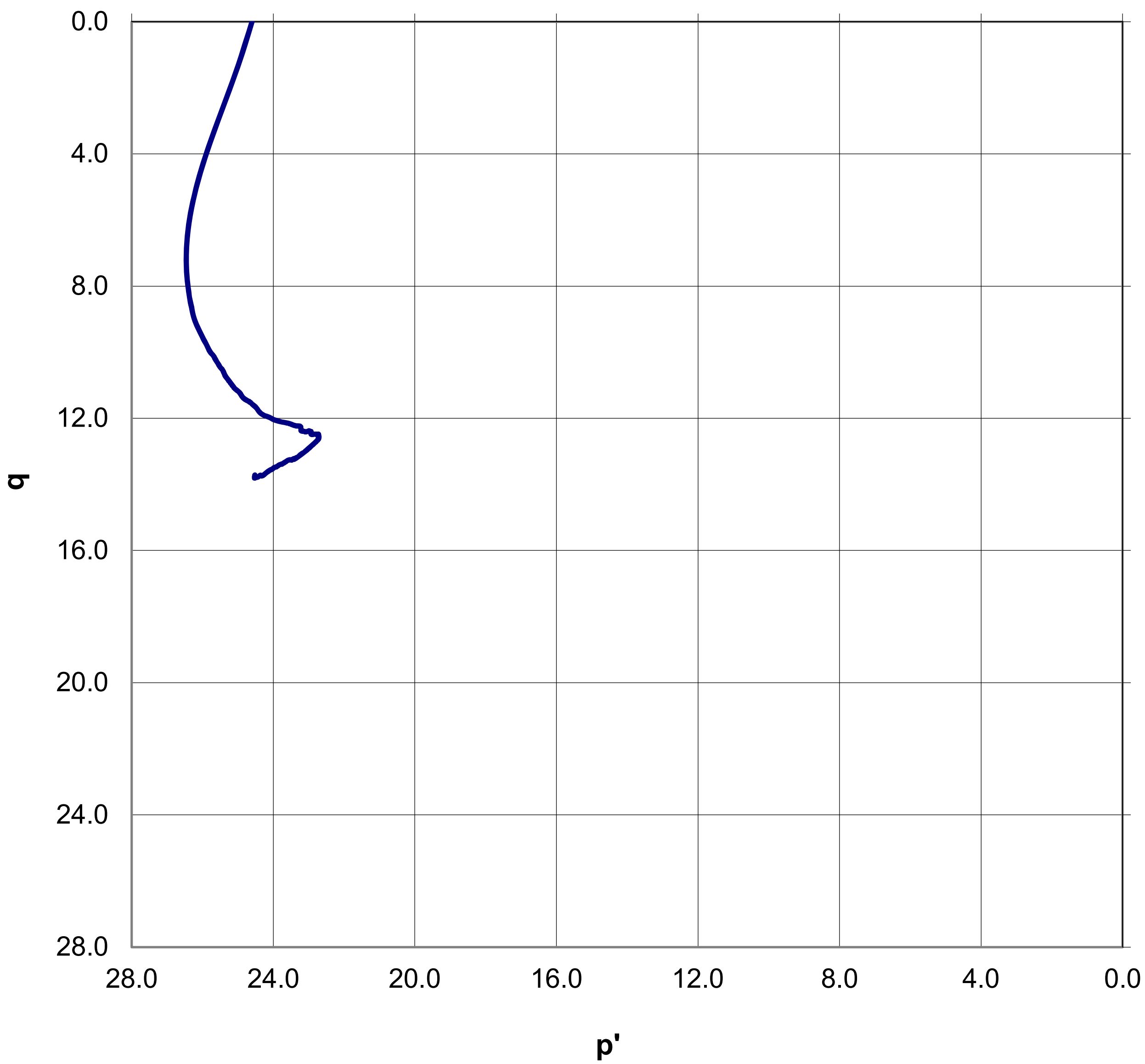


Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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 q vs.p'



Data for Consolidated Undrained (CU) Triaxial Shear Testing

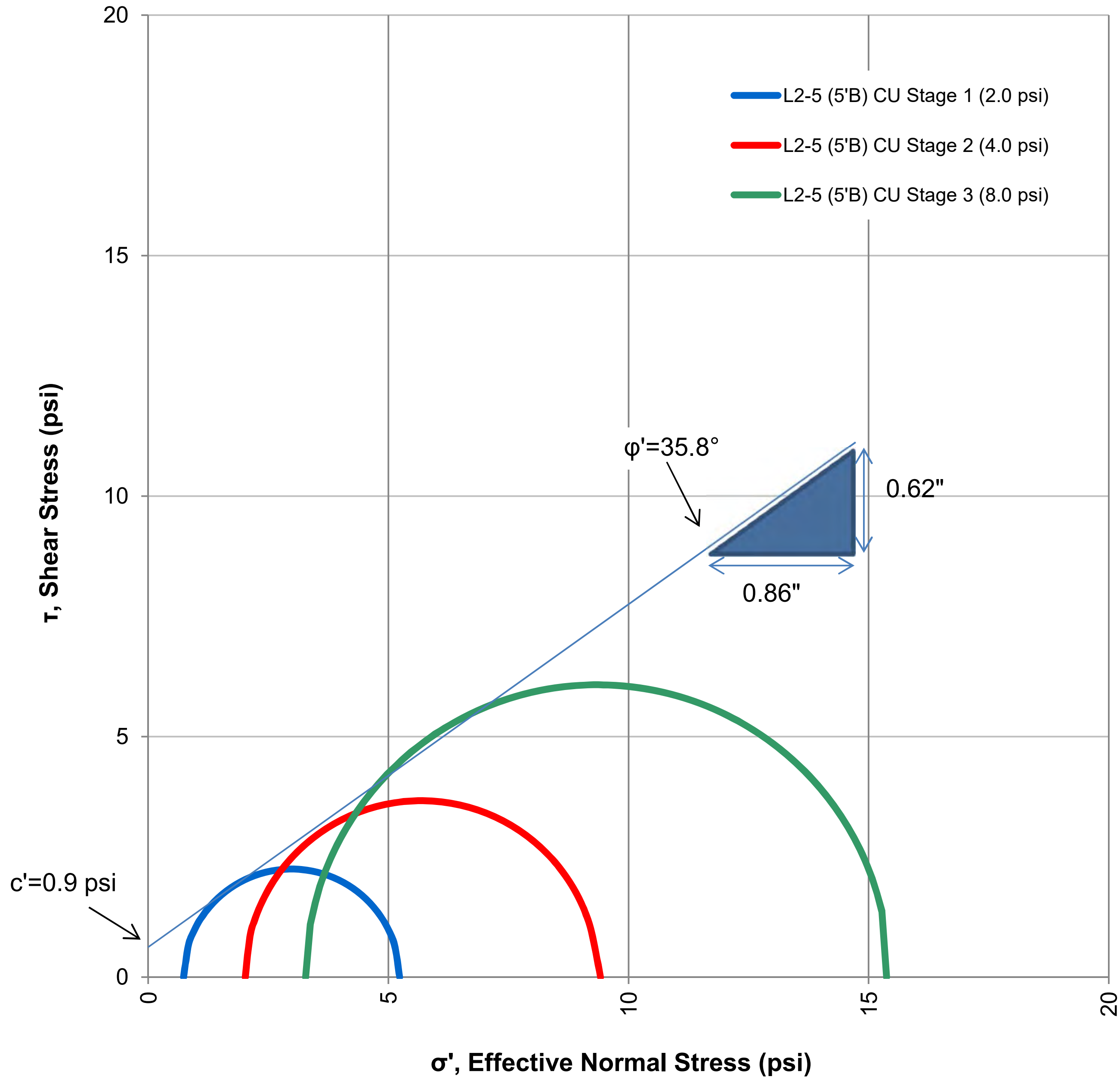
Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-1 (15'A) CU Stage 3 (24.0 psi)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Raw Data

Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)	Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (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	0.74	35.62	13.41	86.09	7.73	35.78	9.56
82.29	0.76	35.61	13.29	86.07	7.98	35.90	9.57
82.38	0.79	35.61	13.20	86.05	8.24	35.99	9.59
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	10.08
85.25	2.47	34.98	10.33	85.51	13.99	37.64	10.09
85.35	2.57	35.02	10.27	85.48	14.23	37.68	10.12
85.43	2.68	34.99	10.21	85.44	14.48	37.75	10.14
85.51	2.78	34.95	10.16	85.41	14.73	37.77	10.16
85.56	2.88	34.92	10.10	85.33	14.94	37.67	10.23
85.61	2.98	34.80	10.05				

Mohr's Circles: Effective

L2-5 (5'B) CU



Estimated Effective Mohr-Coulomb Failure Parameters[1]:
cohesion (c')(psi) = 0.9
friction angle (ϕ')(°) = 35.8

[1]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.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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^2):	18.97
Volume (cm^3):	218.37
Dry Mass (g):	366.98
Dry Density (g/cm^3):	1.68
Dry Unit Weight (lbf/ft^3):	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:	☑ In situ sample, extruded ☐ Remolded Sample
Trimming Procedure:	NA
Split:	NA
Percent Coarse Material (%):	<5%
Particle Density (g/cm^3):	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

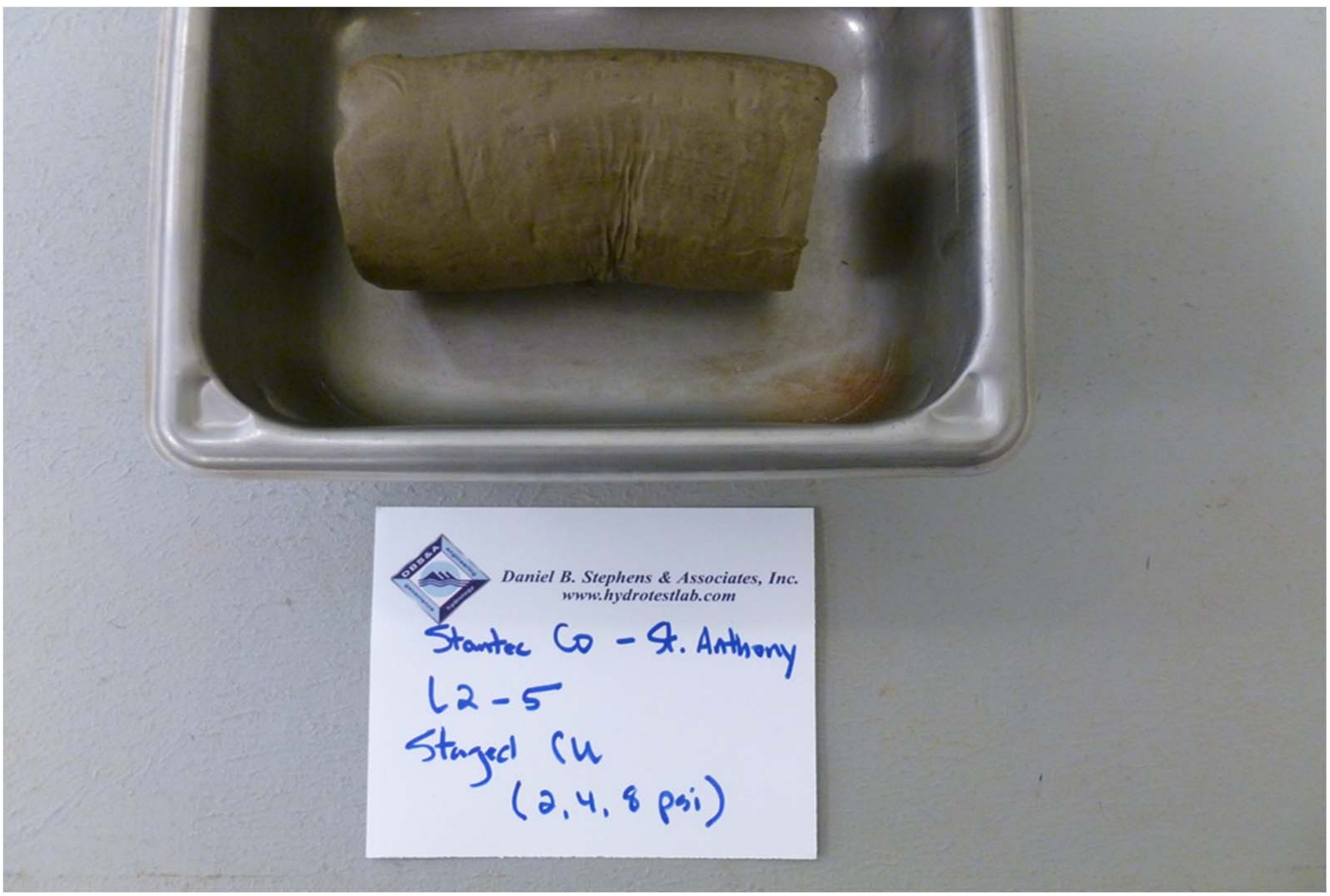
Data for Consolidated Undrained (CU) Triaxial Shear Testing

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



Data for Consolidated Undrained (CU) Triaxial Shear Testing

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^3):	0.513
Area (cm^2):	18.97
Area Determined by Method:	☑ A ☐ B
Volume (cm^3):	217.85
Dry Density (g/cm^3):	1.68
Dry Unit Weight (lbf/ft^3):	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:

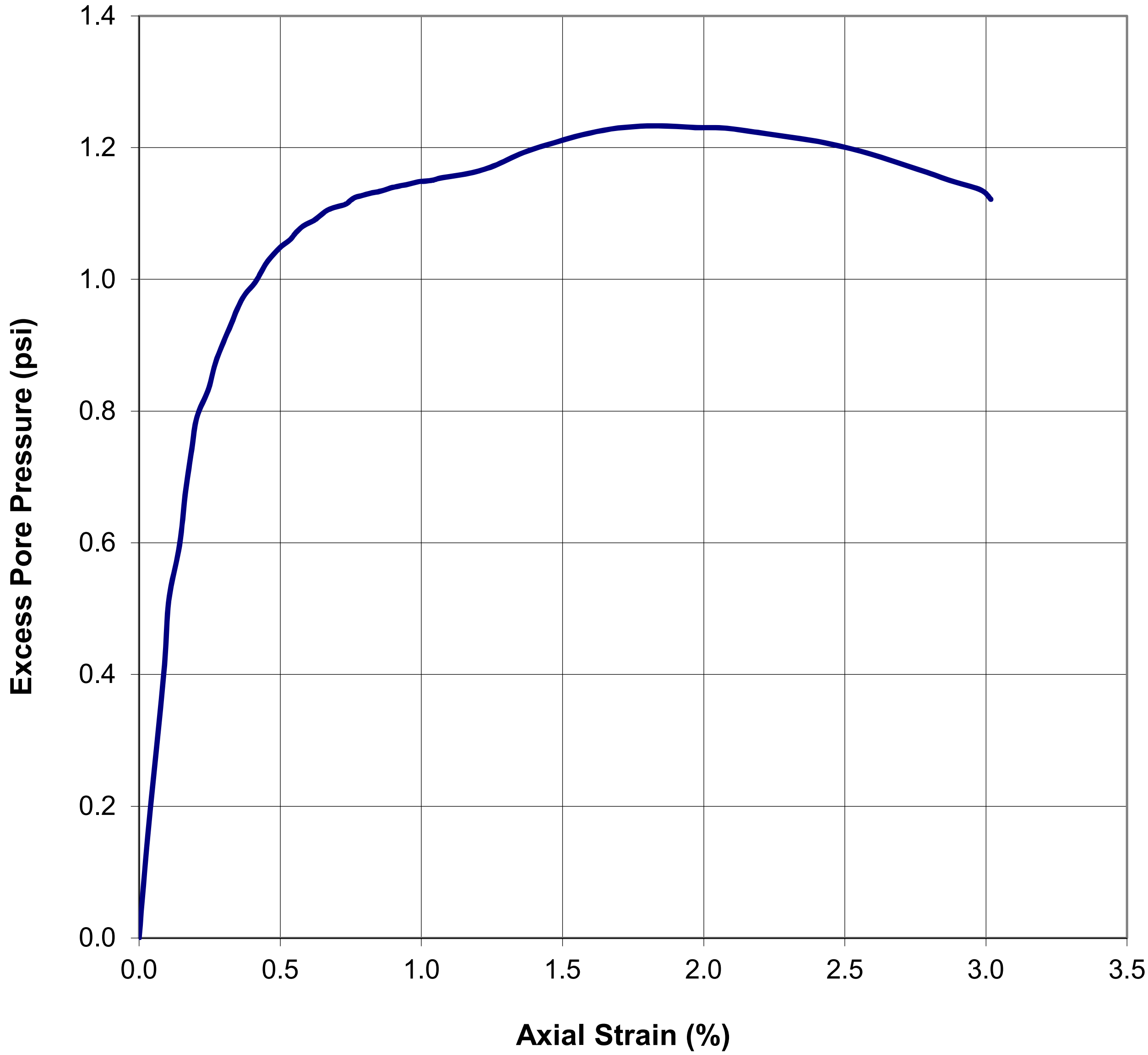
Test was halted after reaching a maximum target of 3% strain. Failure was interpreted as the peak deviator stress achieved.

Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

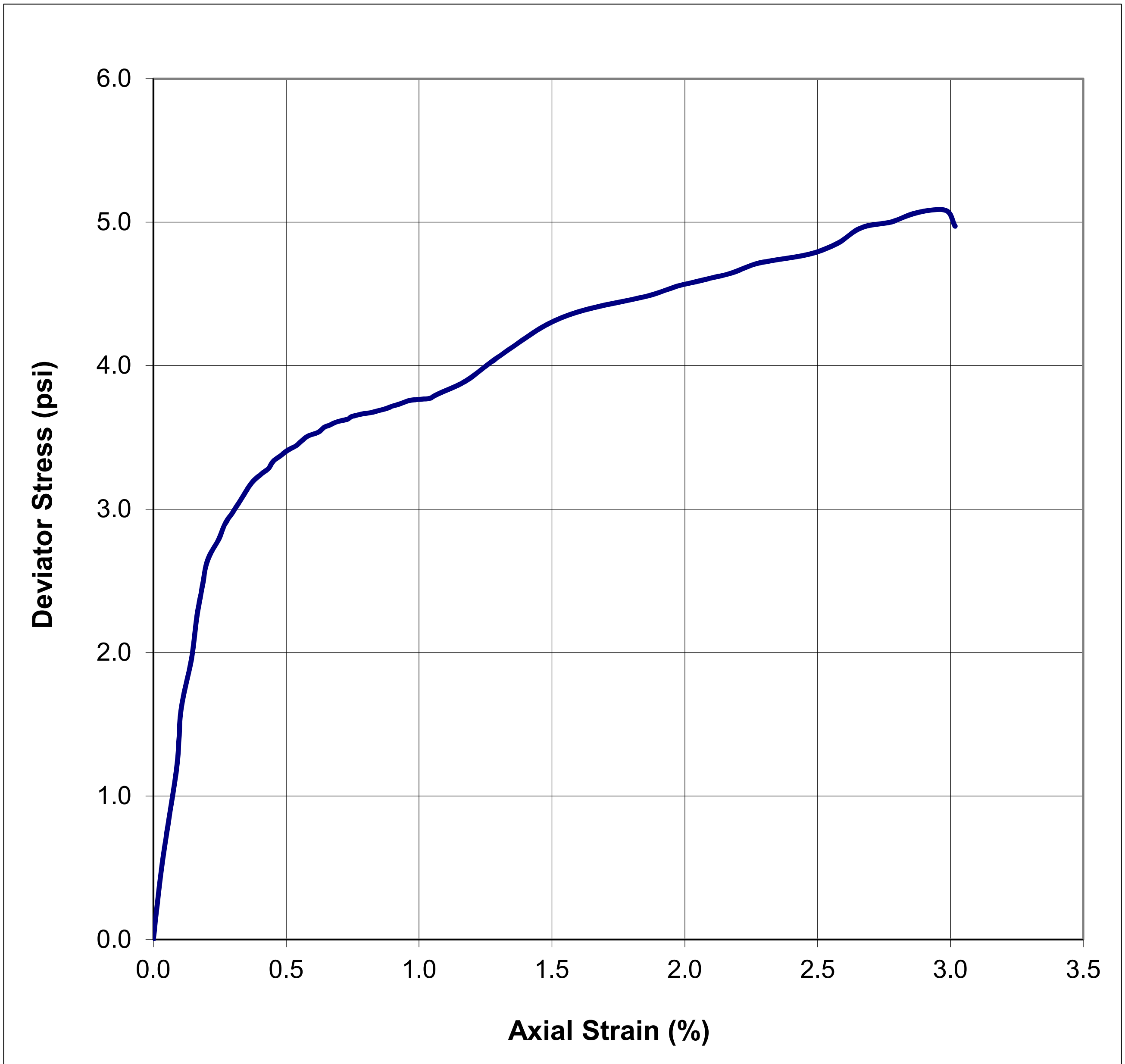
Plot of Excess Pore Pressure vs. Axial Strain



Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

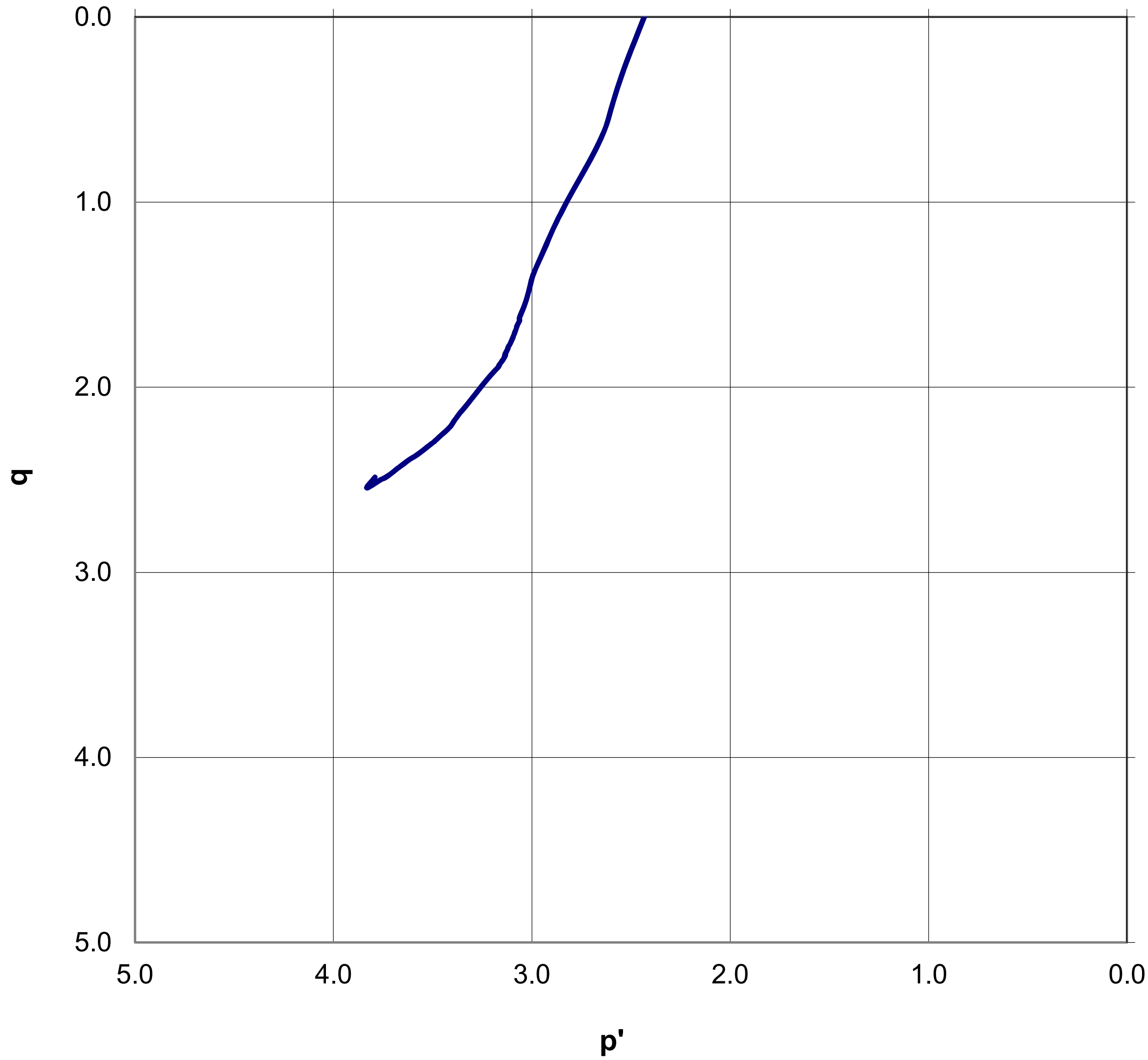
Plot of Deviator Stress vs. Axial Strain



Data for Consolidated Undrained (CU) Triaxial Shear Testing

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'



Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)	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				
81.28	0.14	3.33	1.37				
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				
81.75	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				

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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^3):	1.608
Area (cm^2):	18.97
Area Determined by Method:	☑ A ☐ B
Volume (cm^3):	216.76
Dry Density (g/cm^3):	1.69
Dry Unit Weight (lbf/ft^3):	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.

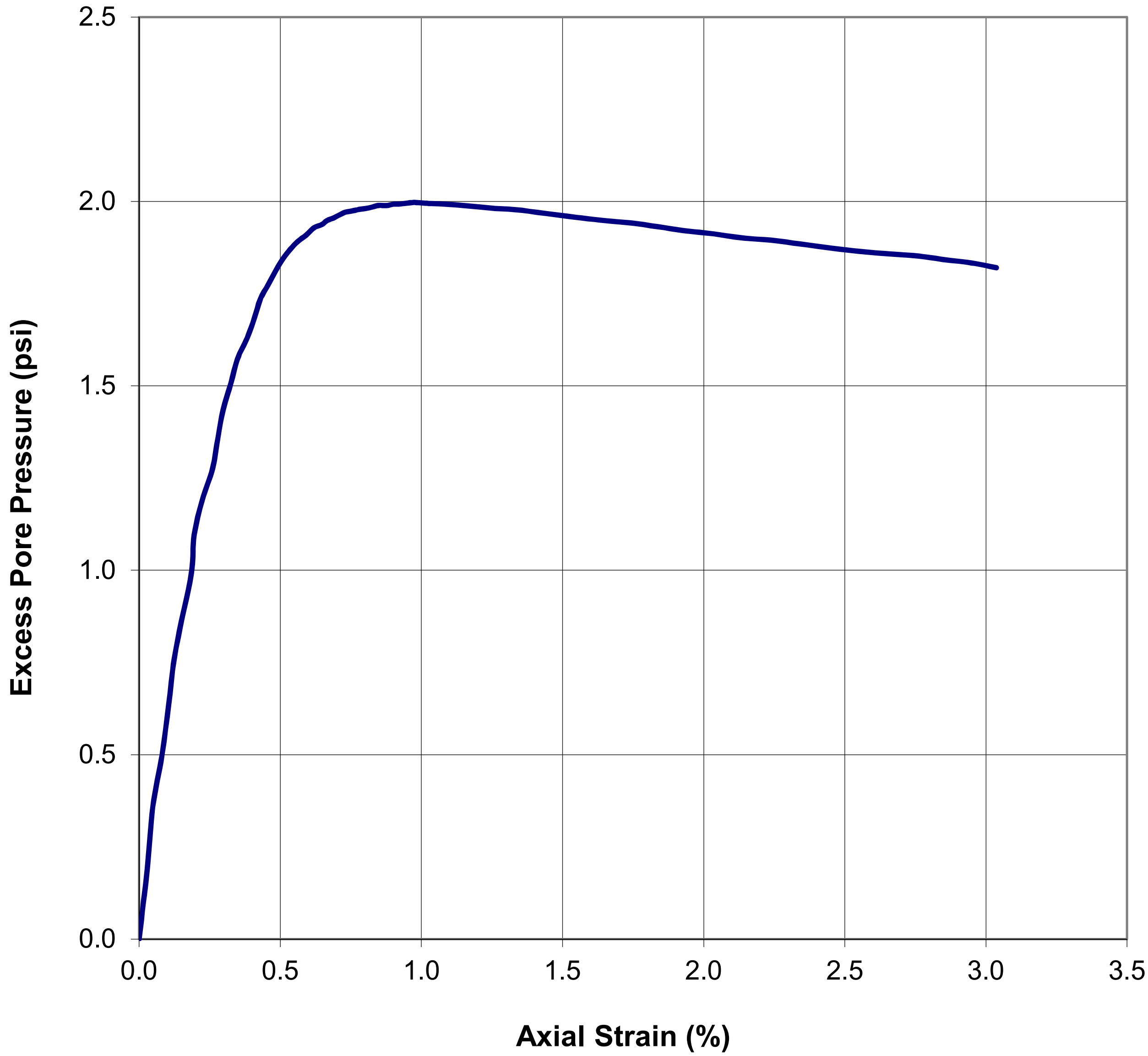
Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

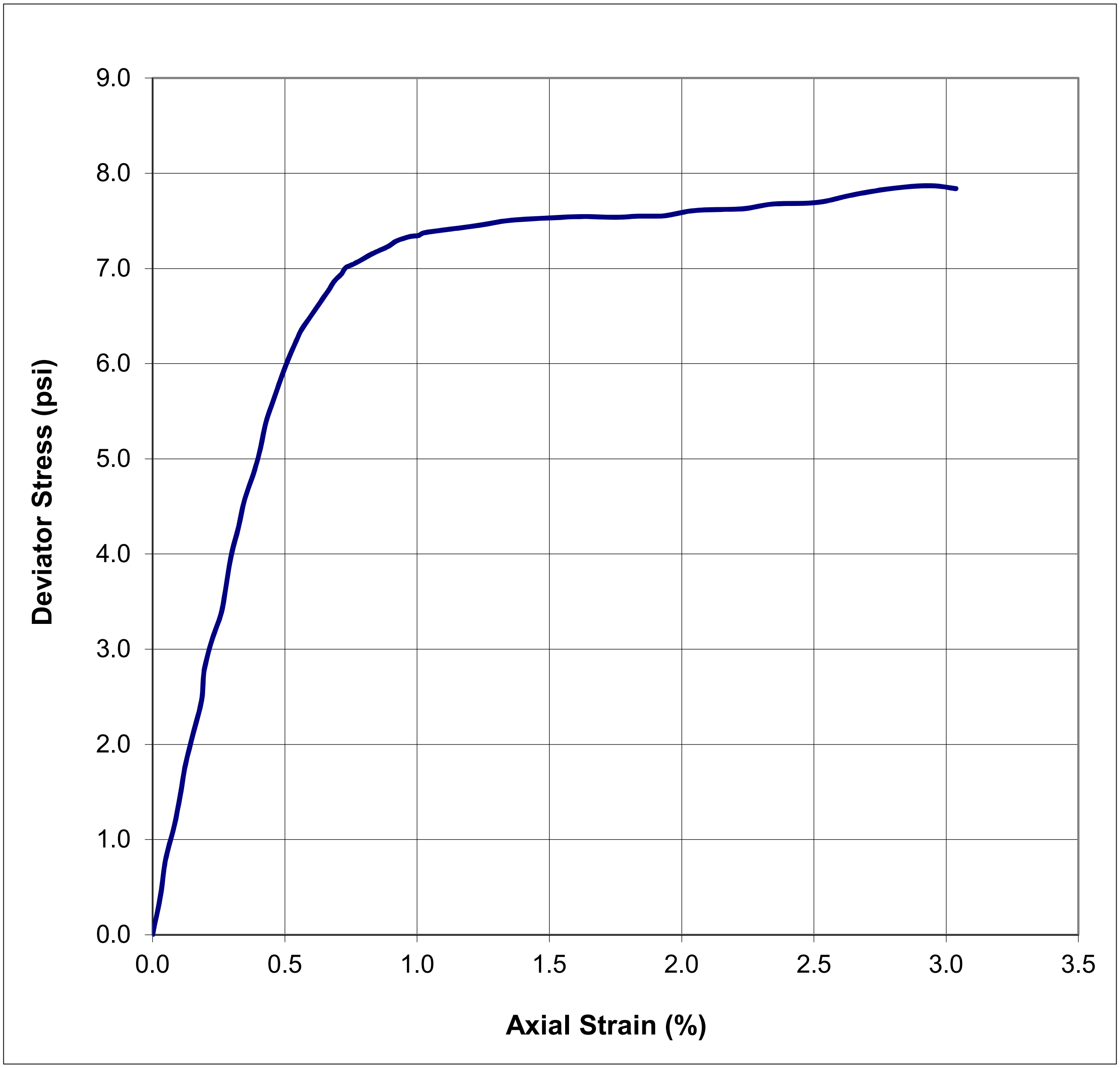


Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

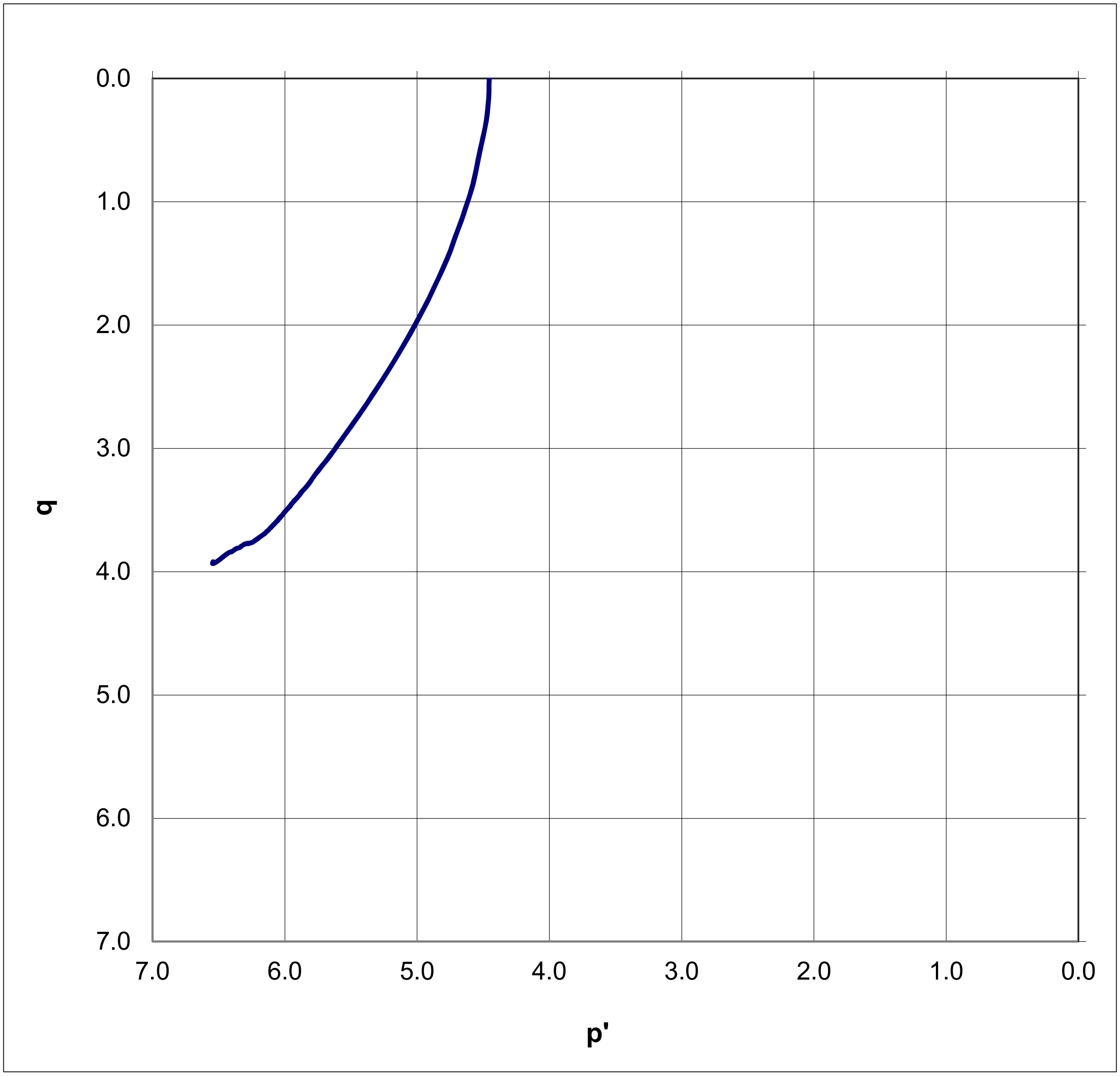


Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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'



Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)	Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (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	0.30	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	1.24	9.49	2.03				
82.52	1.33	9.54	2.04				
82.51	1.43	9.56	2.04				
82.50	1.54	9.59	2.05				
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				

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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^3):	1.356
Area (cm^2):	18.97
Area Determined by Method:	☑ A ☐ B
Volume (cm^3):	217.01
Dry Density (g/cm^3):	1.69
Dry Unit Weight (lbf/ft^3):	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.

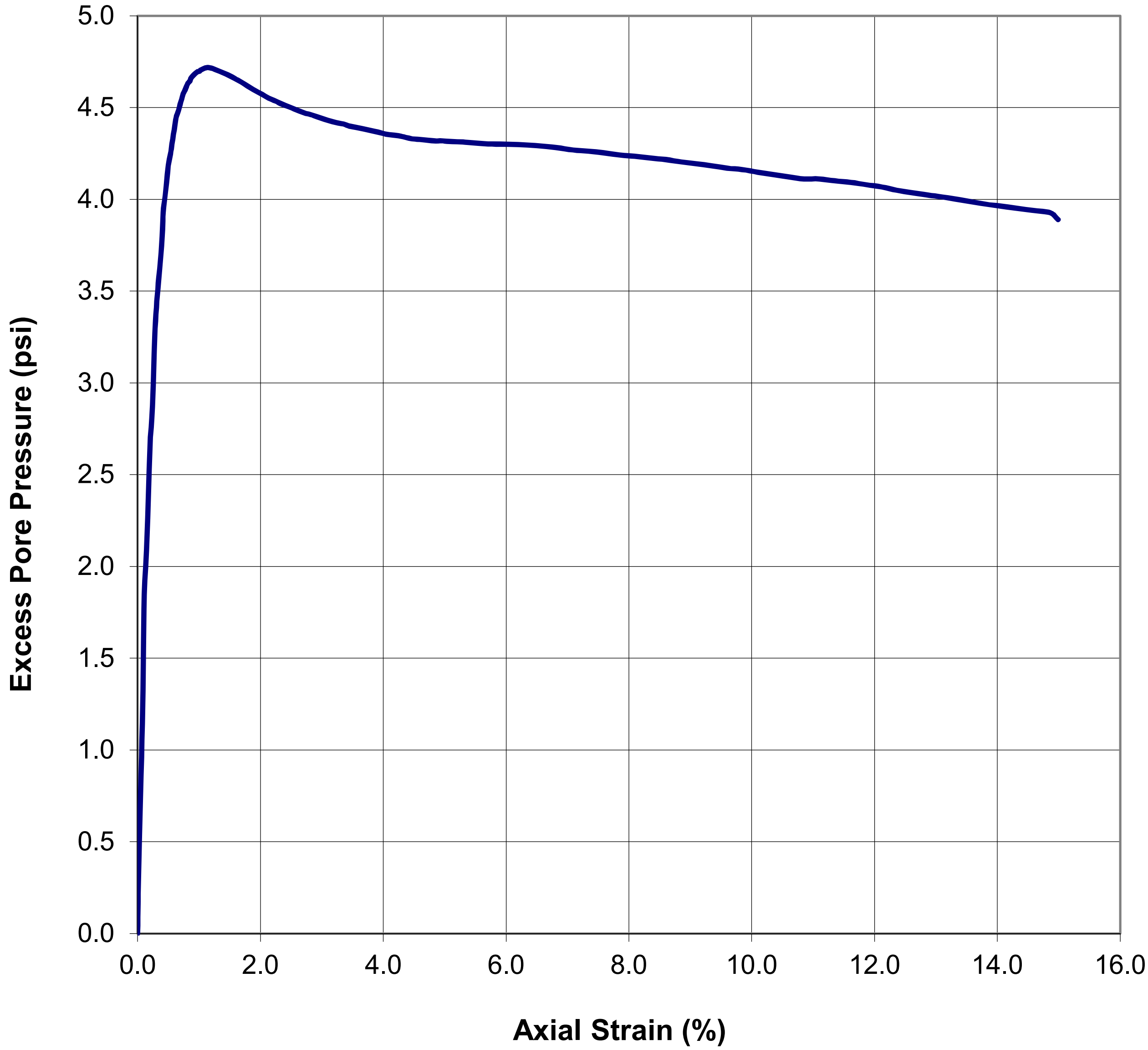
Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

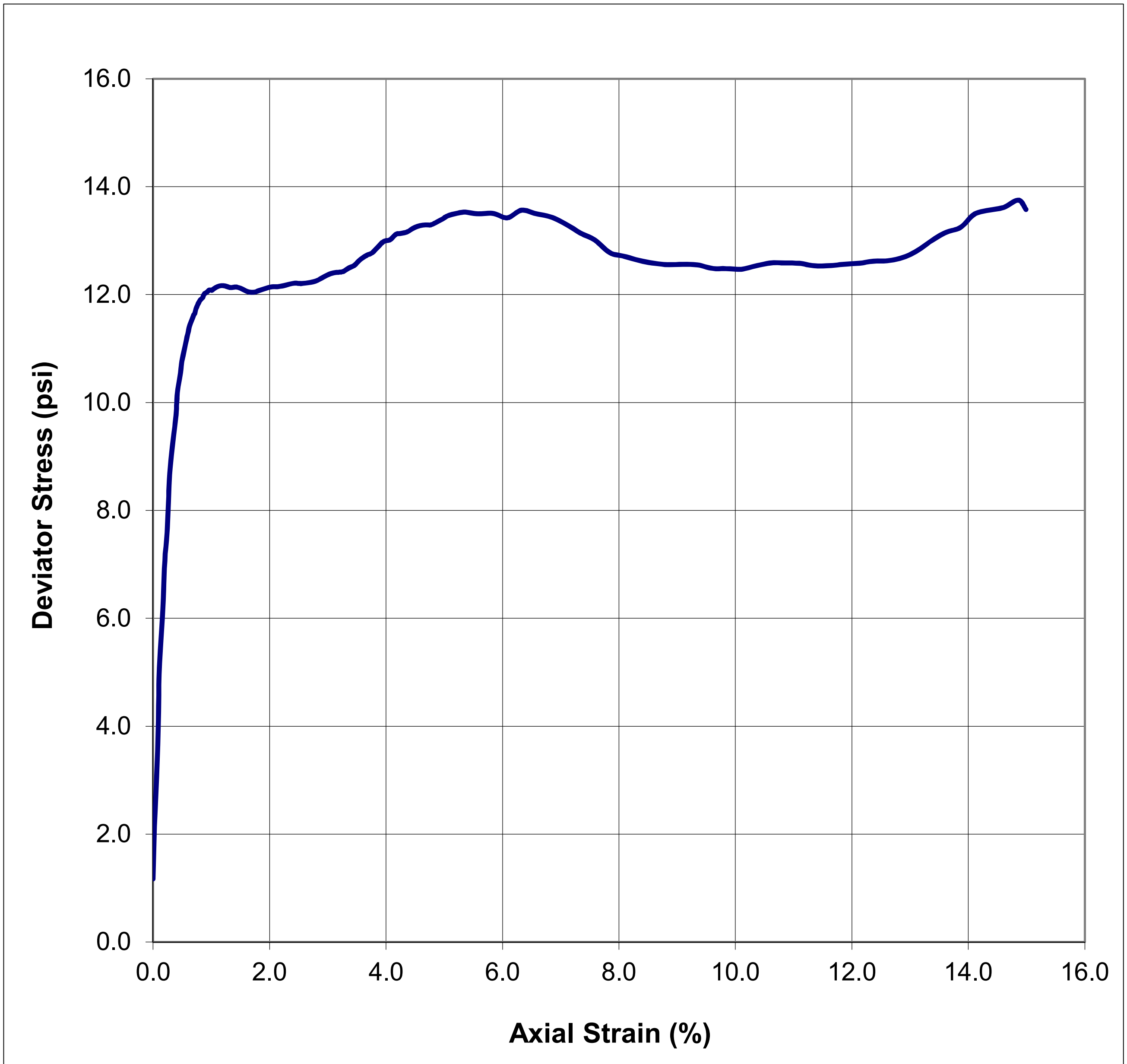


Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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

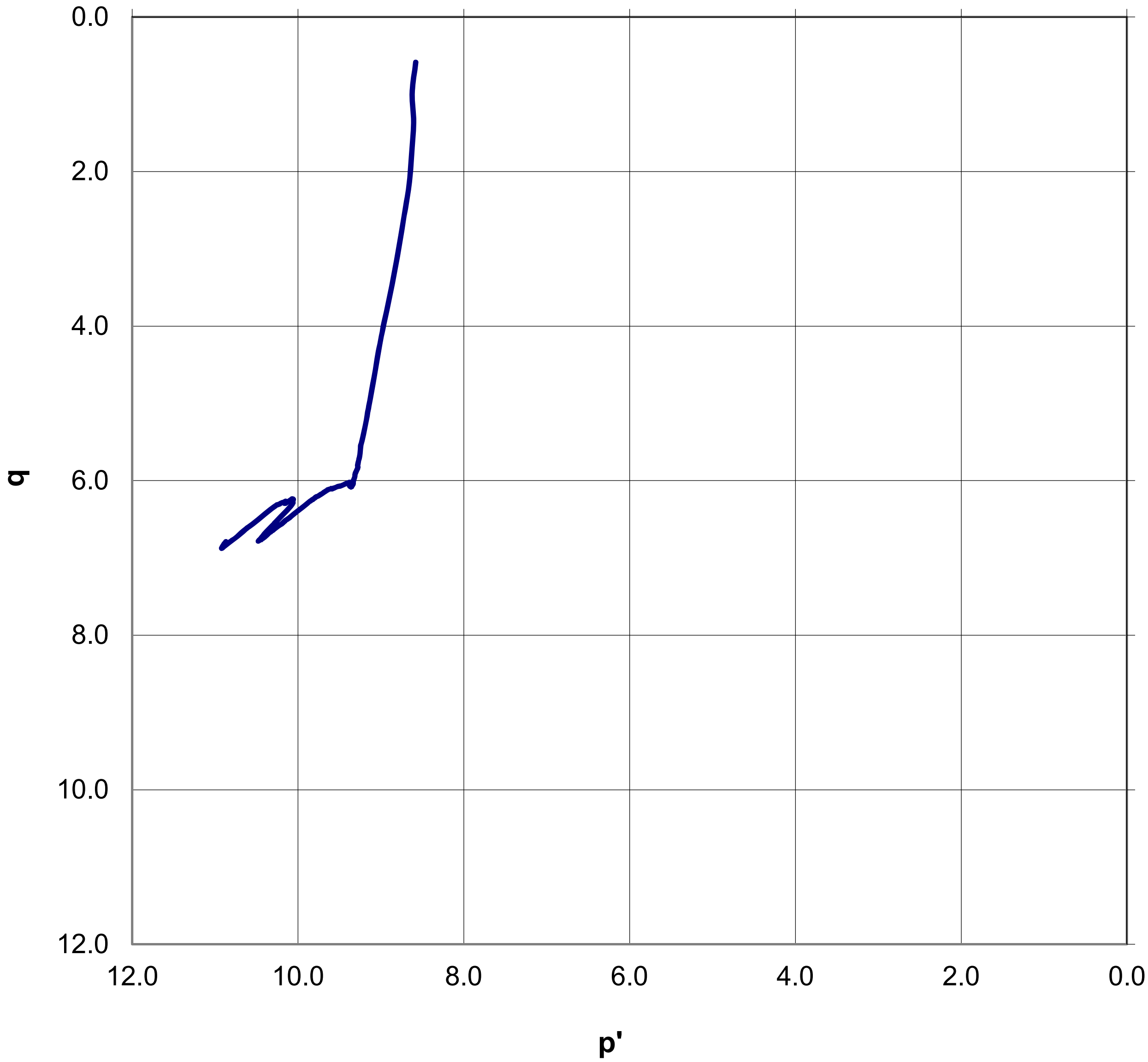


Daniel B. Stephens & Associates, Inc.

Data for Consolidated Undrained (CU) Triaxial Shear Testing

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'



Data for Consolidated Undrained (CU) Triaxial Shear Testing

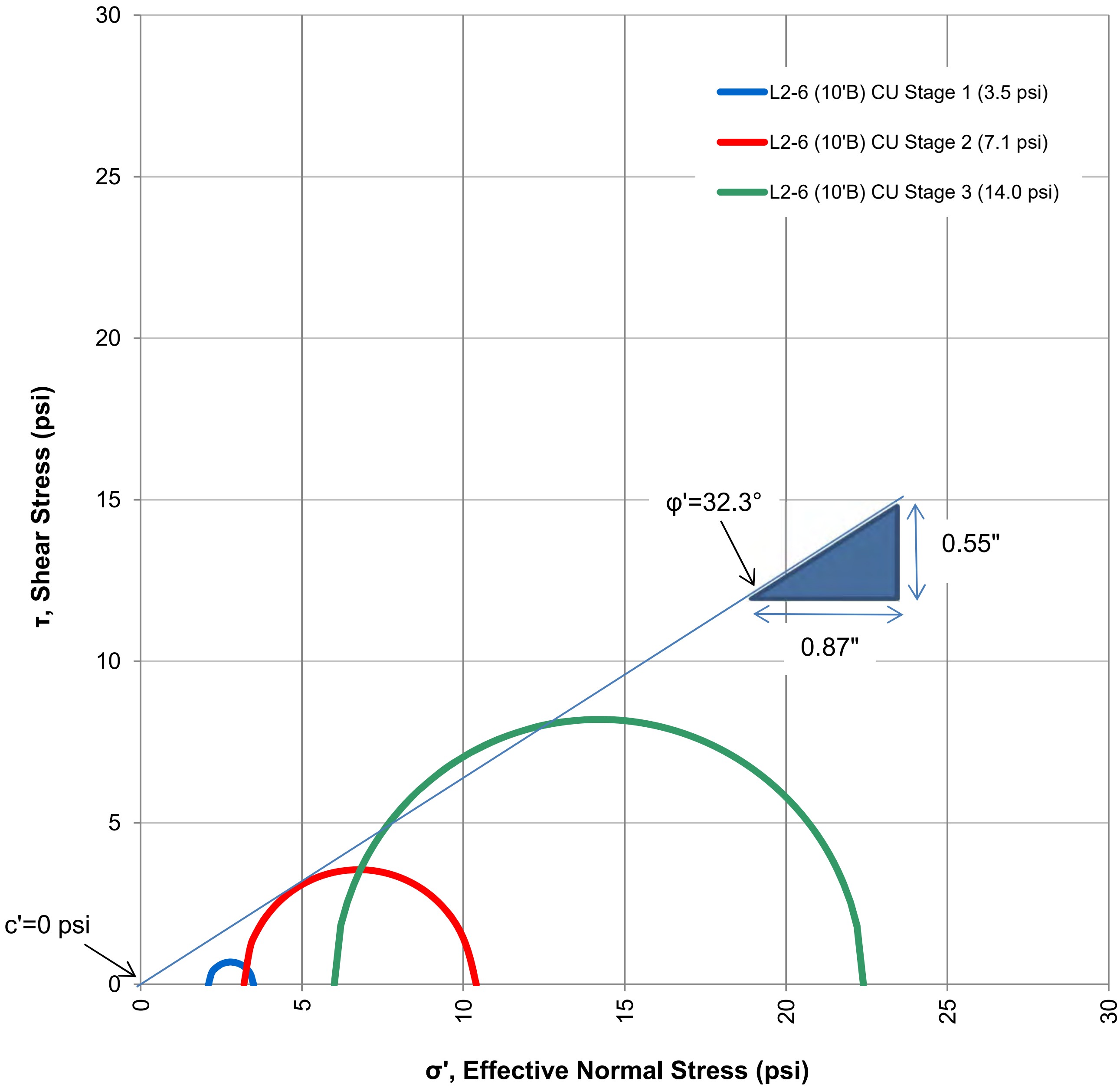
Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-5 (5'B) CU Stage 3 (8.0 psi)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Raw Data

Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)	Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)
80.73	0.00	9.16	7.99	85.15	3.15	15.98	3.57
81.08	0.02	9.59	7.65	85.14	3.26	16.00	3.57
81.49	0.05	9.97	7.24	85.14	3.35	16.07	3.58
81.88	0.08	10.42	6.84	85.12	3.45	16.13	3.59
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	1.02	15.38	3.29	84.86	10.35	16.38	3.85
85.44	1.13	15.43	3.28	84.85	10.61	16.44	3.86
85.44	1.22	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



Estimated Effective Mohr-Coulomb Failure Parameters[1]:
cohesion (c')(psi) = 0
friction angle (ϕ')(°) = 32.3

[1]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.

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
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^2):	18.15
Volume (cm^3):	205.89
Dry Mass (g):	320.37
Dry Density (g/cm^3):	1.56
Dry Unit Weight (lbf/ft^3):	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:	☑ In situ sample, extruded ☐ Remolded Sample
Trimming Procedure:	NA
Split:	NA
Percent Coarse Material (%):	<5%
Particle Density (g/cm^3):	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

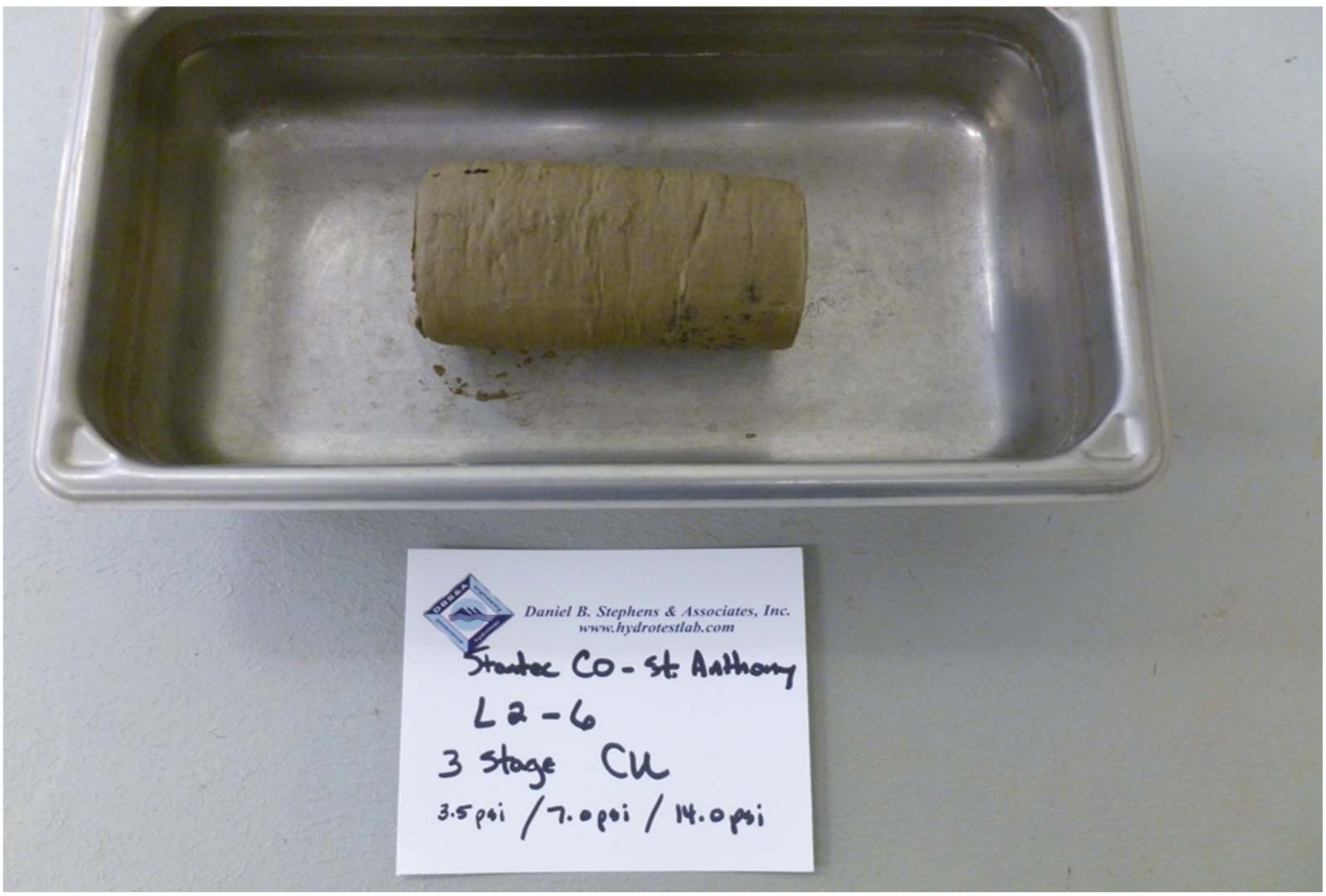
Data for Consolidated Undrained (CU) Triaxial Shear Testing

Job Name: Stantec Consulting Services Inc
Job Number: DB18.1151.00
Sample Number: L2-6 (10'B) CU
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



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 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^3):	2.46
Area (cm^2):	18.15
Area Determined by Method:	☑ A ☐ B
Volume (cm^3):	203.43
Dry Density (g/cm^3):	1.57
Dry Unit Weight (lbf/ft^3):	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

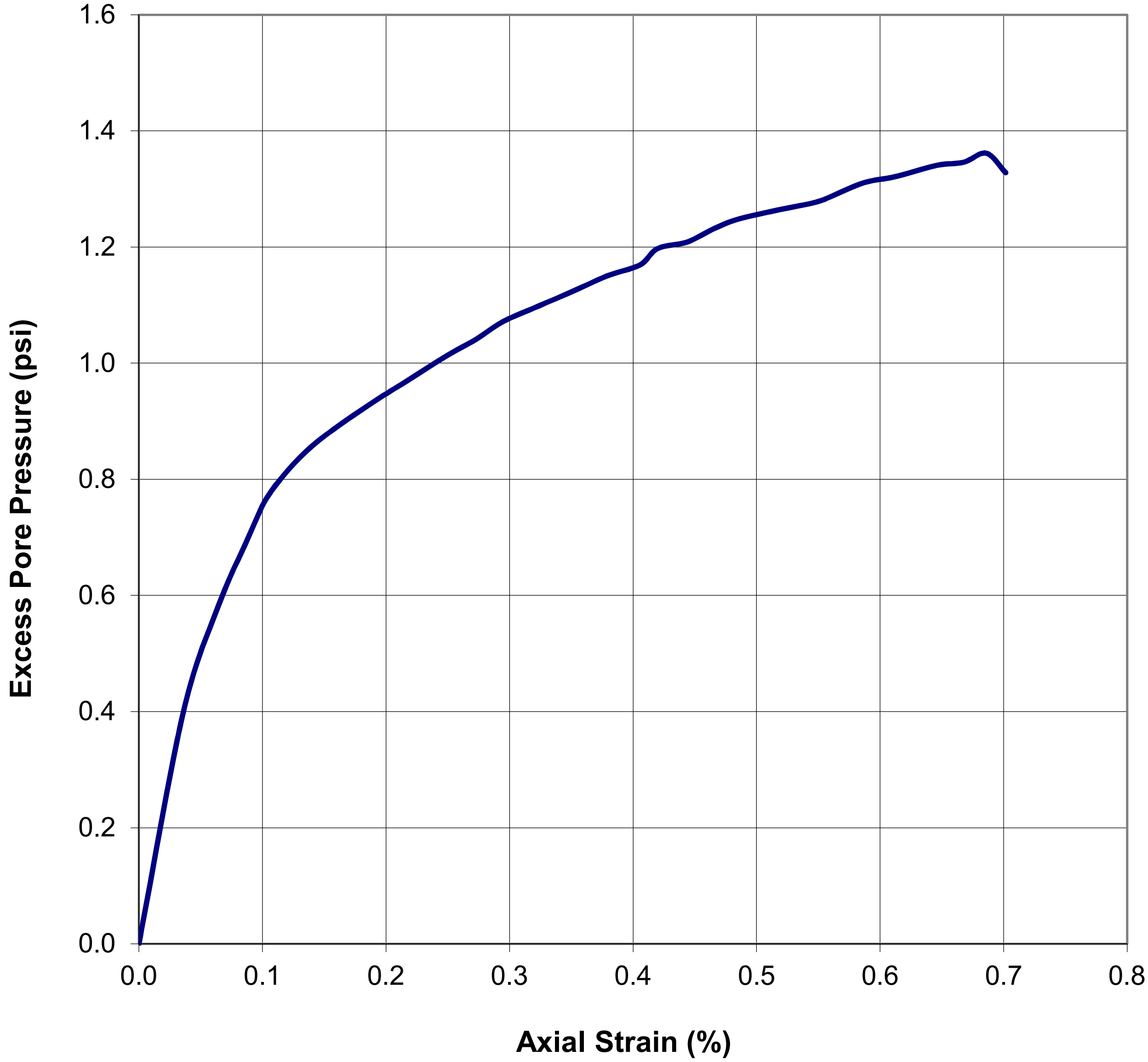
Test Notes:
Test was halted prior to reaching a maximum target of 3% strain, after a reduction in deviator stress was recorded. Failure was interpreted as the peak deviator stress achieved.

Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

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 1 (3.5 psi)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

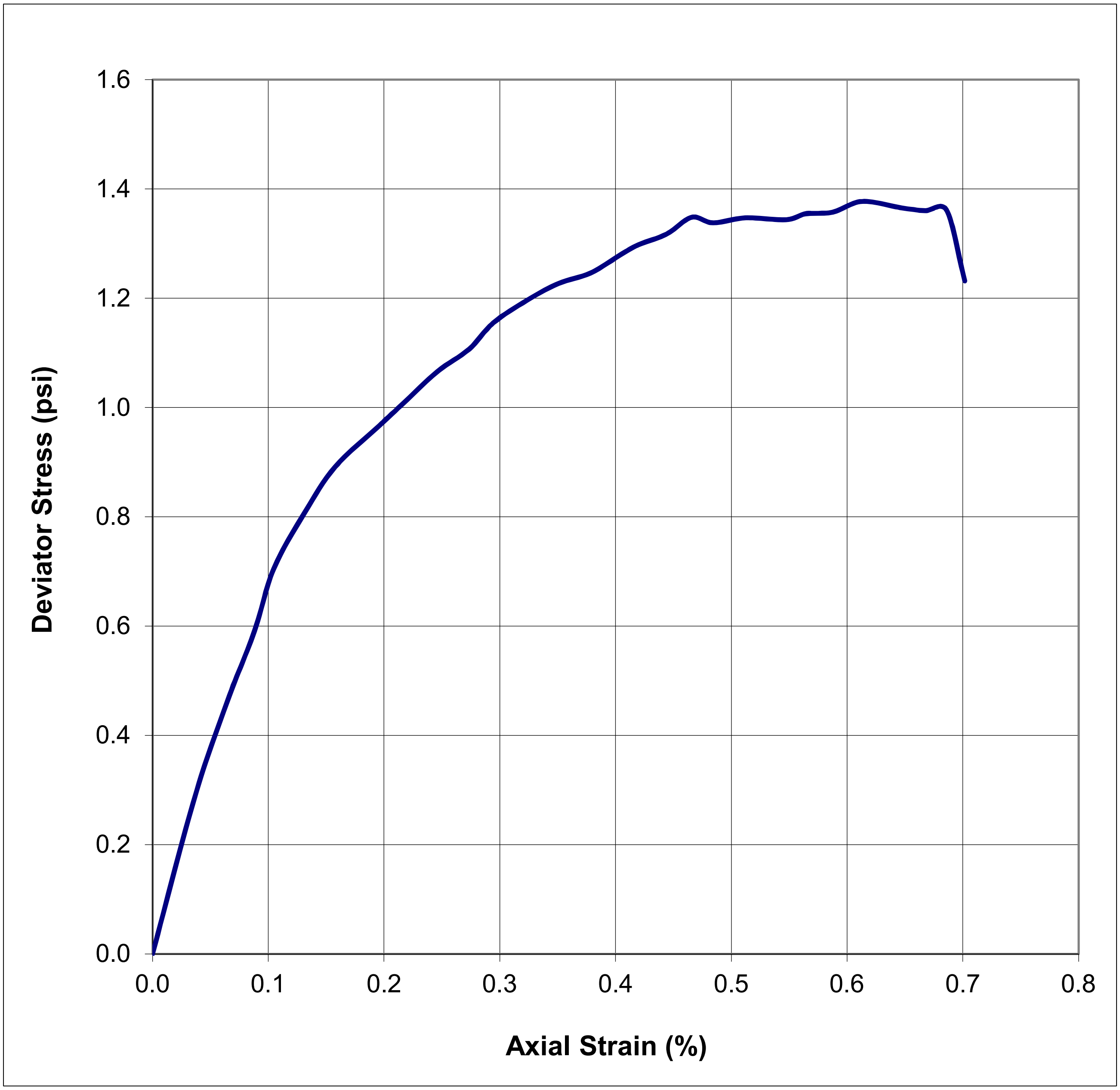
Plot of Excess Pore Pressure vs. Axial Strain



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 1 (3.5 psi)
Project Name:	St. Anthony Geotech Investigation
PO Number:	233001076-DBS

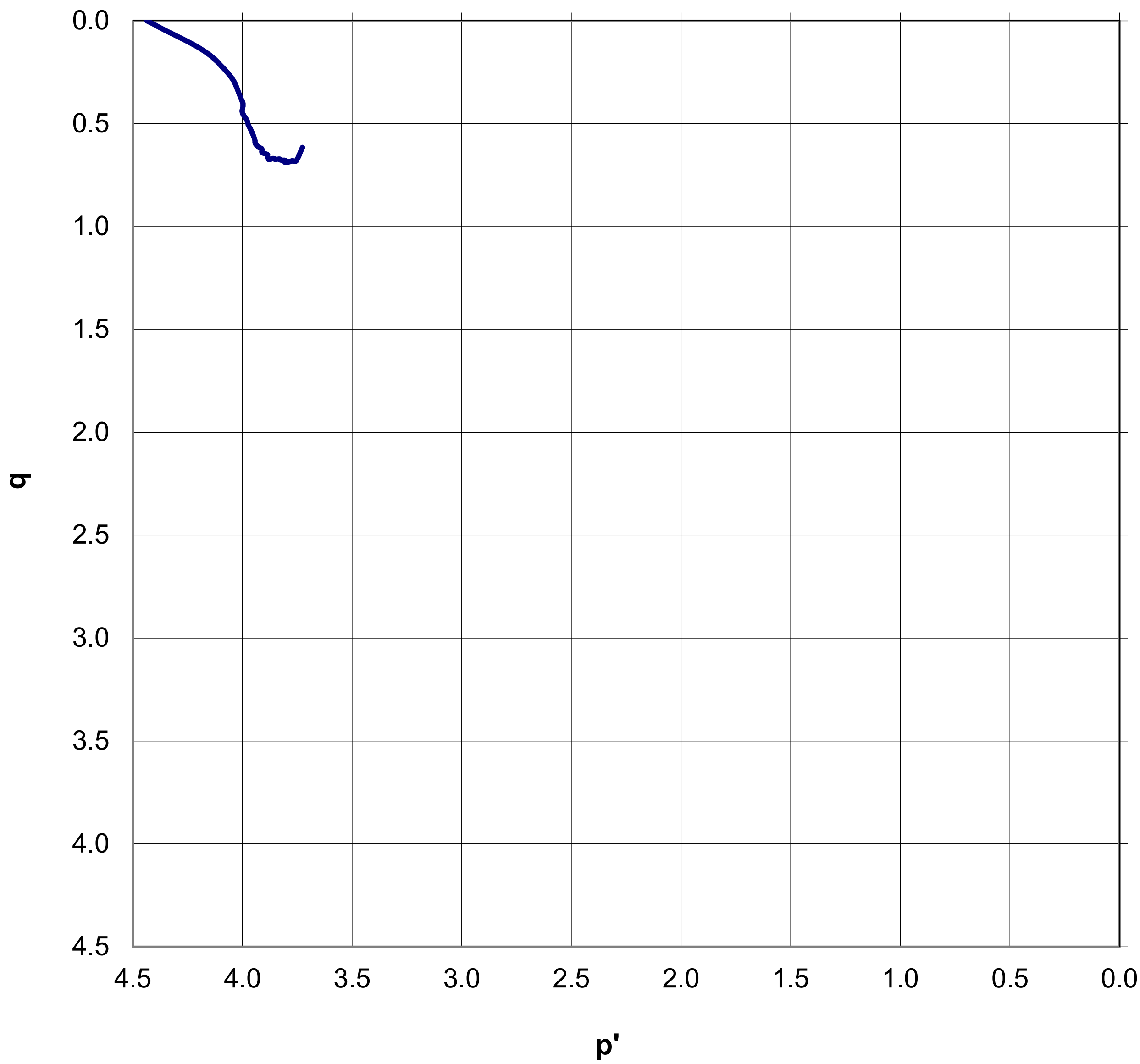
Plot of Deviator Stress vs. Axial Strain



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 1 (3.5 psi)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Plot of q vs.p'



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 1 (3.5 psi)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Raw Data

Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)	Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (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				

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

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^3):	2.60
Area (cm^2):	18.15
Area Determined by Method:	☑ A ☐ B
Volume (cm^3):	203.30
Dry Density (g/cm^3):	1.58
Dry Unit Weight (lbf/ft^3):	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:

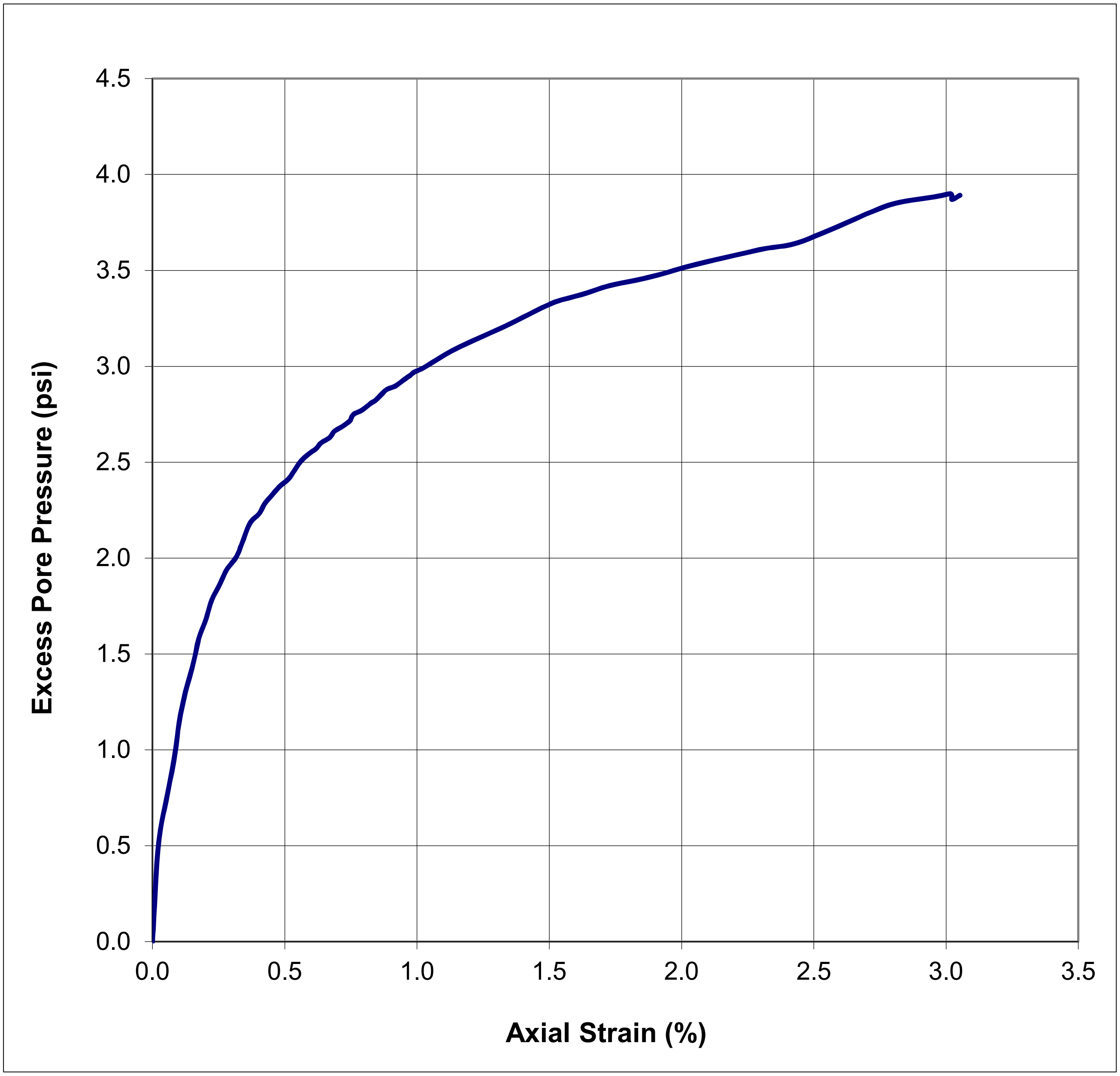
Test was halted after reaching a maximum target of 3% strain. Failure was interpreted as the peak deviator stress achieved.

Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

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

Plot of Excess Pore Pressure vs. Axial Strain

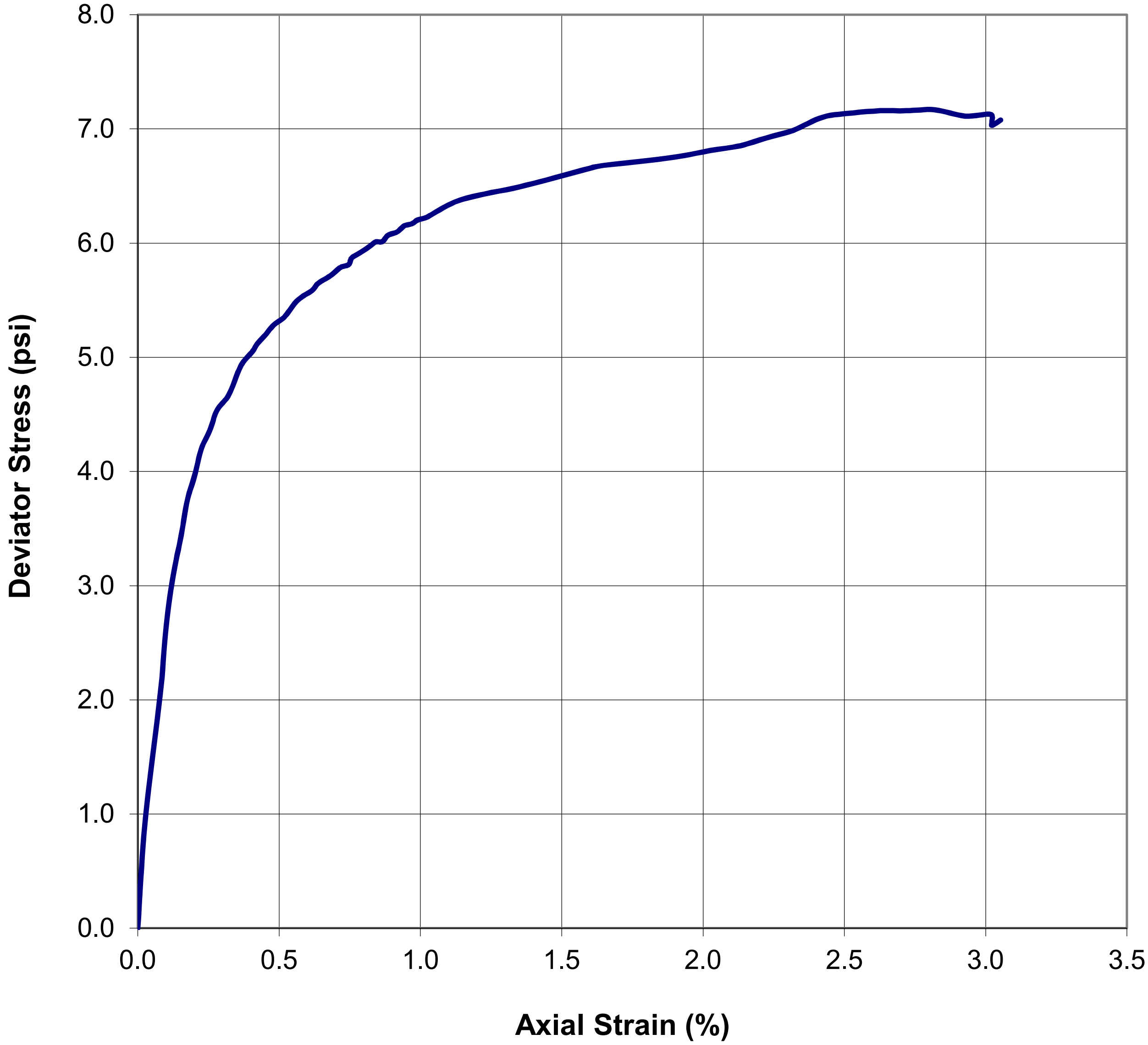


Daniel B. Stephens & Associates, Inc.

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

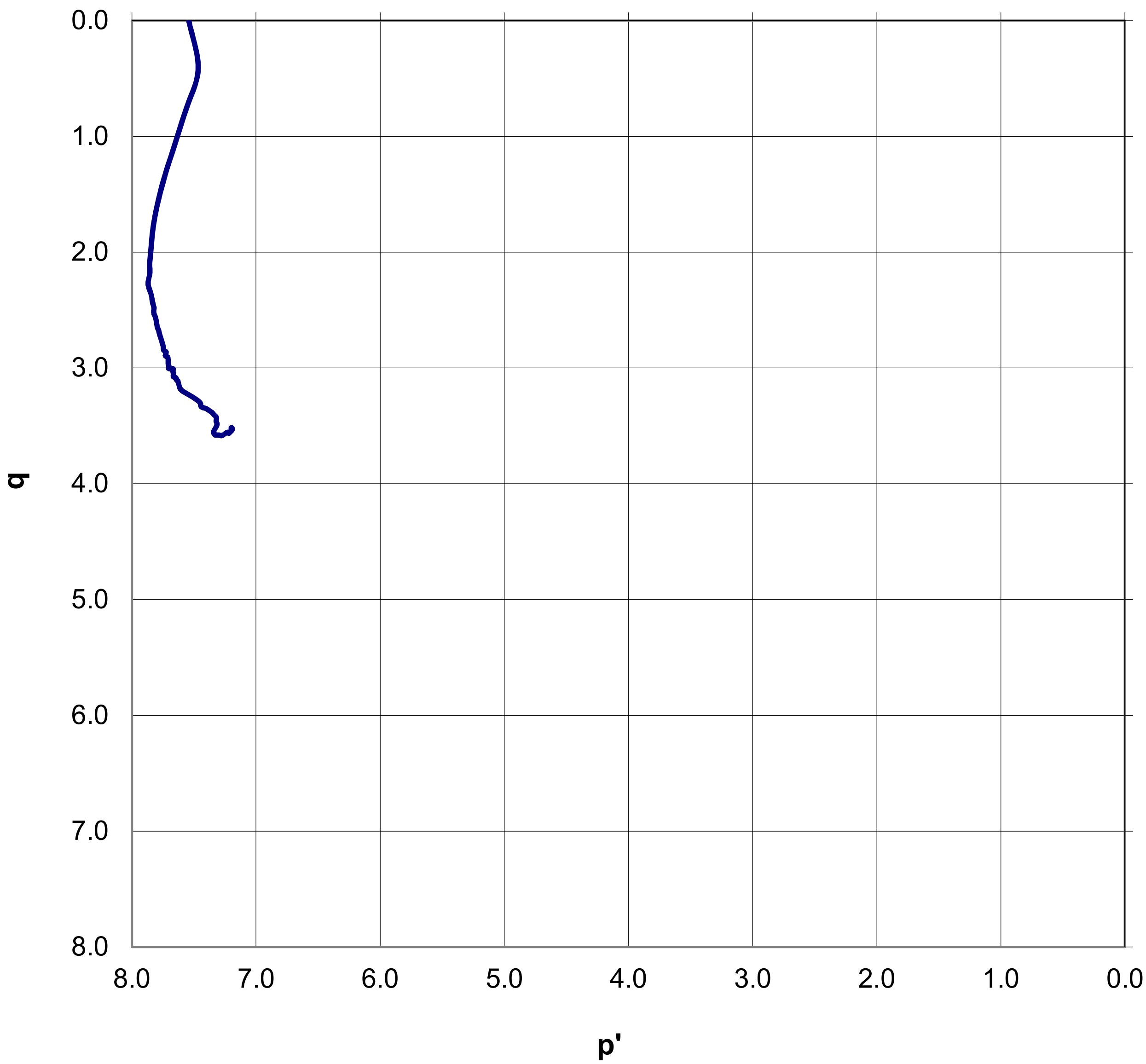
Plot of Deviator Stress vs. Axial Strain



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

Plot of q vs.p'



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

Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)
81.58	0.00	7.06	7.06
82.08	0.02	7.40	6.57
82.33	0.05	7.86	6.31
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
83.86	0.42	9.89	4.77
83.91	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	10.29	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
85.47	3.02	10.24	3.18
85.45	3.02	10.23	3.20
85.47	3.05	10.26	3.18

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 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^3):	4.85
Area (cm^2):	18.15
Area Determined by Method:	☑ A ☐ B
Volume (cm^3):	201.04
Dry Density (g/cm^3):	1.59
Dry Unit Weight (lbf/ft^3):	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.

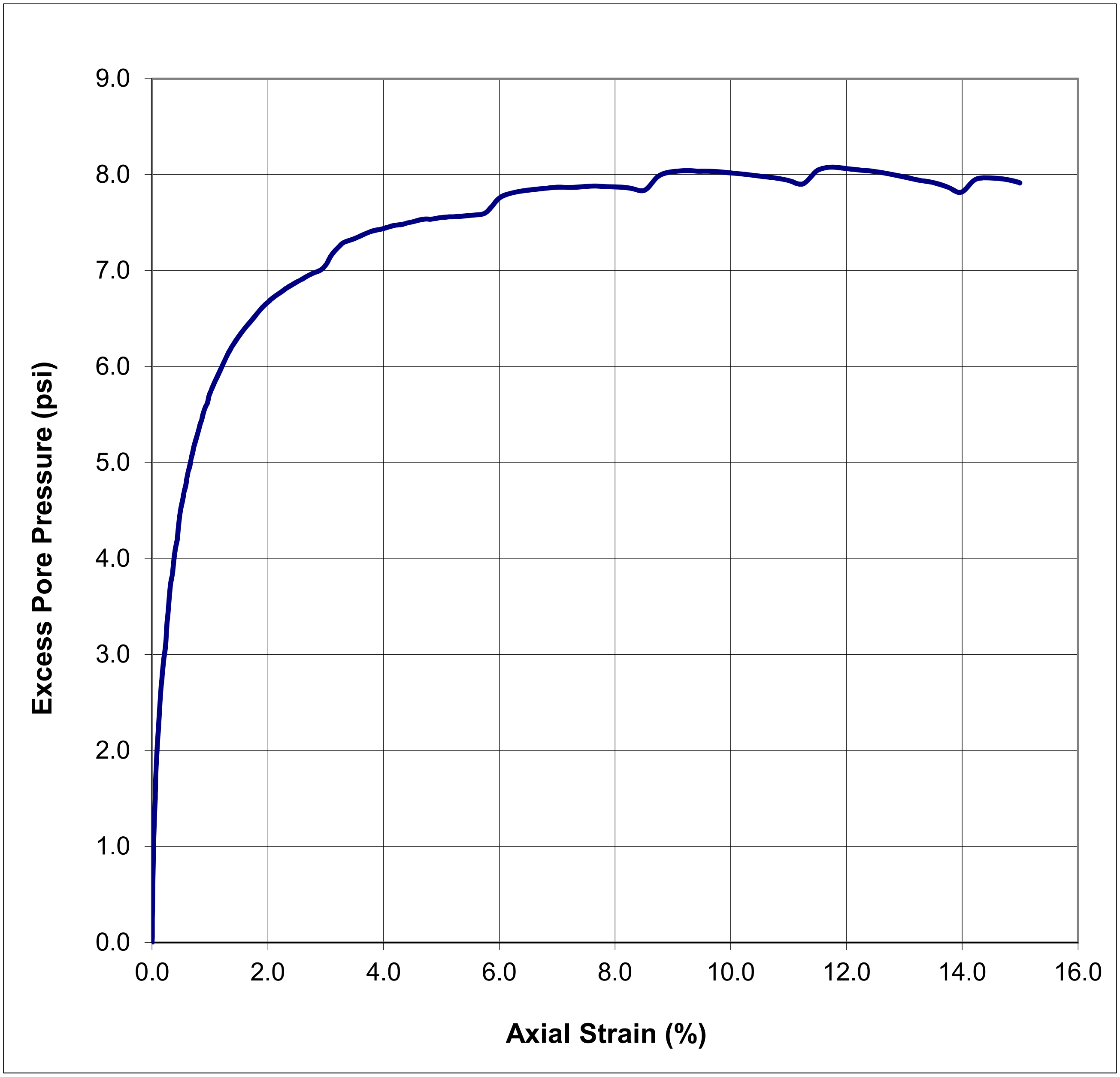
Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

Daniel B. Stephens & Associates, Inc.

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 3 (14.0 psi)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Plot of Excess Pore Pressure vs. Axial Strain

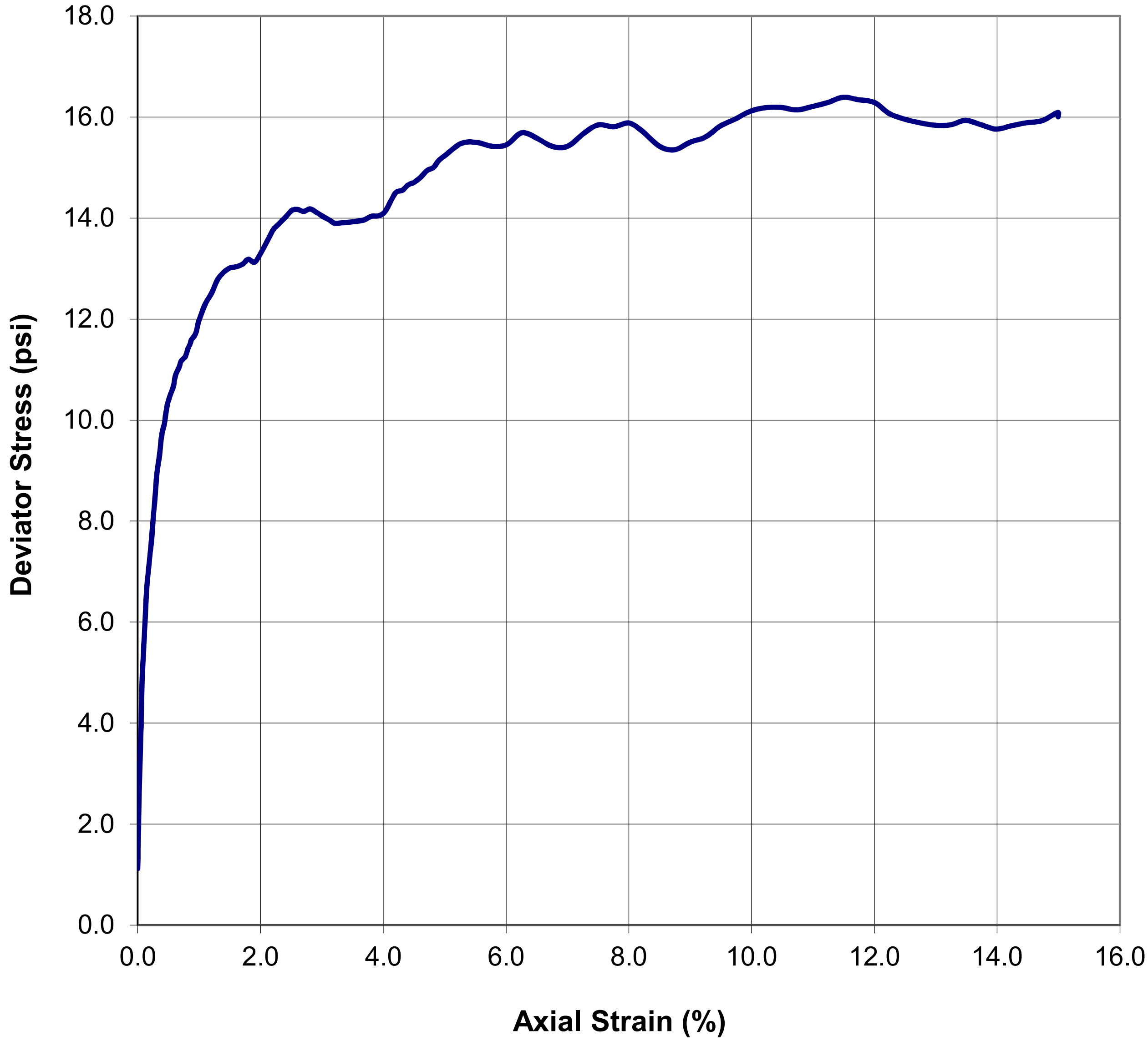


Daniel B. Stephens & Associates, Inc.

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 3 (14.0 psi)
Project Name:	St. Anthony Geotech Investigation
PO Number:	233001076-DBS

Plot of Deviator Stress vs. Axial Strain

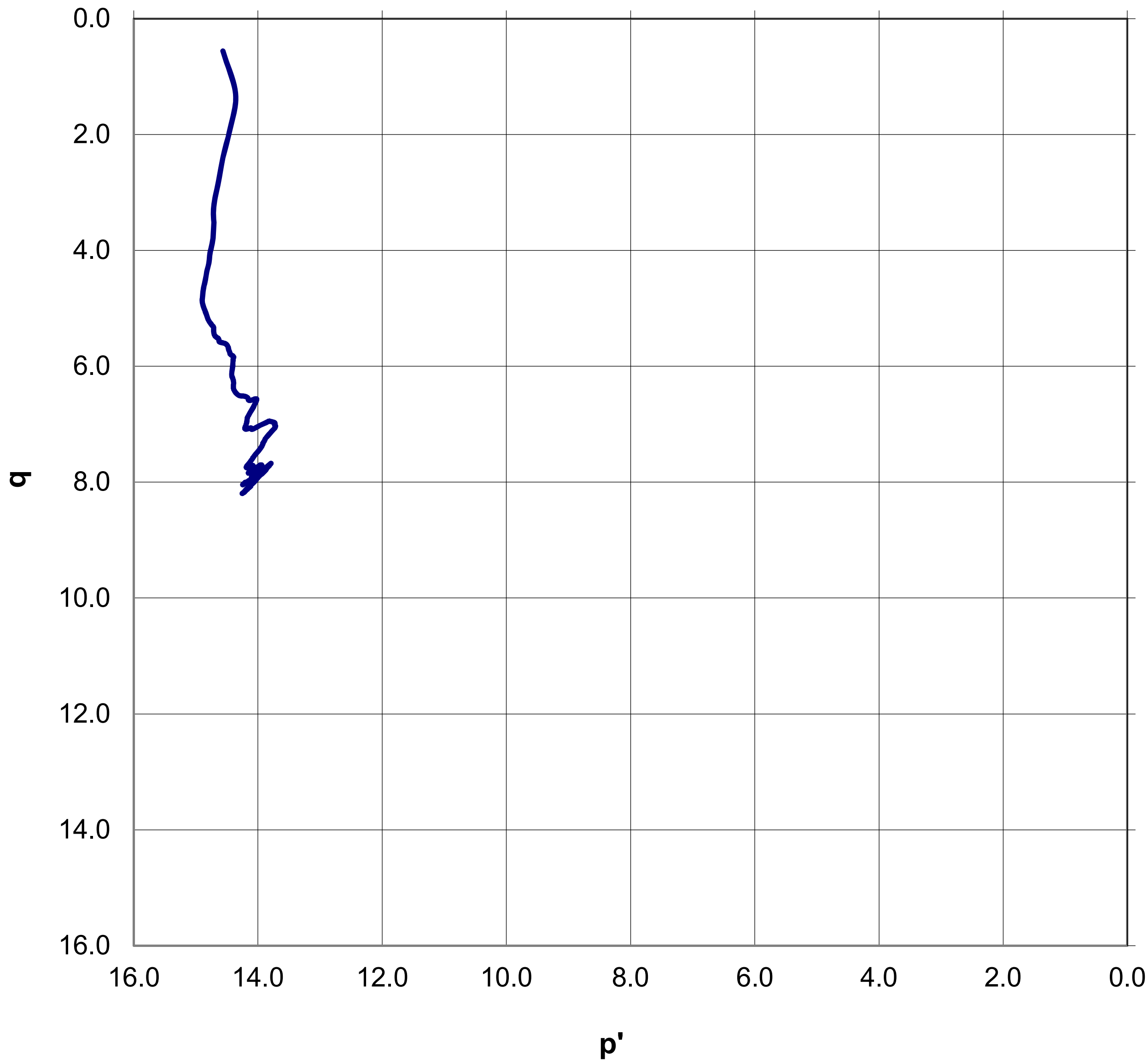


Daniel B. Stephens & Associates, Inc.

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 3 (14.0 psi)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Plot of q vs.p'



Daniel B. Stephens & Associates, Inc.

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 3 (14.0 psi)
Project Name: St. Anthony Geotech Investigation
PO Number: 233001076-DBS

Raw Data

Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)	Pore Pressure (psi)	Axial Strain (%)	Effective Major Stress (psi)	Effective Minor Stress (psi)
81.60	0.00	15.13	14.01	88.77	3.11	20.88	6.91
82.55	0.02	15.67	13.05	88.84	3.21	20.77	6.88
83.06	0.05	16.36	12.54	88.90	3.31	20.75	6.84
83.43	0.07	16.96	12.17	88.92	3.40	20.74	6.83
83.74	0.10	17.41	11.85	88.94	3.51	20.73	6.80
83.99	0.13	17.78	11.60	88.96	3.60	20.71	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	21.80	6.35
86.44	0.60	20.11	9.31	89.42	6.25	22.00	6.31
86.51	0.62	20.16	9.24	89.44	6.50	21.87	6.28
86.57	0.65	20.17	9.18	89.46	6.76	21.68	6.26
86.64	0.67	20.16	9.11	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	2.80	21.19	7.01	89.56	14.73	22.09	6.17
88.61	2.90	21.09	6.97	89.52	14.98	22.29	6.20
88.66	3.00	20.99	6.95	89.52	14.99	22.21	6.20

Laboratory Tests and Methods

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 ^{241}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
Pik Yee Yuen — 5/23/18
Radiochemistry Primary Data Reviewer — Date

Radiochemistry Final 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

ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

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.

ALS WORKORDER # 1804497

		TURNAROUND TIME	
		SAMPLER	
PAGE	1 of 1	DISPOSAL	BY LAB or RETURN
PROJECT NAME	St. Anthony Geotechnical Investigation	SITE ID	St. Anthony Mine
PROJECT No.	233001076	EDD FORMAT	Microsoft Excel Spreadsheet
		PURCHASE ORDER	
COMPANY NAME	Stantec Consulting Services	BILL TO COMPANY	Stantec Consulting Services
SEND REPORT TO	Cameron Fritz	INVOICE ATTN TO	Jason Cumbers
ADDRESS	3325 S Timberline Rd #150	ADDRESS	3325 S Timberline Rd #150
CITY / STATE / ZIP	Fort Collins, CO 80525	CITY / STATE / ZIP	Fort Collins, CO 80526
PHONE	(970) 212-2759	PHONE	(970) 212-2755
FAX		FAX	
E-MAIL	cameron.fritz@stantec.com	E-MAIL	Jason.cumbers@stantec.com

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	Ra-226 (EPA 901.1)
B	Uranium (EPA 901.1)
C	Thorium-230 (EPA 901.1)
D	Gross alpha (EPA 901.1)
E	
F	
G	
H	
I	
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	P1-2 20'	Soil	4/9/18	11:00am		N/A		✓	✓	✓	✓							
2	P1-2 40'	Soil	4/9/18	11:30am		N/A		✓	✓	✓	✓							
3	P1-2 60'	Soil	4/11/18	2:30 pm		N/A		✓	✓	✓	✓							
4	P2-1 10'	Soil	4/14/18	4:15 pm		N/A		✓	✓	✓	✓							
5	P2-1 20'	Soil	4/14/18	4:25pm		N/A		✓	✓	✓	✓							
6	P2-2 10'	Soil	4/15/18	8:30 am		N/A		✓	✓	✓	✓							
7	P4-3 5'	Soil	4/16/18	12:10 pm		N/A		✓	✓	✓	✓							
8	P4-5 5'	Soil	4/16/18	10:00am		N/A		✓	✓	✓	✓							
9	P4-5 15'	Soil	4/16/18	10:10am		N/A		✓	✓	✓	✓							
10	P4-9 20'	Soil	4/15/18	1:30pm		N/A		✓	✓	✓	✓							
11	P4-9 30'	Soil	4/15/18	1:50pm		N/A		✓	✓	✓	✓							
12	BW-1 10'	Soil	4/18/18	9:35am		N/A		✓	✓	✓	✓							

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES

REPORT LEVEL / QC REQUIRED	
	Summary (Standard QC)
X	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	Cameron Fritz	Cameron Fritz	4/18/18	4:00 pm
RECEIVED BY	Emily Lyons	Emily Lyons	4·23·18	0900
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

PRESERVATION KEY 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

ALS Environmental
225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

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.

ALS WORKORDER # 1804492
PAGE 1 of 1
DISPOSAL: BY LAB or RETURN

PROJECT NAME	St. Anthony Geotechnical Investigation	TURNAROUND TIME	
		SAMPLER	
PROJECT No.	233001076	SITE ID	St. Anthony Mine
		EDD FORMAT	Microsoft Excel Spreadsheet
		PURCHASE ORDER	
COMPANY NAME	Stantec Consulting Services	BILL TO COMPANY	Stantec Consulting Services
SEND REPORT TO	Cameron Fritz	INVOICE ATTN TO	Jason Cumbers
ADDRESS	3325 S Timberline Rd #150	ADDRESS	3325 S Timberline Rd #150
CITY / STATE / ZIP	Fort Collins, CO 80525	CITY / STATE / ZIP	Fort Collins, CO 80526
PHONE	(970) 212-2759	PHONE	(970) 212-2755
FAX		FAX	
E-MAIL	cameron.fritz@stantec.com	E-MAIL	jason.cumbers@stantec.com

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	Radium-226 (EPA 901.1)
B	Uranium (EPA 901.1)
C	Thorium-230 (EPA 901.1)
D	Gross alpha (EPA 901.1)
E	
F	
G	
H	
I	
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
13	BW-4 5'	S	4/18/18	12:00pm		N/A		✓	✓	✓	✓							
14	BW-4 15'	S	4/18/18	12:15pm		N/A		✓	✓	✓	✓							
15	BW-3 10'	S	4/18/18	12:50pm		N/A		✓	✓	✓	✓							
16	BW-2 5'	S	4/18/18	1:45pm		N/A		✓	✓	✓	✓							
17	BW-2 20'	S	4/18/18	2:05pm		N/A		✓	✓	✓	✓							

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES

REPORT LEVEL / QC REQUIRED	
	Summary (Standard QC)
X	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	Cameron Fritz	Cameron Fritz	4/18/18	7:00pm
RECEIVED BY	Emily Lyons	Emily Lyons	4.23.18	0900
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

PRESERVATION KEY: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: Stantec Workorder No: 1804492

Project Manager: LPS Initials: Gm Date: 4.23.18

1. Does this project require any special handling in addition to standard ALS procedures?		YES	NO
2. Are custody seals on shipping containers intact?	NONE	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?		YES	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
7. Were airbills / shipping documents present and/or removable?	DROP OFF	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/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?		YES	NO
11. Were all samples placed in the proper containers for the requested analyses?		YES	NO
12. Are all samples within holding times for the requested analyses?		YES	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	N/A	YES	NO
15. Do any water samples contain sediment? Amount Amount of sediment: ____ dusting ____ moderate ____ 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 ONLY	YES	NO

Cooler #:	1	2						
Temperature (°C):	Amb	Amb						
No. of custody seals on cooler:	0	0						
DOT Survey/ Acceptance Information — External µR/hr reading:	9							
Background µR/hr reading:	9							

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, EXCEPT #1 AND #16.

If applicable, was the client contacted? YES / NO / NA Contact: ____ Date/Time: ____

Project Manager Signature / Date: 4/24/18

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

FROM: (907) 947-2225
CAMERON FRITZ

718 MARIGOLD LN

FORT COLLINS CO 80526
US

SHIP DATE: 19APR18
ACTWGT: 36.00 LB
CAD: 006993643/SSFE1904
DIMMED: 15 X 12 X 12 IN

TO

ALS ENVIRONMENTAL
225 COMMERCE DR

FORT COLLINS CO 80524 **(US)**

(800) 443-1511 REF:
INV:
PO: DEPT:

FedEx
Ground

G

1 of 2

TRK# **7805 9618 7711**

MASTER

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7711

FROM: (907) 947-2225
CAMERON FRITZ

718 MARIGOLD LN

FORT COLLINS CO 80526
US

SHIP DATE: 19APR18
ACTWGT: 18.00 LB
CAD: 006993643/SSFE1904
DIMMED: 15 X 12 X 12 IN

TO

ALS ENVIRONMENTAL
225 COMMERCE DR

FORT COLLINS CO 80524 **(US)**

(800) 443-1511 REF:
INV:
PO: DEPT:

FedEx
Ground

G

2 of 2
MPS# **7805 9618 7722**
Mstr# 7805 9618 7711

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7722

Gross Alpha by GFPC

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 SOP: PAI 702 Rev 21
Date Collected: 14-May-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

Final Aliquot: 1.50 g
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	0.02 +/- 0.18	0.51	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.

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*

Gross Alpha by GFPC

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 SOP: PAI 702 Rev 21
Date Collected: 14-May-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

Final Aliquot: 2.50 g
Result Units: pCi/g
File Name: ABC0517E

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
12587-46-1	GROSS ALPHA	16.9 +/- 3.0	0.4	15.06	112	70 - 130	P

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.

Abbreviations:

TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: *AB1804492-1*

Gross Alpha by GFPC

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	P

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 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.

Abbreviations:
MDC - Sample specific Minimum Detectable Concentration

Data Package ID: *AB1804492-1*

Gross Alpha by GFPC

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 Result +/- 2 s TPU	Sample MDC	Sample Flags	Duplicate Result +/- 2 s TPU	Duplicate MDC	Duplicate Flags	DER	DER 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

Abbreviations:
TPU - Total Propagated Uncertainty
DER - Duplicate Error Ratio
BDL - Below Detection Limit
NR - Not Reported

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: 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/g
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*

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: P1-2 40'
Lab ID: 1804492-2

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: 0.516 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	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*

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:	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.

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:	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/g
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.

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: 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*

Gross Alpha by GFPC

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.
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*

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: 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.

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: P4-3 5'
Lab ID: 1804492-7

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: 2.07 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	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*

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: 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*

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: 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*

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: 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*

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: 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*

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-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.

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-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*

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-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*

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

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*

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/g
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*

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.
2. 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

Date: 5/23/18

Radiochemistry Final Data Reviewer

Date: 5/29/18

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

ALS Environmental
225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

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.

ALS WORKORDER #	1804497
PAGE	1 of 1
DISPOSAL	BY LAB or RETURN

		TURNAROUND TIME	
		SAMPLER	
PROJECT NAME	St. Anthony Geotechnical Investigation	SITE ID	St. Anthony Mine
PROJECT No.	233001076	EDD FORMAT	Microsoft Excel Spreadsheet
		PURCHASE ORDER	
COMPANY NAME	Stantec Consulting Services	BILL TO COMPANY	Stantec Consulting Services
SEND REPORT TO	Cameron Fritz	INVOICE ATTN TO	Jason Cumbers
ADDRESS	3325 S Timberline Rd #150	ADDRESS	3325 S Timberline Rd #150
CITY / STATE / ZIP	Fort Collins, CO 80525	CITY / STATE / ZIP	Fort Collins, CO 80526
PHONE	(970) 212-2759	PHONE	(970) 212-2755
FAX		FAX	
E-MAIL	cameron.fritz@stantec.com	E-MAIL	jason.cumbers@stantec.com

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	Ra-226 (EPA 901.1)
B	Uranium (EPA 901.1)
C	Thorium-230 (EPA 901.1)
D	Gross alpha (EPA 901.1)
E	
F	
G	
H	
I	
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	P1-2 20'	Soil	4/9/18	11:00am		N/A		✓	✓	✓	✓							
2	P1-2 40'	Soil	4/9/18	11:30am		N/A		✓	✓	✓	✓							
3	P1-2 60'	Soil	4/11/18	2:30 pm		N/A		✓	✓	✓	✓							
4	P2-1 10'	Soil	4/14/18	4:15 pm		N/A		✓	✓	✓	✓							
5	P2-1 20'	Soil	4/14/18	4:25 pm		N/A		✓	✓	✓	✓							
6	P2-2 10'	Soil	4/15/18	8:30 am		N/A		✓	✓	✓	✓							
7	P4-3 5'	Soil	4/16/18	12:10 pm		N/A		✓	✓	✓	✓							
8	P4-5 5'	Soil	4/16/18	10:00am		N/A		✓	✓	✓	✓							
9	P4-5 15'	Soil	4/16/18	10:10am		N/A		✓	✓	✓	✓							
10	P4-9 20'	Soil	4/15/18	1:30pm		N/A		✓	✓	✓	✓							
11	P4-9 30'	Soil	4/15/18	1:50pm		N/A		✓	✓	✓	✓							
12	BW-1 10'	Soil	4/18/18	9:35am		N/A		✓	✓	✓	✓							

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES

REPORT LEVEL / QC REQUIRED	
	Summary (Standard QC)
X	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	Cameron Fritz	Cameron Fritz	4/18/18	4:00 pm
RECEIVED BY	Emily Lyons	Emily Lyons	4·23·18	0900
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

PRESERVATION KEY 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

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.

ALS WORKORDER #: 1804492
PAGE 1 of 1
DISPOSAL: BY LAB or RETURN

		TURNAROUND TIME	
		SAMPLER	
PROJECT NAME	St. Anthony Geotechnical Investigation	SITE ID	St. Anthony Mine
PROJECT No.	233001076	EDD FORMAT	Microsoft Excel Spreadsheet
		PURCHASE ORDER	
COMPANY NAME	Stantec Consulting Services	BILL TO COMPANY	Stantec Consulting Services
SEND REPORT TO	Cameron Fritz	INVOICE ATTN TO	Jason Cumbers
ADDRESS	3325 S Timberline Rd #150	ADDRESS	3325 S Timberline Rd #150
CITY / STATE / ZIP	Fort Collins, CO 80525	CITY / STATE / ZIP	Fort Collins, CO 80526
PHONE	(970) 212-2759	PHONE	(970) 212-2755
FAX		FAX	
E-MAIL	cameron.Fritz@stantec.com	E-MAIL	jason.cumbers@stantec.com

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	Radium-226 (EPA 901.1)
B	Uranium (EPA 901.1)
C	Thorium-230 (EPA 901.1)
D	Gross alpha (EPA 901.1)
E	
F	
G	
H	
I	
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
13	BW-4 5'	S	4/18/18	12:00pm		N/A		✓	✓	✓	✓							
14	BW-4 15'	S	4/18/18	12:15pm		N/A		✓	✓	✓	✓							
15	BW-3 10'	S	4/18/18	12:50pm		N/A		✓	✓	✓	✓							
16	BW-2 5'	S	4/18/18	1:45pm		N/A		✓	✓	✓	✓							
17	BW-2 20'	S	4/18/18	2:05pm		N/A		✓	✓	✓	✓							

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES

REPORT LEVEL / QC REQUIRED

	Summary (Standard QC)
X	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	Cameron Fritz	Cameron Fritz	4/18/18	7:00pm
RECEIVED BY	Emily Lyons	Emily Lyons	4.23.18	0900
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

PRESERVATION KEY 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: Stantec Workorder No: 1804492

Project Manager: LPS Initials: GM Date: 4.23.18

1. Does this project require any special handling in addition to standard ALS procedures?		YES	NO
2. Are custody seals on shipping containers intact?	NONE	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?		YES	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
7. Were airbills / shipping documents present and/or removable?	DROP OFF	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/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?		YES	NO
11. Were all samples placed in the proper containers for the requested analyses?		YES	NO
12. Are all samples within holding times for the requested analyses?		YES	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	N/A	YES	NO
15. Do any water samples contain sediment? Amount. Amount of sediment: ____ dusting ____ moderate ____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 ONLY	YES	NO

Cooler #:	1	2						
Temperature (°C):	Amb	Amb						
No. of custody seals on cooler:	Ø	Ø						
External µR/hr reading:	9							
Background µR/hr reading:	9							

DOT Survey/ Acceptance Information

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, EXCEPT #1 AND #16.

If applicable, was the client contacted? YES / NO / NA Contact: ____________ Date/Time: ____________

Project Manager Signature / Date: 4/24/18

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

FROM: (907) 947-2225
CAMERON FRITZ

718 MARIGOLD LN

FORT COLLINS CO 80526
US

SHIP DATE: 19APR18
ACTWGT: 36.00 LB
CAD: 006993643/SSFE1904
DIMMED: 15 X 12 X 12 IN

TO

ALS ENVIRONMENTAL
225 COMMERCE DR

FORT COLLINS CO 80524 **(US)**

(800) 443-1511 REF:
INV:
PO: DEPT:

FedEx
Ground

G

1 of 2
TRK# **7805 9618 7711**
MASTER

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7711

FROM: (907) 947-2225
CAMERON FRITZ

718 MARIGOLD LN

FORT COLLINS CO 80526
US

SHIP DATE: 19APR18
ACTWGT: 18.00 LB
CAD: 006993643/SSFE1904
DIMMED: 15 X 12 X 12 IN

TO

ALS ENVIRONMENTAL
225 COMMERCE DR

FORT COLLINS CO 80524 **(US)**

(800) 443-1511 REF:
INV:
PO: DEPT:

FedEx
Ground

G

2 of 2

MPS# **7805 9618 7722**

Mstr# 7805 9618 7711

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7722

Isotopic Thorium by Alpha Spectroscopy

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*

Isotopic Thorium by Alpha Spectroscopy

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 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	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14269-63-7	Th-230	2.63 +/- 0.42	0.04	2.464	107	85 - 121	P

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.

Abbreviations:

TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: *TH1804492-1*

Isotopic Thorium by Alpha Spectroscopy

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	Analyte	Sample Result +/- 2 s TPU	Sample MDC	Sample Flags	Duplicate Result +/- 2 s TPU	Duplicate MDC	Duplicate Flags	DER	DER 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.
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

Abbreviations:
TPU - Total Propagated Uncertainty
DER - Duplicate Error Ratio
BDL - Below Detection Limit
NR - Not Reported

Data Package ID: *TH1804492-1*

Isotopic Thorium by Alpha Spectroscopy

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/g
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.

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*

Isotopic Thorium by Alpha Spectroscopy

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*

Isotopic Thorium by Alpha Spectroscopy

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*

Isotopic Thorium by Alpha Spectroscopy

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

Final Aliquot: 0.538 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	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.

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*

Isotopic Thorium by Alpha Spectroscopy

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/g
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*

Isotopic Thorium by Alpha Spectroscopy

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 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	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.
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: *TH1804492-1*

Isotopic Thorium by Alpha Spectroscopy

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*

Isotopic Thorium by Alpha Spectroscopy

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
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.

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*

Isotopic Thorium by Alpha Spectroscopy

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.

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*

Isotopic Thorium by Alpha Spectroscopy

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.

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*

Isotopic Thorium by Alpha Spectroscopy

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.

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*

Isotopic Thorium by Alpha Spectroscopy

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

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.

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*

Isotopic Thorium by Alpha Spectroscopy

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*

Isotopic Thorium by Alpha Spectroscopy

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*

Isotopic Thorium by Alpha Spectroscopy

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*

Isotopic Thorium by Alpha Spectroscopy

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/g
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*

Isotopic Thorium by Alpha Spectroscopy

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.

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*

Isotopic Thorium by Alpha Spectroscopy

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/g
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.

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*

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, 3rd 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.

5. 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:

Analyte	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:

Analyte	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.

Emily Lyons ______________________ __5/21/18____

Emily Lyons | Date

Inorganics Primary Data Reviewer

______________________ ____5/29/18____

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

ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

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.

ALS WORKORDER # 1804497

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DISPOSAL: BY LAB or RETURN

		TURNAROUND TIME	
		SAMPLER	
PROJECT NAME	St. Anthony Geotechnical Investigation	SITE ID	St. Anthony Mine
PROJECT No.	233001076	EDD FORMAT	Microsoft Excel Spreadsheet
		PURCHASE ORDER	
COMPANY NAME	Stantec Consulting Services	BILL TO COMPANY	Stantec Consulting Services
SEND REPORT TO	Cameron Fritz	INVOICE ATTN TO	Jason Cumbers
ADDRESS	3325 S Timberline Rd #150	ADDRESS	3325 S Timberline Rd #150
CITY / STATE / ZIP	Fort Collins, CO 80525	CITY / STATE / ZIP	Fort Collins, CO 80526
PHONE	(970) 212-2759	PHONE	(970) 212-2755
FAX		FAX	
E-MAIL	cameron.fritz@stantec.com	E-MAIL	jason.cumbers@stantec.com

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	Ra-226 (EPA 901.1)
B	Uranium (EPA 901.1)
C	Thorium-230 (EPA 901.1)
D	Gross alpha (EPA 901.1)
E	
F	
G	
H	
I	
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	P1-2 20'	Soil	4/9/18	11:00am		N/A		✓	✓	✓	✓							
2	P1-2 40'	Soil	4/9/18	11:30am		N/A		✓	✓	✓	✓							
3	P1-2 60'	Soil	4/11/18	2:30 pm		N/A		✓	✓	✓	✓							
4	P2-1 10'	Soil	4/14/18	4:15 pm		N/A		✓	✓	✓	✓							
5	P2-1 20'	Soil	4/14/18	4:25 pm		N/A		✓	✓	✓	✓							
6	P2-2 10'	Soil	4/15/18	8:30 am		N/A		✓	✓	✓	✓							
7	P4-3 5'	Soil	4/16/18	12:10 pm		N/A		✓	✓	✓	✓							
8	P4-5 5'	Soil	4/16/18	10:00am		N/A		✓	✓	✓	✓							
9	P4-5 15'	Soil	4/16/18	10:10 am		N/A		✓	✓	✓	✓							
10	P4-9 20'	Soil	4/15/18	1:30 pm		N/A		✓	✓	✓	✓							
11	P4-9 30'	Soil	4/15/18	1:50 pm		N/A		✓	✓	✓	✓							
12	BW-1 10'	Soil	4/18/18	9:35 am		N/A		✓	✓	✓	✓							

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES

REPORT LEVEL / QC REQUIRED	
	Summary (Standard QC)
X	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw

PRESERVATION KEY: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	Cameron Fritz	Cameron Fritz	4/18/18	4:00 pm
RECEIVED BY	Emily Lyons	Emily Lyons	4·23·18	0900
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

ALS Environmental
225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

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.

ALS WORKORDER # 1804492

PAGE 1 of 1

DISPOSAL: BY LAB or RETURN

		TURNAROUND TIME		SAMPLER:
PROJECT NAME	St. Anthony Geotechnical Investigation	SITE ID	St. Anthony Mine	
PROJECT No.	233001076	EDD FORMAT	Microsoft Excel Spreadsheet	
		PURCHASE ORDER		
COMPANY NAME	Stantec Consulting Services	BILL TO COMPANY	Stantec Consulting Services	
SEND REPORT TO	Cameron Fritz	INVOICE ATTN TO	Jason Cumbers	
ADDRESS	3325 S Timberline Rd #150	ADDRESS	3325 S Timberline Rd #150	
CITY / STATE / ZIP	Fort Collins, CO 80525	CITY / STATE / ZIP	Fort Collins, CO 80526	
PHONE	(970) 212-2759	PHONE	(970) 212-2755	
FAX		FAX		
E-MAIL	cameron.Fritz@stantec.com	E-MAIL	jason.cumbers@stantec.com	

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	Radium-226 (EPA 901.1)
B	Uranium (EPA 901.1)
C	Thorium-230 (EPA 901.1)
D	Gross alpha (EPA 901.1)
E	
F	
G	
H	
I	
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
13	BW-4 5'	S	4/18/18	12:00pm		N/A		✓	✓	✓	✓							
14	BW-4 15'	S	4/18/18	12:15pm		N/A		✓	✓	✓	✓							
15	BW-3 10'	S	4/18/18	12:50pm		N/A		✓	✓	✓	✓							
16	BW-2 5'	S	4/18/18	1:45pm		N/A		✓	✓	✓	✓							
17	BW-2 20'	S	4/18/18	2:05pm		N/A		✓	✓	✓	✓							

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES

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REPORT LEVEL / QC REQUIRED	
	Summary (Standard QC)
X	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	Cameron Fritz	Cameron Fritz	4/18/18	7:00pm
RECEIVED BY	Emily Lyons	Emily Lyons	4·23·18	0900
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

PRESERVATION KEY: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: Stantec Workorder No: 1804492

Project Manager: LRS Initials: GM Date: 4.23.18

1. Does this project require any special handling in addition to standard ALS procedures?		YES	NO
2. Are custody seals on shipping containers intact?	NONE	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?		YES	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
7. Were airbills / shipping documents present and/or removable?	DROP OFF	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/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?		YES	NO
11. Were all samples placed in the proper containers for the requested analyses?		YES	NO
12. Are all samples within holding times for the requested analyses?		YES	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	N/A	YES	NO
15. Do any water samples contain sediment? Amount Amount of sediment: ____ dusting ____ moderate ____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 ONLY	YES	NO

Cooler #:	1	2						
Temperature (°C):	Amb	Amb						
No. of custody seals on cooler:	Ø	Ø						
External µR/hr reading:	9							
Background µR/hr reading:	9							

DOT Survey/ Acceptance Information

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, EXCEPT #1 AND #16.

If applicable, was the client contacted? YES / NO / NA Contact: ____________ Date/Time: ____________

Project Manager Signature / Date: 4/24/18

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

FROM: (907) 947-2225
CAMERON FRITZ
718 MARIGOLD LN
FORT COLLINS CO 80526
US

SHIP DATE: 19APR18
ACTWGT: 36.00 LB
CAD: 006993643/SSFE1904
DIMMED: 15 X 12 X 12 IN

TO

ALS ENVIRONMENTAL
225 COMMERCE DR

FORT COLLINS CO 80524 **(US)**

(800) 443-1511 REF:
INV:
PO: DEPT:

FedEx
Ground

G

1 of 2

TRK# **7805 9618 7711**

MASTER

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7711

FROM: (907) 947-2225
CAMERON FRITZ

718 MARIGOLD LN

FORT COLLINS CO 80526
US

SHIP DATE: 19APR18
ACTWGT: 18.00 LB
CAD: 006993643/SSFE1904
DIMMED: 15 X 12 X 12 IN

TO

ALS ENVIRONMENTAL
225 COMMERCE DR

FORT COLLINS CO 80524 **(US)**

(800) 443-1511 REF:
INV:
PO: DEPT:

FedEx
Ground

G

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*

ICPMS Metals

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: SOIL
% Moisture: N/A
Date Collected: N/A
Date Extracted: 26-Apr-18
Date Analyzed: 27-Apr-18
Prep Method: SW3050 Rev B

Prep Batch: IP180426-3
QCBatchID: IP180426-3-1
Run ID: IM180426-10A8
Cleanup: NONE
Basis: N/A
File Name: 096SMPL_

Sample Aliquot: 1 g
Final Volume: 100 ml
Result Units: UG/KG
Clean DF: 1

CASNO	Target Analyte	DF	Result	Result Qualifier	Reporting Limit	DL
7440-61-1	URANIUM	10	10	U	10	

Data Package ID: *IM1804492-1*

ICPMS Metals

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
% Moisture: N/A
Date Collected: N/A
Date Extracted: 04/26/2018
Date Analyzed: 04/27/2018
Prep Method: SW3050B

Prep Batch: IP180426-3
QCBatchID: IP180426-3-1
Run ID: IM180426-10A8
Cleanup: NONE
Basis: N/A
File Name: 097SMPL_

Sample Aliquot: 1 g
Final Volume: 100 ml
Result Units: UG/KG
Clean DF: 1

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*

ICPMS Metals

Method SW6020A

Matrix Spike And Matrix Spike Duplicate

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'
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: SW3050 Rev B

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: 101SMPL_

CASNO	Target Analyte	Sample Result	Samp Qual	MS Result	MS Qual	Reporting Limit	Spike Added	MS % Rec.	Control Limits
7440-61-1	URANIUM	36000		35100		10.7	1070	-88	75 - 125%

Field ID: P1-2 20'
LabID: 1804492-1MSD

Sample Matrix: SOIL
% Moisture: 9.0
Date Collected: 09-Apr-18
Date Extracted: 26-Apr-18
Date Analyzed: 27-Apr-18
Prep Method: SW3050 Rev B

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_

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*

ICPMS Metals

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*

ICPMS Metals

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*

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*

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*

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 ^{222}Rn to approach secular equilibrium with its parent, ^{226}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 ^{226}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 ^{226}Ra source in the same geometry and configuration as the samples.

6. The library used for calibration and analysis employs multiple peaks for the ^{226}Ra progeny, ^{214}Pb (352 and 295 keV) and ^{214}Bi (609 and 1120 keV). Using these peaks avoids the use of the problematic ^{226}Ra photopeak at 186 keV, which suffers from poorly resolvable interference from ^{235}U at the same energy. Final activity results for ^{226}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 ______________________ 5/23/18

Pik Yee Yuen — Date

Radiochemistry Primary Data Reviewer

______________________ 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

ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

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.

ALS WORKORDER # 1804497

PAGE 1 of 1

DISPOSAL BY LAB or RETURN

		TURNAROUND TIME	
		SAMPLER	
PROJECT NAME	St. Anthony Geotechnical Investigation	SITE ID	St. Anthony Mine
PROJECT No.	233001076	EDD FORMAT	Microsoft Excel Spreadsheet
		PURCHASE ORDER	
COMPANY NAME	Stantec Consulting Services	BILL TO COMPANY	Stantec Consulting Services
SEND REPORT TO	Cameron Fritz	INVOICE ATTN TO	Jason Cumbers
ADDRESS	3325 S Timberline Rd #150	ADDRESS	3325 S Timberline Rd #150
CITY / STATE / ZIP	Fort Collins, CO 80525	CITY / STATE / ZIP	Fort Collins, CO 80526
PHONE	(970) 212-2759	PHONE	(970) 212-2755
FAX		FAX	
E-MAIL	cameron.fritz@stantec.com	E-MAIL	Jason.cumbers@stantec.com

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	Ra-226 (EPA 901.1)
B	Uranium (EPA 901.1)
C	Thorium-230 (EPA 901.1)
D	Gross alpha (EPA 901.1)
E	
F	
G	
H	
I	
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	P1-2 20'	Soil	4/9/18	11:00am		N/A		✓	✓	✓	✓							
2	P1-2 40'	Soil	4/9/18	11:30am		N/A		✓	✓	✓	✓							
3	P1-2 60'	Soil	4/11/18	2:30 pm		N/A		✓	✓	✓	✓							
4	P2-1 10'	Soil	4/14/18	4:15 pm		N/A		✓	✓	✓	✓							
5	P2-1 20'	Soil	4/14/18	4:25 pm		N/A		✓	✓	✓	✓							
6	P2-2 10'	Soil	4/15/18	8:30 am		N/A		✓	✓	✓	✓							
7	P4-3 5'	Soil	4/16/18	12:10 pm		N/A		✓	✓	✓	✓							
8	P4-5 5'	Soil	4/16/18	10:00am		N/A		✓	✓	✓	✓							
9	P4-5 15'	Soil	4/16/18	10:10 am		N/A		✓	✓	✓	✓							
10	P4-9 20'	Soil	4/15/18	1:30pm		N/A		✓	✓	✓	✓							
11	P4-9 30'	Soil	4/15/18	1:50pm		N/A		✓	✓	✓	✓							
12	BW-1 10'	Soil	4/18/18	9:35am		N/A		✓	✓	✓	✓							

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES

REPORT LEVEL / QC REQUIRED	
	Summary (Standard QC)
X	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	Cameron Fritz	Cameron Fritz	4/18/18	4:00 pm
RECEIVED BY	Emily Lyons	Emily Lyons	4.23.18	0900
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

PRESERVATION KEY 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

ALS Environmental
225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

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.

ALS WORKORDER #: 1804492

		TURNAROUND TIME	
		SAMPLER	
PAGE	1 of 1	DISPOSAL	BY LAB or RETURN
PROJECT NAME	St. Anthony Geotechnical Investigation	SITE ID	St. Anthony Mine
PROJECT No.	233001076	EDD FORMAT	Microsoft Excel Spreadsheet
		PURCHASE ORDER	
COMPANY NAME	Stantec Consulting Services	BILL TO COMPANY	Stantec Consulting Services
SEND REPORT TO	Cameron Fritz	INVOICE ATTN TO	Jason Cumbers
ADDRESS	3325 S Timberline Rd #150	ADDRESS	3325 S Timberline Rd #150
CITY / STATE / ZIP	Fort Collins, CO 80525	CITY / STATE / ZIP	Fort Collins, CO 80526
PHONE	(970) 212-2759	PHONE	(970) 212-2755
FAX		FAX	
E-MAIL	cameron.Fritz@stantec.com	E-MAIL	jason.cumbers@stantec.com

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	Radium-226 (EPA 901.1)
B	Uranium (EPA 901.1)
C	Thorium-230 (EPA 901.1)
D	Gross alpha (EPA 901.1)
E	
F	
G	
H	
I	
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
13	BW-4 5'	S	4/18/18	12:00pm		N/A		✓	✓	✓	✓							
14	BW-4 15'	S	4/18/18	12:15pm		N/A		✓	✓	✓	✓							
15	BW-3 10'	S	4/18/18	12:50pm		N/A		✓	✓	✓	✓							
16	BW-2 5'	S	4/18/18	1:45pm		N/A		✓	✓	✓	✓							
17	BW-2 20'	S	4/18/18	2:05pm		N/A		✓	✓	✓	✓							

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES

REPORT LEVEL / QC REQUIRED	
	Summary (Standard QC)
X	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	Cameron Fritz	Cameron Fritz	4/18/18	7:00pm
RECEIVED BY	Emily Lyons	Emily Lyons	4·23·18	0900
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

PRESERVATION KEY: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: Stantec Workorder No: 1804492

Project Manager: LPS Initials: Gu Date: 4.23.18

1. Does this project require any special handling in addition to standard ALS procedures?		YES	NO
2. Are custody seals on shipping containers intact?	NONE	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?		YES	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
7. Were airbills / shipping documents present and/or removable?	DROP OFF	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/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?		YES	NO
11. Were all samples placed in the proper containers for the requested analyses?		YES	NO
12. Are all samples within holding times for the requested analyses?		YES	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	N/A	YES	NO
15. Do any water samples contain sediment? Amount Amount of sediment: ____ dusting ____ moderate ____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 ONLY	YES	NO

Cooler #:	1	2						
Temperature (°C):	Amb	Amb						
No. of custody seals on cooler:	0	0						
DOT Survey/ Acceptance Information — External µR/hr reading:	9							
Background µR/hr reading:	9							

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, EXCEPT #1 AND #16.

If applicable, was the client contacted? YES / NO / NA Contact: ____________ Date/Time: ____________

Project Manager Signature / Date: 4/24/18

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

FROM: (907) 947-2225
CAMERON FRITZ

718 MARIGOLD LN

FORT COLLINS CO 80526
US

SHIP DATE: 19APR18
ACTWGT: 36.00 LB
CAD: 006993643/SSFE1904
DIMMED: 15 X 12 X 12 IN

TO

ALS ENVIRONMENTAL
225 COMMERCE DR

FORT COLLINS CO 80524 **(US)**

(800) 443-1511 REF:
INV:
PO: DEPT:

FedEx
Ground

G

1 of 2
TRK# **7805 9618 7711**
MASTER

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7711

FROM: (907) 947-2225
CAMERON FRITZ

718 MARIGOLD LN

FORT COLLINS CO 80526
US

SHIP DATE: 19APR18
ACTWGT: 18.00 LB
CAD: 006993643/SSFE1904
DIMMED: 15 X 12 X 12 IN

TO

ALS ENVIRONMENTAL
225 COMMERCE DR

FORT COLLINS CO 80524 **(US)**

(800) 443-1511 REF:
INV:
PO: DEPT:

FedEx
Ground

G

2 of 2
MPS# **7805 9618 7722**
Mstr# 7805 9618 7711

80524

9622 0019 0 (000 000 0000) 0 00 7805 9618 7722

Gamma Spectroscopy Results

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
Library: RA226.LIB

Sample Matrix: SOIL
Prep SOP: PAI 739 Rev 12
Date Collected: 02-May-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

Final Aliquot: 215 g
Result Units: pCi/g
File Name: 180883d03

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:

U - Result is less than the sample specific MDC or less than the associated TP U

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

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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
Library: RA226.LIB

Sample Matrix: SOIL
Prep SOP: PAI 739 Rev 12
Date Collected: 02-May-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

Final Aliquot: 215 g
Result Units: pCi/g
File Name: 180592d09

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control 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 TPU

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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			Duplicate			DER	DER Lim
		Result +/- 2 s TPU	MDC	Flags	Result +/- 2 s TPU	MDC	Flags		
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.
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

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.

Abbreviations:
TPU - Total Propagated Uncertainty
DER - Duplicate Error Ratio
BDL - Below Detection Limit
NR - Not Reported

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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
U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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'	**Sample Matrix:**	SOIL	**Prep Batch:**	GS180502-2	**Final Aliquot:**	182 g
Lab ID:	1804492-1DUP	**Prep SOP:**	PAI 739 Rev 12	**QCBatchID:**	GS180502-2-1	**Prep Basis:**	Dry Weight
		Date Collected:	09-Apr-18	**Run ID:**	GS180502-2A	**Moisture(%):**	NA
Library:	RA226.LIB	**Date Prepared:**	02-May-18	**Count Time:**	30 minutes	**Result Units:**	pCi/g
		Date Analyzed:	17-May-18	**Report Basis:**	Dry Weight	**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.
W - DER is greater than Warning Limit of 1.42
D - DER is greater than Control Limit of 2.13

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.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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
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: 199 g
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:

U - Result is less than the sample specific MDC or less than the associated TP U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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'	**Sample Matrix:** SOIL	**Prep Batch:** GS180502-2	**Final Aliquot:** 180 g
Lab ID: 1804492-3	**Prep SOP:** PAI 739 Rev 12	**QCBatchID:** GS180502-2-1	**Prep Basis:** Dry Weight
Library: RA226.LIB	**Date Collected:** 11-Apr-18	**Run ID:** GS180502-2A	**Moisture(%):** NA
	Date Prepared: 02-May-18	**Count Time:** 30 minutes	**Result Units:** pCi/g
	Date Analyzed: 17-May-18	**Report Basis:** Dry Weight	**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 U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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 SOP: PAI 739 Rev 12
Date Collected: 14-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: 188 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
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 U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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
Library: RA226.LIB

Sample Matrix: SOIL
Prep SOP: PAI 739 Rev 12
Date Collected: 14-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: 184 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: 180584d09

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
U
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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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'	**Sample Matrix:** SOIL	**Prep Batch:** GS180502-2	**Final Aliquot:** 195 g
Lab ID: 1804492-6	**Prep SOP:** PAI 739 Rev 12	**QCBatchID:** GS180502-2-1	**Prep Basis:** Dry Weight
Library: RA226.LIB	**Date Collected:** 15-Apr-18	**Run ID:** GS180502-2A	**Moisture(%):** NA
	Date Prepared: 02-May-18	**Count Time:** 30 minutes	**Result Units:** pCi/g
	Date Analyzed: 17-May-18	**Report Basis:** Dry Weight	**File Name:** 180594d10

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.91 +/- 0.21	0.36	0.5	NA	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TP U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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 U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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/g
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 U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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
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: 213 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
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	M3

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TP U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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'	**Sample Matrix:** SOIL	**Prep Batch:** GS180502-2	**Final Aliquot:** 246 g
Lab ID: 1804492-10	**Prep SOP:** PAI 739 Rev 12	**QCBatchID:** GS180502-2-1	**Prep Basis:** Dry Weight
Library: RA226.LIB	**Date Collected:** 15-Apr-18	**Run ID:** GS180502-2A	**Moisture(%):** NA
	Date Prepared: 02-May-18	**Count Time:** 30 minutes	**Result Units:** pCi/g
	Date Analyzed: 17-May-18	**Report Basis:** Dry Weight	**File Name:** 180882d03

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	3.14 +/- 0.48	0.39	0.5	NA	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TP U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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 30'
Lab ID: 1804492-11
Library: RA226.LIB

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: GS180502-2A
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
U
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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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'	**Sample Matrix:**	SOIL	**Prep Batch:**	GS180502-2	**Final Aliquot:**	204 g
Lab ID:	1804492-12	**Prep SOP:**	PAI 739 Rev 12	**QCBatchID:**	GS180502-2-1	**Prep Basis:**	Dry Weight
		Date Collected:	18-Apr-18	**Run ID:**	GS180502-2A	**Moisture(%):**	NA
Library:	RA226.LIB	**Date Prepared:**	02-May-18	**Count Time:**	30 minutes	**Result Units:**	pCi/g
		Date Analyzed:	18-May-18	**Report Basis:**	Dry Weight	**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 U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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'	**Sample Matrix:** SOIL	**Prep Batch:** GS180502-2	**Final Aliquot:** 202 g
Lab ID: 1804492-13	**Prep SOP:** PAI 739 Rev 12	**QCBatchID:** GS180502-2-1	**Prep Basis:** Dry Weight
	Date Collected: 18-Apr-18	**Run ID:** GS180502-2A	**Moisture(%):** NA
Library: RA226.LIB	**Date Prepared:** 02-May-18	**Count Time:** 30 minutes	**Result Units:** pCi/g
	Date Analyzed: 17-May-18	**Report Basis:** Dry Weight	**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 U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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
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: 207 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: 180585d09

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:

U - Result is less than the sample specific MDC or less than the associated TP U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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
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: 209 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: 180595d10

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 U
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.

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.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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/g
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 U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Gamma Spectroscopy Results

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 20'
Lab ID: 1804492-17
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: 215 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
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 U

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.

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.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS1804492-1*

Appendix D MATERIAL BALANCE CALCULATIONS

APPENDIX D: MATERIAL BALANCE CALCULATIONS

Revisioning

Rev.	Date	Description	By	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

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.

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.

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 30th 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^3)
ρ_{de} = dry density of excavated soil (lb/ft^3)

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^3)
W_s = weight of dry soil (lb)
ρ_{dc} = dry density of re-compacted soil (lb/ft^3)

Most Site facilities contain a known volume of material available for excavation, which was then converted to a re-compacted 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**

*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.

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Attachment D.1 – Volume Reduction Calculations Table

Source	Destination	Source				Placed				Volume Reduction
		Excavated Vol. (cy)	Excavated Vol (ft^3)	Dry Density (pcf)	Dry Soil Weight (lb)	Max (Proctor) Dry Density (pcf)	Compacted Dry Density (pcf)	Dry Soil Weight (lb)	Compacted Vol. (cy)	
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%**

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.

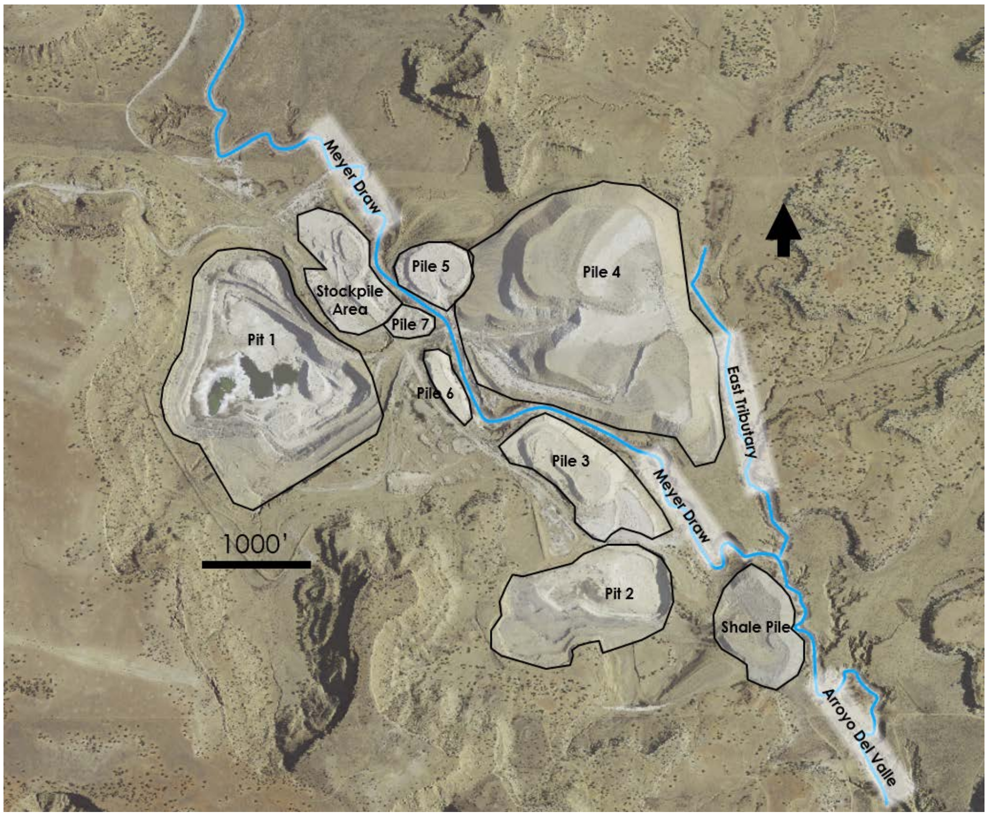

Figure 1: Project Site Existing Conditions (Photo Data: 05/31/2011)

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 (minutes)	100-Year Rainfall Depth (inches)	10-Year Rainfall Depth (inches)	5-Year Rainfall Depth (inches)	2-Year Rainfall 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 Parameter	100-Year Storm Value	10-Year Storm Value	5-Year Storm Value	2-Year Storm Value
c	88.8	57.3	47.0	32.2
e	0.982	0.896	0.895	0.890
f	7.77	7.95	7.86	7.82

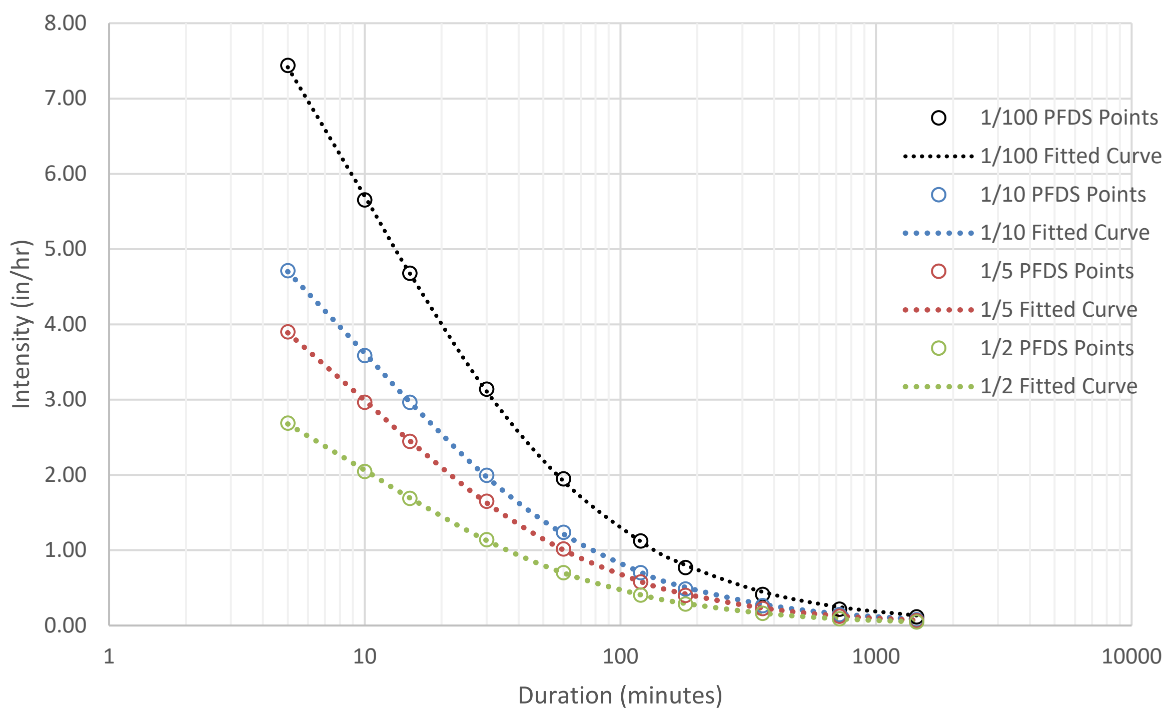

Figure 2: Intensity-Duration-Frequency Curves

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.

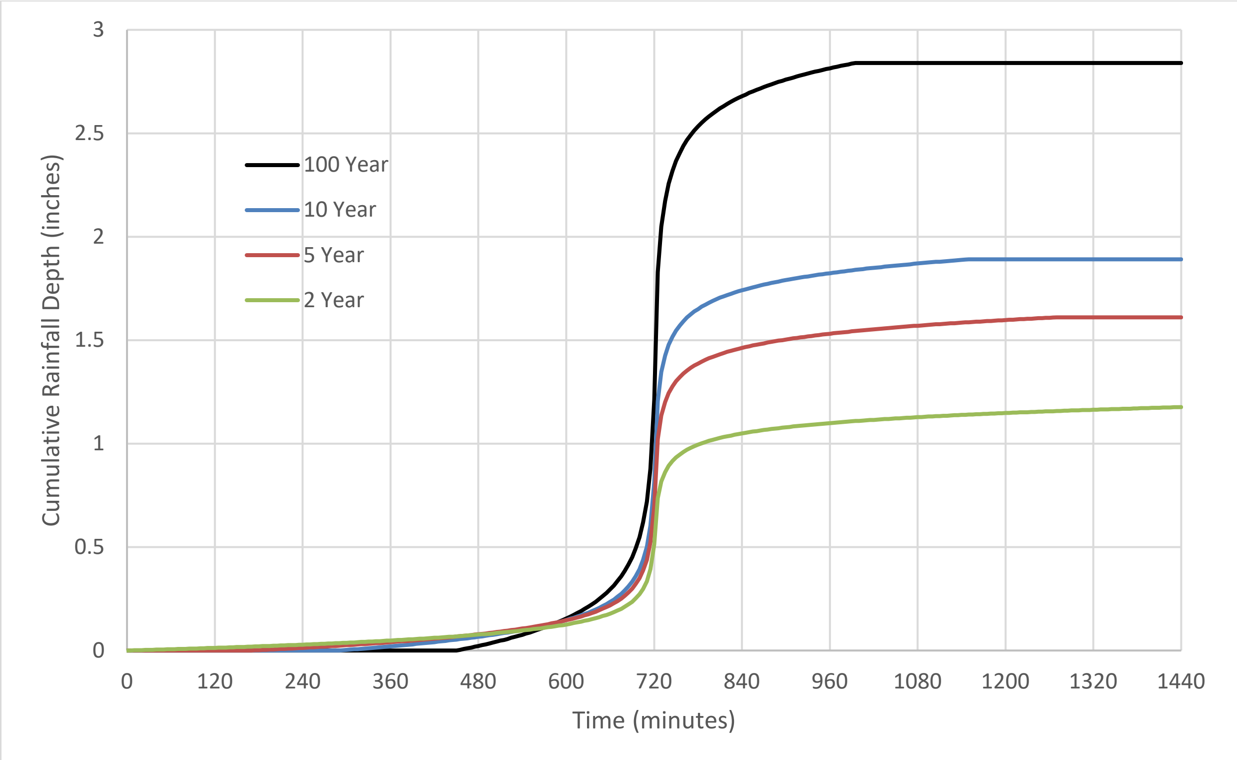

Figure 3: Cumulative Rainfall Hyetographs

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

Soil	fines content (%)	clay content (%)	Silt content (%)	Sand content (%)	median d10 (mm)	Sat. hydraulic conductivity, Rosetta estimate (cm/sec)	Sat. hydraulic conductivity, Rosetta estimate (in/hr)	in-situ med. Vol. water content (%)	median estimated vol. saturated 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 Content (-)	Suction Head (in)	Ksat (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:

$\bar{K}_{S,WS}$ = The saturated hydraulic conductivity for each watershed (in/hr)
$\bar{S}_{WS}$ = The suction head for the watershed of interest (in)

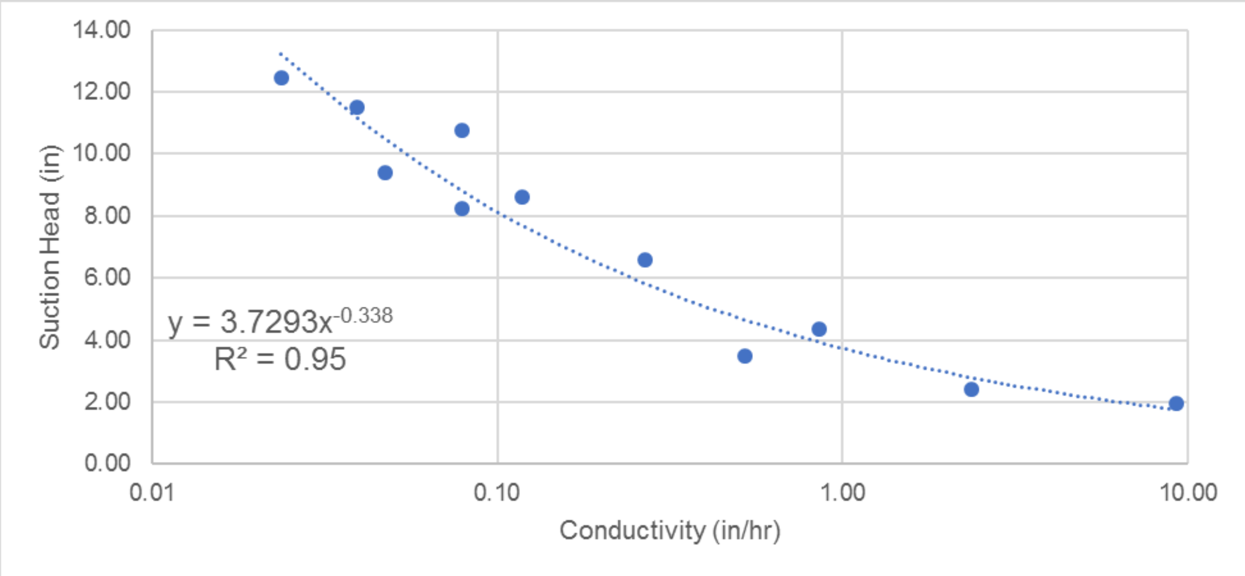

Figure 4: Regression of calculated Suction Head Values as a Function of Hydraulic Conductivity

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.

<u>Sheet Flow Travel Time, T_{sf}</u>

The sheet flow travel time, T_{sf}, 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_{sf} 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, T_{sc}

The shallow concentrated flow travel time, T_{sc}, 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, T_{oc}

The open channel flow travel time, T_{oc}, 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_{sc} 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 26.6mi^2) 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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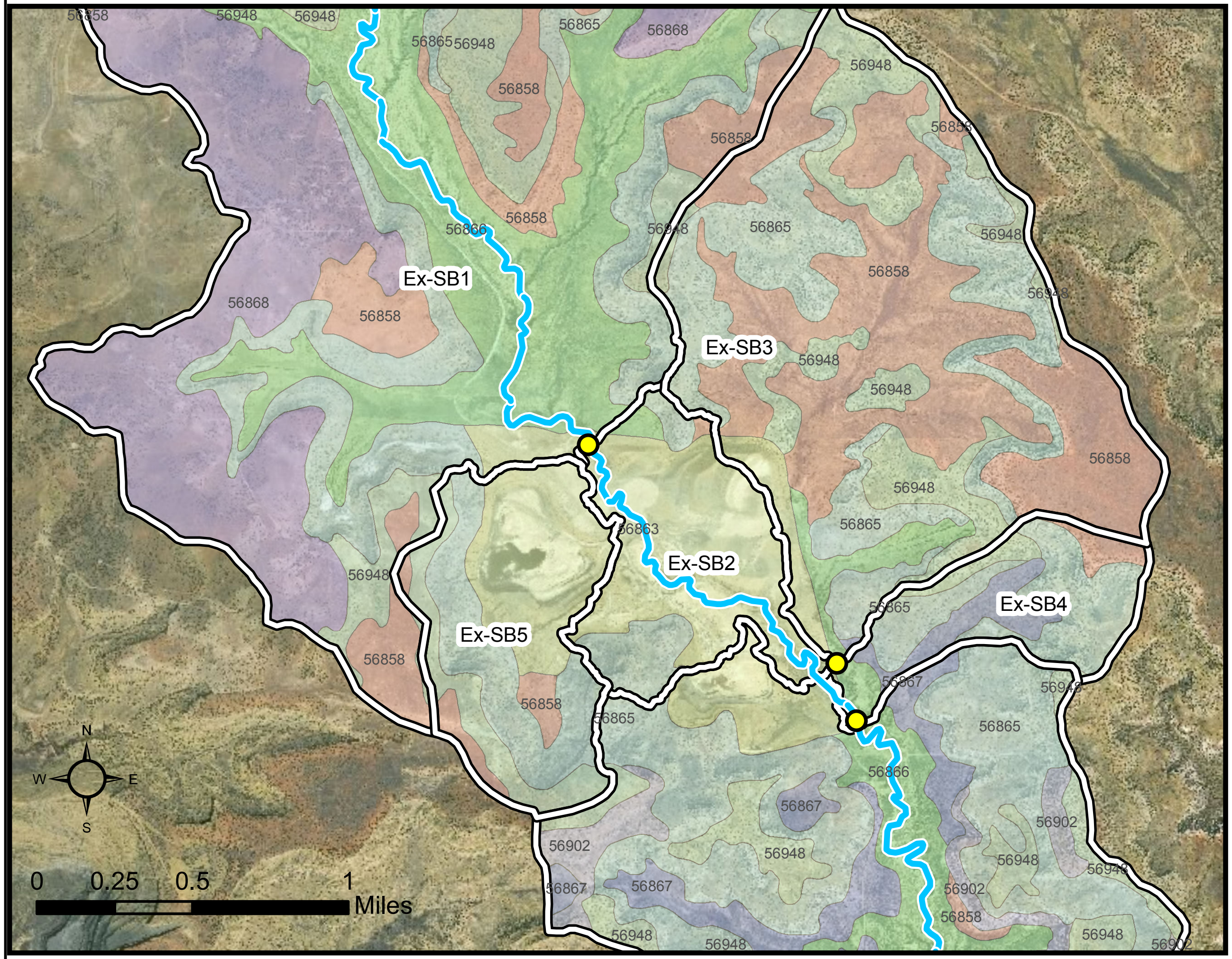
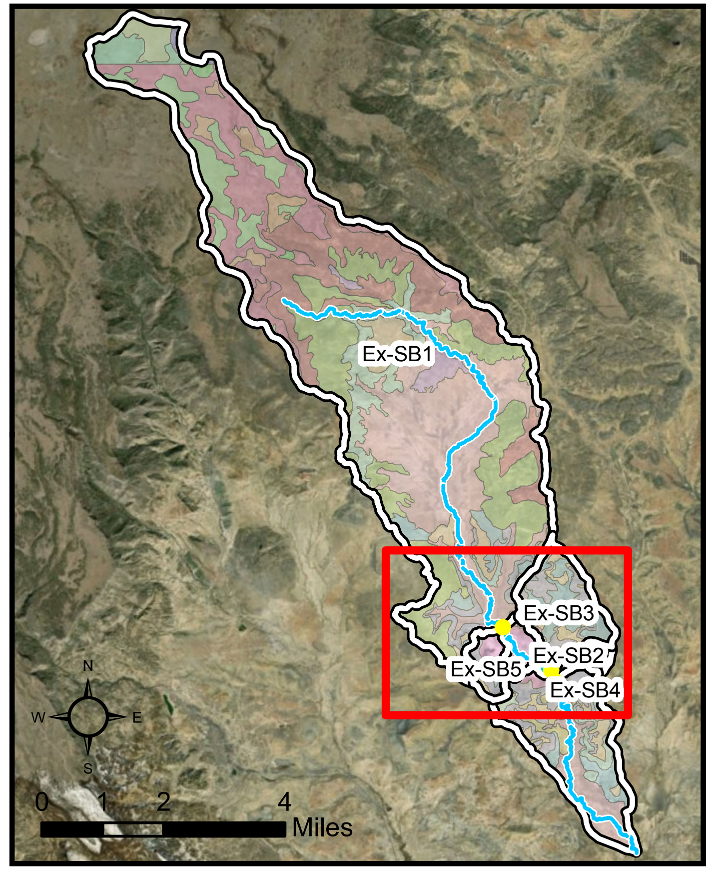
ATTACHMENT A

Watershed Delineation Maps, HEC-HMS Element Construction, Watershed Area Tables





Legend

- Basin Outlets
- Arroyo del Valle
- Existing Sub-basins

HUC12 Soils Mapunit

56858	56865	56870	56902	57298
56863	56866	56871	56903	57299
	56867	56872	56909	57300
	56868	56873	56948	

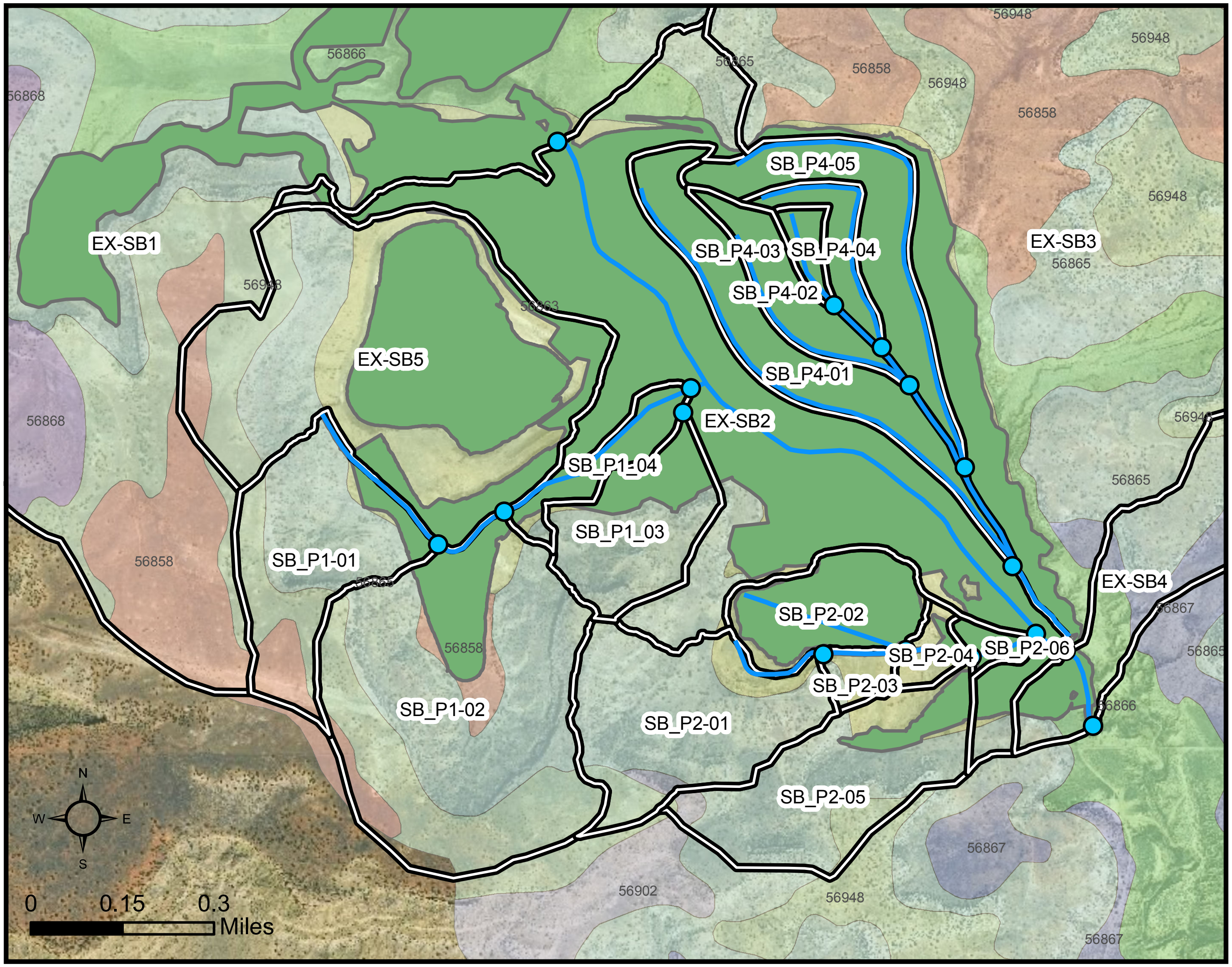
Stantec

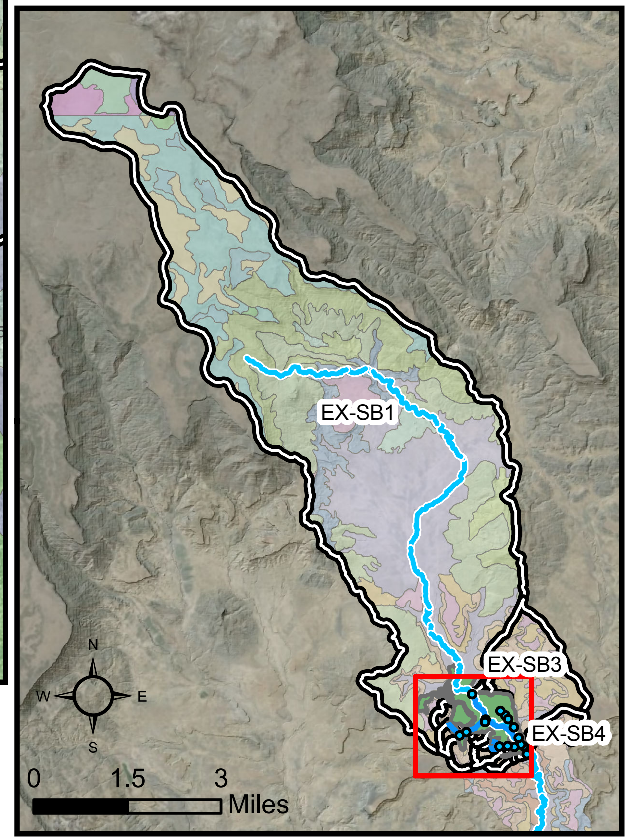
DATE: 1/28/2019

PROJECT NO: 233001076

General Electric
St. Anthony Mine Closeout Plan

Attachment A
Watershed Delineation Map
Existing Conditions





Legend

- Arroyo del Valle
- Design Sub-basins
- Design Flow Paths
- Basin Outlets
- Post Remedial Mine Areas

HUC12 Soils Mapunit

56858	56865	56870	56902	57298
56863	56866	56871	56903	57299
	56867	56872	56909	57300
	56868	56873	56948	

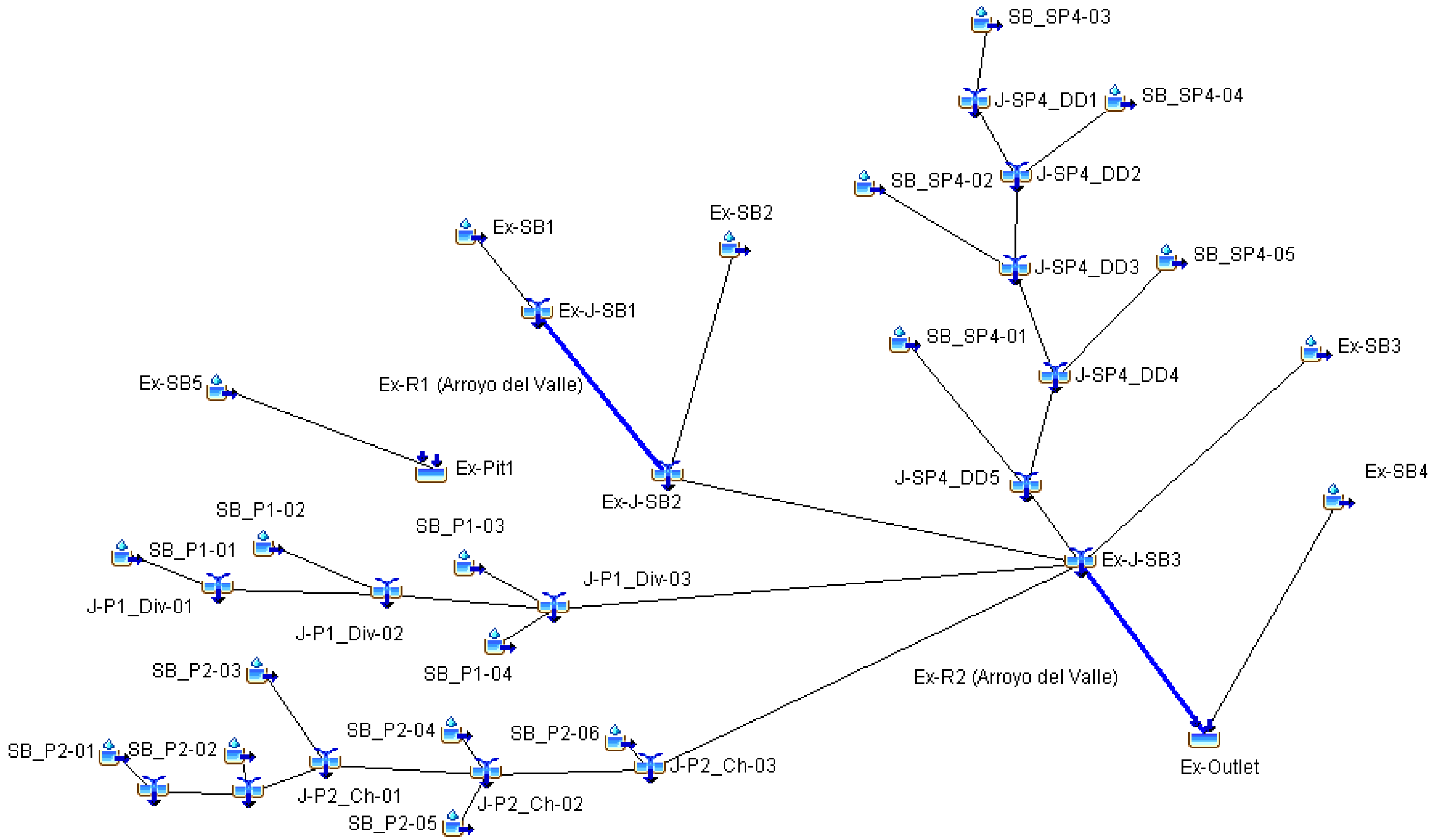
Stantec

DATE: 1/28/2019

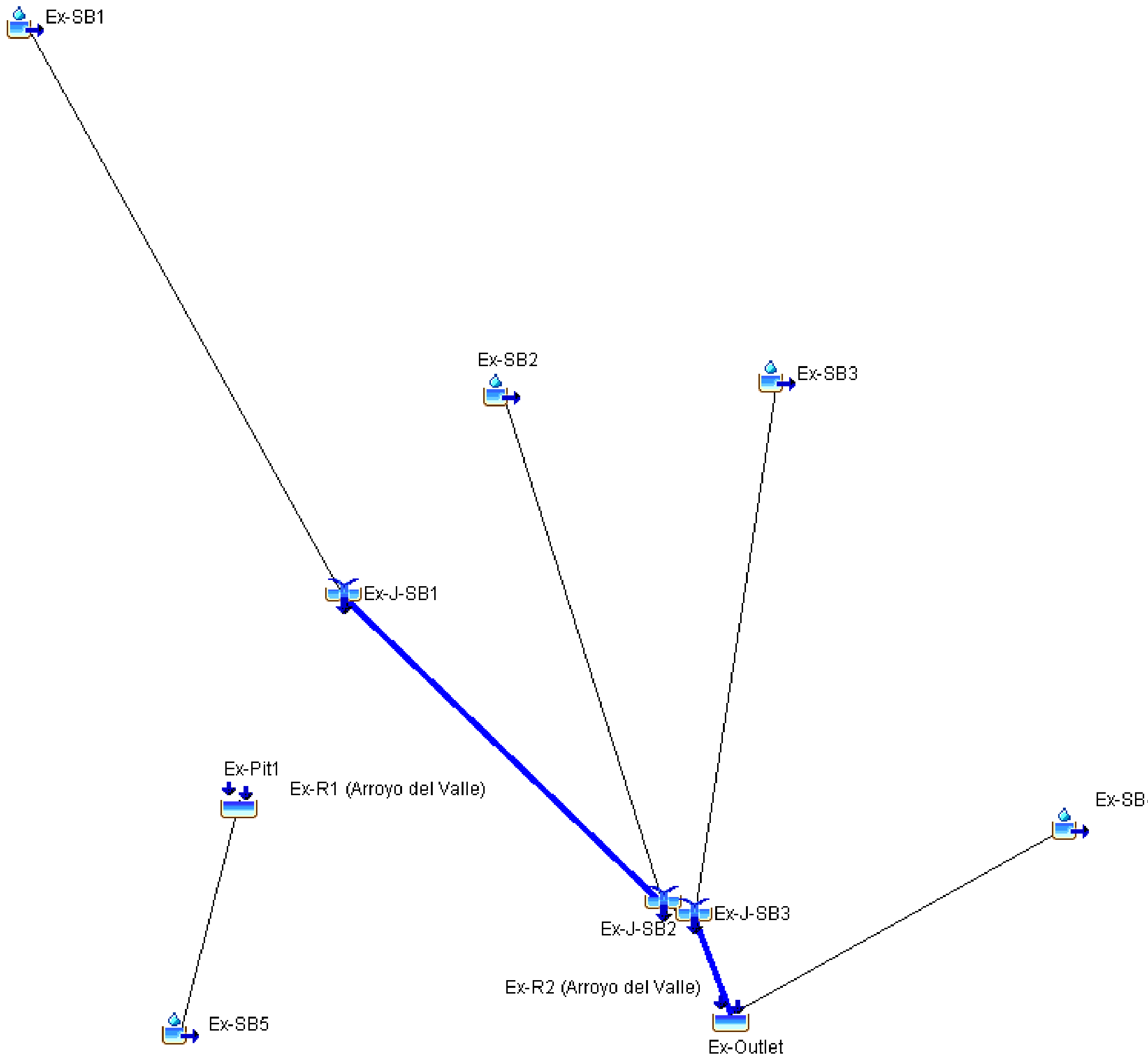
PROJECT NO: 233001076

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^2)
Ex-SB1	26.626
Ex-SB2	0.491
Ex-SB3	1.876
Ex-SB4	0.335
Ex-SB5	0.571

Proposed Conditions	
Subbasin	Area (mi^2)
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

Cumulative Rainfall Depth (inches)				
Time (min)	2-Year	5-Year	10-Year	100-Year
0	0	0	0	0
5	0	0	0	0
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	0.004	0	0	0
40	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	0.007	0	0	0
70	0.007	0	0	0
75	0.008	0	0	0
80	0.008	0	0	0
85	0.009	0	0	0
90	0.009	0	0	0
95	0.01	0	0	0
100	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
135	0.015	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	0.018	0	0	0
165	0.018	0	0	0
170	0.019	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	0.022	0.004	0	0
200	0.023	0.005	0	0
205	0.024	0.006	0	0
210	0.024	0.007	0	0
215	0.025	0.008	0	0
220	0.026	0.009	0	0
225	0.026	0.01	0	0
230	0.027	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	0.031	0.016	0	0
260	0.031	0.017	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	0.035	0.022	0	0
290	0.036	0.023	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	0.04	0.029	0.007	0
320	0.041	0.03	0.008	0
325	0.042	0.031	0.01	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	0.046	0.036	0.016	0
350	0.047	0.038	0.017	0
355	0.047	0.039	0.019	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	0.051	0.044	0.025	0
380	0.052	0.046	0.027	0
385	0.053	0.047	0.028	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	0.059	0.054	0.037	0
415	0.06	0.056	0.039	0
420	0.061	0.057	0.041	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	0.067	0.066	0.051	0
450	0.068	0.067	0.053	0
455	0.07	0.069	0.055	0.003
460	0.071	0.071	0.057	0.007
465	0.072	0.073	0.059	0.011
470	0.074	0.075	0.062	0.014
475	0.075	0.077	0.064	0.018
480	0.077	0.079	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	0.081	0.085	0.074	0.034
500	0.083	0.087	0.076	0.038
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	0.091	0.099	0.09	0.061
530	0.093	0.101	0.093	0.066
535	0.095	0.104	0.096	0.071
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	0.105	0.118	0.113	0.099
565	0.108	0.121	0.117	0.105
570	0.11	0.124	0.121	0.111
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	0.12	0.138	0.138	0.139
595	0.123	0.142	0.143	0.147
600	0.126	0.146	0.148	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	0.143	0.17	0.176	0.201
630	0.147	0.176	0.183	0.212
635	0.152	0.182	0.19	0.223
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	0.279
660	0.178	0.219	0.235	0.296
665	0.185	0.228	0.247	0.315
670	0.193	0.239	0.26	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	0.252	0.321	0.359	0.494
700	0.272	0.349	0.393	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	0.737	1.021	1.206	1.83
730	0.817	1.136	1.346	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	0.96	1.338	1.592	2.439
765	0.97	1.353	1.609	2.467
770	0.98	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	1.013	1.412	1.681	2.582
800	1.018	1.42	1.69	2.596
805	1.023	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	1.043	1.453	1.73	2.662
835	1.046	1.458	1.736	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	1.061	1.478	1.76	2.71
865	1.063	1.482	1.764	2.717
870	1.066	1.485	1.768	2.724
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	1.075	1.497	1.783	2.748
895	1.077	1.5	1.787	2.754
900	1.079	1.503	1.79	2.759
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	1.518	1.808	2.789
935	1.092	1.52	1.811	2.793
940	1.093	1.523	1.814	2.798
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

Cumulative Rainfall Depth (inches)				
Time (min)	2-Year	5-Year	10-Year	100-Year
965	1.101	1.533	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	1.106	1.541	1.835	2.833
990	1.108	1.542	1.837	2.836
995	1.109	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	1.115	1.553	1.85	2.84
1025	1.116	1.554	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	1.122	1.562	1.861	2.84
1055	1.123	1.563	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	1.127	1.569	1.869	2.84
1080	1.128	1.57	1.87	2.84
1085	1.129	1.571	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	1.133	1.578	1.88	2.84
1115	1.134	1.579	1.881	2.84
1120	1.135	1.58	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	1.139	1.585	1.888	2.84
1145	1.139	1.586	1.889	2.84
1150	1.14	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	1.144	1.592	1.891	2.84
1180	1.145	1.593	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	1.149	1.598	1.891	2.84
1210	1.149	1.599	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	1.153	1.604	1.891	2.84
1240	1.154	1.605	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	1.157	1.609	1.891	2.84
1270	1.157	1.61	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	1.161	1.61	1.891	2.84
1300	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	1.164	1.61	1.891	2.84
1330	1.165	1.61	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	1.168	1.61	1.891	2.84
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	1.171	1.61	1.891	2.84
1390	1.171	1.61	1.891	2.84
1395	1.172	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	1.174	1.61	1.891	2.84
1425	1.175	1.61	1.891	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

Time of Conentration								*Storage Coeff*
Method	*Area (mi2)*	*L (mi)*	*Lca (mi)*	*El_Max (ft)*	*El_Min (ft)*	*S (ft/mi)*	*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
Sabol (Desert/Mountain)	0.3	1.3	0.7	6345	5951.9	312	0.7	0.5

Proposed Conditions - Clark UH Parameters, Tc and R by FHWA

1/100-Year Storm Assumed

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

ObjectID	SF Length (ft)	High Elevation (ft)	Low Elevation (ft)	SF Roughness Factor "n"	SF Slope (ft/ft)	Max Sheet Flow Length (ft)	Guess Intensity (in/hr)	Select Design Storm	Avg. Effective Rainfall Depth (in)	New Intensity (in/hr)	Iterate to 0	Intensity (ft/s)	$Tt_{(i*Tt)}$ (s)	SF Tt (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	100yr 24hr	1.73	2.5	0.01	5.8E-05	858	14.3

ObjectID	SCF Length (ft)	High Elevation (ft)	Low Elevation (ft)	k value	SCF Slope (ft/ft)	Velocity (ft/s)	Tt (min)	Tt if V=1.0 ft/s (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

ObjectID	CF Length (ft)	High Elevation (ft)	Low Elevation (ft)	Channel Roughness Factor "n"	Channel Slope (ft/ft)	Guess Flow Depth (ft)	Channel Bottom Width "B" (ft)	xH:1V-1	xH:1V-2	Flow Area "A" (ft2)	Channel Hydraulic Radius "Rh" (ft)	Calculated Discharge (cfs)	Modeled Discharge	Modeled Discharge (cfs)	Iterate to 0	Tt (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
SB_Ex2	41.74	0.70	0.31	1.55	0.68	0.98

Existing Conditions - Clark UH Parameters, Tc and R by FHWA

ObjectID	**Tc (HRS)**	**R (HRS)**
Ex-SB2	**0.743**	**0.664**

1/100-Year Storm Assumed

ObjectID	*SF Length (ft)*	*High Elevation (ft)*	*Low Elevation (ft)*	*SF Roughness Factor "n"*	*SF Slope (ft/ft)*	*Max Sheet Flow Length (ft)*	*Guess Intensity (in/hr)*	Select Design Storm	*Avg. Effective Rainfall Depth (in)*	*New Intensity (in/hr)*	*Iterate to 0*	*Intensity (ft/s)*	*$Tt_{(i*Tt)}$ (s)*	*SF Tt (min)*
Ex-SB2	141	6248.8	6244.1	0.100	0.03	182.01	6.6	100yr 24hr	5	6.6	0.00	1.5E-04	427	7.1

ObjectID	*SCF Length (ft)*	*High Elevation (ft)*	*Low Elevation (ft)*	*k value*	*SCF Slope (ft/ft)*	*Velocity (ft/s)*	*Tt (min)*	*Tt if V=1.0 ft/s (min)*	*Tt (min)*
Ex-SB2	1400.9	6244.1	6178.6	0.305	0.047	2.18	10.73	23.35	10.73

ObjectID	*CF Length (ft)*	*High Elevation (ft)*	*Low Elevation (ft)*	*Channel Roughness Factor "n"*	*Channel Slope (ft/ft)*	*Guess Flow Depth (ft)*	*Channel Bottom Width "B" (ft)*	*xH:1V-1*	*xH:1V-2*	*Flow Area "A" (ft2)*	*Channel Hydraulic Radius "Rh" (ft)*	*Calculated Discharge (cfs)*	Modeled Discharge	*Modeled Discharge (cfs)*	*Iterate to 0*	*Tt (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

ObjectID	*Tc (min)*	*Tc (hrs)*	*A*	*L(mi)*	*Storage Coefficient "R" (hrs)*	*R/Tc*
Ex-SB2	44.58	0.74	0.49	1.89	0.66	0.89

Muskingum-Cunge Flow Routing

Reach	High Elevation (ft)	Low Elevation (ft)	Length (ft)	Slope (ft/ft)	Manning's n	Shape	Side Slope
EX-R1 (Arroyo del Valle)	6024	5960	7410	0.00864	0.04	Triangle	2
EX-R2 (Arroyo del Valle)	5960	5951.9	1492	0.00543	0.04	Triangle	2

ATTACHMENT D

HEC-HMS Model Results

HEC-HMS Model Results

Existing Conditions								
	1/100-Year Event		1/10-Year Event		1/5-Year Event		1/2-Year Event	
Hydrologic Element	Peak Discharge (cfs)	Volume (ac-ft)	Peak Discharge (cfs)	Volume (ac-ft)	Peak Discharge (cfs)	Volume (ac-ft)	Peak Discharge (cfs)	Volume (ac-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	
Hydrologic Element	Peak Discharge (cfs)	Volume (ac-ft)
Ex-J-SB1	4080	1632
Ex-J-SB2	4081	1654
Ex-J-SB3	4105	1743
Ex-Outlet	4102	1755
Ex-Pit1	172	12
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.

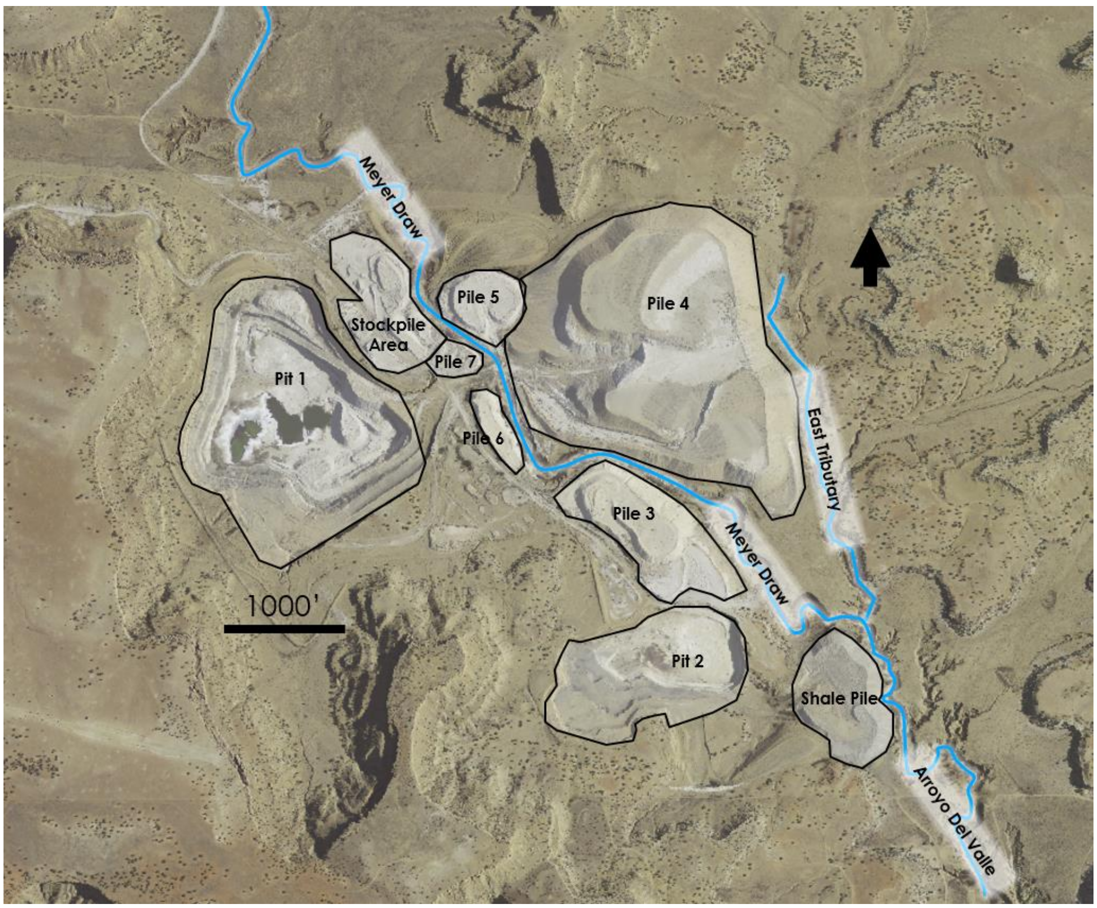


Figure 1: Project Site Existing Conditions (Photo Data: 05/31/2011)

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.

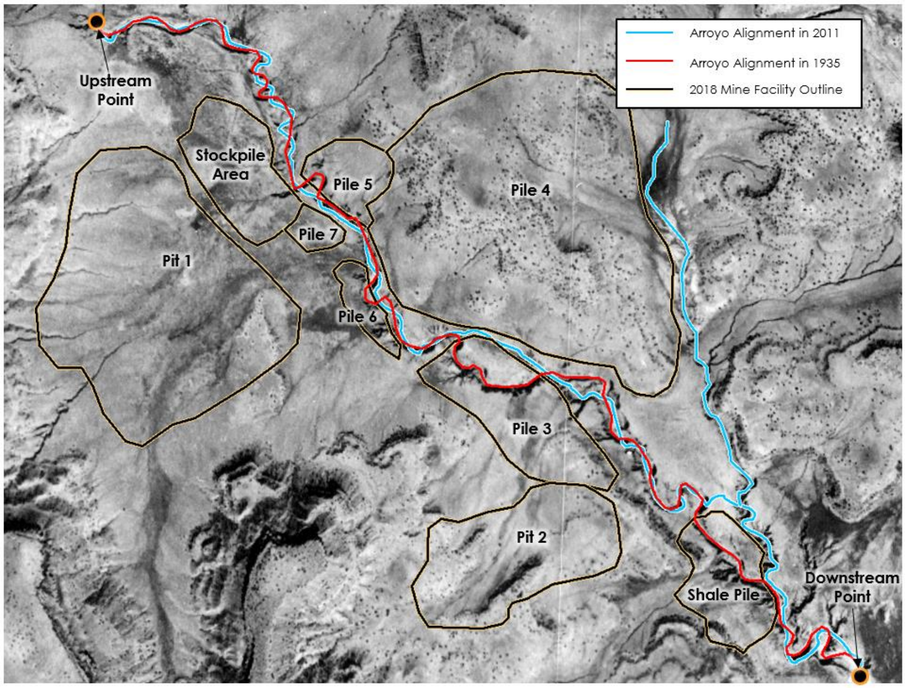


Figure 2: Project Site Prior to Mining Activities

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).

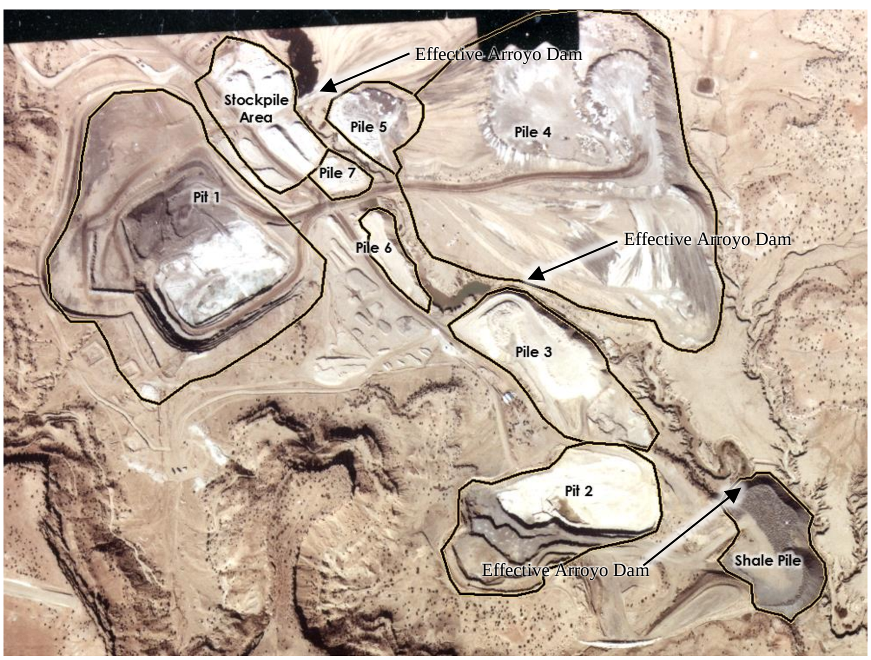


Figure 3: Project Site During Mine Operation

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.

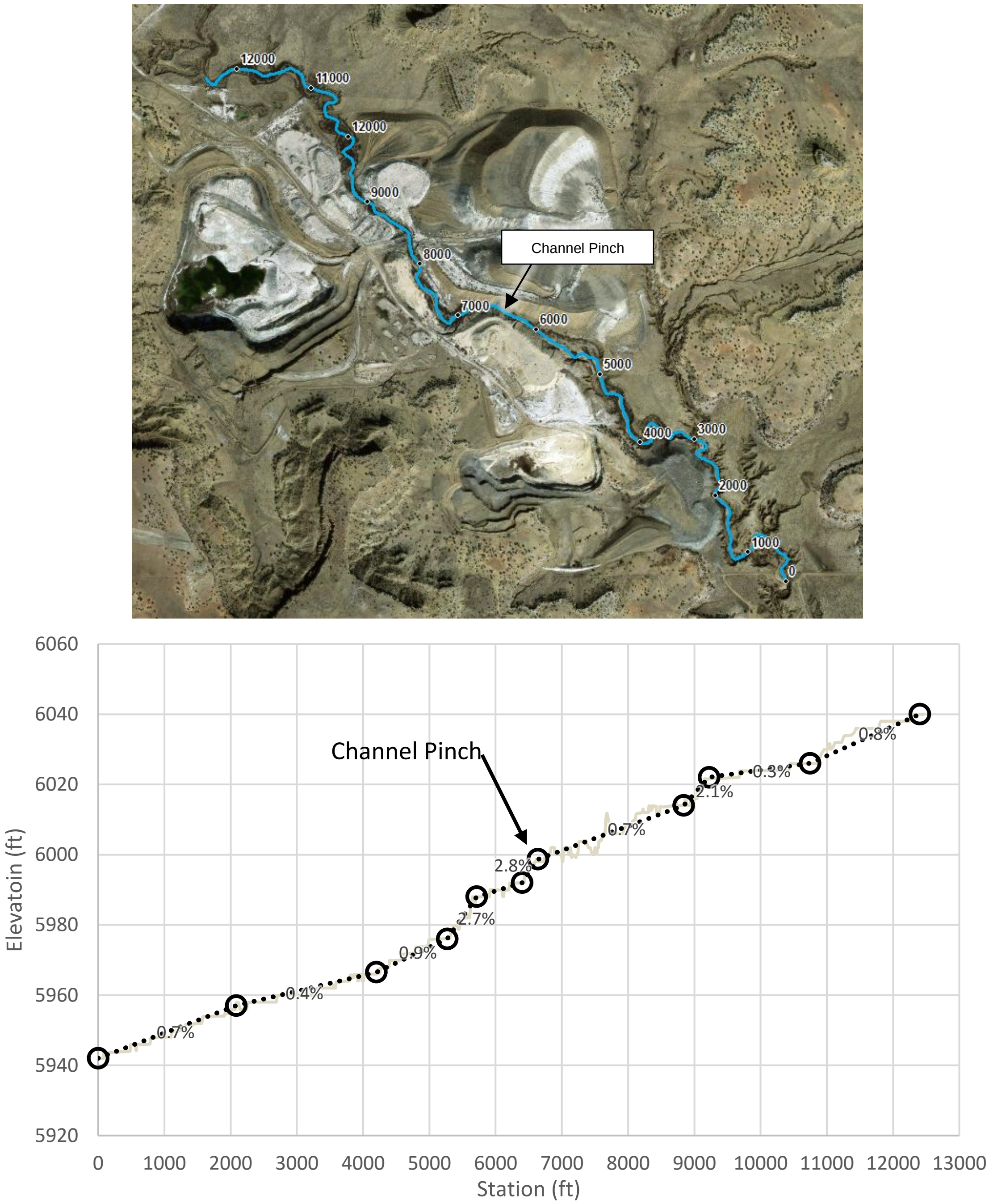


Figure 4: Plan and Profile of the Existing (2011) Arroyo

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).

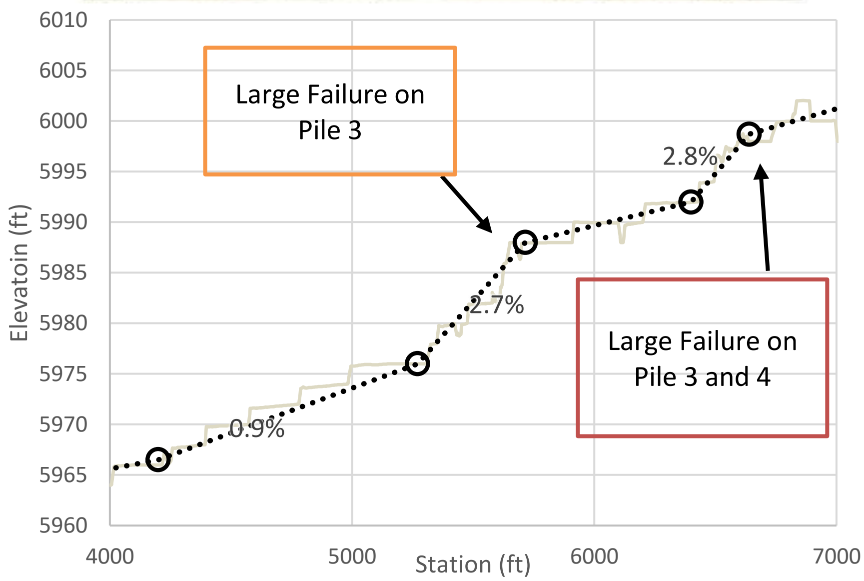


Figure 5: Plan and Profile between Stations 4000 and 7000

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).

$$Q_d = \frac{1.49}{n} * A * \left(\frac{A}{P}\right)^{\frac{2}{3}} * S^{\frac{1}{2}} \qquad \text{Equation 2}$$

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_d) at dominant discharge was determined by fluid continuity (Equation 3).

$$V_d = \frac{Q_d}{A} \qquad \text{Equation 3}$$

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).

$$B = 0.5 * F_d^{0.6} * F_r^{-0.4} * Q_d^{0.4} \qquad \text{Equation 4}$$

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_d = 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_d) equal to 40 is typically observed in regional arroyos
- Average Froude Number (F_r) 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).

$$q_s = 0.0064 * \frac{n^{1.77} * V^{4.32} * G^{0.45}}{Y^{0.3} * D_{50}^{0.61}} * C \qquad \text{Equation 5}$$

Where:

q_s= 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_{50} = 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_2 = 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).

$$D_{50r} = C_s * C_v * C_t * Y * \left[\left(\frac{\gamma_w}{SG_{rr}*\gamma_w-\gamma_w}\right)^{0.5} * \frac{V}{\sqrt{K_1*g*Y}}\right]^{2.5} * K_a * K_b \qquad \text{Equation 6}$$

Where:

D_{50r} = minimum stable median stone diameter, inches

C_s = side slope stability coefficient, 0.3 for angular rock on 3:1 side slope

C_v= velocity distribution coefficient, 1.0 for straight channel

C_t= riprap thickness coefficient, 1.0 for 2*D_{50} thickness

Y = channel flow depth, feet (100-year event)

γ_w = specific weight of water, 62.4 pounds per foot cubed

SG_{rr}= riprap specific gravity, 2.65 assumed

V = channel velocity, feet per second (100-year event)

K_1 = side slope correction factor, given as $K_1 = \sqrt{1 - \frac{\sin^2\theta}{\sin^2\varphi}}$

θ = bank side slope angle with horizontal, 3H:1Z = 18.4 (deg)

φ = riprap angle of repose, 40 degrees assumed

g = gravitational acceleration constant, 32.2 feet per second squared

K_a= unit conversion constant, feet to inches (12)

K_b = 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.

$$n = \frac{P_u n_u + P_l n_l}{P_t} \qquad \text{Equation 7}$$

Where:

P_u = wetted perimeter of the unlined portion of the channel cross section, feet

n_u = unlined channel roughness, 0.03 (USGS, 1989)

P_l = wetted perimeter of the lined portion of the channel cross section, feet

n_l = lined channel roughness, as computed by Strickler's Equation from USACE (1994)

$$n_l = 0.036 * D_{90} *^{\frac{1}{6}}$$

D_{90} = diameter which is larger than 90 percent of stones in riprap gradation, 16 inches assumed

P_t = 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.

$$SF = \frac{D50_{rr}}{D50_r} \qquad \text{Equation 8}$$

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.

$$Y_s = Z_l * 0.47 * \left(\frac{Q}{f}\right)^{\frac{1}{3}} \qquad \text{Equation 9}$$

Where:

Y_s = predicted scour depth, feet

Z_l = Lacey's multiplying factor

f = Lacey's silt factor computed as $f = 1.76 * D_{50n}^{\frac{1}{2}}$

D_{50n}= 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).

$$Y_s = Y * \left(\frac{0.0685*V^{0.8}}{Y_h^{0.4}*S^{0.3}} - 1\right) \qquad \text{Equation 10}$$

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_{50}	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.

Table 2: Riprap Sizing Results

	Meyer Draw Channel	East Tributary 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, $D50_f$	7.5 inches	5.2 inches
Stability Factor, SF	1.6	1.7

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.

Table 3: Channel Scour Results

	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

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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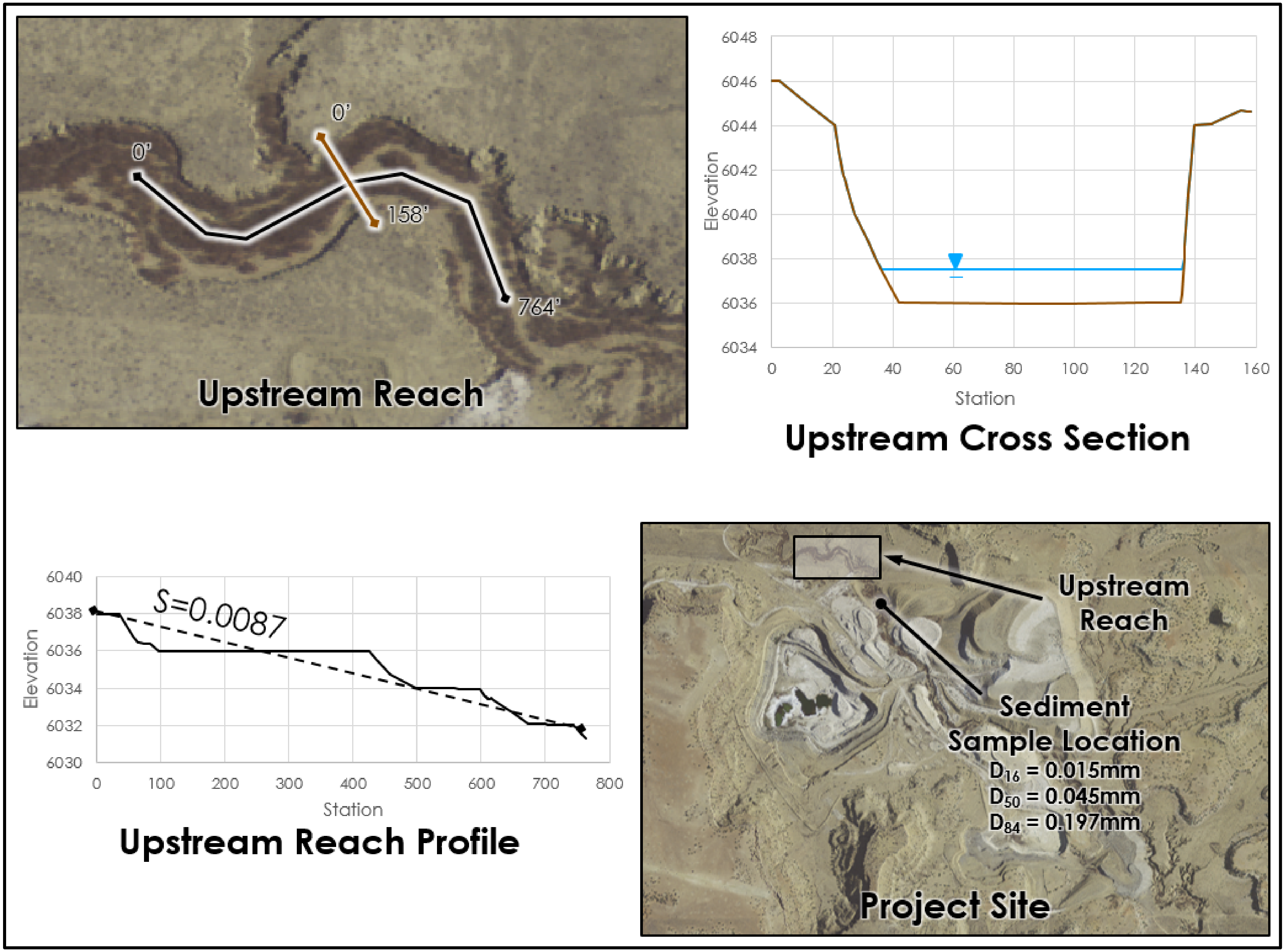
Zeller, M.E. 1981. Scour depth formula for estimation of toe protection against general scour. Pima County Department of Transportation and Flood Control District, Tucson, Arizona.

ATTACHMENT A

Upstream Cross Section Figure



0'
0'
158'
764'
Upstream Reach
6048
6046
6044
6042
6040
6038
6036
6034
Elevation
0
20
40
60
80
100
120
140
160
Station
Upstream Cross Section
6040
6038
6036
6034
6032
6030
Elevation
S=0.0087
0
100
200
300
400
500
600
700
800
Station
Upstream Reach Profile
Upstream Reach
Sediment Sample Location
D_{16} = 0.015mm
D_{50} = 0.045mm
D_{84} = 0.197mm
Project Site

ATTACHMENT B

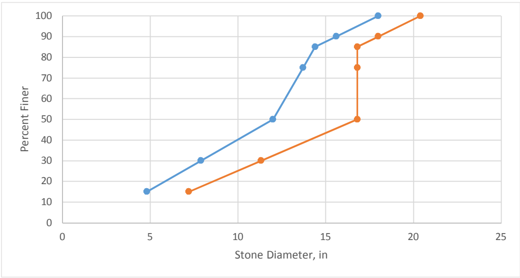
Calculation Worksheets

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	D50 x 0.4	D50 x 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 - Hydrauilc Engineering Circular No. 11

USACE, 1994. Hydraulic Design of Flood Control Channels. U.S. Army Corps of Engineers. Engineering Manual 1110-2-1601.

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	Trib	Notes
Shear Velocity, u* (fps) :	1.030	1.075	Eq. 6.10 (HEC-15, 2005)
Kinematic Viscosity, v (ft2/s) :	1.21E-05	1.21E-05	Fluid Property of Water (assumed)
Particle Reynolds Number, Re :	8.51E+04	6.66E+04	Eq. 6-9 (HEC-15, 2005)
Computed F* :	0.0760	0.0641	See Table 6.1 (HEC-15, 2005)
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	

NCH Research Program Report 108	Main	Trib	Notes
Channel Shear, T (lbs/ft2) :	1.8	1.7	Eq. TS14C-2 (NEH-TS14c, 2007)
Critical Shera, Tc (lbs/ft2) :	4.0	3.0	Eq. TS14C-3 (NEH-TS14c, 2007)
Minimum Stable D50, (in) :	5.33	5.04	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)
RR Stability Factor :	1.71	1.18	

FHWA - HEC-11	Main	Trib	Notes
Side Slope Correction, K1 :	0.87	0.87	Eq. 7 (HEC-11, 1989)
RR SG Factor Correction, Csg :	1.00	1.00	Eq. 8 (HEC-11, 1989)
Stabilty Factor SF:	1.00	1.00	Assumed
Stablity Factor Correction, Csf :	0.76	0.76	Eq. 9 (HEC-11, 1989)
Minimum Stable D50, (in) :	5.77	4.28	Eq. 6 (HEC-11, 1989)
RR Stability Factor :	2.08	2.10	

Isbash Method	Main	Trib	Notes
Turbulence Coeff. C :	1.20	1.20	For "Low Turbidity" C = 1.2. For "High Turbidity" C = 0.86
Min Stable D50 :	7.88	5.26	Eq. TS14C-1 (NEH-TS14c, 2007)
RR Stability Factor :	1.52	1.71	

Cal-Trans RSP	Main	Trib	Notes
Flow Type Coeff, :	0.67	0.67	For "Parallel flow" VM = 0.67, "impinging flow" VM = 1.33
Minimum Stone Weight, W (lbs) :	30.80	9.17	Eq. TS14c-18 (NEH-TS14c, 2007)
Miminum Stable D50 (in) :	6.85	4.58	Cubic shaped RR assumed
RR Stability Factor :	1.75	1.97	

Arroyo Scour Depth Calculation

Design Riprap Diameter, D50d (in) :	12	9	
	Main	**Trib**	**Notes**
	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	
Median Bed Particle Size, D50b (mm) :	0.045	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, Zl (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		
Design Scour Protection Depth, Dp (ft) :	2.6	1.2	Design Parameter
Stone Launch Angle, (Z:1) :	2	2	(USACE, 1994)
Stone Volume Increase Factor (%) :	25%	25%	Table 3-2 (USACE, 1994)
Riprap Layer Thickness, Trr (ft) :	2	1.5	Trr = 2*D50
Riprap Buried Depth, Drr (ft) :	3	3	Design Parameter
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

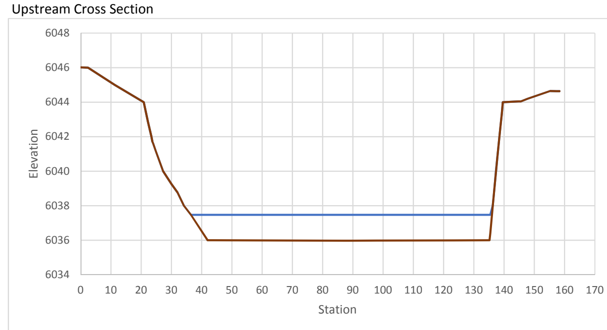
Upstream Cross Section

Design Discharge, Qd (cfs) :	820	
Channel Roughness, n :	0.031	
Bed Slope, S (ft/ft) :	0.0087	
Channel Invert Ele. (ft) :	6035.9702	
Flow Depth, Y (ft) :	1.5	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)	0.271	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 :	1.8	Eq. C.2 From SSCAFCA, 2008
Corrected Unit Sediment Discharge, qs (cfs/ft) :	0.49	

Design Cross Section

Design Discharge, Qd (cfs) :	820	
Channel Roughness, n :	0.031	
Bed Slope, S (ft/ft) :	0.0075	
Channel Bottom Width, B (ft) :	80	Eq. 3.35 From SSCAFCA, 2008
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) :	1.7	Iterate - Try : 1.6978
Iterate to Zero :	0.1	
Area, A (ft2) :	144	
Wetted Perimeter, P (ft) :	91	
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)	0.252	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 :	1.8	Eq. C.2 From SSCAFCA, 2008
Corrected Unit Sediment Discharge, qs (cfs/ft) :	0.45	

Upstream Cross Section



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.

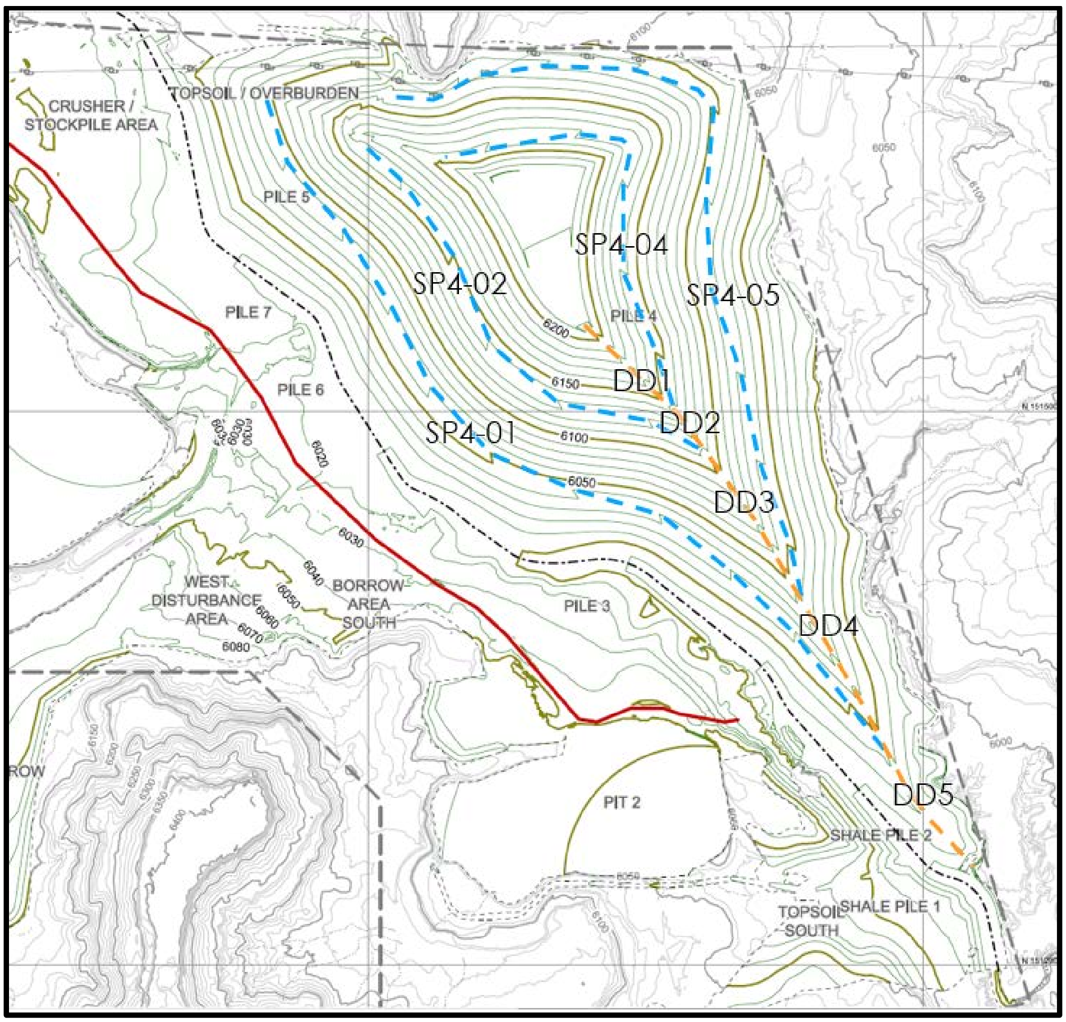


Figure 1: Plan View of the Proposed Stockpile 4

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_{rr}	ft	1.15	1.15	1.15	1.15
Bench Side Slope, Z_1:1	-	20	20	20	20
Bench Side Riprap Armoring Width, W_{dd}	ft	23	23	23	23
Hill Side Slope, Z_2:1	-	5	5	5	5
Channel Depth, H_b	-	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_{dd}	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 Channel Riprap			
Median Diameter, D_{50}	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, n_s	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 Poor Cover
Vegetation Cover Factor, C_f	0.38	-	Table 3.1 (Temple et.al., 1987) – Grass Mixture with Poor Cover

Channel Hydraulics

Stantec evaluated channel hydraulics assuming normal flow depth, using the Manning's equation (Equation 1).

$$Q = \frac{1.49}{n_c} * A * \left(\frac{A}{P}\right)^{\frac{2}{3}} * S^{\frac{1}{2}} \qquad \text{Equation 1}$$

Where:

n_c = 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

$$P = Y * \left(\sqrt{1 + Z_1} + \sqrt{1 + Z_2}\right)$$

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.

$$n_c = \frac{P_{rr} * n_{rr} + P_v * n_v}{P_t} \qquad \text{Equation 2}$$

Where:

n_c = composite roughness

n_{rr} = riprap lining roughness

n_v = vegetation lining roughness

P_{rr} = wetted perimeter of the riprap lining, feet

P_v = wetted perimeter of the vegetation lining, feet

P_t = wetted perimeter of the channel

Stantec used the riprap lining roughness computation method recommended in HEC-15 (FHA, 2005)in this analysis (Equation 3).

$$n_{rr} = \frac{1.49 * d_a^{\frac{1}{6}}}{\sqrt{g} * f(Fr) * f(REG) * f(CG)} \qquad \text{Equation 3}$$

$$f(Fr) = \left(\frac{0.28 * Fr}{b}\right)^{\log\left(\frac{0.755}{b}\right)}$$

$$f(REG) = 13.434 * \left(\frac{T}{D_{50}}\right)^{0.492} * b^{1.025 * \left(\frac{T}{D_{50}}\right)^{0.118}}$$

$$f(CG) = \left(\frac{T}{d_a}\right)^{-b}$$

Where:

d_a = 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_{50} = median riprap particle diameter, feet

The vegetation lining roughness was evaluated by Equation 4 (Temple et.al., 1987).

$$n_v = e^{C_i * \left(0.0133 * [\ln(q_v)]^2 - 0.0954 * \ln(q_v) + 0.297\right) - 4.16} \qquad \text{Equation 4}$$

Where:

C_i = 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_v = 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.

$$\tau = \gamma * Y * S \qquad \text{Equation 5}$$

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).

$$\tau_{p-rr} = \frac{F_* * \gamma_W * (SG - 1) * D_{50}}{SF} \qquad \text{Equation 6}$$

Where:

$\tau_{p\text{-}rr}$ = maximum permissible shear stress on the riprap, pounds per foot squared

F_* = Shield's parameter, dimensionless

γ_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.

$$Re = \frac{\sqrt{g * Y * S} * D_{50}}{\nu} \qquad \text{Equation 7}$$

Where:

v = kinematic viscosity of water, $1.21*10^{-5}$ 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 (τ_s) and is directly impacted by the vegetation covering as the full channel shear forces are resisted by the combined soil and vegetation system.

$$\tau_s = \gamma_w * Y_v * S * (1 - C_f) * \left(\frac{n_s}{n_v}\right)^2 \qquad \text{Equation 8}$$

The remainder of the total shear stress is applied to the vegetation. The applied vegetal stress (τ_v) is computed by Equation 9.

$$\tau_v = \gamma_w * Y_v * S - \tau_s \qquad \text{Equation 9}$$

Stantec evaluated the maximum permissible effective shear stress on the underlying soil particles (τ_a) 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.

$$\tau_a = (1.07 * I^2 + 7.15 * I + 11.9) * 10^{-4} * C_e^2 \qquad \text{Equation 10}$$

Where:

τ_a = permissible effective shear stress on the soil, pounds per square foot

C_e = 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 (τ_{va}) .

$$\tau_{va} = 0.75 * C_i \qquad \text{Equation 11}$$

Equation 12 computes a stability factor (SF) for the riprap and both the soil and vegetation lining .

$$SF = \frac{\tau_{p*}}{\tau_{a*}} \qquad \text{Equation 12}$$

Where:

SF = stability factor

τ_{p*} = maximum permissible stress

τ_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_{50}) as outlined in Table 4.

Table 4: Downdrain Design Median Stone Diameter

	DD1	DD2	DD3	DD4	DD5
Median Stone Diameter, D_{50}	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_{dd}) was evaluated using Equation 13.

$$n_{dd} = 0.029 * (25.4 * D_{50} * S)^{0.147} \quad \text{Equation 13}$$

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.

$$D_{50f} = 1.413 * q^{0.529} * S^{0.794} * K \quad \text{Equation 14}$$

$$D_{50f} = 0.46 * q^{0.529} * S^{0.307} * K \quad \text{Equation 15}$$

Where:

D_{50f} = 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.

$$SF = \frac{D_{50}}{D_{50f}} \quad \text{Equation 16}$$

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, n_{rr}	-	0.110	0.114	0.126	0.113
Vegetation Roughness, n_v	-	0.074	0.106	N/A[1]	0.086
Composite Roughness, n_c	-	0.103	0.114	0.126	0.109

ft = feet; fps = feet per second

1. Flow is predicted to be contained entirely inside of the riprap lining

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, τ	lbs/ft^2	1.76	1.61	1.37	1.69
Maximum Permissible Shear, $\tau_{p\text{-}rr}$	lbs/ft^2	2.42	2.42	2.42	2.42
Riprap Stability Factor, SF	-	1.4	1.5	1.8	1.4

lbs/ft^2 = 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_s	lbs/ft^2	0.009	0.002	N/A[1]	0.005
Vegetation Applied Shear, τ_v	lbs/ft^2	0.32	0.17	N/A[1]	0.25
Maximum Permissible Soil Shear, τ_a	lbs/ft^2	0.021	0.021	0.021	0.021
Maximum Permissible Vegetation Shear, τ_{va}	lbs/ft^2	3.00	3.00	3.00	3.00
Soil Stability Factor	-	2.3	8.9	N/A[1]	3.9
Vegetation Stability Factor	-	9.5	17.4	N/A[1]	11.9

lbs/ft^2 = pounds per square foot

1. 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, n_{dd}	-	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_{50f}	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, Zl: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		
Soil Type :	SM	
Soil Plasticity Index, PI :	10	
Soil Void Ratio, e :	0.605	
Void Ratio Correction Factor, Ce :	1.05095	
Basi Allowable Shear, Tab (lbs/ft2) :	0.01904	
Soil Roughness, ns :	0.0156	
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

Downdrain Channel Calculations

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, Zl: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.

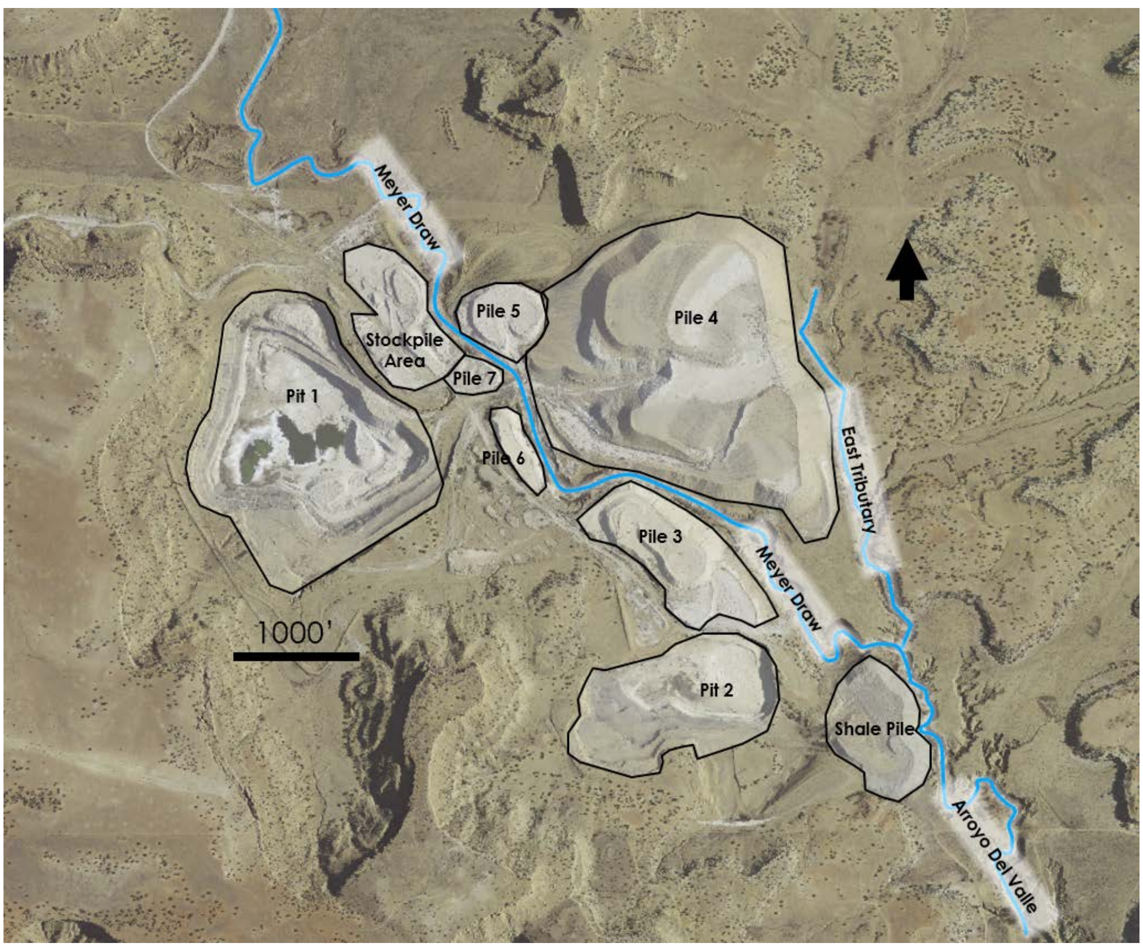


Figure 1: Project Site Existing Conditions (Photo Data: 05/31/2011)

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	Pit 1 Diversion Channel				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_{min})	0.098	0.008	0.005	0.043	0.004	0.039	0.048	0.037	0.037
Maximum Channel Slope (S_{max})	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	0 ft	0 ft	0 ft	10 ft	10 ft	10 ft	10 ft	15 ft
Channel Side Slope Angle (Z:1)	3	3[1]	3[1]	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_{50d})	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).

$$Q = \frac{1.49}{n} * A * \left(\frac{A}{P}\right)^{\frac{2}{3}} * S^{\frac{1}{2}} \qquad \text{Equation 1}$$

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.

$$n = 0.0292 * (D_{50d} * 25.4 * S)^{0.147} \qquad \text{Equation 2}$$

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).

$$V = \frac{Q}{A} \qquad \text{Equation 3}$$

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).

$$for\ 0.02 < S \leq 0.1;\ \ D_{50f} = \ 12 * (1.923 * q * S)^{0.529} \qquad \text{Equation 4a}$$

$$for\ 0.1 < S;\ \ D_{50f} = 12 * (0.233 * q * S^{0.58})^{0.529} \qquad \text{Equation 4b}$$

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).

$$D_{50f} = 12 * K_1 * C_s * C_v * C_t * Y * \left[\left(\frac{1}{SG-1}\right)^{0.5} * \frac{V}{\sqrt{K_1 * 32.2 * Y}}\right]^{2.5} \quad \text{Equation 5}$$

Where:

K = gradation coefficient, 1.15 assumed as suggested in NEH TS14c (NRCS, 2007b)
C_s = stability coefficient, 0.3 as suggested in USACE (1994) angular riprap
C_v = 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, $k_1 = \sqrt{1 - \frac{\sin^2\theta}{\sin^2\Phi}}$

θ = side slope angle, degrees where $\theta = \tan^{-1}\left(\frac{1}{Z}\right)$

Φ = riprap angle of repose, 40 degrees assumed

Stantec evaluated the design riprap by computing a riprap stability factor using Equation 6.

$$SF = \frac{D_{50d}}{D_{50f}} \quad \text{Equation 6}$$

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.

$$Y_s = Z_l * 0.47 * \left(\frac{Q}{f}\right)^{\frac{1}{3}} \quad \text{Equation 7}$$

Where:

Y_s = predicted scour depth, feet
Z_l = Lacey's multiplying factor

f = Lacey's silt factor computed as $f = 1.76 * D_{50n}^{\frac{1}{2}}$
D_{50n}= 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 0.06 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.

$$Y_s = Y * \left(\frac{0.0685 * V^{0.8}}{Y_h^{0.4} * S^{0.3}} - 1\right) \quad \text{Equation 8}$$

Where:

Y_h = hydraulic depth of flow where $Y_h = \frac{A}{B + Y * Z}$.

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[1/2]	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[1]	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[2]	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[2]	Equation 4a	Equation 5	Equation 5	Equation 4a	Equation 5	Equation 4a	Equation 4a	Equation 4a	Equation 4b
Median Riprap at Brink of Failure, 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
2. Maximum 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

Parameter	Diversion Channel 1 Sta. 08+00 to 14+00	Diversion Channel 1 Sta. 14+00 to 27+50	Diversion Channel 2 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

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) :	0.86	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-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	0.019	0.009	0.074	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	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) :	10.86	18.24	66.41	38.06	
Wetted Per., P (ft) :	15.5	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) :	4.3	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	

Diversion Channel Scour Depths

	Pit 1		Pit 2	Notes
		Design Parameters		
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 Scour Depth - Pemberton and Lara and 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, Zl (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.

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/m^2-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/m^2-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 75th 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	75th 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 70th 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/cm^3)	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 70th 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 70th 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 30th 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 70th percentile porosity calculations.

Stantec compared the 30th percentile laboratory moisture contents with the NRC-recommended value of 6 percent. Because the laboratory values were less than 6 percent, the 30th 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 30th 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 (cm^2/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/m^2-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 ($pCi/m^2/s$)
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

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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										
Layer #	Material	Lab Results				RADON Program Input Parameters			
		Data Sample ID*	Moisture Content (%, g/g)	$\rho_{d,max}$ (g/cm^3)	Porosity (%)	30th Percentile Moisture Content (%, g/g)	ρ_d (g/cm^3)	70th Percentile Porosity (%)	Ra-226 Activity (pCi/g)
1	North Topsoil/West Borrow (Cover)	TN-2 (20'A)	6.0	1.89	50.8	5.1	1.74	47.6	1.0
		BW-1 (30'A)		1.87	47.3				
		BW-2 (10'A)	5.9		42.8				
		BW-3 (5'A)	3.8		38.9				
2	Topsoil/Overburden (Subsoil)	T/O-1 (20'A)	11.4	1.83	35.6	6.9	1.70	39.2	1.0
		T/O-1 (45'B)	7.2		42.9				
		T/O-2 (15'A)	11.3		38.6				
		T/O-3 (15'B)	9.9		29.5				
		T/O-3 (40'B)	6.8		39.3				
		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

*TN = North Topsoil, BW = West Borrow, T/O = Topsoil/Overburden

Pit 2										
		Lab Results				RADON Program Input Parameters				
Layer #	Material	Data Sample ID*	Moisture Content (%, g/g)	$\rho_{d,max}$ (g/cm^3)	Porosity (%)	30th Percentile Moisture Content (%, g/g)	ρ_d (g/cm^3)	70th Percentile Porosity (%)	Ra-226 Activity (pCi/g)
1	West Borrow (Cover)	TN-2 (20'A)	6.0	1.89	50.8	5.1	1.74	47.6	1.0
		BW-1 (30'A)		1.87	47.3				
		BW-2 (10'A)	5.9		42.8				
		BW-3 (5'A)	3.8		38.9				
2	South Topsoil (Subsoil)	TS-1 (5'A)	7.8	1.92	30.8	6.9	1.79	39.3	1.0
		TS-2 (15'A)	8.9		39.6				
		TS-3 (10'A)	6.0		39.3				
		TS-4 (10'A)	7.0		25.4				
3	Pile 3 (Waste)	P3-1 (5'A)	7.3	2.00	29.7	6.9	1.86	37.6	20.6
		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				
		P3-4 (10'A)	9.3		41.8				
		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				

*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)	$\rho_{d,max}$ (g/cm^3)	Porosity (%)	30th Percentile Moisture Content (%, g/g)	ρ_d (g/cm^3)	70th Percentile Porosity (%)	Ra-226 Activity (pCi/g)
1	West Borrow & Lobo Tract Combination (Cover)	TN-2 (20'A)	6.0	1.89	50.8	4.2	1.68	47.6	1.0
		BW-1 (30'A)		1.87	47.3				
		BW-2 (10'A)	5.9		42.8				
		BW-3 (5'A)	3.8		38.9				
		L1-1 (10'A)	6.3	1.81	47.6				
		L1-2 (20'B)			33.9				
		L1-3 (5'A)	4.2		43.4				
		L1-4 (5'B)	7.5		46.7				
		L2-1 (5'B)	4.1		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				
2	Pile 4 (Waste)	P4-5 (20'A)	7.3	2.05	34.4	7.8	1.84	39.9	20.5
		P4-6 (10'A)	10.0		40.2				
		P4-7 (5'A)	9.8		43.7				
		P4-7 (25'B)	6.2		33.5				
		P4-8 (15'B)	13.0		38.9				

*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_d (g/cm^3)	Ra-226 Activity (pCi/g)	Emanation Coefficient[4]	Moisture Content (%, g/g)	Layer Thickness (cm)	Layer Thickness (ft)	Radon Emanation (pCi/m^2/s)
Pit 1[1]	1	North Topsoil (4") West Borrow (20")	0.476	1.74	1	0.35	5.1	61.0	2.00	**16.2**
	2	Topsoil/Overburden	0.392	1.70	1	0.35	6.9	223	7.32	
	3[3]	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	
Pit 2	1	West Borrow (24")	0.476	1.74	1	0.35	5.1	61.0	2.00	**3.8**
	2	South Topsoil	0.393	1.79	1	0.35	6.9	243.8	8.00	
	3	Pile 3	0.376	1.86	20.6	0.35	6.9	500	16.40	
Pile 4[2]	1	West Borrow/Lobo Tract Mix	0.476	1.68	1	0.35	4.2	79.3	2.60	**20.0**
	2	Pile 4	0.399	1.84	20.5	0.35	7.8	500	16.40	

(1) Pit 1 cover was modeled as a single 24" layer comprising 20" of West Borrow material and 4" of North Topsoil material

(2) Pile 4 cover was modeled using a fixed radon flux to determine the minimum required cover thickness

(3) Layer thickness includes Pit 1 Infill material from in-pit excavation (assumed to have similar material properties)

(4) 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
-----*****! RADON !*****-----

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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 & TAILINGS		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 l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Crusher Stockpile Waste Rock

THICKNESS	226	cm
POROSITY	.376	
MEASURED MASS DENSITY	1.86	g cm^-3
MEASURED RADIUM ACTIVITY	98.1	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

THICKNESS	79.3	cm
POROSITY	.376	
MEASURED MASS DENSITY	1.86	g cm^-3
MEASURED RADIUM ACTIVITY	117	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
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

THICKNESS	223	cm
POROSITY	.392	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	1	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	3.187D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.9	%
MOISTURE SATURATION FRACTION	.299	
CALCULATED DIFFUSION COEFFICIENT	2.518D-02	cm^2 s^-1

LAYER 4 Cover - 4" North Topsoil over 20" West Borrow

THICKNESS	61	cm
POROSITY	.476	
MEASURED MASS DENSITY	1.74	g cm^-3
MEASURED RADIUM ACTIVITY	1	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
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	ICOST	CRITJ	ACC
4	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
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 l^-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

♀

Pit 2 Cover Radon Flux
-----*****! RADON !*****-----

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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 & TAILINGS		2.65

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	3	
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Pile 3 Waste Rock

THICKNESS	500	cm
POROSITY	.376	
MEASURED MASS DENSITY	1.86	g cm^-3
MEASURED RADIUM ACTIVITY	20.6	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
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

THICKNESS	243.8	cm
POROSITY	.393	
MEASURED MASS DENSITY	1.79	g cm^-3
MEASURED RADIUM ACTIVITY	1	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
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

THICKNESS	61	cm
POROSITY	.476	
MEASURED MASS DENSITY	1.74	g cm^-3
MEASURED RADIUM ACTIVITY	1	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
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	ICOST	CRITJ	ACC
3	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.128D-02	3.760D-01	7.490D-05	3.413D-01	1.860
2	2.438D+02	2.389D-02	3.930D-01	3.348D-06	3.143D-01	1.790
3	6.100D+01	3.928D-02	4.760D-01	2.687D-06	1.864D-01	1.740

BARE SOURCE FLUX FROM LAYER 1: 2.815D+01 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-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

♀

Pile 4 Cover Thickness
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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 & TAILINGS		2.65

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	2	
DEFAULT RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	2	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Pile 4 Waste Rock

THICKNESS	500	cm
POROSITY	.399	
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

THICKNESS	76.2	cm
POROSITY	.476	
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	4.2	%
MOISTURE SATURATION FRACTION	.148	
CALCULATED DIFFUSION COEFFICIENT	4.424D-02	cm^2 s^-1

♀

Pile 4 Cover Thickness

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
2	-1.000D+00	0.000D+00	2	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.038D-02	3.990D-01	6.948D-05	3.597D-01	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	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.205D+01	6.369D+03
2	7.927D+01	2.002D+01	0.000D+00

♀

APPENDIX F.2: COVER EROSIONAL STABILITY ANALYSES

Revisioning					
Rev.	**Date**	**Description**	**By**	**Checked**	**Date**
0	*01/28/19*	*Draft for Internal Review*	*M. Kapp*	*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

Table of Contents

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.

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.

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 τ_a = allowable shear strength (in psf)
τ_{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:

$$\tau_{va} = 0.75C_I$$

Where τ_{va} = allowable vegetation shear strength (in psf)
C_I =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:

$$\tau_e = \gamma dS\left(1 - C_f\right)(n_s/n)^2$$

Where τ_e = effective shear stress (in psf)
γ = 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_s = soil grain roughness factor (0.0156 for cohesive soil), and
n = Manning's roughness coefficient for vegetated surface

$$n = e^{C_i\left(0.0133[\ln q]^2 - 0.0954\ln q + 0.297\right) - 4.16}$$

The effective shear stress on vegetation is calculated as:

$$\tau_v = \gamma dS - \tau_e$$

Where τ_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.

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_{75} value was selected to be 0.005 inches based on the average result of mechanical analyses of the North Topsoil and Borrow West soils.

Table 1. Soil Properties

Material	Dry Unit Weight (pcf)	Specific Gravity	Plasticity Index (%)	Calculated Void Ratio	D_{75}(1) (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

(1) Diameter for which 75% of the material is finer

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.

Table 2. Time of concentration summary

Description	Slope (ft/ft)	Slope Length (ft)	Calculated T_c (min)	T_c 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 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.

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			Vegetation 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.

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 Commision (NRC), 1990. Final Staff Technical Position Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites. August.

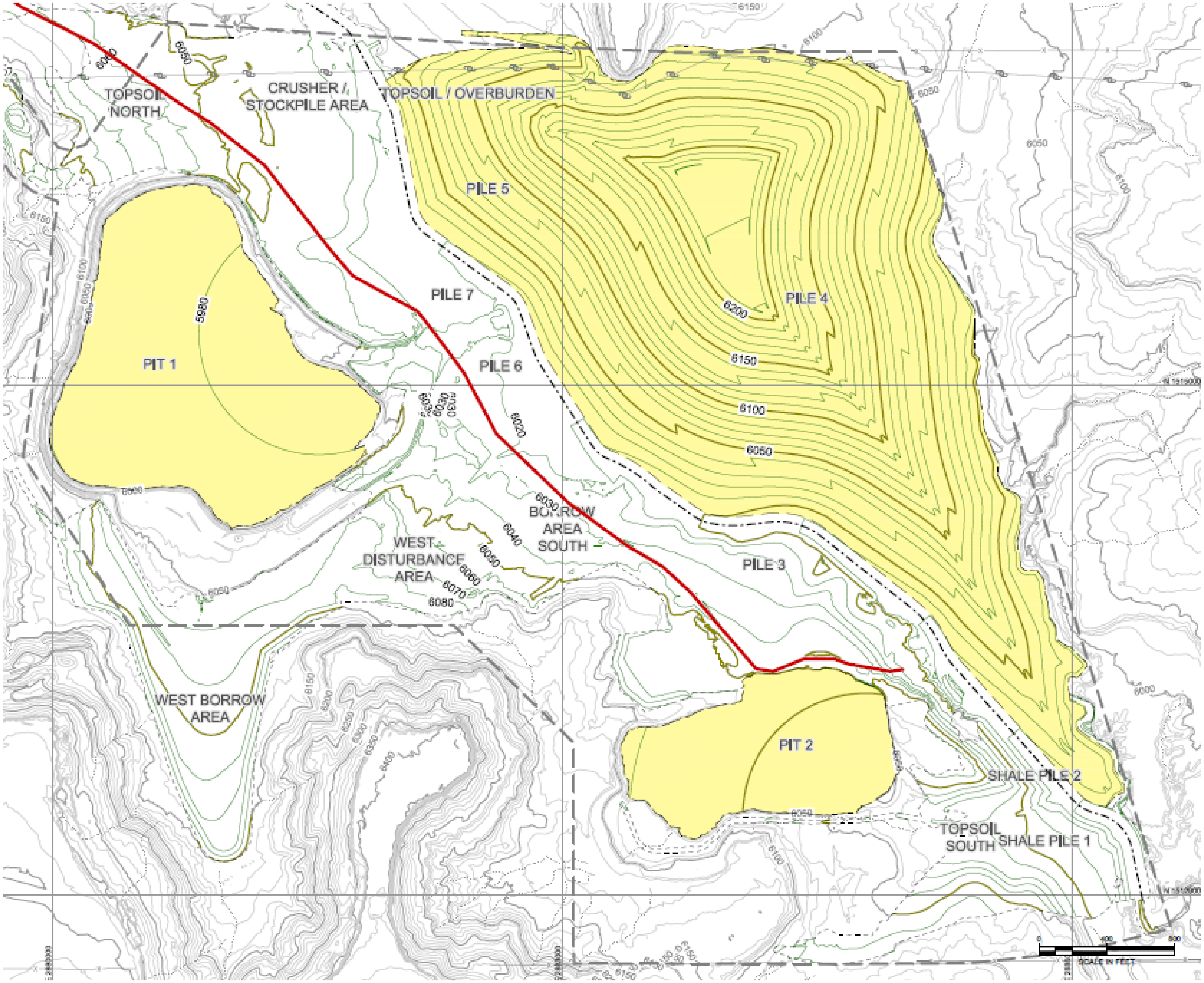


Figure 1. Pit 1, Pit 2, and Pile 4 Cover Slopes

ATTACHMENT F.2.1

FACTOR OF SAFETY CALCULATIONS

Client: GE/UNC
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_c (min)	T_c 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

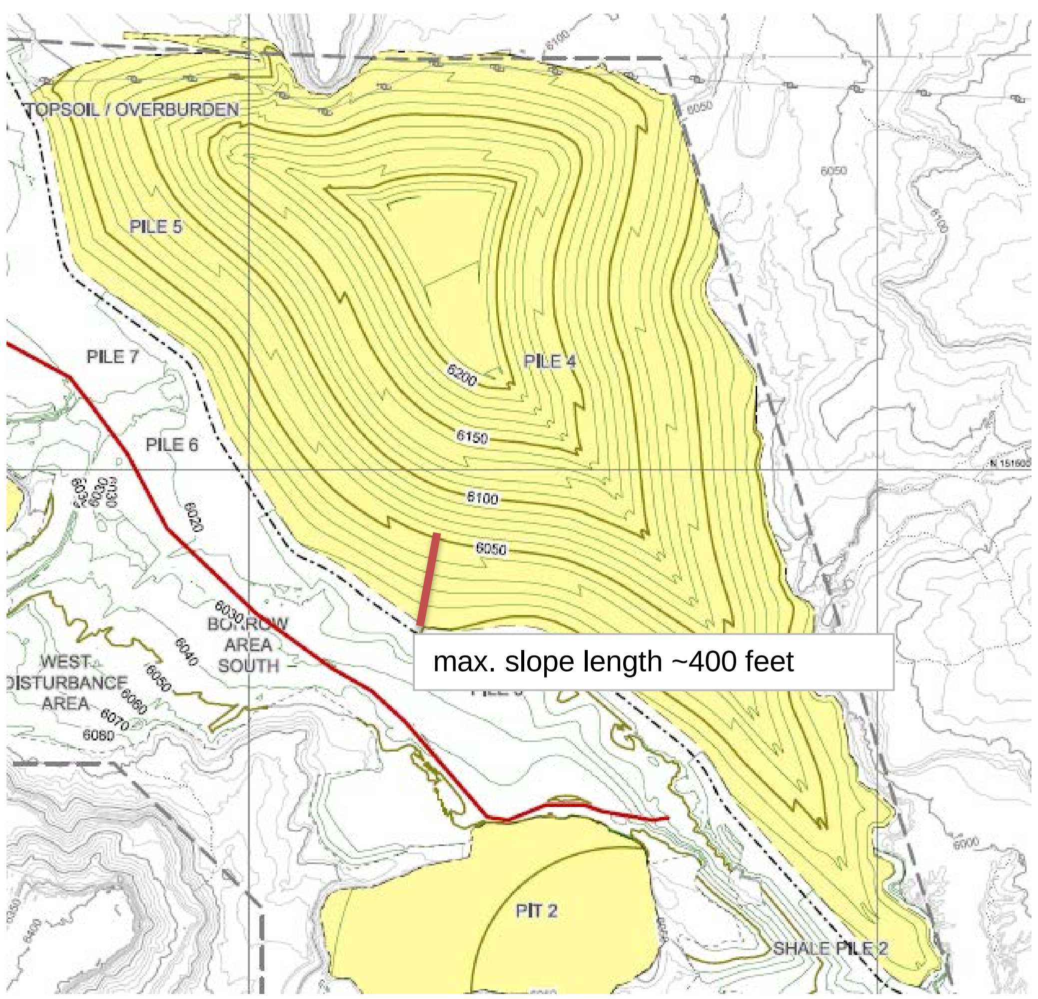
Source: Kirpich (1940) as presented in NUREG CR-4620

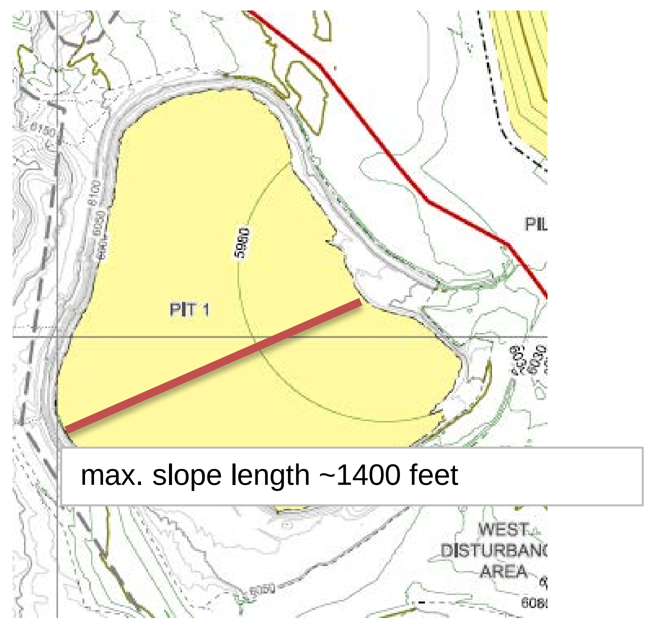
Formula: t_c=0.00013*L^0.77/S^0.385 with L in feet, t_c in hours

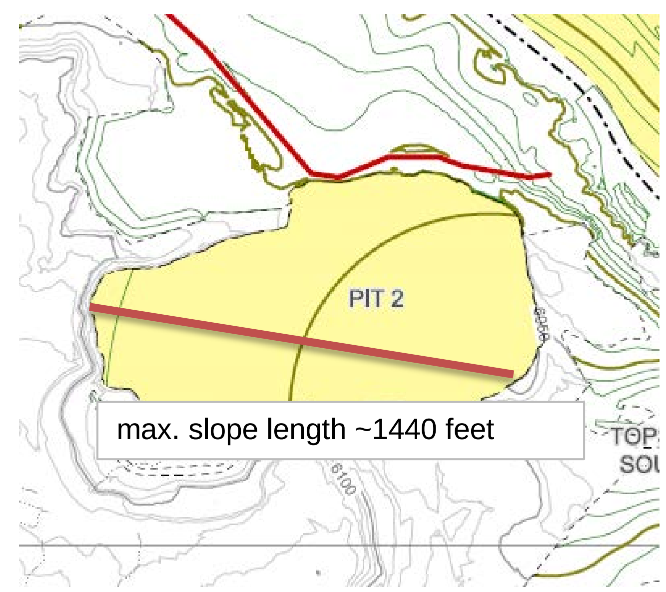
Minimum T_c = 2.5 minutes based on recommendation on pg. 12 of NUREG CR-4620 (Nelson et al., 1986)

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.







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
C	88.79	88.79	88.79
e	0.89	0.89	0.89
f	7.77	7.77	7.77
Intensity (in/hr) :	8.85	5.2	5.5

IDF Fitting	c	e	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 intensity (mm/hr)
T_d	=	The storm duration of the specific return period
c, e, f	=	Fitting parameters

Client: GE/UNC
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_c 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_c (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
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 Commision (NRC), 1990. Final Staff Technical Position Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites.. August 1990.

Client: GE/UNC
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)	Design geometry
0.200	Cover Surface Grade, S_0 (ft/ft)	Calculated from design geometry
11.3	Slope Angle, θ_0 (deg)	Calculated from design geometry
400	Original Slope Length, L_0 (ft)	Calculated from design geometry

Flow Characteristics

0.049	Design Flow (cfs/ft)	Calculated. DOE, 1989. Equation (3), page 66.
3	Concentration Factor, F	As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3.
0.147	Concentrated Design Flow, Q (cfs/ft)	Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Cover Soil Properties

10	Plasticity Index, PI	Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.
104.8	Dry Density (pcf)	Calculated from Proctor tests on samples from Lobo and West Borrow
2.65	Specific Gravity	Estimate
0.578	Calculated Void ratio	Calculated
0.004	Diameter for which 75% of the Material is Finer, d_{75} (in)	from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.5	Representative Stem Length, h_{stem} (ft)	Lower bound stem length for proposed cover vegetation, assumes poor establishment (see existing conditions photo right)
67	Representative Stem Density, M_{stem} (stems/ft^2)	Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with poor coverage selected to represent established cover vegetation.
0.375	Cover Factor, C_f	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, γ_w (pcf)	

CALCULATIONS

4.00	Retardance Curve Index, C_i	Calculated per Temple et. al., 1987. Equation 1.3
3.00	Allowable Shear Stress on Vegetation, t_{va} (psf)	Calculated per Temple et. al., 1987. Equation 1.17
0.0190	base allowable tractive shear stress (psf) t_{ab} (psf)	Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with $10 \leq PI \leq 20$
1.07	void ratio correction factor, C_e	Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML
0.0217	Allowable Shear Stress on Soil of Vegetated Slope, t_a (psf)	Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.
0.0156	Manning's coefficient for the soil particles, n_s	Per Temple et. al., 1987. For cohesive soils
0.1289	Manning's Coefficient for Vegetated Conditions, n	Calculated per Temple et. al., 1987. Equation 4.1a
0.119	Assumed Depth of Flow, d (ft)	Iterate d until q calculated equals q design
0.147	q (cfs/ft), with veg	q calculated
0.000	qcalc - qdesign	Iterate d until q calculated equals q design
1.24	Average Flow Velocity, V (ft/sec)	Calculated as q/d
0.0136	Effective Stress on the Soil, t_e (psf)	Calculated per Temple et. al., 1987. Equation 4.3a
1.47	Effective Stress on the Vegetation, t_{ve} (psf)	Calculated per Temple et. al., 1987. Equation 4.9a
1.6	**Ratio of Allowable Stress to Effective Stress on Soil, FS_{soil}**	Calculated
2.0	**Ratio of Allowable Stress to Effective Stress on Veg., FS_{veg}**	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, Agriculture Handbook 667.
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 Commision (NRC), 2002. Design of Erosion Protection for Long-Term Stabilization; NUREG-1623. September 2002.

Client: GE/UNC
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)	Design geometry
0.200	Cover Surface Grade, S_0 (ft/ft)	Calculated from design geometry
11.3	Slope Angle, θ_0 (deg)	Calculated from design geometry
400	Original Slope Length, L_0 (ft)	Calculated from design geometry

Flow Characteristics

0.049	Design Flow (cfs/ft)	Calculated. DOE, 1989. Equation (3), page 66.
3	Concentration Factor, F	As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3.
0.147	Concentrated Design Flow, Q (cfs/ft)	Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Cover Soil Properties

10	Plasticity Index, PI	Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.
104.8	Dry Density (pcf)	Calculated from Proctor tests on samples from Lobo and West Borrow
2.65	Specific Gravity	Estimate
0.578	Calculated Void ratio	Calculated
0.004	Diameter for which 75% of the Material is Finer, d_{75} (in)	from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.75	Representative Stem Length, h_{stem} (ft)	Stem length for proposed cover vegetation, assumes fair establishment
133	Representative Stem Density, M_{stem} (stems/ft^2)	Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with fair coverage selected to represent established cover vegetation.
0.6	Cover Factor, C_f	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, γ_w (pcf)	

CALCULATIONS

5.13	Retardance Curve Index, C_i	Calculated per Temple et. al., 1987. Equation 1.3
3.85	Allowable Shear Stress on Vegetation, t_{va} (psf)	Calculated per Temple et. al., 1987. Equation 1.17
0.0190	base allowable tractive shear stress (psf) t_{ab} (psf)	Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with $10 \leq PI \leq 20$
1.07	void ratio correction factor, C_e	Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML
0.0217	Allowable Shear Stress on Soil of Vegetated Slope, t_a (psf)	Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.
0.0156	Manning's coefficient for the soil particles, n_s	Per Temple et. al., 1987. For cohesive soils
0.2351	Manning's Coefficient for Vegetated Conditions, n	Calculated per Temple et. al., 1987. Equation 4.1a
0.170	Assumed Depth of Flow, d (ft)	Iterate d until q calculated equals q design
0.147	q (cfs/ft), with veg	q calculated
0.000	qcalc - qdesign	Iterate d until q calculated equals q design
0.87	Average Flow Velocity, V (ft/sec)	Calculated as q/d
0.0037	Effective Stress on the Soil, t_e (psf)	Calculated per Temple et. al., 1987. Equation 4.3a
2.12	Effective Stress on the Vegetation, t_{ve} (psf)	Calculated per Temple et. al., 1987. Equation 4.9a
5.8	**Ratio of Allowable Stress to Effective Stress on Soil, FS_{soil}**	Calculated
1.8	**Ratio of Allowable Stress to Effective Stress on Veg., FS_{veg}**	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, Agriculture Handbook 667.
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 Commision (NRC), 2002. Design of Erosion Protection for Long-Term Stabilization; NUREG-1623. September 2002.

Client: GE/UNC
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)	Design geometry
0.010	Cover Surface Grade, S_0 (ft/ft)	Calculated from design geometry
0.6	Slope Angle, θ_0 (deg)	Calculated from design geometry
1400	Original Slope Length, L_0 (ft)	Calculated from design geometry

Flow Characteristics

0.101	Design Flow (cfs/ft)	Calculated. DOE, 1989. Equation (3), page 66.
3	Concentration Factor, F	As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3.
0.3038	Concentrated Design Flow, Q (cfs/ft)	Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Cover Soil Properties

10	Plasticity Index, PI	Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.
108.6	Dry Density (pcf)	Calculated from Proctor tests on samples from Lobo and West Borrow
2.65	Specific Gravity	Estimate
0.523	Calculated Void ratio	Calculated
0.005	Diameter for which 75% of the Material is Finer, d_{75} (in)	from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.5	Representative Stem Length, h_{stem} (ft)	Lower bound stem length for proposed cover vegetation, assumes poor establishment (see existing conditions photo right)
67	Representative Stem Density, M_{stem} (stems/ft^2)	Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with poor coverage selected to represent established cover vegetation.
0.375	Cover Factor, C_f	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, γ_w (pcf)	

CALCULATIONS

4.00	Retardance Curve Index, C_i	Calculated per Temple et. al., 1987. Equation 1.3
3.00	Allowable Shear Stress on Vegetation, t_{va} (psf)	Calculated per Temple et. al., 1987. Equation 1.17
0.0190	base allowable tractive shear stress (psf) t_{ab} (psf)	Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with $10 \leq PI \leq 20$
1.10	void ratio correction factor, C_e	Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML
0.0231	Allowable Shear Stress on Soil of Vegetated Slope, t_a (psf)	Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.
0.0156	Manning's coefficient for the soil particles, n_s	Per Temple et. al., 1987. For cohesive soils
0.0868	Manning's Coefficient for Vegetated Conditions, n	Calculated per Temple et. al., 1987. Equation 4.1a
0.354	Assumed Depth of Flow, d (ft)	Iterate d until q calculated equals q design
0.304	q (cfs/ft), with veg	q calculated
0.000	qcalc - qdesign	Iterate d until q calculated equals q design
0.86	Average Flow Velocity, V (ft/sec)	Calculated as q/d
0.0045	Effective Stress on the Soil, t_e (psf)	Calculated per Temple et. al., 1987. Equation 4.3a
0.22	Effective Stress on the Vegetation, t_{ve} (psf)	Calculated per Temple et. al., 1987. Equation 4.9a
5.2	**Ratio of Allowable Stress to Effective Stress on Soil, FS_{soil}**	Calculated
13.8	**Ratio of Allowable Stress to Effective Stress on Veg., FS_{veg}**	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, Agriculture Handbook 667.
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 Commision (NRC), 2002. Design of Erosion Protection for Long-Term Stabilization; NUREG-1623. September 2002.

Client: GE/UNC
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)	Design geometry
0.010	Cover Surface Grade, S_0 (ft/ft)	Calculated from design geometry
0.6	Slope Angle, θ_0 (deg)	Calculated from design geometry
1400	Original Slope Length, L_0 (ft)	Calculated from design geometry

Flow Characteristics

0.101	Design Flow (cfs/ft)	Calculated. DOE, 1989. Equation (3), page 66.
3	Concentration Factor, F	As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3.
0.3038	Concentrated Design Flow, Q (cfs/ft)	Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Cover Soil Properties

10	Plasticity Index, PI	Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.
108.6	Dry Density (pcf)	Calculated from Proctor tests on samples from Lobo and West Borrow
2.65	Specific Gravity	Estimate
0.523	Calculated Void ratio	Calculated
0.005	Diameter for which 75% of the Material is Finer, d_{75} (in)	from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.75	Representative Stem Length, h_{stem} (ft)	Stem length for proposed cover vegetation, assumes fair establishment
133	Representative Stem Density, M_{stem} (stems/ft^2)	Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with fair coverage selected to represent established cover vegetation.
0.6	Cover Factor, C_f	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, γ_w (pcf)	

CALCULATIONS

5.13	Retardance Curve Index, C_i	Calculated per Temple et. al., 1987. Equation 1.3
3.85	Allowable Shear Stress on Vegetation, t_{va} (psf)	Calculated per Temple et. al., 1987. Equation 1.17
0.0190	base allowable tractive shear stress (psf) t_{ab} (psf)	Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with $10 \leq PI \leq 20$
1.10	void ratio correction factor, C_e	Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML
0.0231	Allowable Shear Stress on Soil of Vegetated Slope, t_a (psf)	Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.
0.0156	Manning's coefficient for the soil particles, n_s	Per Temple et. al., 1987. For cohesive soils
0.1416	Manning's Coefficient for Vegetated Conditions, n	Calculated per Temple et. al., 1987. Equation 4.1a
0.475	Assumed Depth of Flow, d (ft)	Iterate d until q calculated equals q design
0.304	q (cfs/ft), with veg	q calculated
0.000	qcalc - qdesign	Iterate d until q calculated equals q design
0.64	Average Flow Velocity, V (ft/sec)	Calculated as q/d
0.0014	Effective Stress on the Soil, t_e (psf)	Calculated per Temple et. al., 1987. Equation 4.3a
0.30	Effective Stress on the Vegetation, t_{ve} (psf)	Calculated per Temple et. al., 1987. Equation 4.9a
16.0	**Ratio of Allowable Stress to Effective Stress on Soil, FS_{soil}**	Calculated
13.0	**Ratio of Allowable Stress to Effective Stress on Veg., FS_{veg}**	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, Agriculture Handbook 667.
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 Commision (NRC), 2002. Design of Erosion Protection for Long-Term Stabilization; NUREG-1623. September 2002.

Client: GE/UNC
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)	Design geometry
0.015	Cover Surface Grade, S_0 (ft/ft)	Calculated from design geometry
0.9	Slope Angle, θ_0 (deg)	Calculated from design geometry
1440	Original Slope Length, L_0 (ft)	Calculated from design geometry

Flow Characteristics

0.111	Design Flow (cfs/ft)	Calculated. DOE, 1989. Equation (3), page 66.
3	Concentration Factor, F	As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3.
0.3329	Concentrated Design Flow, Q (cfs/ft)	Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Cover Soil Properties

10	Plasticity Index, PI	Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.
108.6	Dry Density (pcf)	Calculated from Proctor tests on samples from Lobo and West Borrow
2.65	Specific Gravity	Estimate
0.523	Calculated Void ratio	Calculated
0.005	Diameter for which 75% of the Material is Finer, d_{75} (in)	from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.5	Representative Stem Length, h_{stem} (ft)	Lower bound stem length for proposed cover vegetation, assumes poor establishment (see existing conditions photo right)
67	Representative Stem Density, M_{stem} (stems/ft^2)	Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with poor coverage selected to represent established cover vegetation.
0.375	Cover Factor, C_f	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, γ_w (pcf)	

CALCULATIONS

4.00	Retardance Curve Index, C_i	Calculated per Temple et. al., 1987. Equation 1.3
3.00	Allowable Shear Stress on Vegetation, t_{va} (psf)	Calculated per Temple et. al., 1987. Equation 1.17
0.0190	base allowable tractive shear stress (psf) t_{ab} (psf)	Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with $10 \leq PI \leq 20$
1.10	void ratio correction factor, C_e	Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML
0.0231	Allowable Shear Stress on Soil of Vegetated Slope, t_a (psf)	Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.
0.0156	Manning's coefficient for the soil particles, n_s	Per Temple et. al., 1987. For cohesive soils
0.0829	Manning's Coefficient for Vegetated Conditions, n	Calculated per Temple et. al., 1987. Equation 4.1a
0.323	Assumed Depth of Flow, d (ft)	Iterate d until q calculated equals q design
0.333	q (cfs/ft), with veg	q calculated
0.000	qcalc - qdesign	Iterate d until q calculated equals q design
1.03	Average Flow Velocity, V (ft/sec)	Calculated as q/d
0.0067	Effective Stress on the Soil, t_e (psf)	Calculated per Temple et. al., 1987. Equation 4.3a
0.30	Effective Stress on the Vegetation, t_{ve} (psf)	Calculated per Temple et. al., 1987. Equation 4.9a
3.5	**Ratio of Allowable Stress to Effective Stress on Soil, FS_{soil}**	Calculated
10.2	**Ratio of Allowable Stress to Effective Stress on Veg., FS_{veg}**	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, Agriculture Handbook 667.
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 Commision (NRC), 2002. Design of Erosion Protection for Long-Term Stabilization; NUREG-1623. September 2002.

Client: GE/UNC
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

TEMPLE METHOD FOR EROSION OF VEGETATED SLOPES

Notes:

Slope Geometry

100	Top Slope, (Xhoriz:1.5vert)	Design geometry
0.015	Cover Surface Grade, S_0 (ft/ft)	Calculated from design geometry
0.9	Slope Angle, θ_0 (deg)	Calculated from design geometry
1440	Original Slope Length, L_0 (ft)	Calculated from design geometry

Flow Characteristics

0.111	Design Flow (cfs/ft)	Calculated. DOE, 1989. Equation (3), page 66.
3	Concentration Factor, F	As recommended in NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 3.
0.3329	Concentrated Design Flow, Q (cfs/ft)	Calculated per NUREG-1623 (NRC, 2002); Appendix A, Page A-7, Step 5.

Cover Soil Properties

10	Plasticity Index, PI	Two Atterberg Limits from Lobo indicate 17 and 22, one other NP, none from WB.
108.6	Dry Density (pcf)	Calculated from Proctor tests on samples from Lobo and West Borrow
2.65	Specific Gravity	Estimate
0.523	Calculated Void ratio	Calculated
0.005	Diameter for which 75% of the Material is Finer, d_{75} (in)	from particle-size for Lobo and Borrow West, median from 15 results

Vegetation

0.75	Representative Stem Length, h_{stem} (ft)	Stem length for proposed cover vegetation, assumes fair establishment
133	Representative Stem Density, M_{stem} (stems/ft^2)	Temple et. al., 1987. page: 44 Table 3.1. Grass mixture with fair coverage selected to represent established cover vegetation.
0.6	Cover Factor, C_f	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, γ_w (pcf)	

CALCULATIONS

5.13	Retardance Curve Index, C_i	Calculated per Temple et. al., 1987. Equation 1.3
3.85	Allowable Shear Stress on Vegetation, t_{va} (psf)	Calculated per Temple et. al., 1987. Equation 1.17
0.0190	base allowable tractive shear stress (psf) t_{ab} (psf)	Per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML with $10 \leq PI \leq 20$
1.10	void ratio correction factor, C_e	Calculated per Temple et. al., 1987. Table 3.3, Page 47. For cohesive soils, ML
0.0231	Allowable Shear Stress on Soil of Vegetated Slope, t_a (psf)	Calculated per Temple et. al., 1987. Eqn 3.1, Page 43.
0.0156	Manning's coefficient for the soil particles, n_s	Per Temple et. al., 1987. For cohesive soils
0.1335	Manning's Coefficient for Vegetated Conditions, n	Calculated per Temple et. al., 1987. Equation 4.1a
0.429	Assumed Depth of Flow, d (ft)	Iterate d until q calculated equals q design
0.333	q (cfs/ft), with veg	q calculated
0.000	qcalc - qdesign	Iterate d until q calculated equals q design
0.78	Average Flow Velocity, V (ft/sec)	Calculated as q/d
0.0022	Effective Stress on the Soil, t_e (psf)	Calculated per Temple et. al., 1987. Equation 4.3a
0.40	Effective Stress on the Vegetation, t_{ve} (psf)	Calculated per Temple et. al., 1987. Equation 4.9a
10.5	**Ratio of Allowable Stress to Effective Stress on Soil, FS_{soil}**	Calculated
9.6	**Ratio of Allowable Stress to Effective Stress on Veg., FS_{veg}**	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, Agriculture Handbook 667.
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 Commision (NRC), 2002. Design of Erosion Protection for Long-Term Stabilization; NUREG-1623. September 2002.

Appendix G AGRONOMIC DATA

CEDAR CREEK ASSOCIATES, INC.
5586 Overhill Dr. Fort Collins, Colorado 80526 (970) 223-0775

Cedar Creek Technical Report

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 26th through April 17th 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 pre-determined 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.

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 Laboratory Results - Suitability 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_3-N	4D6*	> 0.1+	ppm
Phosphorus (P)	4D6*	> 1+	ppm
Potassium (K)	4D6*	> 20+	ppm
Zinc (Zn)	4D6*	> 0.25+	ppm
Iron (Fe)	4D6*	> 1.0+	ppm
Manganese (Mn)	4D6*	> 0.1+	ppm
Copper (Cu)	4D6*	> 0.1+	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

* Soil Survey 2014 as Reference + Values Can Be Increased Through OM Additions

* EC > 6 excludes use as surficial growth media unless mixed. EC between 3-6 requires special consideration in the reclamation plan.

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.

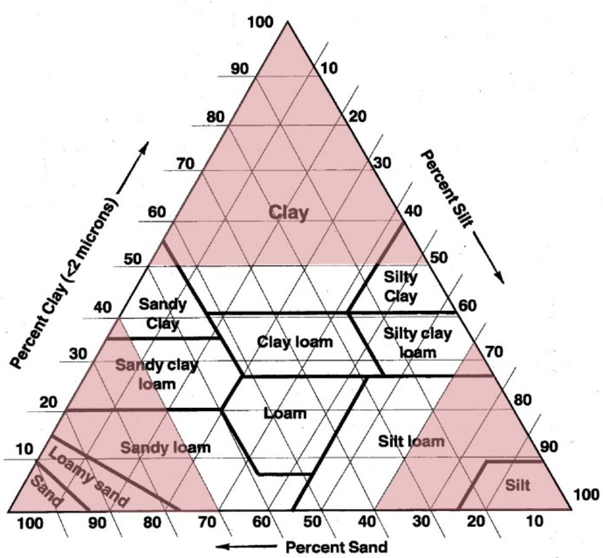


Figure 1: – Soil texture triangle, with unsuitable textural classes highlighted in red.

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 Mine - Soil and Geologic Materials Characterization
South Borrow

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	Paste pH	Paste EC mmhos/cm	Lime Estimate	% Organic Matter	ppm NO_3-N	ppm P	ppm K	ppm Zn	ppm Fe	ppm Mn	ppm 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

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	meq/L Ca	meq/L Mg	meq/L Na	meq/L 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	Sandy Clay Loam
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	Sandy Clay Loam
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	Sandy Clay Loam
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

* = Below Reporting Limits
+ Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed
+ Values in orange are moderately elevated, and may require special consideration in the reclamation plan

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.

Table 3 St. Anthony Mine - Soil and Geologic Materials Characterization
West Borrow

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	Paste pH	Paste EC mmhos/cm	Lime Estimate	% Organic Matter	ppm NO_3-N	ppm P	ppm K	ppm Zn	ppm Fe	ppm Mn	ppm 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 Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	meq/L Ca	meq/L Mg	meq/L Na	meq/L K	SAR	% Sand	% Silt	% Clay	Texture
R2829	BW-1	0	35	3.1	0.2	2.8	4.7	0.80	49	20	31	Sandy Clay Loam
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	Sandy Clay Loam
Average				9.4	1.2	4.9	4.8	1.18	45	24	31	Clay Loam

*= Below Reporting Limits

+ Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed

+ Values in orange are moderately elevated, and may require special consideration in the reclamation plan

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.

Table 4 St. Anthony Mine - Soil and Geologic Materials Characterization
Lobo Tract Borrow

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	Paste pH	Paste EC mmhos/cm	Lime Estimate	% Organic Matter	ppm NO_3-N	ppm P	ppm K	ppm Zn	ppm Fe	ppm Mn	ppm 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

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	meq/L Ca	meq/L Mg	meq/L Na	meq/L 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	Sandy Clay Loam
R2595	L1-1	10	15	9.1	0.5	2.9	4.0	0.88	48	20	32	Sandy Clay Loam
R2596	L1-1	15	20	5.5	0.3	2.0	3.4	0.77	60	19	21	Sandy Clay Loam
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
R2604	L2-5	0	10	30.2	2.1	4.6	6.0	0.83	28	28	44	Clay
R2605	L2-5	10	20	25.3	1.6	5.0	8.8	0.92	24	22	54	Clay
R2602	L2-6	7	10	37.8	1.1	16.6	14.7	2.38	26	20	54	Clay
R2603	L2-6	11	13	21.6	0.6	7.2	10.8	1.24	14	22	64	Clay
R2606	L2-7	0	10	19.7	2.5	7.1	3.7	1.39	60	19	21	Sandy Clay Loam
R2607	L2-7	10	20	24.4	1.2	8.0	9.1	1.33	52	26	22	Sandy Clay Loam
Average				27.8	1.6	9.8	10.9	1.50	44	21	34	Clay Loam

*= Below Reporting Limits
+ Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed
+ Values in orange are moderately elevated, and may require special consideration in the reclamation plan

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 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, 2, 3, 4, and 7

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	Paste pH	Paste EC mmhos/cm	Lime Estimate	% Organic Matter	ppm NO_3-N	ppm P	ppm K	ppm Zn	ppm Fe	ppm Mn	ppm Cu
R2586	P1-2	60	65	4.2	9.8	low	1.2	0.08	2.93	88.38	6.36	187.20	32.90	3.92
R2587	P2-1	25	30	4.2	4.6	low	1.1	<0.1	4.14	136.80	2.29	153.30	15.69	4.99
R2590	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
R2588	P3-4	0	25	6.2	2.5	low	0.4	0.39	2.10	34.31	0.86	11.72	1.30	3.80
R2589	P3-4	35	40	5.8	4.1	low	0.7	<0.1	4.13	50.71	0.51	44.53	4.90	2.04
R2585	P4 (white sand)	0	1	8.2	42.1	low	0.8	60.40	1.43	94.48	0.32	5.15	0.20	0.77
R2833	P4-5	0	1	7.9	10.7	high	0.9	0.07	2.30	44.70	3.70	61.00	27.60	1.60
R2834	P4-7	0	1	6.9	1.3	low	0.2	0.30	1.60	66.70	0.23	6.70	4.10	0.42
R2835	P4-9	0	1	7.5	3.6	medium	0.4	<0.1	2.00	19.90	0.20	2.70	1.10	0.54
R2836	P7-1	0	1	7.6	4.8	high	0.4	0.07	1.00	68.50	0.16	5.00	0.97	1.00

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	meq/L Ca	meq/L Mg	meq/L Na	meq/L K	SAR	% Sand	% Silt	% Clay	Texture
R2586	P1-2	60	65	219.8	37.8	105.9	51.3	4.70	66	10	24	Sandy Clay Loam
R2587	P2-1	25	30	201.6	13.1	54.7	9.6	3.68	58	12	30	Sandy Clay Loam
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	1	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	Sandy Clay Loam
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)
*= Below Reporting Limits
+ Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed
+ Values in orange are moderately elevated, and may require special consideration in the reclamation plan

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.

Table 6 St. Anthony Mine - Soil and Geologic Materials Characterization
North and South Topsoil Piles

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	Paste pH	Paste EC mmhos/cm	Lime Estimate	% Organic Matter	ppm NO3-N	ppm P	ppm K	ppm Zn	ppm Fe	ppm Mn	ppm 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 Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	meq/L Ca	meq/L Mg	meq/L Na	meq/L 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	Sandy Clay Loam
R2622	TS-3	25	30	22.3	2.0	11.9	7.1	1.61	68	6	26	Sandy Clay Loam
R2623	TS-4	0	10	25.1	1.3	8.3	5.7	1.37	70	8	22	Sandy Clay Loam
R2624	TS-4	10	20	26.6	1.6	9.4	7.0	1.51	68	11	21	Sandy Clay Loam

*= Below Reporting Limits

+ Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed

+ Values in orange are moderately elevated, and may require special consideration in the reclamation plan

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 ($CaSO_4$) 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.

Table 7 St. Anthony Mine - Soil and Geologic Materials Characterization
Topsoil / Overburden Pile

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	Paste pH	Paste EC mmhos/cm	Lime Estimate	% Organic Matter	ppm NO_3-N	ppm P	ppm K	ppm Zn	ppm Fe	ppm Mn	ppm 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	T/O-4	0	10	7.7	2.7	very high	0.8	3.60	1.51	168.70	0.20	10.11	2.88	1.13
R2578	T/O-4	30	40	7.8	4.1	very high	0.8	8.60	1.88	148.40	1.16	8.99	2.93	5.22
R2579	T/O-5	0	5	7.8	4.0	high	0.7	7.50	2.30	101.20	0.10	2.91	0.49	0.87
R2580	T/O-5	5	10	7.8	3.7	high	0.7	13.50	2.53	102.50	0.13	3.81	0.67	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	0.20	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

Laboratory Sample ID	Client Sample ID	Top Depth (ft)	Bottom Depth (ft)	meq/L Ca	meq/L Mg	meq/L Na	meq/L 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	50	24.6	13.4	9.0	0.6	2.07	40	30	30	Clay Loam
R2561	T/O-1	70	90	12.5	12.4	6.7	0.4	1.90	60	20	21	Sandy Clay Loam
R2576	T/O-2	0	20	27.3	2.1	8.5	9.4	1.32	36	24	40	Clay
R2625	T/O (shale)	0	1	28.7	1.8	4.8	0.4	0.90	16	34	50	Clay
R2562	T/O-3	0	5	24.6	0.9	7.0	7.7	1.20	52	26	22	Sandy Clay Loam
R2563	T/O-3	5	10	24.9	0.9	8.0	8.4	1.33	46	24	30	Sandy Clay Loam
R2564	T/O-3	10	15	25.9	1.1	8.2	9.8	1.34	34	30	36	Clay Loam
R2565	T/O-3	15	20	25.9	1.2	7.9	7.5	1.32	44	26	30	Clay Loam
R2566	T/O-3	20	25	11.8	0.8	5.8	6.7	1.38	58	20	22	Sandy Clay Loam
R2567	T/O-3	25	30	18.0	0.6	7.9	9.8	1.42	56	20	24	Sandy Clay Loam
R2568	T/O-3	30	35	26.4	1.4	7.7	9.2	1.28	40	28	32	Clay Loam
R2569	T/O-3	35	40	25.4	1.2	8.0	9.3	1.32	42	28	30	Clay Loam
R2570	T/O-3	40	45	25.3	1.6	7.9	8.3	1.31	36	30	34	Clay Loam
R2571	T/O-3	50	55	23.1	1.5	8.8	7.0	1.46	64	12	24	Sandy Clay Loam
R2572	T/O-3	55	60	29.8	1.4	8.5	8.1	1.33	48	24	28	Sandy Clay Loam
R2573	T/O-3	65	70	27.3	1.7	8.5	10.3	1.32	48	26	26	Sandy Clay Loam
R2574	T/O-3	70	75	23.6	1.2	7.9	6.8	1.35	54	24	22	Sandy Clay Loam
R2575	T/O-3	75	80	14.1	2.1	4.5	1.4	1.31	70	18	12	Sandy Loam
R2577	T/O-4	0	10	26.2	4.7	8.2	10.8	1.29	32	28	40	Clay
R2578	T/O-4	30	40	24.8	1.8	8.3	6.8	1.37	58	20	22	Sandy Clay Loam
R2579	T/O-5	0	5	25.0	1.5	8.3	9.1	1.36	56	20	24	Sandy Clay Loam
R2580	T/O-5	5	10	21.9	3.1	8.1	6.7	1.44	64	16	21	Sandy Clay Loam
R2581	T/O-5	10	15	25.3	1.3	9.0	8.6	1.42	60	16	24	Sandy Clay Loam
R2582	T/O-5	15	20	22.7	1.2	8.6	7.3	1.43	58	20	22	Sandy Clay Loam
R2583	T/O-5	20	25	24.0	0.7	7.7	7.8	1.32	64	12	24	Sandy Clay Loam
R2584	T/O-5	25	29	25.6	1.4	7.2	6.1	1.28	60	20	21	Sandy Clay Loam
	Average			23.7	2.8	7.7	6.8	1.39	49	23	27	Sandy Clay Loam

* = Below Reporting Limits
+ Values in red are sufficiently elevated to be excluded as surficial growth media unless mixed
+ Values in orange are moderately elevated, and may require special consideration in the reclamation plan

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 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 Alluvium
Lobo Tract	3	Cover / Planting Media	24 inches	Topsoil Alluvium
Borrow South	4	Cover / Planting Media	24 inches	Topsoil Alluvium
Topsoil / Overburden Pile	5	Cover / Planting Media (on < 10% slopes) Subsoil / Rooting Media	24-36 inches	Topsoil Alluvium Shale Coal Gypsum Precipitates
South Topsoil Pile	6	Subsoil / Rooting Media	N / A	Topsoil Alluvium White Saline Sandstone 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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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	BMP's
Cedar Creek Associates, Inc.	Cedar Creek
Mining Act Reclamation Program	MARP
New Mexico Mining and Minerals Division	NMMMD
Post-Mining Land Use	PMLU
United Nuclear Corporation	UNC
Western Regional Climate Center	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

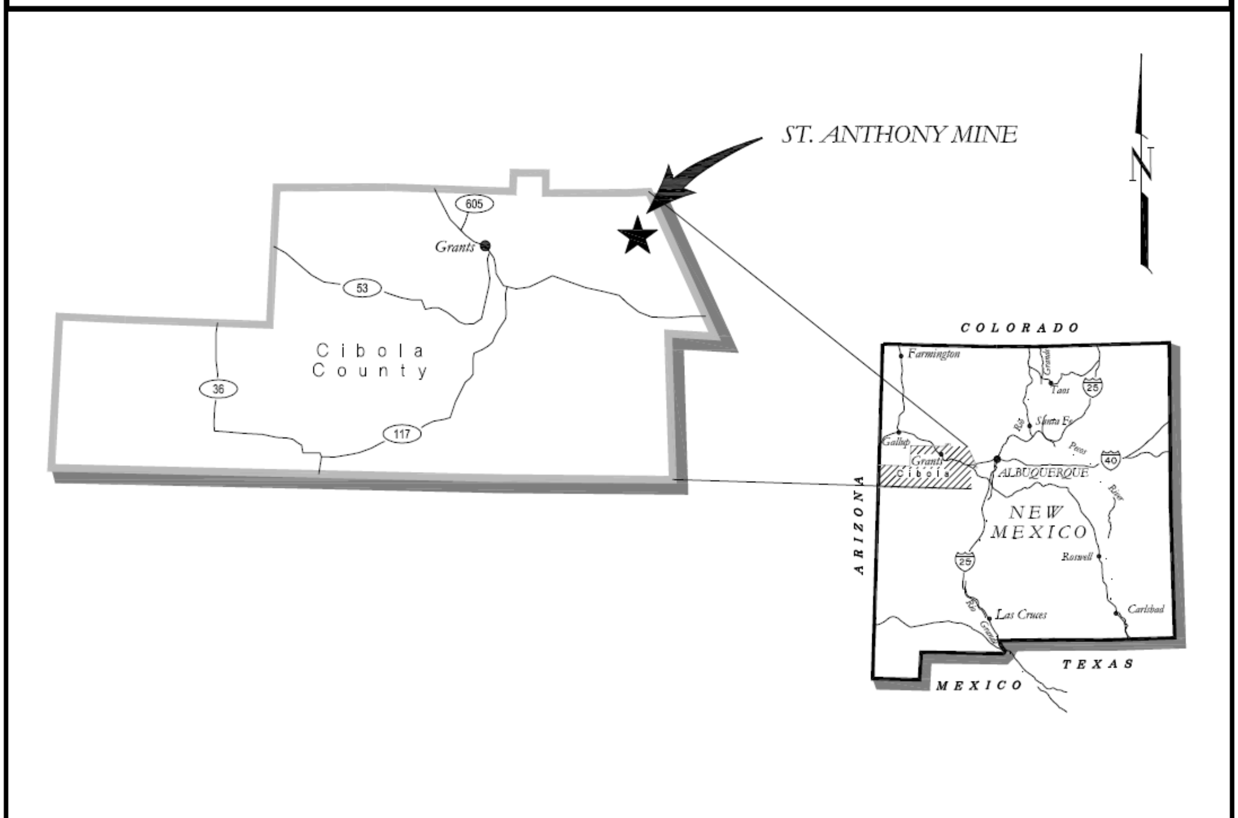
A basic framework for all reclamation including soil/growth media considerations, seeding considerations, and proposed amendments can be established for the entirety of the project. Site-specific considerations in addition to this framework can be applied or adjusted in the future to meet site-specific 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.

Map 1 - St. Anthony Mine - Project Location



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.

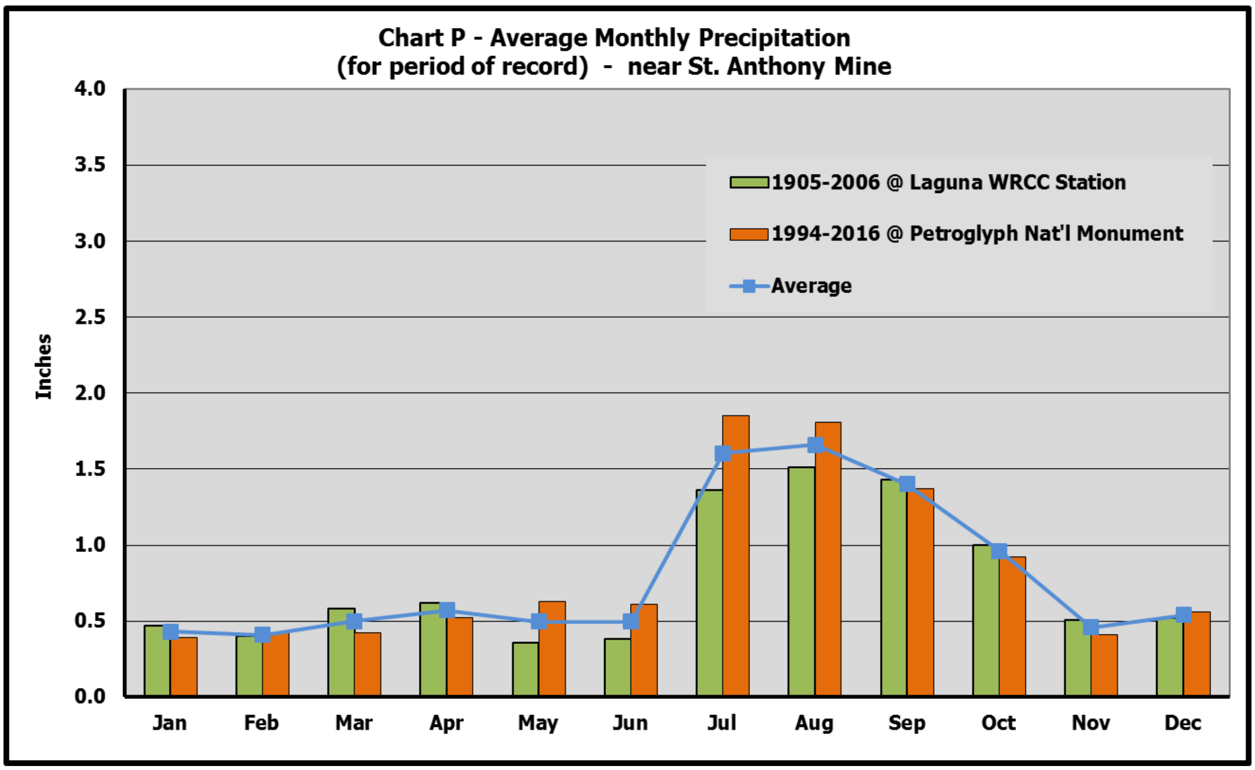
Grasslands are herbaceous communities dominated by grasses and occasional forbs that can sometimes be seasonally dominant. Trees and larger shrubs are largely absent from this type except for the occasional invader of local sites. Grasslands in this part of New Mexico may be dominated by annual grasses, 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 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_3-N	4D6*	> 0.1+	ppm
Phosphorus (P)	4D6*	> 1+	ppm
Potassium (K)	4D6*	> 20+	ppm
Zinc (Zn)	4D6*	> 0.25+	ppm
Iron (Fe)	4D6*	> 1.0+	ppm
Manganese (Mn)	4D6*	> 0.1+	ppm
Copper (Cu)	4D6*	> 0.1+	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

* Soil Survey 2014 as Reference + 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
				Alluvium
Lobo Tract	3	Cover / Planting Media	24 inches	Topsoil
				Alluvium
Borrow South	4	Cover / Planting Media	24 inches	Topsoil
				Alluvium
Topsoil / Overburden Pile	5	Cover / Planting Media (on < 10% slopes)	24-36 inches	Topsoil
				Alluvium
				Shale
		Subsoil / Rooting Media		Coal
				Gypsum Precipitates
South Topsoil Pile	6	Subsoil / Rooting Media	N / A	Topsoil
				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.

Table 3 St. Anthony Mine - Reclamation Plan - 2018

Reclamation Seed Mix

No.	Obs. On Site	Common Name	Scientific Nomenclature	PLS / lb.**	Recomd. PLS lbs / ac	PLS / ft^2	% of Seeds in Mix	Comment (Based on Site-specific Findings or Professional Judgment)
				Recommendations				This entire mix can be drill seeded
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	XX	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 Penstemon	*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 value
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 seeded

Alternative species which may be used as substitutes for tertiary species or added to the overall mix for additional diversity.

Group	Obs. On Site	Common Name	Scientific Nomenclature	PLS / lb.**	Recomd. PLS lbs / ac	PLS / ft^2	% of Seeds in Mix	Comment
Grasses	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.
Grasses	XX	New Mexico Needlegrass	*Stipa neomexicana*	70,000	0.00	0.0		
Grasses	XX	Purple three-awn	*Aristida purpurea*	250,000	0.00	0.0		
Forbs		Small Burnet	*Sanguisorba minor*	55,000	0.00	0.0		
Shrubs		Wyoming Big Sagebrush	*Artemisia tridentata wyo.*	2,500,000	0.00	0.0		
Shrubs		Rubber Rabbitbrush	*Chrysothamnus naseousus*	400,000	0.00	0.0		
Shrubs		Black Sagebrush	*Artemisia nova*	907,200	0.00	0.0		

Primary Species - Should not be substituted. (dark shading: nos. 1–4, 13)

Secondary Species - Substitute only when seed is not available. Substitutions should be: grass for grass, forb for forb, shrub for shrub. (light shading: nos. 5, 7, 9, 10, 14)

Tertiary Species - May be substituted, but recommendation is to plant as indicated.

* 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 bias-free 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.

1. 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.

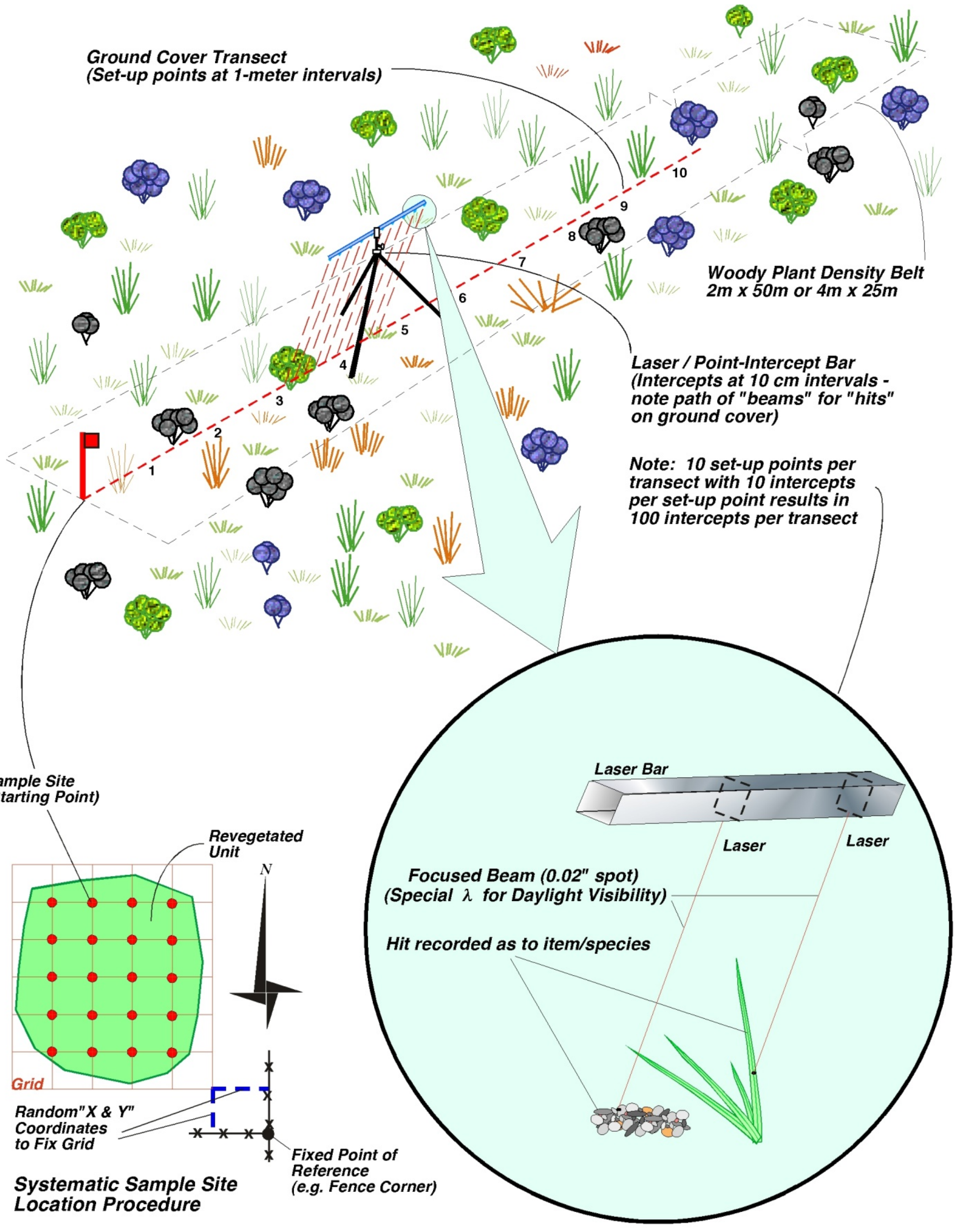


Figure 1

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 semi-quantitative 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^2 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^2 should be considered to be poor and a possible candidate for remediation. Efforts with 1 – 2 perennial emergents per ft^2 are considered to be fair, 2 - 3 perennial emergents per ft^2 are considered moderately good, 3 – 4 perennial emergents per ft^2 are considered to be good and 4 – 5 perennial emergents per ft^2 are considered to be very good. Finally, greater than five perennial emergents per ft^2 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. <u>Vegetative Ground Cover Criterion:</u>

   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. <u>Woody Plant Density Standard:</u>

   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 (μ) with 90% confidence. These limits facilitate a very strong estimate of the target population.

When the inequality ($n_{min} \leq n$) is true, sampling is adequate and nmin is determined as follows:

$$\boxed{n_{min} = (t^2 s^2) / (d\bar{x})^2}$$

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

$\bar{x}$ = 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 ($n_{min} \leq n$) 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.

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