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Area 9
Report 6063b

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Subject: **Coal Creek Crossing- Access Road Slope Stability, Healy, Alaska**
Final Geotechnical Exploration and Mitigation Recommendations

Dear Mr. Ireys:

This letter report presents the results of our field investigation, the results of laboratory soil testing, and our recommendations regarding slope stability mitigation for the access road near the Cripple Creek bridge. This work was completed as part of the Coal Creek Crossing design effort as maintaining the access road is critical to completion of the Coal Creek Crossing project and future mine reclamation efforts in the area.

INTRODUCTION

The Alaska Department of Natural Resources (DNR) made improvements to an existing mining road in 2020 to serve as access for reclamation efforts for abandoned coal mines in the area. The road improvement efforts were part of the Cripple Creek Crossing project (Project No. 52959-2). The mining road was likely constructed in the 1950's and had since been abandoned. Part of the improvements to the road included placing an estimated 2,000 to 4,000 cubic yards of fill on the downslope side of the road at approximately Stations 25+00 to 27+00 to widen the road for passage of large vehicles, trucks, and heavy equipment.

Immediately after the improvements were completed, a portion of the downslope below the road began to slump. The slump was monitored during 2020 to the fall of 2022. Slumping continued at a consistent pace until the fall of 2022 when it increased movement and deteriorated further due to heavy rainfall.

The location of the unstable slope is near Stations 24+00 to 27+50 of the Coal Cripple Creek Crossing project. The site location is shown in Figures A-1 and A-2 in Appendix A.

Scope of Work. DOWL was contracted to perform investigation and design work for the Coal Creek Crossing project in June of 2022. After a site visit was conducted for that project, it was determined that additional investigation and analysis was needed for the slope stability concern. An amendment to the Coal Creek Crossing project to perform additional geotechnical engineering services including drilling test borings, soil sampling, laboratory testing, geotechnical analysis, and report preparation was issued October 19, 2022.

FIELD EXPLORATION AND LABORATORY TESTING

Site Reconnaissance

A site reconnaissance focused on the Coal Creek Crossing project was conducted from September 14 through 15, 2022. The site visit crew consisted of three representatives from DOWL and two representatives from DNR. The purpose of the site reconnaissance was to observe the existing conditions and review the project design with DNR prior to commencing with the hydrologic analysis and the geotechnical field exploration. The slope failure location was visually inspected and initial observations recorded. During the site reconnaissance, it was agreed that if no problematic soils or conditions were encountered at the Coal Creek Crossing location and budget and schedule restraints allowed, preliminary geotechnical investigation would be conducted at the unstable slope location.

Preliminary Geotechnical Investigation

The Coal Creek Crossing geotechnical investigation was conducted from September 19 through September 21, 2022. Three test borings were conducted at the Coal Creek Crossing location and one test boring (Test Boring 4) was conducted at the unstable slope location. The investigation information, analysis, and recommendations related to the Coal Creek Crossing location are presented in a separate report.

The location of Test Boring 4 was selected based on logistical capabilities and at the suggestion of DNR while the geotechnical investigation was ongoing. The test boring was drilled on the top of the slope above the road where the slope failure had occurred. The purpose of this boring was to investigate groundwater conditions in the slope, depth to bedrock (if present), and material properties. Test Boring 4 was drilled to a depth of 70 feet which is approximately the access road’s elevation below the top of the slope. Other locations near or on the unstable slope were inaccessible with the drill rig available or required an excavator to create safe access down the slope face.

The initial test boring at the slope stability location (Test Boring 4) was drilled using a Mobile B80 mounted on a custom truck owned and operated by Wininger Drilling of Wasilla, Alaska. The test boring was advanced with the overburden drilling eccentric (ODEX) air rotary method. The drilling was supervised, and the samples logged by a geologist with our firm. The Modified Penetration Test (MPT) was performed in the test borings by driving a 2.5 inch inside-diameter, split-spoon sampler a distance of 24 inches ahead of the casing with a 340-pound auto-hammer falling 30 inches in general accordance with ASTM Standard Test method for Standard Penetration Test and Split-Barrel Sampling of Soils (D1586). The MPT is typically used in gravelly or frozen soils and yields a larger and more representative sample recovery in coarse grained soils. The N-values shown on the logs are raw data from the field and have not been adjusted for sampling equipment type or overburden pressure.

Slope Stability Geotechnical Investigation

The Slope Stability geotechnical investigation was conducted October 14 through October 16, 2022. The test borings were drilled using a Geoprobe 6712D rubber-mounted drill rig fitted with continuous-flight, hollow-stem auger. The rig is owned and operated by Discovery Drilling of Anchorage, Alaska. The drilling was supervised, and the samples logged by a geologist with our firm. Three test borings were conducted on the slope face to depths of 21.5 to 36.5 feet. The MPT test was performed for most of the samples with one sample collected with a Shelby tube.

The N-values shown on the logs are raw data from the field and have not been adjusted for sampling equipment type or overburden pressure.

Soil samples recovered during the drilling, excavation, and hand-sampling were visual-manually classified in the field in general accordance with ASTM D2488 and sealed in plastic bags to preserve their natural water content. The samples were transported to Alaska Testlab in Anchorage for further testing.

A slotted PVC standpipe was installed in all of the test borings and the depth to the groundwater was measured prior to leaving the site after drilling to allow the water levels to stabilize. No measurable groundwater was present in the standpipes at the time of the investigation. The PVC was left in place for future groundwater measurements.

Access paths and drilling pads on the slope face were created using a Caterpillar 320 excavator. The excavator is owned and operated by Greenstone Station of Fairbanks, Alaska. Two test pits were also conducted for the Coal Creek Crossing project and the results presented in the report for the crossing. Care was taken to disturb the slope only as much as needed to create access to the drilling locations. Upon completion of the drilling, the access path and pad materials were placed back against the slope as best as possible to promote surficial drainage and limit disturbance to the slope.

Drone imagery was collected of the unstable slope and an orthomosaic and photogrammetric surface model was generated.

No environmental testing or monitoring was conducted as a part of this investigation.

Laboratory Testing

Laboratory tests were performed on select samples to measure soil index properties. These properties provide a basis for estimating engineering properties. Soil testing included moisture content, grain-size analyses, and frost classification tests. Samples will be stored until January 2023, after which time they will be discarded unless other arrangements are made. Laboratory test results are presented on the graphic logs and within Appendix C.

<u>Moisture Content</u>. The natural moisture content of most recovered soil samples was determined in general accordance with ASTM D2216. The water contents are reported on the graphic test boring logs in Appendix B.

<u>Moisture-Density Relationship</u>. One moisture-density or modified Proctor test was performed in accordance with ASTM D1557. This was conducted on a bulk sample collected from the slide area to determine the maximum dry density of the fill and optimum moisture content.

<u>Particle-Size Distribution Tests</u>. Two particle distribution tests were performed in accordance with ASTM D6913. This test consisted of mechanical sieving and the results are presented in Appendix C.

<u>Limited Mechanical Analyses.</u> Fifteen limited mechanical analyses were performed on selected samples to supplement visual-manual classification in the field. This test is performed in general accordance with ASTM D1140 to determine the percentage of material finer than the #4 and

#200 screen generating percentages of gravel, sand, and silt-sized particles. The results are incorporated into the graphic test boring logs and are presented in Appendix C.

Frost Classification. One frost classification test was performed in accordance with ASTM D422. This test determines the percentage of particles finer than 0.02 mm which is an indicator of the frost susceptibility of the soils. The results are included on the graphic test boring logs and in Appendix C.

Atterberg Limits. Eight Atterberg Limits tests were performed in accordance with ASTM D4318, multipoint method A. The liquid limit, plastic limit, and plasticity index numbers obtained from the test are used to classify the soil fines as silts or clays. In addition, the limits can be used to estimate strength and settlement characteristics of soils. The results of the plasticity index tests are presented on the test boring logs in Appendix B.

Direct Shear. Three direct shear tests were performed in accordance with ASTM D3080 on selected material from the toe of the slope. The results of the tests can be used to estimate strength characteristics. The results of the direct shear tests are included in Appendix C.

Consolidated Undrained (CU) Triaxial Compression. Three CU tests were performed in general accordance with ASTM D4767 on remolded residual clay material. The results of tests can be used to estimate strength characteristics. The results are included in Appendix C.

SITE CONDITIONS

Regional Geology

The project is located on the outer extents of the Alaska Range with cliffs and canyons cut into the exposed outcrops of Tertiary aged sandstone, mudstone, claystone, coal-bearing sedimentary rocks, and weakly cemented gravel conglomerates. Regionally, outcrops of weakly cemented gravel and sand conglomerates to unconsolidated deposits, known as the Nenana Gravel, are present. The Nenana Gravel deposits, as well as alluvial and colluvial deposits which source material from the deposit, are generally composed of cobbles, gravel, sand, and varying amounts of silt. The access road and unconsolidated material within the unstable slope are largely composed of Nenana Gravel sourced material.

Surface Conditions

The access road traverses along the northeast side of an approximately 150-foot-tall ridge. The access road along the edge of the slope is approximately 3,200 feet long from the top of the ridge to the Cripple Creek crossing bridge. Cripple Creek is located along the northeast base of the slope approximately 100 vertical feet below the road and flows to the northwest before joining with Healy Creek just north of the Cripple Creek crossing bridge. The slope plateaus about 70 feet in elevation above the access road to the west of the unstable slope location. The material source for the fill placed on the slope is located on the top of the plateau of the slope approximately 1,500 feet to the south-southeast of the unstable slope location. An abandoned and overgrown road is present at the base of the fill slope which traverses parallel to Cripple Creek.

The unstable slope is lightly vegetated with grass. The surrounding slopes are vegetated with mature evergreen and deciduous trees, alders, and other shrubs and grasses. Several mature trees immediately below and in contact the existing fill are leaning or have bends in their trunks indicating periods when they were previously leaning. No leaning trees were observed downslope of the abandoned road elevation between the fill and Cripple Creek. Surficial drainage on the northeast side of the ridge is to the north-northwest along the access road and to the northeast down the unstable slope.

The unstable slope area is about 250 to 300 feet long as measured along the access road and slopes down about 60 feet over a horizontal distance of about 120 feet. At the time of the investigation the main scarp was approximately 8 feet tall at the highest point and approximately 270 feet long measured along the scarp. The main scarp is within approximately 16 feet of the left shoulder (upslope) of the access road at its narrowest point. Secondary tension cracks and bulges have formed downslope of the main scarp with visibly open cracks generally forming within about 60 feet downslope of the main scarp. An additional tension crack is present within the fill immediately downslope of the access road about 100 feet southeast of the main scarp.

Site photographs are included as Appendix E.

Subsurface Conditions
The soil descriptions, stratigraphy, and the classifications shown on the test boring logs are the geologist's and geotechnical engineer's interpretation of the field data and the results of the laboratory soil testing. The largest particle size that can be recovered with standard drill hole samplers is often smaller than the maximum particle size in a gravelly soil deposit. Therefore, the soil descriptions and test results for gravelly soils tend to be biased toward the finer particle sizes. Refer to the Test Boring Log - Descriptive Guide in Appendix B immediately following the test boring logs for a more detailed presentation on sample sizes, sample quality, frost classifications, soil types, and the soil classification procedures.

<u>Sand and Gravel (Nenana Gravel).</u> The sand and gravel deposit (Nenana Gravel) is present in the ridge above the access road and may extend below the road to some extent. The dense sand and gravel deposit was encountered in Test Boring 4 and extends from the top of the ridge ground surface to depth of at least 70 feet (approximately equal elevation as the road at the unstable slope location). The sand and gravel generally classify as a poorly graded gravel with silt and sand, poorly graded sand with silt and gravel, silty gravel with sand, and silty sand with gravel. The silt content varies from 5 to 20 percent. The moisture content of the sand and gravel ranges from 3 to 7 percent. The sand and gravel are medium dense to very dense with uncorrected MPT N-values ranging from 10 to 44 with an average uncorrected MPT N-value of 30.

<u>Existing Fill.</u> The existing fill is the surficial material on the unstable slope and extends from 5 to 20 feet deep with deeper fill present near the original ground depression right of Station 25+75. The existing fill as recovered in the samples and observable at the surface generally classifies as a silty gravel with sand, poorly graded gravel with silt and poorly graded sand with silt and gravel. The silt content varies from as low as 6 percent to as high as 13 percent. The moisture content of the existing fill ranges from 5 to 21 percent with an average of 10 percent. The existing fill is very loose to loose with uncorrected MPT N-values ranging from 2 to 9 blows with an average uncorrected MPT N-value of 4 blows. The existing fill contains cobbles and boulders to 18 inches in diameter where exposed in the scarp and inferred from drilling action.

Disturbed Sand and Gravel (Colluvium or Older Fill). The surficial existing fill is underlain by disturbed sand and gravel originating as colluvium, older fill, and/or landslide deposits. This material has similar properties as the existing fill in portions of the slope and is observed near the toe of the slope. In the upper portions of the failed slope, the material may be present below recently placed fill, but isn't distinguishable in the samples. At the toe of the unstable slope, the disturbed sand and gravel extends from the ground surface to depth of about 15 feet. Additionally, the portion of the toe exposed by the excavator to create a drill pad contains visually displaced layers containing organics, organic mat layers, and stumps (see photos 14 through 17 in Appendix E).

The disturbed sand and gravel generally classify as silty sand with gravel, poorly graded gravel with silt and sand, and clayey sand. The fines content varies from 10 to 47 percent. The moisture content of the disturbed sand and gravel ranges from 5 to 21 percent. The disturbed sand and gravel are loose to medium dense with uncorrected MPT N-values ranging from 4 to 16 blows with an average uncorrected MPT N-value of 8 blows.

Residual Claystone. Underlying the existing fill and disturbed sand and gravel is a layer of residual soil or completely weathered claystone. This deposit is about 1 to 3 feet thick where encountered during the exploration. This deposit ranges in classification from sandy fat clay and elastic silt with sand to lean clay and clayey sand with gravel. The moisture content of the residual claystone ranges from 13 to 24 percent. The liquid limit ranges from 8 to 57 with respective plasticity indices of 29 and 33. The residual claystone is firm to stiff with uncorrected MPT N-values ranging from 4 to 8 blows with an average uncorrected MPT N-value of 6 blows.

Weathered Claystone. Claystone was encountered beneath the unconsolidated materials. The claystone is soft (R1), increasingly weathered closer to the surface and residual material, contains oxidized fracture surfaces, trace fine sand, trace coal seams less 1/8-inch thick, and has low plasticity classifying as lean clay when broken down. The claystone is soft and weathered enough to retain moisture and has a moisture content ranging from 17 to 20 percent. The claystone has uncorrected MPT N-values ranging from 11 to 24 blows with an average uncorrected MPT N-value of 20 blows. The thickness of the claystone is unknown; sandstone was recovered within a single sample from a depth of 35 feet in Test Boring 3.

Groundwater

Groundwater was not encountered within the test borings and no measurable groundwater was present within the PVC standpipes at the time of the exploration. However, it is possible that a water table/phreatic surface may develop within the slope seasonally and/or in response to precipitation events.

Permafrost

Permafrost was not encountered in the test borings. However, permafrost is present regionally and may be present within the slope.

ENGINEERING ANALYSIS AND DISCUSSION

In general, repairing the slope to a stable condition is feasible. The following sections discuss the observed conditions, our interpretation of the data, and our analyses of the data. See the Recommendations section for additional details on the geotechnical engineering recommendations and construction considerations.

Topographic Surfaces

Three topographic surfaces and one inferred topographic surface were available for analysis of the slope failure. A description of each data set follows:

- A set of terrestrial survey points collected by DNR along the existing failed slope surface
    - Limited to the slope failure surface below the road elevation
- Fixed-wing aerial LiDAR of the preexisting surface prior to road rehabilitation in 2020
    - Large data set with relatively small number of points per square yard and unknown absolute accuracy specifically at the slope failure location
- Drone aerial photogrammetry surface collected at the time of the geotechnical investigation
    - The drone did not have RTK capabilities for real time position correction and surveyed ground control points were not available at the time of the imagery collection
    - Snow cover of about 6 to 9 inches was present during the drone imagery collection
- The Cripple Creek Crossing project plan and profile set was used to approximate the constructed slope prior to movement for modeling analysis.

The terrestrial survey points of the existing failed slope surface were used to best fit the various data sets to create a two-dimensional cross section for slope stability modeling. The drone photogrammetric surface was initially processed without control points and was then reoptimized using the terrestrial survey points to recalibrate the location of the surface and orthomosaics. This back-calibration method is inherently less accurate than using RTK correction or ground control points located by survey at the time of the drone image acquisition. However, comparison of the resultant surface with the terrestrial survey points indicates an estimated general accuracy of approximately +/- one-foot horizontally and vertically but portions of the surface may be off up to approximately four feet. The two-dimensional reference cross section location used for slope modeling is shown overlying the resultant photogrammetric surface in Figure 1.

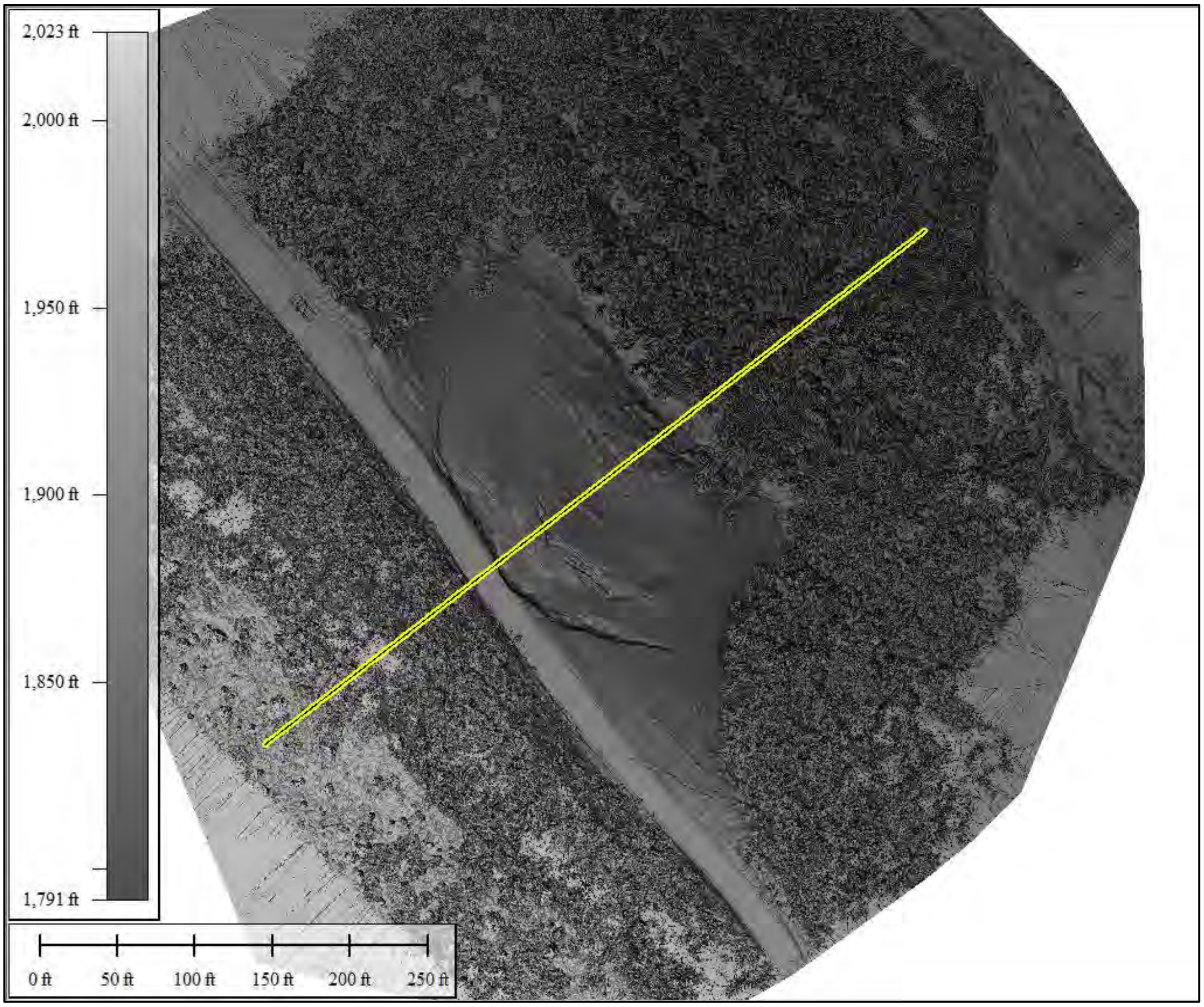


Figure 1: Photogrammetric Surface and Slope Stability Modeling Cross Section

Slope Analysis

An interpretive geologic cross section was developed using exploration borings and topographic data. A detailed slope stability analysis has been completed using the SLOPE/W computer program. SLOPE/W is a two-dimensional, limit-equilibrium slope stability program. For the analyses, Spencer's Method was utilized which satisfies both force and moment equilibrium. The slope stability analysis was performed on the critical slope cross section, which was assumed to correspond with the current and historic observed failure location. Engineering strength parameters were assigned to the various materials based on laboratory data, field data, empirical correlations, and engineering judgement. Due to limited traffic, traffic loads were not included in the stability model. The cross section was analyzed for static and pseudo-static conditions (seismic).

<u>Assumed Water Table Conditions.</u>

Groundwater was not encountered during subsurface exploration; however, our observations indicate that surface drainage tends to collect along the road and is transported to the failure area, where it saturates the slope. As tension cracks and surface imperfections form, this progressively increases infiltration, influencing slope stability. To account for this behavior, we have assumed a water table near the ground surface at the road that daylights near the creek.

Assumed Soil Parameters

Strength parameters utilized in the analysis were based on subsurface exploration results, laboratory results, use of published data for typical strength values for similar materials, and engineering judgment.

The following table summarizes shear strength testing results. Strength parameters are generally separated into two main components, friction angle (ϕ) and cohesion (C). These two parameters relate to the shear strength of the soil, i.e., the shear stress at which failure will occur for a given normal stress. Higher values are indicative of higher soil strength.

TABLE 1
SOIL STRENGTH TESTING RESULTS

Location	Depth (feet)	USCS[1.]	Engineering Properties		
			Test	Total Stress	
				ϕ[1]	C[1.]
TB-2	12.5-14.0’	SC	Direct Shear	11.7°	374 psf

[1.]SC = Clayey Sand, ϕ= internal friction angle, C = cohesion

Tables 2-4 summarize strength parameters from the subsurface exploration, laboratory testing, and published values separated into the major soil/bedrock layers encountered during the subsurface exploration. Once preliminary strength values were selected based on these sources, a calibration was performed by modeling the slope before failure. Through an iterative process, soil properties were adjusted until a Factor of Safety near 1.0 was attained, indicating a state of impending failure. The Factor of Safety is defined as the resisting forces divided by the driving forces. Table 5 presents final strength parameters selected for analyses based on this calibration.

TABLE 2
STRENGTH PARAMETERS – INITIAL VALUES BASED ON SPT BLOW COUNTS

Soil Type	USCS	N Range[1.]	N_{ave}[1.]	ϕ (degrees)[1.]	C (psf)[1.]
Existing Fill	SP-SM/GM	4 to 30	10	30	--
Disturbed Sand & Gravel [Colluvium]	SC/SP-SM	9 to 22	14	31	--
Sand & Gravel [Nenana Gravels]	GP-GM/ SP-SM/GM/ SM	19 to 50+	50+	35+	--
Residual Claystone	CL	7 to 22	17	--	1275
Weathered Claystone	CL	37 to 45	41	--	3075

[1.]N = SPT blow counts in blows/ft, N_{ave} = average SPT blow counts, ϕ = internal friction angle, C = cohesion

TABLE 3 STRENGTH PARAMETERS – BASED ON LABORATORY TESTING				
Soil Type	**USCS**	**γ_d (pcf)[1.]**	**ϕ (degrees)[1.]**	**C (psf)[1.]**
Existing Fill	SP-SM/GM	146	--	--
Disturbed Sand & Gravel [Colluvium]	SC/SP-SM	137	11.7	374
Sand & Gravel [Nenana Gravels]	GP-GM/ SP-SM/GM/ SM	--	--	--
Residual Claystone	CL	110	7.6	--
Weathered Claystone	CL	--	--	--

[1.] ϕ = internal friction angle, C = cohesion, γ_d = in-situ dry unit weight

TABLE 4 STRENGTH PARAMETERS – PUBLISHED VALUES[1.]				
Soil Type	**USCS**	**γ_d (pcf)[2.]**	**ϕ (degrees)[2.]**	**C (psf)[2.]**
Existing Fill	SP-SM/GM	100-135	34-37	0-1050
Disturbed Sand & Gravel [Colluvium]	SC/SP-SM	100-125	31-37	230-1550
Sand & Gravel [Nenana Gravels]	GP-GM/ SP-SM/GM/ SM	100-135	34-37+	0-1050
Residual Claystone	CL	95-120	28	270-1800
Weathered Claystone	CL	95-120	28	270-1800

[1.] NAVFAC, 1986

[2.] ϕ = internal friction angle, C = cohesion, γ_d = dry unit weight

As mentioned previously, the strength parameters selected for final analysis and presented in Table 5, were developed through an iterative process. This process included:

1. Selection of preliminary soil parameters based on Tables 2-4.
2. Modeling the original slope.
3. Comparing the model results from (2) to the actual observed failure surface.
4. Making iterative adjustments to soil parameters until a Factor of Safety of approximately 1.0 was attained and the model failure surface reasonably corresponded with the actual failure surface.

TABLE 5
STRENGTH PARAMETERS – UTILIZED FOR ANALYSES

Soil Type	USCS	γ (pcf)[1.]	ϕ (degrees)[1.]	C (psf)[1.]
Existing Fill	SP-SM/GM	120	26	100
Disturbed Sand & Gravel [Colluvium]	SC/SP-SM	130	34	150
Sand & Gravel [Nenana Gravels]	GP-GM/ SP-SM/GM/ SM	140	42	--
Residual Claystone	CL	120	25	250
Weathered Claystone	CL	125	35	150

1. ϕ = internal friction angle, C = cohesion, γ = moist unit weight

<u>Findings and Mitigation</u>
This section of the report discusses the findings of the slope stability modeling and the recommended mitigation option derived from the modeling process. Additional information on the recommended mitigation option is presented in following sections.

General
Based on available information, it is likely that the slope failure was caused by a complex mechanism involving surface water infiltration and soils exhibiting relatively low shear strength. The failure appears to be almost entirely within the historically placed fills and disturbed colluvium. The following sections present results of the analysis; output from the slope stability model are included in Appendix D.

Existing – Static
An analysis was performed to evaluate the static slope stability of the existing slope. To complete the analysis, a wide range of failure surfaces were examined ranging from deep seated circular failure surfaces to shallow failure surfaces. Utilizing this approach, calculated minimum Factors of Safety of the existing slope are 1.13, which is less than typically recommended factors of safety (1.30). Furthermore, tension cracks currently present in the hillside, will likely result in a lower factor of safety, especially during times of surface water infiltration.

Model failure surfaces indicate the critical failure surface is located almost entirely within the previously placed fill. With regards to the road, the predicted failure surface will likely result in a progressive failure moving upslope if not mitigated.

Mitigation Analysis
Based on our findings, site observations, and historical slope failures at the subject site, we recommend mitigating the slope by removing all previously placed fill, disturbed colluvium, and residual claystone to firm weathered claystone and replacing the material with compacted sand and gravel fill sourced from the Nenana Gravels formation.

As part of the excavation, the toe of the new fill should be keyed two or more feet into firm claystone or undisturbed native material with a subsurface drain installed that daylights out of the slope at the lowest point. Excavation will bench through the residual claystone exposing firm claystone. A non-woven separation geotextile is necessary with one to two feet of freely draining aggregate placed to collect water from the slope and transport it to the keyway drain. Because the Nenana Gravel may contains fines, a second non-woven geotextile for separation should be placed between the drain rock and overlying fill. In addition to the subsurface drains, mitigation should also include surface drainage improvements to reduce the potential for surface water infiltration into the slope.

To verify the recommended mitigation option, static, pseudostatic, and probability analyses have been completed.

The following soil strengths have been assumed for the fill. These parameters should be confirmed during construction.

TABLE 6
STRENGTH PARAMETERS – FILL

Soil Type	USCS	γ (pcf)[1.]	ϕ (degrees)[1.]	C (psf)[1.]
Proposed Fill	SP-SM/GM	140 pcf	38°	50 psf

[1.] ϕ = internal friction angle, C = cohesion, γ = moist unit weight

Static – Mitigation

An analysis was performed to evaluate the static slope stability of the proposed slope. To complete the analysis, a wide range of failure surfaces were examined ranging from deep seated circular failure surfaces to shallow failure surfaces. Utilizing this approach, calculated minimum Factors of Safety of the slope are 1.36, which exceed typically recommended factors of safety (1.30). This assumes that a subsurface drain system is installed which prevents a phreatic surface from forming within the fill. If no drain is installed and a phreatic surface develops, the Factor of Safety is calculated as 1.14 which is similar to the current existing slope.

Model failure surfaces of the recommended slope with drainage indicate the critical failure surface is relatively shallow (within the fill) and starts near the edge of road and daylights near the old two-track road downslope.

Pseduo-static Condition - Mitigation

In areas where liquefaction is not anticipated, a pseudo-static analysis is generally performed to evaluate seismic slope stability. This is achieved by evaluating the sensitivity of the soils to the estimated peak ground acceleration (PGA) anticipated for the site. The pseudo-static approach represents the effects of an earthquake by using a horizontal acceleration coefficient (k_h) applied to the slope soils. Typical horizontal coefficients are one-half of the PGA which is used to estimate additional driving forces during an earthquake (Hynes-Griffin and Franklin, 1984). The PGA for the site was determined for using the USGS Unified Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/) for return periods 475-years at 0.235g, 975-

years at 0.306g, and 2,475-years at 0.414g which assumes a site class B/C condition or weak rock anticipated below the weathered claystone and sandstone. The subsurface exploration did not explore below the weathered rock, but other boreholes in the area indicate 50+ blows are typical in Nenana Gravels and bedrock at depth. The USGS Unified Hazard Tool PGA's are attached with the slope stability output in Appendix D.

Slope stability analysis of the 475-year return period or 10 percent in 50 years used a horizontal coefficient of 0.118g and produced a factor of safety of 1.08 which is fractionally below the typical minimum FS>1.1. Additionally, a yield acceleration analysis was completed, which identifies the acceleration needed to initiate movement (FS<1); however, the scale or amount of movement requires a more advanced dynamic analysis such as Newmark deformation analysis which is beyond the scope of this work. The required yield acceleration to initiate movement of 0.16g correlates to 0.32g seismic acceleration which is slightly higher than the 975-year or 5% in 50 years return period at 0.306g which has a FS>1 but is less than the typical minimum of 1.1 or 1.08 for the 475-year return period acceleration.

Probabilistic Analysis

The previously discussed Factors of Safety indicate the relative stability of the slopes; however, they do not indicate the actual risk level of the slopes due to variability of input parameters such as soil strengths. For this reason, a probabilistic analysis has been completed for the proposed slope mitigation. To complete the analysis a Monte Carlo scheme consisting of 2,000 trials was utilized to arrive at a Factor of Safety distribution for the critical failure surface. The analysis examined varying soil strengths for the soils most likely to fail, that is the fill and disturbed colluvium. All parameters were assumed to have a normal distribution. The following table summarizes ranges utilized for soil parameters along with average values. For each trial, a random number is generated that corresponds to a value within these ranges.

TABLE 7
PROBABILISTIC STRENGTH PARAMETERS

Soil Type	ϕ (degrees)[1.]		C (psf)[1.]	
	Mean	Range	Mean	Range
Proposed Fill	38	33-43	50	0-100
Disturbed Sand & Gravel [Colluvium]	34	24-44	150	50-250
Sand & Gravel [Nenana Gravels]	42	37-47	--	--

[1.] ϕ = internal friction angle, C = cohesion

The analysis resulted in a Factor of Safety ranging between 1.15 and 1.57 with a mean value of 1.36. The probability of failure (iterations resulting in FS<1.0) was calculated to be 0%.

<u>Stability Summary</u>

In summary, the existing slope is in a state of impending movement that will eventually completely impede the road as the failure surface migrates progressively uphill. The following are observations from the stability analysis.

- Factors of Safety of the existing slope are 1.13 for static conditions. There is potential that some areas will experience Factors of Safety lower and higher than those calculated in the analysis. Generally, a Factor of Safety of 1.3 is considered acceptable for slopes when uncertainties or consequences of failure are limited. Based on this criterion, the analyses resulted in Factors of Safety less than required minimums.

- Factors of safety for the proposed mitigation option exceed required static factors of safety (1.36 vs. 1.30) provided drainage is included in the design. Factors of safety for pseudostatic conditions are less than 1.0 for a return period event of 2,500 years. The yield acceleration coefficient under pseudostatic conditions required to initiate movement is 0.16g. This means an earthquake with PGA on the order of 0.32g would likely be required to initiate movement. Initiation of movement does not inherently imply complete slope failure and the damage may be minimal. How much movement for a specific return period can be analyzed using the Newmark deformation analysis methods, however, given the temporary nature of the road, mitigating higher seismic accelerations against potential initiation of movement may not be economically feasible or recommended.

- A deep-seated failure of the entire slope is unlikely due to the more competent weathered bedrock encountered at depth. Resistance to a deep-seated failure will rely on a keyed toe into competent bedrock or a fill berm to provide passive resistance for the overlying fill.

- In addition to potential slope failures, minor sloughing due to unbalanced soil masses or erosion may occur over time. Long term erosion will further increase the instability of the slopes. Slopes should be revegetated to protect against erosion and surface water drainages maintained over the design life of the access road.

TABLE 8
SLOPE STABILITY SUMMARY

Description	Minimum Factor of Safety	
	Spencer Circular	Recommended
Existing		
Original Ground (used for calibration)	**1.00**	1.3*
Existing Slope	**1.13**	1.3*
Mitigation		
Static	1.36	1.3*
Static w/o drainage	**1.14**	1.3*
475-year Seismic Stability	**1.08**	1.1-1.3**
Yield Acceleration – 0.16g	1.00	N/A

* USACOE, 2003 **NCHRP Report 611, 2008

RECOMMENDATIONS

These recommendations are based on professional judgment and experience and the data collected during the site exploration and soil laboratory tests. These recommendations generally are not the only design options available; there may be several acceptable alternatives. These recommendations are not intended to represent the only way, but rather to indicate one appropriate option based on the information available.

Earthwork

The existing fill, disturbed colluvium, and residual claystone will need to be excavated prior to reconstructing the slope. The slope must be reconstructed from the bottom up. A suitable staging and stockpile area would be on the overgrown lower access road to the north of the toe of the slope.

<u>Excavation.</u> The existing fill should be excavated and stockpiled for reconstruction of the slope. Any unsuitable material, such as organics, must be separated from otherwise useable fill. Any soil containing organics, clay, or clayey sand shall not be included in backfilling the slope.

Excavation should begin at the toe of the existing slope and should key into the claystone bedrock to a minimum depth of 2 feet for a width of 10 feet. The bottom of the key trench should form the base of the drainage layer and should grade at minimum slope of 2 percent to an outfall location towards Cripple Creek; See the Subsurface Drainage Layer and Geotextile recommendations.

Excavation should then follow the claystone contact up slope and bench into the bedrock to a depth of approximately 3 feet over a minimum distance of approximately 6 feet proceeding in lifts up the slope. The benching ratio can be adjusted to fit field conditions so long as progressive lifts continue to remove the residual claystone layer and key into the bedrock (or dense to very dense gravel if in-situ Nenana Gravel deposits are encountered) as excavation and backfill progresses upslope. Benches should be limited to 5 to 10 feet high with a horizontal bench half the height.

<u>Frozen Soils.</u> Do not place fill over frozen soils. Do not fill or backfill with frozen soils. If permafrost is encountered during the excavation, the geotechnical engineer should be consulted before proceeding with slope reconstruction.

<u>Fill.</u> The existing fill is suitable for reuse to backfill the slope so long as it does not contain any lumps, frozen material, organic matter, fines in excess of 15 percent, or other deleterious matter. Due to the increased relative density required during backfill and the necessity to waste any material containing excess fines and organics, additional fill will likely be required to reconstruct the slope. All reusable excavation and imported fill shall have a minimum maximum dry density of 130 pcf as determined by ASTM D1557 and meet the following gradation requirements:

Sieve Size	Percent Finer
3”	100*
No. 4	20-60
No. 200	0-15

* The fill may contain up to 10 percent cobbles.

<u>Subsurface Drainage Layer.</u> A subsurface drainage layer is recommended to prevent the formation of a phreatic surface in the slope. The drainage layer should consist of a gravel layer encompassed in geotextile fabric along the base and benched portion of the excavated slope.

Perforated PVC pipes should be embedded in the drainage layer located at the base of the slope and grade to drain towards Cripple Creek.

The subsurface drainage layer shall consist of material meeting the requirements for Porous Backfill, Gradation A or B, as defined in Section 703-2.10 of the Alaska Department of Transportation and Public Facilities Standard Specifications for Highway Construction (DOT&PF SSHC). The subsurface drainage layer shall be a minimum of 24-inches thick.

Geotextile. The geotextile to encompass the drainage layer shall be a non-woven geotextile that meets the requirements for Geotextile for Erosion Control as defined in Section 729-2.01 of the DOT&PF SSHC which refers to AASHTO M288 for properties with a Class 1 strength or better, a minimum permittivity of 0.5 sec^{-1}, and a maximum apparent opening size of 0.43 mm. The geotextile must be placed in accordance with Section 631 of the DOT&PF SSHC.

Optionally, drainage geocomposites may provide an economical solution if drain rock must be imported or for near vertical applications against benched slopes where repeated handling/flipping over of the geotextile will be required to place and compact the drain rock and embankment in progressive lifts without damage to the geotextile. It's feasible that drainage geocomposite could replace most of the drain rock. Specific products and their application would require additional design considerations.

Fill Placement. Fill should be placed and compacted in lifts not exceeding 12 inches in loose thickness if a large vibratory compactor is used, or not exceeding 6 inches in loose thickness if a hand-operated compactor is used. Each lift of fill should be compacted throughout its entire depth to a density of at least 95 percent of the maximum dry density as determined by modified Proctor, ASTM D1557. Excavations should be completely dewatered before placement of fill.

Fill Testing. Frequent, in-place density tests should be performed in each lift of fill to verify that the fill has been properly compacted prior to placing subsequent lifts. The number of tests performed in each lift should be commensurate with the size of the area worked by the contractor, the variability of the soil types used as fill, and the amount of time an inspector spends on-site observing the work. At a minimum, we recommend the following inspection and testing program or as approved by the Engineer:

- Full-time inspection of benching, excavation, and backfill operations
- One mechanical analysis per 2000 cubic yards of fill
- One in-place density per 1,000 square feet per lift
- A minimum of one modified Proctor (ASTM D1557) per soil type used as fill or backfill

Dewatering and Drainage

Dewatering. Groundwater was not encountered during the investigation. However, based on the extent of the recommended excavation and presence of claystone which will perch any water that enters the slope, dewatering may be necessary. Dewatering the excavations until they are properly backfilled is necessary.

Surface Drainage Control. Surface water currently drains down the access road from the south. Tension cracks and previously existing surfaces beneath the fill create preferential paths for surface water to infiltrate into the slope, saturate the fill, and create pore pressures which negatively influence the stability of the slope. Surface water should be controlled to limit infiltration.

LIMITATIONS

DOWL based the conclusions and recommendations presented in this report, based on the assumption that site conditions are not substantially different than those exposed by the explorations. If during construction, subsurface conditions are different from those encountered in the explorations, advise DOWL at once to review those conditions and reconsider recommendations if necessary. The geotechnical recommendations provided herein are based on the premise that an adequate program of tests and observations will be conducted during construction in order to document compliance with DOWL's recommendations and to confirm conditions exposed during subgrade preparations. DOWL geotechnical personnel must review final designs to verify that recommendations provided herein have been properly implemented.

If there is a substantial lapse of time between submission of this report and the start of work at the site, and especially if conditions have changed due to natural causes or construction operations at or near the site, contact DOWL to review this report and to evaluate the applicability of the conclusions and recommendations presented herein.

Do not separate the figures from the text for independent use. DOWL performed these services consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar time and budgetary constraints. No warranty is made or implied.

Any conclusions made by a construction contractor or bidder relating to construction means, methods, techniques, sequences, or costs based upon the information provided in this report are not the responsibility of DNR or DOWL.

If you have any questions regarding this report or its use, or if we may provide additional services, please call.

Sincerely,
DOWL

STATE OF ALASKA
49TH
Jeremiah Erik Holland
CE 12636
REGISTERED PROFESSIONAL ENGINEER
3-6-23

Paul Pribyl, CPG
Project Geologist

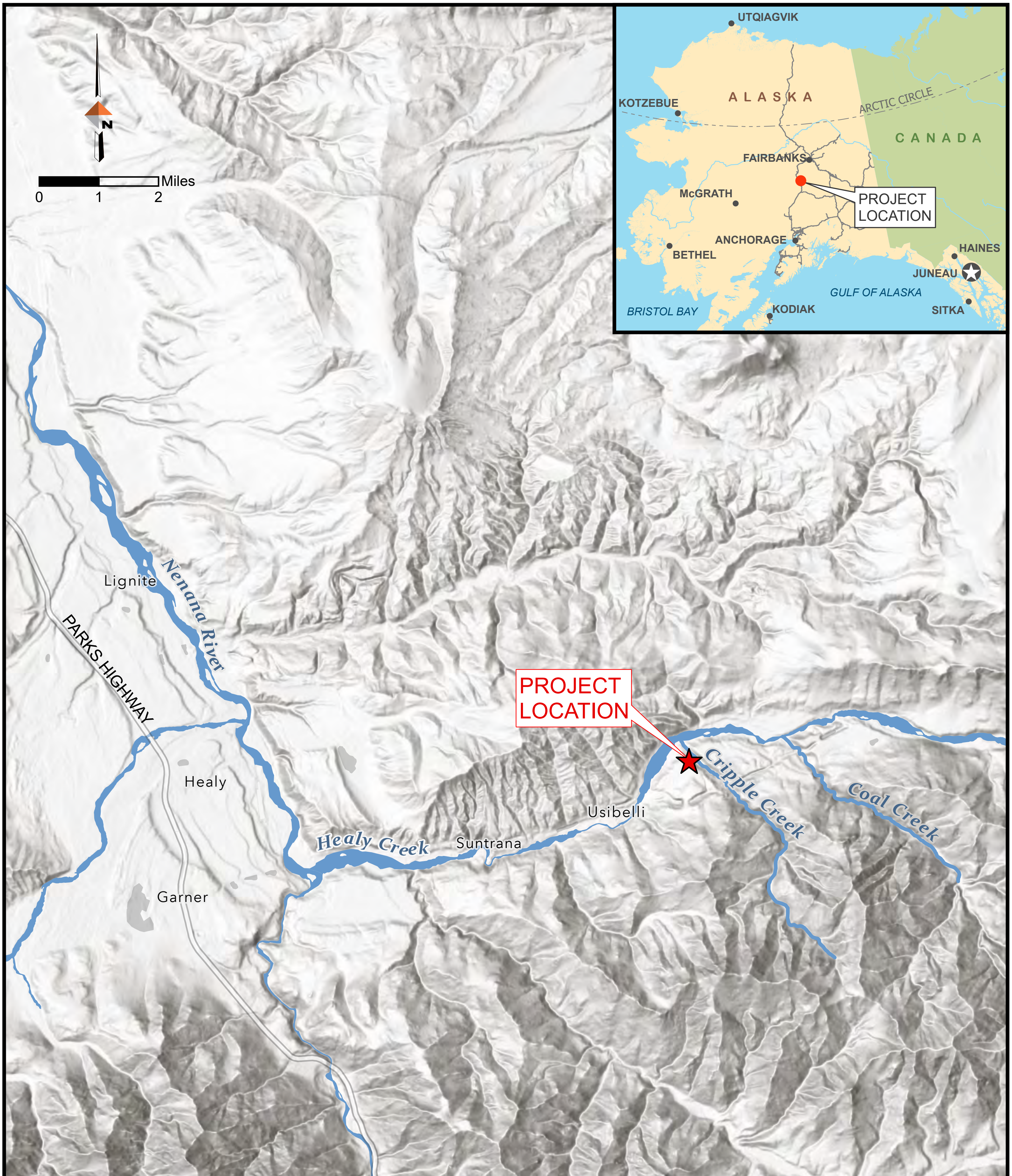
Jeremiah E. Holland, PE
Senior Geotechnical Engineer

Appendices:
- Appendix A: Vicinity and Test Boring Location Maps
- Appendix B: Test Boring Logs and Descriptive Guide
- Appendix C: Laboratory Testing Results
- Appendix D: Slope Stability Figures and Seismic Data
- Appendix E: Photographic Log

c: Roger Allely

APPENDIX A

Vicinity and Test Boring Location Maps



DOWL	Project Location & Vicinity COAL CREEK INVESTIGATION - SLOPE STABILITY Healy, Alaska	PROJECT	1136.90097.01
		DATE	Dec 06, 2022
		FIGURE A-1	

DOWL

Investigation Locations

COAL CREEK INVESTIGATION - SLOPE STABILITY

Healy, Alaska

PROJECT	1136.90097.01
DATE	Dec 06, 2022

FIGURE A-2

APPENDIX B

Test Boring Logs and Descriptive Guide

TEST BORING 1

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:
SURFACE: Gravel

DEPTH (FEET)	Other Tests	Moisture Content (%)	Blows / Foot	Sample No.	Sample Type	Soil Class	Frost Depth	Frost Class	Description	DEPTH
0	MA Proctor			Bulk		GM		F1	**FILL**, **SILTY GRAVEL WITH SAND**, brown, 41% sand, 13% silt, 4.1% 0.02mm, gravel subangular to 3", fine to coarse sand, moist, cobbles and boulders to 18" (~ 5-10%)	4.5
5	LMA	6	3	1	2.5" I.D. Spoon	SP SM		F2	45% gravel, 47% sand, 8% silt **FILL**, **POORLY GRADED SAND WITH SILT AND GRAVEL**, brown, 35-45% gravel, 8-10% silt, gravel subangular to 3", fine to coarse sand, moist, contains cobbles and boulders	
		11	3	2	2.5" I.D. Spoon					
10		6	6	3	2.5" I.D. Spoon					
	LMA	5	3	4	2.5" I.D. Spoon				35% gravel, 55% sand, 10% silt	
15		7	4	5	2.5" I.D. Spoon					20.5
20	PI=33 LL=57 LMA	23	4	6	2.5" I.D. Spoon	CH		F3	**SANDY FAT CLAY**, gray and brown intermixed, 10% gravel, 36% sand, high plasticity, gravel subangular to 1", fine to medium sand, moist	22.5
	PI=24 LL=54 wt=110 LMA C-U			7	S	MH		F4	**ELASTIC SILT WITH SAND TO FAT CLAY WITH SAND**, brownish gray, 28% sand, high plasticity, fine sand, moist, contains <1/8" coal seam	24.0
25						BR		PFS	**CLAYSTONE**, gray, 9% sand, low plasticity, fine sand	

KEY
MA = Mechanical Analysis
PI = Plasticity Index
LL = Liquid Limit
wt = Unit Weight
Proctor = Proctor
LMA = Limited Mechanical Analysis
C-U = Triaxial Shear Test - consolidated undrained
TD = Total Depth
☐ = Grab Sample
◪ = SPT Sample
S = Shelby Tube - pushed
T = Direct Push Sample
☒ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: Geoprobe 6712D
OPERATOR: Gary Erickson
METHOD: 6 in. OD hollow-stem auger
FIELD NO.: 1

CLIENT: DNR ML&W
PROJECT: Coal Creek - Slope Stability
LOGGED BY: Paul Pribyl, CPG
TEST BORING COMPLETED: 10-15-22
W.O. 1136.90097.01

DOWL

LOG OF TEST BORING 1

FIGURE B-1

TEST BORING 1 (Continued)

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:
SURFACE: Gravel

Depth (ft)	Other Tests	Moisture Content (%)	Blows / Foot	Sample No.	Sample Type	Soil Graph	Soil Class	Frost Depth	Frost Class	Description	DEPTH
25	PI=18 LL=39 LMA	17	24	8			BR		PFS	**CLAYSTONE**, gray, 9% sand, low plasticity, fine sand, moist, soft (R1), lightly to moderately weathered, contains oxidized fractures, contains trace coal fragments	
30		20	24	9							31.5

TD=31.5'

TEST BORING COMPLETED ON 10-15-22
NO GROUNDWATER ENCOUNTERED WHILE DRILLING
PVC STANDPIPE INSTALLED TO 31.5'
NO MEASURABLE GROUNDWATER ON 10-16-22

DEPTH (FEET): 25, 30, 35, 40, 45, 50

KEY
MA = Mechanical Analysis
PI = Plasticity Index
LL = Liquid Limit
wt = Unit Weight
Proctor = Proctor
LMA = Limited Mechanical Analysis
C-U = Triaxial Shear Test - consolidated undrained
TD = Total Depth
☐ = Grab Sample
◪ = SPT Sample
S = Shelby Tube - pushed
T = Direct Push Sample
☒ = 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: Geoprobe 6712D
OPERATOR: Gary Erickson
METHOD: 6 in. OD hollow-stem auger
FIELD NO.: 1

CLIENT: DNR ML&W
PROJECT: Coal Creek - Slope Stability
LOGGED BY: Paul Pribyl, CPG
TEST BORING COMPLETED: 10-15-22
W.O. 1136.90097.01

DOWL

LOG OF TEST BORING 1

FIGURE B-1

TEST BORING 2

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:
SURFACE: Gravel

Other Tests	Moisture Content (%)	Blows / Foot	Sample No.	Sample Type
	21	4	1	2.5" I.D. Spoon Sample
	5	16	2	2.5" I.D. Spoon Sample
	5	12	3	2.5" I.D. Spoon Sample
PI=12 LL=29 LMA	17	7	4	2.5" I.D. Spoon Sample
PI=9 LL=25 LMA	14	7	5	2.5" I.D. Spoon Sample
PI=15 LL=35 LMA	20	12	6	2.5" I.D. Spoon Sample
	17	21	7	2.5" I.D. Spoon Sample

Soil Class	Frost Class	Description	Depth
SM	F2	**SILTY SAND WITH GRAVEL**, brown and dark brown intermixed, about 25% gravel, 20% silt, low plasticity, gravel subangular to 3", fine to coarse sand, moist, contains organic fibers and wood, possibly disturbed landslide debris or fill	5.5
GP GM	F1	**POORLY GRADED GRAVEL WITH SILT AND SAND**, reddish brown, about 40% sand, 10% silt, gravel subangular to 1.5", fine to coarse sand, moist, possibly landslide debris or fill	9.5
SC	F3	**CLAYEY SAND**, layers of dark brown, light brown, and gray, about 37-47% clay, medium plasticity, fine to medium sand, moist, contains trace coal fragments, possibly disturbed landslide debris	14.5
CL	F3	**LEAN CLAY**, oxidized brown to gray, about 7% sand, medium plasticity, fine sand, interpretted as residual highly weathered claystone	16.0
BR	PFS	**CLAYSTONE**, gray, medium plasticity, fine sand, dry to moist, soft (R1), lightly to moderately weathered	21.5

DEPTH (FEET): 0, 5, 10, 15, 20, 25

TD=21.5'

TEST BORING COMPLETED ON 10-15-22
NO GROUNDWATER ENCOUNTERED WHILE DRILLING
PVC STANDPIPE INSTALLED TO 21.5'
NO MEASURABLE GROUNDWATER ON 10-16-22

KEY
PI = Plasticity Index
LL = Liquid Limit
LMA = Limited Mechanical Analysis
TD = Total Depth
☐ = Grab Sample
◪ = SPT Sample
= Shelby Tube - pushed
= Direct Push Sample
☒ = 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: Geoprobe 6712D
OPERATOR: Gary Erickson
METHOD: 6 in. OD hollow-stem auger
FIELD NO.: 2

CLIENT: DNR ML&W
PROJECT: Coal Creek - Slope Stability
LOGGED BY: Paul Pribyl, CPG
TEST BORING COMPLETED: 10-15-22
W.O. 1136.90097.01

LOG OF EXPLORATION 90097_SLOPE.GPJ BLANK2.GDT 12/9/22

DOWL

LOG OF TEST BORING 2

FIGURE B-2

TEST BORING 3

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:
SURFACE: Gravel

Depth (feet)	Other Tests	Moisture Content (%)	Blows / Foot	Sample No.	Soil Class	Frost Class
~3.7		21	2	1	GM	F1
~6.2	LMA	13	3	2	GM	F1
~8.7		8	9	3	GM	F1
~11.2		6	7	4	GP GM	F1
~16.2	LMA	5	5	5	GP GM	F1
~21.2		7	8	6	GP GM	F1

	DEPTH
FILL, **SILTY GRAVEL WITH SAND**, brown, 38% sand, 13% silt, gravel subangular to 3", fine to coarse sand, moist, cobbles and boulders to 18" (~ 5-10%), contains coal cobbles to 9" (GM, F1)	9.5
POORLY GRADED GRAVEL WITH SILT AND SAND, brown to reddish brown, 47% sand, 6% silt, gravel subangular to 3", fine to coarse sand, moist, contains cobbles and boulders (GP GM, F1)	

DEPTH (FEET): 0, 5, 10, 15, 20, 25

KEY
PI = Plasticity Index
LL = Liquid Limit
LMA = Limited Mechanical Analysis
TD = Total Depth
☐ = Grab Sample
◪ = SPT Sample
▧ = Shelby Tube - pushed
◫ = Direct Push Sample
☒ = 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: Geoprobe 6712D
OPERATOR: Gary Erickson
METHOD: 6 in. OD hollow-stem auger
FIELD NO.: 3

CLIENT: DNR ML&W
PROJECT: Coal Creek - Slope Stability
LOGGED BY: Paul Pribyl, CPG
TEST BORING COMPLETED: 10-16-22
W.O. 1136.90097.01

DOWL

LOG OF TEST BORING 3

FIGURE B-3

TEST BORING 3 (Continued)

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:
SURFACE: Gravel

Depth (Feet)	Other Tests	Moisture Content (%)	Blows / Foot	Sample No.	Sample Type	Soil Graph	Soil Class	Frost Depth	Frost Class	Description	DEPTH
25	PI=8 LL=29 LMA	13	8	7			SC		F3	**CLAYEY SAND WITH GRAVEL**, brownish gray, 17% gravel, 44% silt, low plasticity, gravel subangular to 1.5", fine to coarse sand	25.0
30	PI=25 LL=46 LMA	19	11	8			BR		PFS	**CLAYSTONE**, gray, 8% sand, low plasticity, fine sand, moist, soft (R1), lightly to moderately weathered, contains oxidized fractures, contains trace ~1/8" thick coal seams	28.5
35		14	20	9			BR			**SANDSTONE**, gray with light oxidation, about 25% silt, fine to medium sand, moist, soft (R1), lightly weathered, contains trace coal <2% by volume	33.0
											36.5

TD=36.5'

DEPTH (FEET): 40, 45, 50

TEST BORING COMPLETED ON 10-16-22
NO GROUNDWATER ENCOUNTERED WHILE DRILLING
PVC STANDPIPE INSTALLED TO 36.5'
NO MEASURABLE GROUNDWATER ON 10-16-22

KEY
PI = Plasticity Index
LL = Liquid Limit
LMA = Limited Mechanical Analysis
TD = Total Depth
☐ = Grab Sample
◪ = SPT Sample
▧ = Shelby Tube - pushed
◫ = Direct Push Sample
☒ = 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: Geoprobe 6712D
OPERATOR: Gary Erickson
METHOD: 6 in. OD hollow-stem auger
FIELD NO.: 3

CLIENT: DNR ML&W
PROJECT: Coal Creek - Slope Stability
LOGGED BY: Paul Pribyl, CPG
TEST BORING COMPLETED: 10-16-22
W.O. 1136.90097.01

DOWL

LOG OF TEST BORING 3

FIGURE B-3

TEST BORING 4

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:
SURFACE: Vegetative Mat

Depth (feet)	Other Tests	Temp °F	Moisture Content (%)	Blows / Foot	Sample No.	Soil Class	Frost Depth	Frost Class	Description	Depth
0						OL			6" Vegetative Mat	0.5
						GP GM		S1	**POORLY GRADED GRAVEL WITH SILT AND SAND**, brown, about 30-40% sand, 5-10% silt, gravel subangular to 3", fine to coarse sand, moist	
5			5	13	1					
	LMA		3	19	2					
10			5	10	3					
15	LMA		5	25	4					
20			4	36	5					
25										

DEPTH (FEET)

KEY
MA = Mechanical Analysis
FC = Frost Classification
LMA = Limited Mechanical Analysis
TD = Total Depth
☐ = Grab Sample
= SPT Sample
= Shelby Tube - pushed
= Direct Push Sample
= 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Wininger Drilling
EQUIPMENT: MOBILE B80
OPERATOR: Frank Wininger
METHOD: Air Rotary

CLIENT: DNR ML&W
PROJECT: Coal Creek Crossing
LOGGED BY: Paul Pribyl, CPG
TEST BORING COMPLETED: 9-21-22
W.O. 1136.90097.01

DOWL

LOG OF TEST BORING 4

FIGURE B-4

TEST BORING 4 (Continued)

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:
SURFACE: Vegetative Mat

DEPTH (FEET)	Other Tests	Temp °F	Moisture Content (%)	Blows / Foot	Sample No.	Soil Class	Frost Depth	Frost Class	Description	DEPTH
25			4	18	6	GP/GM		S1	**POORLY GRADED GRAVEL WITH SILT AND SAND**, brown, about 30-40% sand, 5-10% silt, gravel subangular to 3", fine to coarse sand, moist	28.5
30	LMA		4	23	7	SP/SM		S2	**POORLY GRADED SAND WITH SILT AND GRAVEL**, brown, 40% gravel, 5-10% silt, gravel subangular to 1.5", fine to coarse sand, moist	33.3
35			5	35	8	GM		F2	**SILTY GRAVEL WITH SAND**, brown, 40% sand, 20% silt, 7.6% 0.02mm, gravel subangular to 3", fine to coarse sand, moist	
40	MA FC		5	43	9					
45			6	44	10					48.0
50						SP		S2	**POORLY GRADED SAND WITH GRAVEL**, brown, about 35% gravel, 5% silt, gravel subangular to 1", fine to coarse sand, moist	

KEY
MA = Mechanical Analysis
FC = Frost Classification
LMA = Limited Mechanical Analysis
TD = Total Depth
☐ = Grab Sample
◪ = SPT Sample
S = Shelby Tube - pushed
T = Direct Push Sample
☒ = 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Wininger Drilling
EQUIPMENT: MOBILE B80
OPERATOR: Frank Wininger
METHOD: Air Rotary

CLIENT: DNR ML&W
PROJECT: Coal Creek Crossing
LOGGED BY: Paul Pribyl, CPG
TEST BORING COMPLETED: 9-21-22
W.O. 1136.90097.01

DOWL

LOG OF TEST BORING 4

FIGURE B-4

TEST BORING 4 (Continued)

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:
SURFACE: Vegetative Mat

DEPTH (FEET)	Other Tests	Temp °F	Moisture Content (%)	Blows / Foot	Sample No.	Sample Type	Soil Graph	Soil Class	Frost Depth	Frost Class	Description	DEPTH
50–53.8			7	24	11			SP		S2	**POORLY GRADED SAND WITH GRAVEL**, brown, about 35% gravel, 5% silt, gravel subangular to 1", fine to coarse sand, moist	53.8
53.8–58.0			4	43	12			GP		S1	**POORLY GRADED GRAVEL WITH SAND**, brown, about 45% sand, 5% silt, gravel subangular to 3", fine to coarse sand, moist	58.0
58.0–72.0			4	29	13			SM		F2	**SILTY SAND WITH GRAVEL**, brown, 42% gravel, 15% silt, 4.3% 0.02mm, gravel subangular to 3", fine to coarse sand, moist	
	MA FC		5	34	14							
		33.4	7	38	15							72.0

TD=72.0'

TEST BORING COMPLETED ON 9-21-22
NO GROUNDWATER ENCOUNTERED WHILE DRILLING
PVC STANDPIPE INSTALLED TO 72'
NO MEASURABLE GROUNDWATER ON 9-21-22
DRILL ACTION INDICATES COBBLES AND BOULDERS THROUGHOUT DEPOSIT

KEY
MA = Mechanical Analysis
FC = Frost Classification
LMA = Limited Mechanical Analysis
TD = Total Depth
☐ = Grab Sample
◪ = SPT Sample
S = Shelby Tube - pushed
T = Direct Push Sample
☒ = 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Wininger Drilling
EQUIPMENT: MOBILE B80
OPERATOR: Frank Wininger
METHOD: Air Rotary

CLIENT: DNR ML&W
PROJECT: Coal Creek Crossing
LOGGED BY: Paul Pribyl, CPG
TEST BORING COMPLETED: 9-21-22
W.O. 1136.90097.01

DOWL

LOG OF TEST BORING 4

FIGURE B-4

TEST BORING LOG – DESCRIPTIVE GUIDE

Soil Descriptions – The soil classified visually in the field based on drill action, auger cuttings, and sample information. The recovered soil samples are classified visually again in the laboratory. The soil description on the boring log is based on an interpretation of the field and laboratory visual classifications, along with the results of the laboratory testing which may have been performed.

The **soil classification** is based on ASTM Designation D2487 "Standard Test method for Classification of Soils for Engineering Purposes" and ASTM D 2488 "Standard Practice for Description and Identification of Soils (Visual – Manual Procedure)". The soil frost classification is based on the system developed by the U.S. Army Corps of Engineers and is performed in accordance with the Departments of the Army and Air Force Publication TM 5-822-5 "Pavement Design for Roads, Streets, Walks, and Open Storage Areas". Outlines of these classification procedures are presented on the following pages.

The soil color is the subjective interpretation of the individual logging the test boring.

Plasticity Indices - The plasticity of the minus No. 40 fraction of the soil is described and the fine-grained soils are identified from manual tests using the following tables as a guide:

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	none to low	slow to rapid	low or thread cannot be formed
CL	medium to high	none to slow	medium
MH	low to medium	none to slow	low to medium
CH	high to very high	none	high

Plasticity Description	Criteria
Non Plastic	A 1/8" (3.2mm) thread cannot be rolled at any water content
Low	A thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Laboratory Atterberg Limits tests are usually performed on a few of the plastic soils and results are reported on the test boring log. These laboratory tests are performed in accordance with ASTM D4318 "Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils."

Gravel Shape – The shape of the gravel particles is described based on this guide:

Angular: Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular: Particles are similar to angular but have somewhat rounded edges.
Subrounded: Particles exhibit nearly plane sides but have well-rounded corners and edges.
Rounded: Particles have smoothly curved sides and no edges.

Material Size – The maximum nominal size of gravel and predominate percentage of sand particles are described using the following table:

Description	Gravel	Sand
Coarse	Passes 3” (75 mm) sieve, retained on ¾” (19 mm) sieve)	Passes No. 4 sieve, retained on No. 10 sieve
Medium	N/A	Passes No. 10 sieve, retained on No. 40 sieve
Fine	Passes ¾” (19 mm) sieve, retained on No. 4 sieve	Passes No. 40 sieve, retained on No. 200 sieve

Soil Moisture – The soils moisture is described as:

Dry: Powdery, dusty, no visible moisture
Moist: Enough moisture to affect the color of the soil; damp
Moist to Wet: Water in pores but not dripping; capillary zone above water table
Wet: Dripping wet, contains significant free water, or sampled below water table

Field Density Estimates – The subject estimate of the density of coarse-grained soils is based on the observed drill action and on drive sample data. The guide below is used with the Standard Penetration Test (SPT) for sands with minor amounts of fine gravel; however blow counts can be affected strongly by gravel content, thermal state, drilling procedures, condition of equipment, and performance of the test.

Standard Penetration Resistance N (blows/foot)	Relative Soil Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
More than 50	Very Dense

An estimate of the consistency of fine-grained soils is based on the observed drill action and on drive sample data. The guide below is used:

Standard Penetration Resistance N (blows/foot)	Relative Soil Density
0 - 2	Very soft
3 - 4	Soft
5 - 8	Firm
9 - 15	Stiff
16 - 30	Very Stiff
More than 30	Hard

Soil Layer Boundaries – Generally, there is a gradual transition from one soil type to another in a natural soil deposit, and it is difficult to determine accurately the boundaries of the soil layers.

- A *solid diagonal line* between soil layers on the graphic boring log indicates the general region of transition from one soil layer to another.
- A *dashed diagonal line* indicates the soil boundary was detected only by a change in the recovered samples and the actual boundary may be anywhere between the indicated sample depths.
- A soil *horizontal line* between soil layers indicates a relatively distinct transition between soil types was observed in the recovered samples and/or by a distinct change in drill action

Sample Interval – The sample interval is shown graphically on the test boring log and generally is accurate to about 0.5-foot.

Frost Depth and Soil Temperatures – If frozen ground is encountered during drilling, the interval of frozen soil is shown graphically on the test boring log. Generally, the temperature of a few soil samples is measured and shown on the boring log. These sample temperatures only give a qualitative indication of in situ soil temperatures. The temperature of samples can be influenced significantly by ambient air temperature and friction during drilling and sampling. Greater confidence is given to temperatures obtained through thermistors installations.

Soil Moisture Content - Generally, laboratory soil moisture content tests are performed on all recovered samples. Only about 30 grams of minus No.4 material is typically used for the moisture content test, so results reported on the log may not reflect accurately the *in situ* moisture content of gravelly soils.

Soil Density/Unit Weight – The soil density shown on the test boring logs generally is determined by measuring the wet weight, moisture content, and physical dimensions of relatively undisturbed specimens.

Groundwater – The depth to groundwater observed during drilling is generally shown on the test boring log. Alternatively, depth to groundwater can be measured in a perforated PVC pipe installed in the boring to monitor groundwater level. Differences can occur between depth to groundwater during drilling and those measured after drilling due to the time needed to equalize the groundwater elevation during and after drilling.

Penetration Resistance, N – Standard Penetration Tests (SPT) are performed in accordance with ASTM Designation D186 “Standard Method for Penetration Test and Split- Barrel Sampling of Soils”. A Modified Penetration Test (MPT) using a 2.5-inch inside-diameter split spoon driven with a 340-pound hammer falling 30 inches is performed to obtain larger samples, particularly in gravelly soils. The boring log key describes the graphic symbols used to differentiate between sample types.

Undisturbed Samples – Undisturbed Shelby tube samples are obtained in accordance with ASTM D1587, “Standard Practice for Thin-Walled Tube Sampling of Soils.” Generally, 3-inch outside-diameter Shelby tubes are used.

Grab Samples – Grab samples are obtained from the auger flights. The sample depth and interval indicated on the test boring log should be considered a rough approximation. The grab samples may not be representative of in situ soils, particularly in layer soil deposits.

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM DESIGNATION: D2487

Based on the Unified Soil Classification System (USCS)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				USCS Soil Classification: Group Symbol	Group Name [B]
Coarse-Grained Soils More than 50% retained on #200 sieve	Gravels More than 50% of coarse fraction retained on #4 sieve	Clean Gravels Less than 5% fines [C]	$Cu \geq 4$ and $1 \geq Cc \leq 3$ [E]	GW	Well-graded gravel
			$Cu < 4$ and/or $1 \leq Cc \leq 3$ [E]	GP	Poorly graded gravel
		Gravel with Fines More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel [F,G,H]
	Sands 50% or more of coarse fraction passes #4 sieve	Clean Sands Less than 5% fines [D]	$Cu \geq 6$ and $1 \geq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			Cu 6 4 and/or $1 \leq Cc \leq 3$ [E]	SP	Poorly graded sand [I]
		Sands with Fines More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G,H,I]
			Fines classify as CL or CH	SC	Clayey sand [G,H,I]
Fine-Grained Soils 50% or more passes the #200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [J]	CL	Lean clay [K,L,M]
			PI < 4 and plots on or above "A" line [J]	ML	Silt [K,L,M]
		Organic	Liquid limit - oven dried < 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried	OL	Organic silt [K,L,M,O]
	Silt and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [K,L,M]
			PI plots below "A" line	MH	Elastic silt [K,L,M]
		Organic	Liquid limit - oven dried > 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried	OH	Organic clay [K,L,M,Q]
High Organic Soils		Primarily organic matter	dark in color, and organic odor	PT	Peat

A Based on material passing the 3-in sieve

B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name

C Gravels with 5 to 12% require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP GM poorly-graded gravel with silt
GP-GC poorly graded gravel with clay

D Sands with 5 to 12% require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

E $Cu = D_{60}/D_{10}$ $\quad Cc = [(D_{30})^2/(D_{10} x D_{60})]$

F If fines classify as CL-ML, use dual symbol GC-GM, SC-SM

G If soil contains ≥ 15% sand, add "with sand to group name

H If fines are organic, add " with organic fines" to group name

I If soil contains ≥ 15% gravel, add "with gravel" to group name

J If Atterberg Limits plot in hatched area, soil is CL-ML, silty clay

K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

L If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.

M If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

N PI ≥ 4 or plots below "A" line

O PI< 4 or plots below "A" line

P PI plots on or above "A" line

Q PI plots below A line

DESCRIPTION OF FROZEN SOILS (Visual-Manual Procedure) ASTM Designation: D4083

Part I Description of Soil Phase	Classify Soil Phase by ASTM D2487 or D2488					
		Group Symbol	Subgroup: Description	Subgroup: Symbol		Field Identification
Part II Description of Frozen Soil	Segregated ice is not visible by eye	N	Poorly bonded or friable	Nf		Identify by visual examination to determine presence of excess ice, use procedures under Note 2 and hand magnifying lens as necessary. For soils not fully saturated, estimate degree of ice saturation; medium, low. Note presence of crystals or ice coatings around larger particles. (Note 1)
			No excess ice	Nb	Nbn	
			Well-bonded Excess ice		Nbe	
	Segregated ice is visible by eye (ice 1-inc or less in thickness)	V	Individual ice crystal or inclusions	Vx		For ice phase, record the following when applicable: Location, Structure, Orientation, Color, Thickness, Size, Length, Shape, Spacing, Hardness, Pattern of arrangement
			Ice coatings on particles	Vc		
			Random or irregularly oriented ice formations	Vr		
			Stratified or distinctly oriented ice formations	Vs		Estimate volume of visible segregated ice present as percentage of total sample volume. (Note 2)
			Uniformly distributed ice	Vu		
Part III Description of Substantial Ice	Ice (greater than 1-inh in thickness)	ICE	Ice with soil inclusions	ICE+Soil Type		Designate material as ICE (Note 3) and use descriptive terms as follows, usually one item from each group where applicable: <u>HARDNESS</u>: Hard, Soft (of mass, not individual crystals) <u>STRUCTURE (Note 4)</u>: Clear, Cloudy, Porous, Candled, Granular, Stratified <u>COLOR:</u> Colorless, Gray, Blue <u>ADMIXTURES:</u> Contains few thin silt inclusions
			Ice without soil inclusions	ICE		

Note 1: Frozen soils in the N group may, on close examination, indicate presence of ice within the voids of the material by crystalline reflections or by a sheen on fractured or trimmed surfaces. The impression received by the unaided eye, however, is that none of the frozen water occupies space in excess of the original voids in the soils. The opposite is true of frozen soils in the V group

DEFINITIONS

1) <u>Ice coatings on particles</u> - discernible layers of ice found on or below larger soils particles in a frozen soil mass.
2) <u>Ice Crystal</u> - a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in combination with other ice formations.
3) <u>Clear Ice</u> - ice that is transparent and contains only a moderate number of air bubbles.
4) <u>Cloudy Ice</u> - ice that is translucent or relatively opaque due to the content of air or other reasons, but which is essentially sound and impervious
5) <u>Porous Ice</u> - ice that contains numerous voids, usually interconnected and usually resulting from melting at air bubbles or along crystal interfaces from presence of salt or other materials in the water or from the freezing of saturated snow. Though porous, the mass retains its structural unity.
6) <u>Candled Ice -</u> ice that has rotted or otherwise formed into long columnar crystals, very loosely bonded together
7) <u>Granular Ice</u> - ice that is composed of coarse, more or less equidimensional crystals weakly bonded together
8) <u>Ice Lenses</u> - lenticular ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss, and commonly in repeated layers.
9) <u>Ice Segregation</u> - the growth of ice within soil in excess of the amount that may be produced by the in-place conversion of the original void moisture to ice. Ice segregation occurs most often as distinct lenses, layers, veins, and masses, commonly, but not always, oriented normal to the direction of heat loss.
10) <u>Well-Bonded</u> - a condition in which the soil particles are strongly held together by the ice so that the frozen soil possesses relatively high resistance to chipping or breaking.
11) <u>Poorly-Bonded</u> - a condition in which the soil particles are weakly held together by the ice so that the frozen soil has poor resistance to chipping and breaking.
12) <u>Thaw Stable -</u> the characteristics of frozen soils that, upon thawing, do not show loss of strength in comparison to normal, long-time thawed values nor produce detrimental settlement.

Note 2: When visual methods may be inadequate, a simple field test to aid evaluation of the volume of excess ice can be made by placing some frozen soil in a small jay, allowing it to melt, and observing the quantity of supernatant water as a percentage of total volume

Note 3: Where special forms of ice such as hoarfrost can be distinguished, more explicit description should be given

Note 4: Observer should be careful to avoid being misled by surface scratches or frost coating on the ice.

FROST DESIGN SOIL CLASSIFICATION[1]

Frost[2] Group	Kind of Soil	Percentage Finer than 0.02 mm by Weight	Typical Soil Types Under Unified Soil Classification
NFS[3]	(a) Gravels Crushed stone Crushed rock (b) Sands	0 to 1.5 0 to 3	GW and GP SW and SP
PFS[4] (MOA NFS) (MOA F2)	(a) Gravels Crushed stone Crushed rock (b) Sands	1.5 to 3 3 to 10	GW and GP SW and SP
S1 (MOA F1)	Gravelly soils	3 to 6	GW, GP, GW-GM, and GP-GM
S2 (MOA F2)	Sandy soils	3 to 6	SW, SP, SW-SM, and SP-SM
F1	Gravelly soils	6 to 10	GM, GW-GM, and GP-GM
F2	(a) Gravelly soils (b) Sands	10 to 20 6 to 15	GM, GW-GM, and GP-GM SM, SW-SM, and SP-SM
F3	(a) Gravelly soils (b) Sands, except very fine silty sands (c) Clays, PI>12	Over 20 Over 15	GM and GC SM and SC CL and CH
F4	(a) All silts (b) Very fine silty sands (c) Clays, PI<12 (d) Varved clays and other fine-grained, banded sediments	Over 15	ML and MH SM CL and CL-ML CL and ML CL, ML, and SM CL, CH, and ML CL, CH, ML and SM

1 Departments of the Army and Air Force Publication TM 5-822-5/AFM 88-7, "Pavement Design for Roads, Streets, Walks, and Open Storage Areas", Table 18-2.

2 Corps of Engineers Frost groups directly correspond to the Municipality of Anchorage soil frost classification groups, except as noted.

3 Non Frost-Susceptible.

4 Possibly frost-susceptible, but requires laboratory test to determine frost design soil classification.

APPENDIX C

Laboratory Test Results

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Material Test Report

Report No: ASM:22-3943
Issue No: 1

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220735

CC: Dowl
Maria Kampsen

Project: Slope Stability

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 11/23/2022

Sample Details

Sample ID	22-3943-S01	22-3943-S02	22-3943-S03
Client Sample ID	TB1 Sa1	TB1 Sa2	TB1 Sa3
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	6	11	6	
Date Tested		10/21/2022	10/21/2022	10/21/2022	
Tested By		Frank Walters	Frank Walters	Frank Walters	
Percent Gravel	LMA (Internal Method)	45			
Percent Sand		47			
Percent Fines (Silt/Clay)		8			
Group Symbol		SP-SM			
Group Name		Poorly graded sand with silt and gravel			
Tested By		Mikaela Maroney			

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
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Material Test Report

Report No: ASM:22-3943
Issue No: 1

Client:	DOWL, LLC 5015 Business Park Blvd. Suite 4000 Anchorage, AK, 99503	Project Code: 220735 **CC:** Dowl Maria Kampsen
Project:	Slope Stability Anchorage, AK, 99503 1136.90097.01	

The results contained below pertain only to the items tested below. This report should not be reproduced, except in full, without the prior written approval of Alaska Testlab or the agency.

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 11/23/2022

Sample Details

Sample ID	22-3943-S04	22-3943-S05	22-3943-S06
Client Sample ID	TB1 Sa4	TB1 Sa5	TB1 Sa6
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	5	7	23	
Date Tested		10/21/2022	10/21/2022	10/21/2022	
Tested By		Frank Walters	Frank Walters	Frank Walters	
Percent Gravel	LMA (Internal Method)	35			
Percent Sand		55			
Percent Fines (Silt/Clay)		10			
Group Symbol		SP-SM			
Group Name		Poorly graded sand with silt and gravel			
Tested By		Mikaela Maroney			
Group Code	ASTM D2487			CH	
Group Name				Sandy fat clay	
Gravel (%)				10	
Sand (%)				36	
Fines (%)				54	
Tested By	ASTM D2487			Morgan Zinn	
Liquid Limit	ASTM D4318			57	
Plastic Limit				24	
Plasticity Index				33	
Preparation Method				Air Dry	
Oversize Removed By				Dry Sieving over No. 40 sieve	
Liquid Limit Apparatus				Mechanical	
Grooving Tool				Plastic	
Rolling				Hand	
Tested By				Morgan Zinn	
Date Tested				10/27/2022	

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

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Material Test Report

Report No: ASM:22-3943
Issue No: 1

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220735

CC: Dowl
Maria Kampsen

Project: Slope Stability

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 11/23/2022

Sample Details

Sample ID	22-3943-S07	22-3943-S08	22-3943-S09
Client Sample ID	TB1 Sa7 (Shelby)	TB1 Sa8	TB1 Sa9
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	24	17	20	
Date Tested		11/7/2022	10/21/2022	10/21/2022	
Tested By		Cindy Zickefoose	Frank Walters	Frank Walters	
Group Code	ASTM D2487	MH	CL		
Group Name		Elastic silt with sand	Lean clay		
Gravel (%)		0	0		
Sand (%)		28	9		
Fines (%)		72	91		
Tested By	ASTM D2487	Brodie Smith	Morgan Zinn		
Liquid Limit	ASTM D4318	54	39		
Plastic Limit		30	21		
Plasticity Index		24	18		
Preparation Method		Air Dry	Air Dry		
Oversize Removed By		Dry Sieving over No. 40 sieve	Dry Sieving over No. 40 sieve		
Liquid Limit Apparatus		Mechanical	Mechanical		
Grooving Tool		Plastic	Plastic		
Rolling		Hand	Hand		
Tested By		Karen Jackson	Morgan Zinn		
Date Tested		11/20/2022	10/27/2022		

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
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Material Test Report

Report No: ASM:22-3944
Issue No: 1

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220735

CC: Dowl
Maria Kampsen

Project: Slope Stability

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 11/23/2022

Sample Details

Sample ID	22-3944-S01	22-3944-S02	22-3944-S03	22-3944-S04
Client Sample ID	TB2 Sa1	TB2 Sa2	TB2 Sa3	TB2 Sa4
Date Sampled				

Other Test Results

Description	Method	Results				Limits
Water Content (%)	ASTM D2216	21	5	5	17	
Date Tested		10/21/2022	10/21/2022	10/21/2022	10/21/2022	
Tested By		Frank Walters	Frank Walters	Frank Walters	Frank Walters	
Group Code	ASTM D2487				SC	
Group Name					Clayey sand	
Gravel (%)					0	
Sand (%)					53	
Fines (%)					47	
Tested By	ASTM D2487				Mike Bomar	
Liquid Limit	ASTM D4318				29	
Plastic Limit					17	
Plasticity Index					12	
Preparation Method					Air Dry	
Oversize Removed By					Dry Sieving over No. 40 sieve	
Liquid Limit Apparatus					Mechanical	
Grooving Tool					Plastic	
Rolling					Hand	
Tested By					Morgan Zinn	
Date Tested					10/27/2022	

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
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Material Test Report

Report No: ASM:22-3944
Issue No: 1

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220735

CC: Dowl
Maria Kampsen

Project: Slope Stability

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 11/23/2022

Sample Details

Sample ID	22-3944-S05	22-3944-S06	22-3944-S07
Client Sample ID	TB2 Sa5	TB2 Sa6	TB2 Sa7
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	14	20	17	
Date Tested		10/21/2022	10/21/2022	10/21/2022	
Tested By		Frank Walters	Frank Walters	Frank Walters	
Group Code	ASTM D2487	SC	CL		
Group Name		Clayey sand	Lean clay		
Gravel (%)		0	0		
Sand (%)		63	7		
Fines (%)		37	93		
Tested By	ASTM D2487	Mike Bomar	Stephen Brewer		
Liquid Limit	ASTM D4318	25	35		
Plastic Limit		16	20		
Plasticity Index		9	15		
Preparation Method		Air Dry	Air Dry		
Oversize Removed By		Dry Sieving over No. 40 sieve	Dry Sieving over No. 40 sieve		
Liquid Limit Apparatus		Mechanical	Mechanical		
Grooving Tool		Plastic	Plastic		
Rolling		Hand	Hand		
Tested By		Morgan Zinn	Morgan Zinn		
Date Tested		10/21/2022	10/27/2022		

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
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Material Test Report

Report No: ASM:22-3945
Issue No: 1

The results contained below pertain only to the items tested below. This report should not be reproduced, except in full, without the prior written approval of Alaska Testlab or the agency.

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220735

CC: Dowl
Maria Kampsen

Project: Slope Stability

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 11/2/2022

Sample Details

Sample ID	22-3945-S01	22-3945-S02	22-3945-S03	22-3945-S04
Client Sample ID	TB3 Sa1	TB3 Sa2	TB3 Sa3	TB3 Sa4
Date Sampled				

Other Test Results

Description	Method	Results				Limits
Water Content (%)	ASTM D2216	21	13	8	6	
Date Tested		10/21/2022	10/21/2022	10/21/2022	10/21/2022	
Tested By		Frank Walters	Morgan Zinn	Morgan Zinn	Morgan Zinn	
Percent Gravel	LMA (Internal Method)		49			
Percent Sand			38			
Percent Fines (Silt/Clay)			13			
Group Symbol			GM			
Group Name			Silty gravel with sand			
Tested By			Morgan Zinn			

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
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Material Test Report

Report No: ASM:22-3945
Issue No: 1

Client:	DOWL, LLC 5015 Business Park Blvd. Suite 4000 Anchorage, AK, 99503	Project Code: 220735	**CC:** Dowl Maria Kampsen
Project:	Slope Stability Anchorage, AK, 99503 1136.90097.01		

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 11/2/2022

Sample Details

Sample ID	22-3945-S05	22-3945-S06	22-3945-S07	22-3945-S08
Client Sample ID	TB3 Sa5	TB3 Sa6	TB3 Sa7	TB3 Sa8
Date Sampled				

Other Test Results

Description	Method	Results				Limits
Water Content (%)	ASTM D2216	5	7	13	19	
Date Tested		10/21/2022	10/21/2022	10/21/2022	10/21/2022	
Tested By		Frank Walters	Frank Walters	Frank Walters	Frank Walters	
Percent Gravel	LMA (Internal Method)	47				
Percent Sand		47				
Percent Fines (Silt/Clay)		6				
Group Symbol		SP-SM				
Group Name		Poorly graded sand with silt and gravel				
Tested By		Morgan Zinn				
Group Code	ASTM D2487			SC	CL	
Group Name				Clayey sand with gravel	Lean clay	
Gravel (%)				17	0	
Sand (%)				39	8	
Fines (%)				44	92	
Tested By	ASTM D2487			Morgan Zinn	Mike Bomar	
Liquid Limit	ASTM D4318			29	46	
Plastic Limit				21	21	
Plasticity Index				8	25	
Preparation Method				Air Dry	Air Dry	
Oversize Removed By				Dry Sieving over No. 40 sieve	Dry Sieving over No. 40 sieve	
Liquid Limit Apparatus				Mechanical	Mechanical	
Grooving Tool				Plastic	Plastic	
Rolling				Hand	Hand	
Tested By				Morgan Zinn	Morgan Zinn	
Date Tested				10/27/2022	10/21/2022	

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Material Test Report

Report No: ASM:22-3945
Issue No: 1

The results contained below pertain only to the items tested below. This report should not be reproduced, except in full, without the prior written approval of Alaska Testlab or the agency.

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220735

CC: Dowl
Maria Kampsen

Project: Slope Stability

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 11/2/2022

Sample Details

Sample ID	22-3945-S09
Client Sample ID	TB3 Sa9
Date Sampled	

Other Test Results

Description	Method	Results	Limits
Water Content (%)	ASTM D2216	14	
Date Tested		10/21/2022	
Tested By		Frank Walters	
Group Code	ASTM D2487		
Group Name			
Atterberg Limits Estimated			
Tested By			
Method	ASTM D6913		
Preparation Method			
Composite Sieving?			
Separating Sieve(s)			
Cu	ASTM D2487		
Cc			

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

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4040 B Street, Suite 102
Anchorage, AK 99503
Phone: 907-205-1987
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Material Test Report

Report No: ASM:22-3688
Issue No: 1

The results contained below pertain only to the items tested below. This report should not be reproduced, except in full, without the prior written approval of Alaska Testlab or the agency.

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220712

CC: Geotech
Maria Kampsen

Project: Coal Creek Crossing

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 10/11/2022

Sample Details

Sample ID	22-3688-S01	22-3688-S02	22-3688-S03	22-3688-S04	22-3688-S05
Client Sample ID	TB-4 Sa1	TB-4 Sa2	TB-4 Sa3	TB-4 Sa4	TB-4 Sa5
Date Sampled					

Other Test Results

Description	Method	Results					Limits
Water Content (%)	ASTM D2216	5	3	5	5	4	
Date Tested		9/29/2022	9/29/2022	9/29/2022	9/29/2022	9/29/2022	
Tested By		Morgan Zinn	Morgan Zinn	Morgan Zinn	Morgan Zinn	Morgan Zinn	
Percent Gravel	LMA (Internal Method)		66		56		
Percent Sand			29		37		
Percent Fines (Silt/Clay)			5		7		
Group Symbol			GP-GM		GP-GM		
Group Name			Poorly graded gravel with silt and sand		Poorly graded gravel with silt and sand		
Tested By			MZ 9/30/2022		MZ 9/30/2022		

Comments

N/A

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
Phone: 907-205-1987
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Material Test Report

Report No: ASM:22-3688
Issue No: 1

Client:	DOWL, LLC 5015 Business Park Blvd. Suite 4000 Anchorage, AK, 99503	Project Code: 220712	**CC:** Geotech Maria Kampsen
Project:	Coal Creek Crossing Anchorage, AK, 99503 1136.90097.01		

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 10/11/2022

Sample Details

Sample ID	22-3688-S06	22-3688-S07	22-3688-S08	22-3688-S09	22-3688-S10
Client Sample ID	TB-4 Sa6	TB-4 Sa7	TB-4 Sa8	TB-4 Sa9	TB-4 Sa10
Date Sampled					

Particle Size Distribution

Method:
ASTM D 422

Description:
Analysis of Particle Size Distribution in Soils. Sieving for Particles >75µm, Hydrometer

Drying By:

Washed:
Sample Washed

Sieve Size	% Passing (S06)	(S07)	(S08)	(S09)	(S10)	Limits
3in				100		
2in				100		
1½in				100		
1in				97		
¾in				92		
½in				82		
3/8in				76		
No.4				59		
No.10				41		
No.20				33		
No.40				29		
No.60				26		
No.100				23		
No.200				19		
Finer No.200 (75µm)				18.9		

Other Test Results

Description	Method	Results (S06)	(S07)	(S08)	(S09)	(S10)	Limits
Water Content (%)	ASTM D2216	4	4	5	5	6	
Date Tested		9/29/2022	9/29/2022	9/29/2022	9/29/2022	9/29/2022	
Tested By		Morgan Zinn	Morgan Zinn	Morgan Zinn	Morgan Zinn	Morgan Zinn	
Percent Gravel	LMA (Internal Method)		42				
Percent Sand			51				
Percent Fines (Silt/Clay)			7				
Group Symbol			SP-SM				
Group Name			Poorly graded sand with silt and gravel				
Tested By			MZ 9/30/2022				
Dispersion device	ASTM D 422				Dispersant by hand		
Dispersion time (min)							
Shape							
Hardness							
Group Code	ASTM D2487				GM		
Group Name					Silty gravel with sand		
Liquid Limit					0		
Plasticity Index					0		
Gravel (%)					41		
Sand (%)					40		
Fines (%)					19		
Tested By	ASTM D2487				Cindy Zickefoose		

Comments

N/A

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Material Test Report

Report No: ASM:22-3688
Issue No: 1

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220712

CC: Geotech
Maria Kampsen

Project: Coal Creek Crossing

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 10/11/2022

Sample Details

Sample ID	22-3688-S11	22-3688-S12	22-3688-S13	22-3688-S14	22-3688-S15
Client Sample ID	TB-4 Sa11	TB-4 Sa12	TB-4 Sa13	TB-4 Sa14	TB-4 Sa15
Date Sampled					

Particle Size Distribution

Method:
ASTM D 422

Description:
Analysis of Particle Size Distribution in Soils. Sieving for Particles >75µm, Hydrometer

Drying By:

Washed:
Sample Washed

Sieve Size	% Passing					Limits
3in				100		
2in				100		
1½in				100		
1in				94		
¾in				89		
½in				82		
3/8in				75		
No.4				58		
No.10				42		
No.20				35		
No.40				29		
No.60				25		
No.100				20		
No.200				15		
Finer No.200 (75µm)				14.9		

Other Test Results

Description	Method	Results					Limits
Water Content (%)	ASTM D2216	7	4	4	5	7	
Date Tested		9/29/2022	9/29/2022	9/29/2022	9/29/2022	9/29/2022	
Tested By		Morgan Zinn	Morgan Zinn	Morgan Zinn	Morgan Zinn	Morgan Zinn	
Dispersion device	ASTM D 422				Dispersant by hand		
Dispersion time (min)							
Shape							
Hardness							
Group Code	ASTM D2487				SM		
Group Name					Silty sand with gravel		
Atterberg Limits Estimated					Yes		
Gravel (%)					42		
Sand (%)					43		
Fines (%)					15		
Tested By	ASTM D2487				Cindy Zickefoose		

Comments

N/A

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Material Test Report

Report No: MAT:22-3688-S09
Issue No: 1

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220712

CC: Geotech
Maria Kampsen

Project: Coal Creek Crossing

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 10/11/2022

Sample Details

Sample ID 22-3688-S09
Client Sample ID TB-4 Sa9
Specification Sieve SOILS

Other Test Results

Description	Method	Result	Limits
	ASTM D 422		
Dispersion device		Dispersant by hand	
Dispersion time (min)			
Shape			
Hardness			
Water Content (%)	ASTM D2216	5	
Date Tested		9/29/2022	
Tested By		Morgan Zinn	
Group Code	ASTM D2487	GM	
Group Name		Silty gravel with sand	
Liquid Limit		0	
Plasticity Index		0	
Gravel (%)		41	
Sand (%)		40	
Fines (%)		19	
	ASTM D2487		
Tested By		Cindy Zickefoose	
Date Tested		10/10/2022	

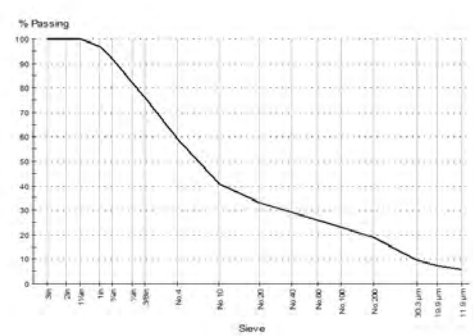
Particle Size Distribution

Method: ASTM D 422

Date Tested: 10/10/2022
Tested By: Cindy Zickefoose

Sieve Size	% Passing	Limits
3in	100	
2in	100	
1½in	100	
1in	97	
¾in	92	
½in	82	
3/8in	76	
No.4	59	
No.10	41	
No.20	33	
No.40	29	
No.60	26	
No.100	23	
No.200	19	
Finer No.200 (75µm)	18.9	
30.3 µm	9.4	
19.9 µm	7.6	
11.9 µm	5.8	

Chart



Comments

N/A

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Material Test Report

Report No: MAT:22-3688-S14
Issue No: 1

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220712

CC: Geotech
Maria Kampsen

Project: Coal Creek Crossing

Anchorage, AK, 99503
1136.90097.01

Maria E Kampsen

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 10/11/2022

Sample Details

Sample ID	22-3688-S14
Client Sample ID	TB-4 Sa14
Specification	Sieve SOILS

Other Test Results

Description	Method	Result	Limits
	ASTM D 422		
Dispersion device		Dispersant by hand	
Dispersion time (min)			
Shape			
Hardness			
Water Content (%)	ASTM D2216	5	
Date Tested		9/29/2022	
Tested By		Morgan Zinn	
Group Code	ASTM D2487	SM	
Group Name		Silty sand with gravel	
Atterberg Limits Estimated		Yes	
Gravel (%)		42	
Sand (%)		43	
Fines (%)		15	
	ASTM D2487		
Tested By		Cindy Zickefoose	
Date Tested		10/10/2022	

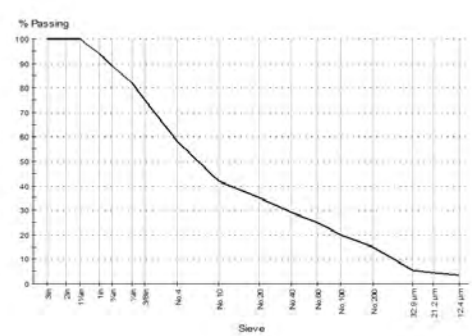
Particle Size Distribution

Method: ASTM D 422

Date Tested: 10/10/2022
Tested By: Cindy Zickefoose

Sieve Size	% Passing	Limits
3in	100	
2in	100	
1½in	100	
1in	94	
¾in	89	
½in	82	
3/8in	75	
No.4	58	
No.10	42	
No.20	35	
No.40	29	
No.60	25	
No.100	20	
No.200	15	
Finer No.200 (75µm)	14.9	
32.9 µm	5.4	
21.2 µm	4.3	
12.4 µm	3.5	

Chart



Comments

Soil Classification of Fines (-#200) in Sieve Analyses Assumed Unless Verified by Additional Testing
No Plasticity Index Test Performed

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Material Test Report

Report No: MAT:22-3689-S03
Issue No: 1

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220712

CC: Geotech
Maria Kampsen

Project: Coal Creek Crossing

Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 10/11/2022

Sample Details

Sample ID	22-3689-S03
Client Sample ID	Bulk-Slide Area Sa1
Specification	Sieve SOILS

Other Test Results

Description	Method	Result	Limits
Date Tested		10/10/2022	

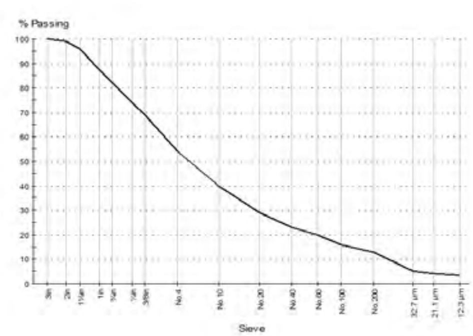
Particle Size Distribution

Method: ASTM D 422

Date Tested: 10/10/2022
Tested By: Mikaela Maroney

Sieve Size	% Passing	Limits
3in	100	
2in	99	
1½in	96	
1in	87	
¾in	82	
½in	74	
3/8in	69	
No.4	54	
No.10	40	
No.20	29	
No.40	23	
No.60	20	
No.100	16	
No.200	13	
Finer No.200 (75µm)	13.4	
32.7 µm	5.2	
21.1 µm	4.1	
12.3 µm	3.5	

Chart



Comments

Soil classification of Fines (-#200) in sieve analyses assumed unless verified by additional testing
No Plasticity Index Test Performed

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Proctor Report

Report No: PTR:22-3689-S03
Issue No: 1

Client: DOWL, LLC
5015 Business Park Blvd. Suite 4000
Anchorage, AK, 99503

Project Code: 220712

CC: Geotech
Maria Kampsen

Project: Coal Creek Crossing

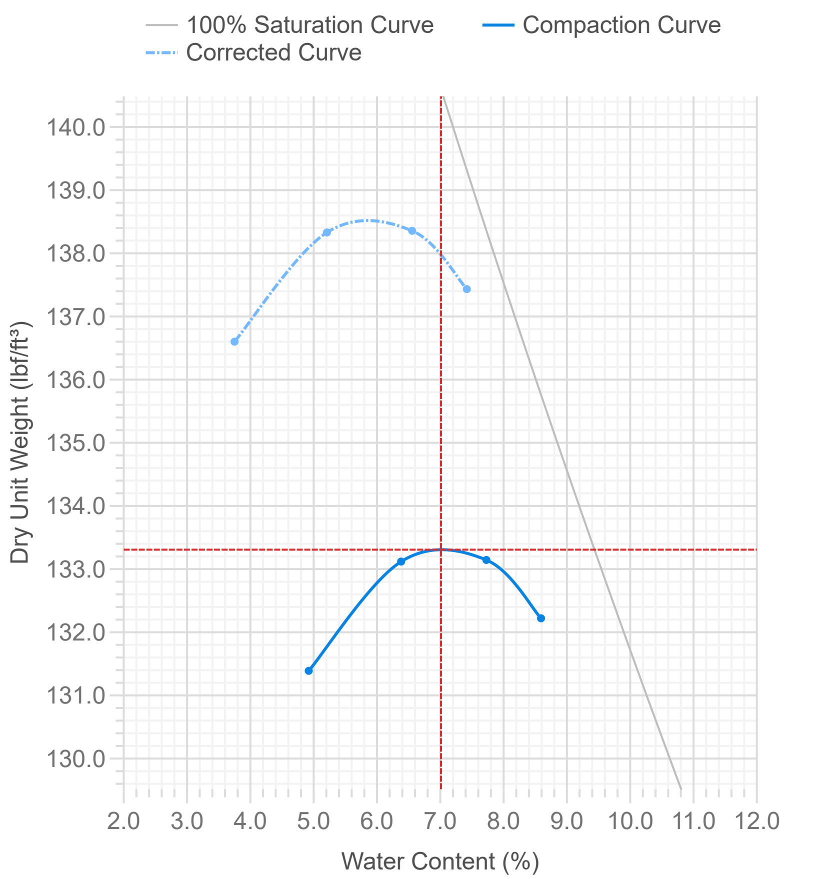
Anchorage, AK, 99503
1136.90097.01

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 10/11/2022

Sample Details

Sample ID: 22-3689-S03
Client Sample ID: Bulk-Slide Area Sa1
Specification: Sieve SOILS

Dry Unit Weight - Water Content Relationship



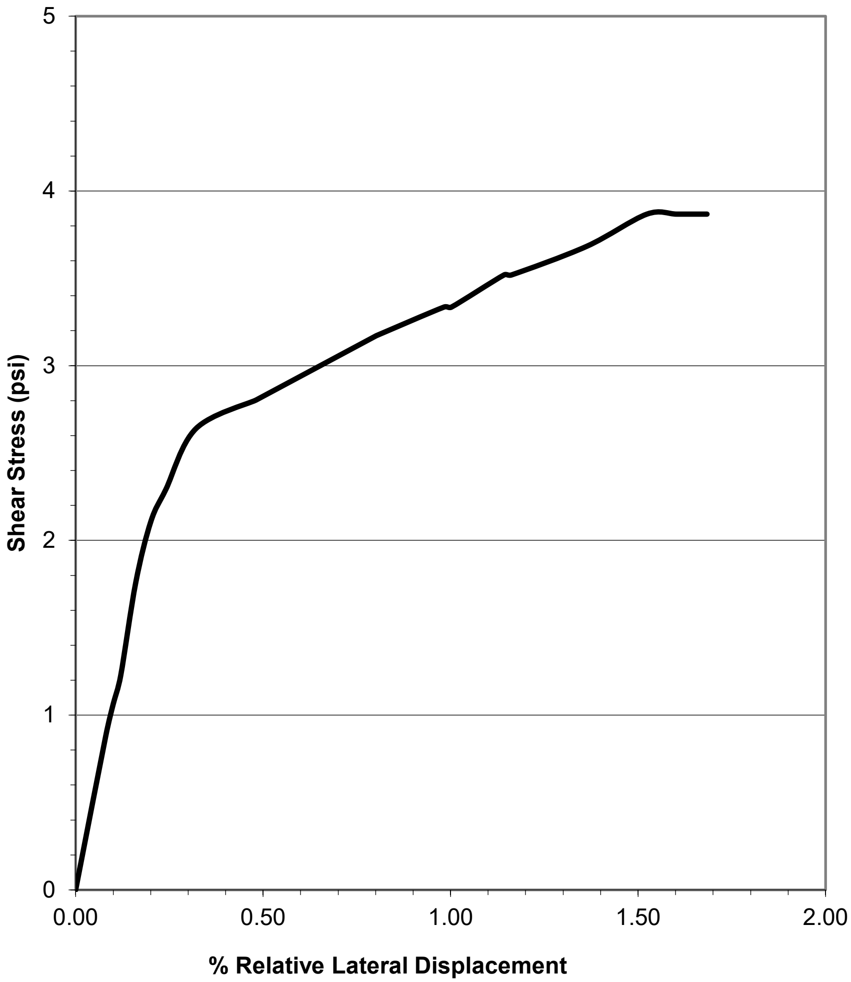
Test Results

ASTM D1557	
Mod. Maximum Dry Unit Weight (lbf/ft³):	**133.3**
Mod. Optimum Water Content (%):	**7.0**
Retained on 3/4″ Sieve (%):	18
Passing 3/4″ Sieve (%):	82
Method:	C
Preparation Method:	Dry
Rammer Type:	Automatic
Test Portion Specific Gravity:	2.68
Determined By:	Assumed
Tested By:	Brodie Smith
Date Tested:	10/6/2022
ASTM D4718	
Corrected Maximum Dry Unit Weight (lbf/ft³):	**138.5**
Corrected Optimum Water Content (%):	**5.8**
Oversize Specific Gravity:	2.70
Oversize Particles (%):	18
ASTM D2487	
Group Code:	GM
Group Name:	Silty gravel with sand
Atterberg Limits Estimated:	Yes

Comments

Alaska Testlab

Project :	Slope Stability
Client:	DOWL,LLC
Project #	220735
Boring #	TB2
Sample #	Sample 5
Initial Dry Density:	129.0 pcf
Normal Stress	7.5 psi
Initial Moisture Content:	14.3 %
Work Order #	22-3944-S05
Date:	November 14, 2022



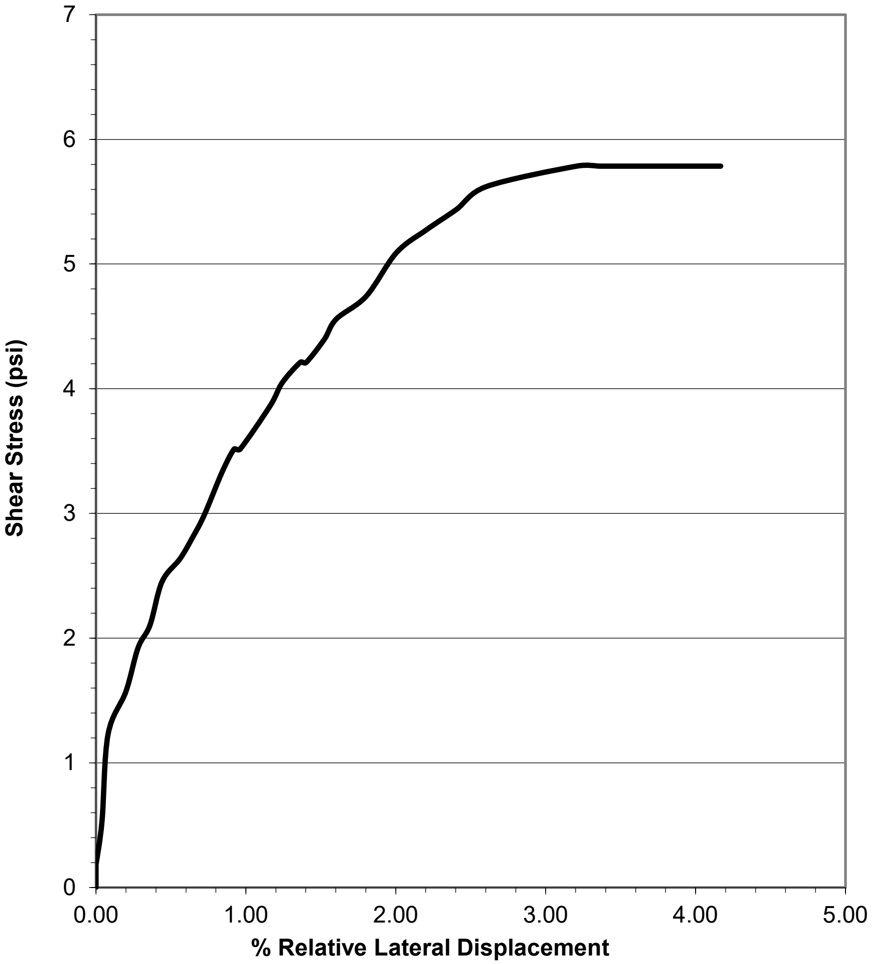
Peak Stress	3.9 psi
Peak Strain	1.8%

Shear Stress Vs. Displacement

WO #	220735
Figure	1

Alaska Testlab

Project :	Slope Stability
Client:	DOWL,LLC
Project #	220735
Boring #	TB2
Sample #	Sample 5
Initial Dry Density:	112.7 pcf
Normal Stress	15.0 psi
Initial Moisture Content:	14.3 %
Work Order #	22-3944-S05
Date:	November 16, 2022

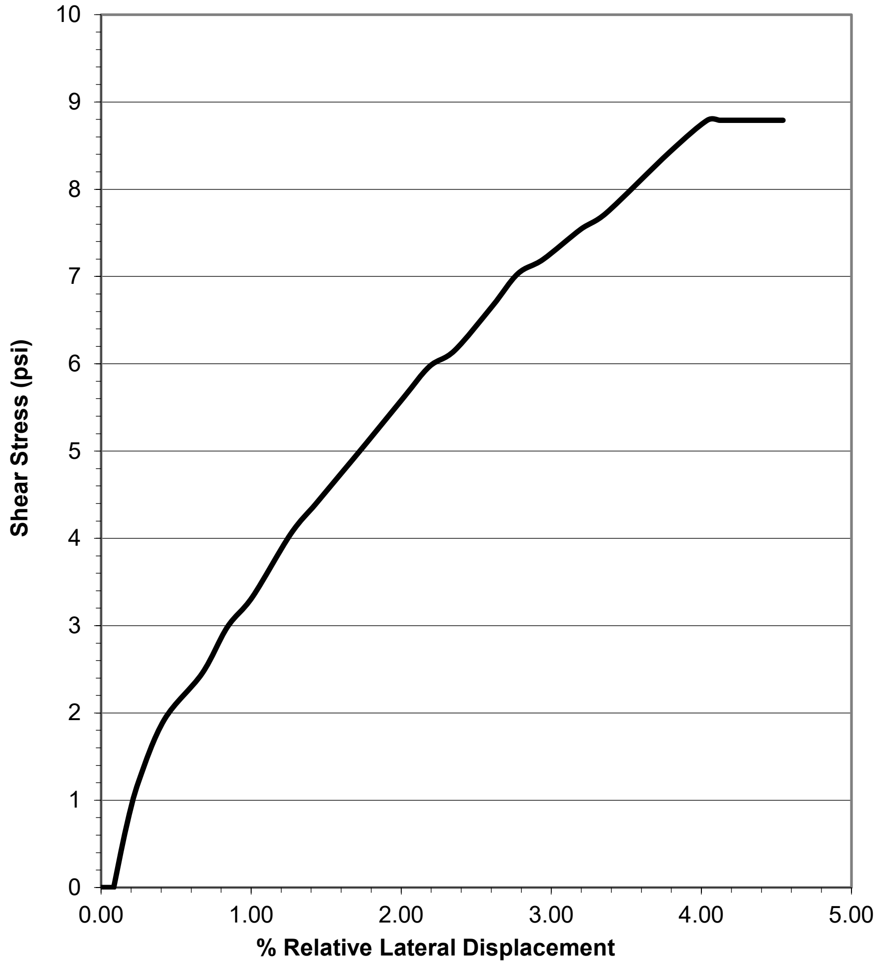


Peak Stress 5.8 psi
Peak Strain 3.2%

	Shear Stress Vs. Displacement	WO #	220735
		Figure	2

Alaska Testlab

Project :	Slope Stability
Client:	DOWL,LLC
Project #	220735
Boring #	TB2
Sample #	Sample 5
Initial Dry Density:	119.2 pcf
Normal Stress	30.0 psi
Initial Moisture Content:	14.0 %
Work Order #	22-3944-S05
Date:	November 21, 2022

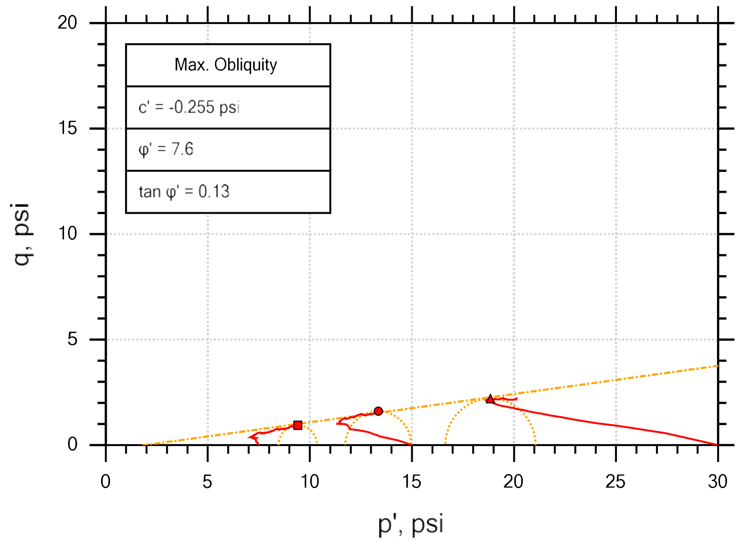


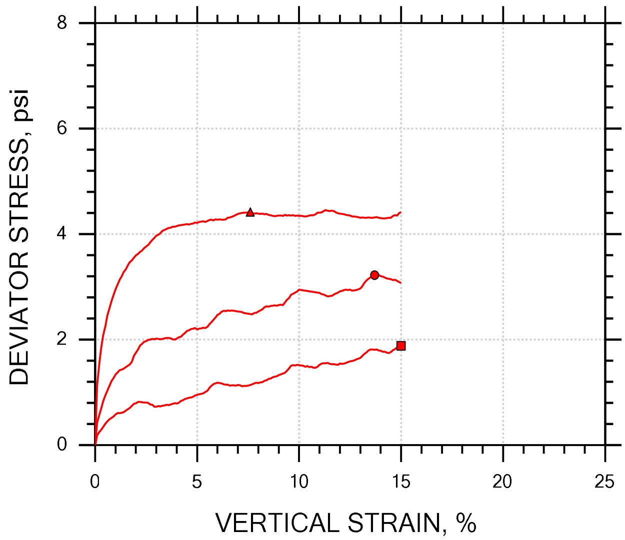
Peak Stress 8.8 psi
Peak Strain 4.0%

Shear Stress Vs. Displacement	WO #	220735
	Figure	3

Client: DOWL, LLC	
Project Name: Slope Stability	
Project Location: Sample 7	
Project Number: 220735	
Tested By: CZ	Checked By: MEK
Boring ID: TB1	
Preparation: Remolded	
Description: Silt with sand, some roots and pebbles	
Classification: Elastic silt with sand	
Group Symbol: MH	
Liquid Limit: 54	Plastic Limit: 30
Plasticity Index: 24	Estimated Specific Gravity: 2.68

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





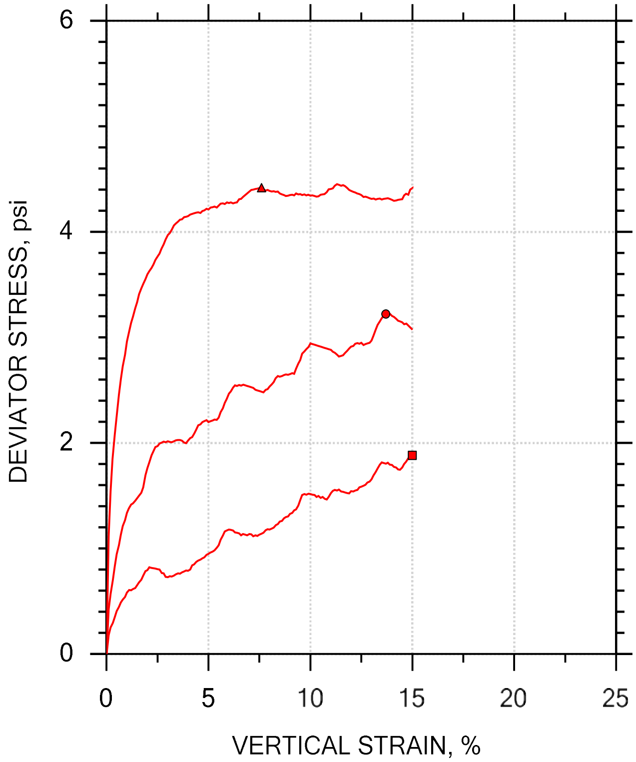
Symbol		■	●	▲	
Sample ID		7	7	7	
Depth, ft		22-23.5	22-23.5	22-23.5	
Test Number		1	2	3	
Initial	Height, in	5.734	5.856	5.903	
	Diameter, in	2.793	2.811	2.803	
	Moisture Content (from Cuttings), %	22.1	24.3	22.5	
	Dry Density, pcf	80.7	78.7	84.5	
	Saturation (Wet Method), %	55.2	57.9	61.6	
	Void Ratio	1.07	1.13	0.979	
Before Shear	Moisture Content, %	22.9	24.3	24.8	
	Dry Density, pcf	104.	101.	100.	
	Cross-sectional Area (Method A), in²	5.222	5.279	6.087	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	0.613	0.652	0.665	
	Back Pressure, psi	46.99	37.99	44.00	
Vertical Effective Consolidation Stress, psi		7.428	14.93	29.66	
Horizontal Effective Consolidation Stress, psi		7.491	15.00	29.99	
Vertical Strain after Consolidation, %		1.676	2.239	11.28	
Volumetric Strain after Consolidation, %		0.8972	3.178	4.798	
Time to 50% Consolidation, min		0.0000	0.0000	0.0000	
Shear Strength, psi		0.9419	1.611	2.210	
Strain at Failure, %		15.0	13.7	7.60	
Strain Rate, %/min		0.02000	0.02000	0.02000	
Deviator Stress at Failure, psi		1.884	3.223	4.420	
Effective Minor Principal Stress at Failure, psi		8.466	11.74	16.64	
Effective Major Principal Stress at Failure, psi		10.35	14.97	21.06	
B-Value		0.97	1.14	1.00	

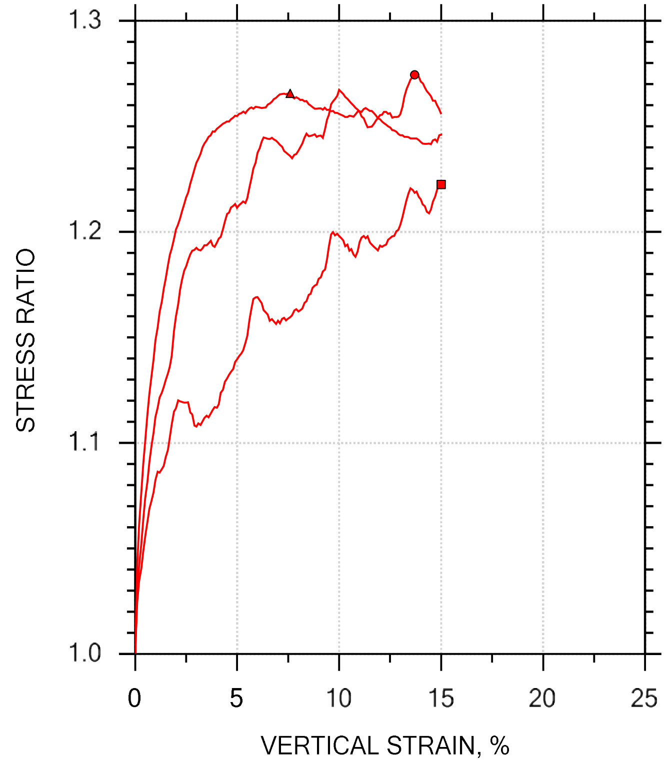
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

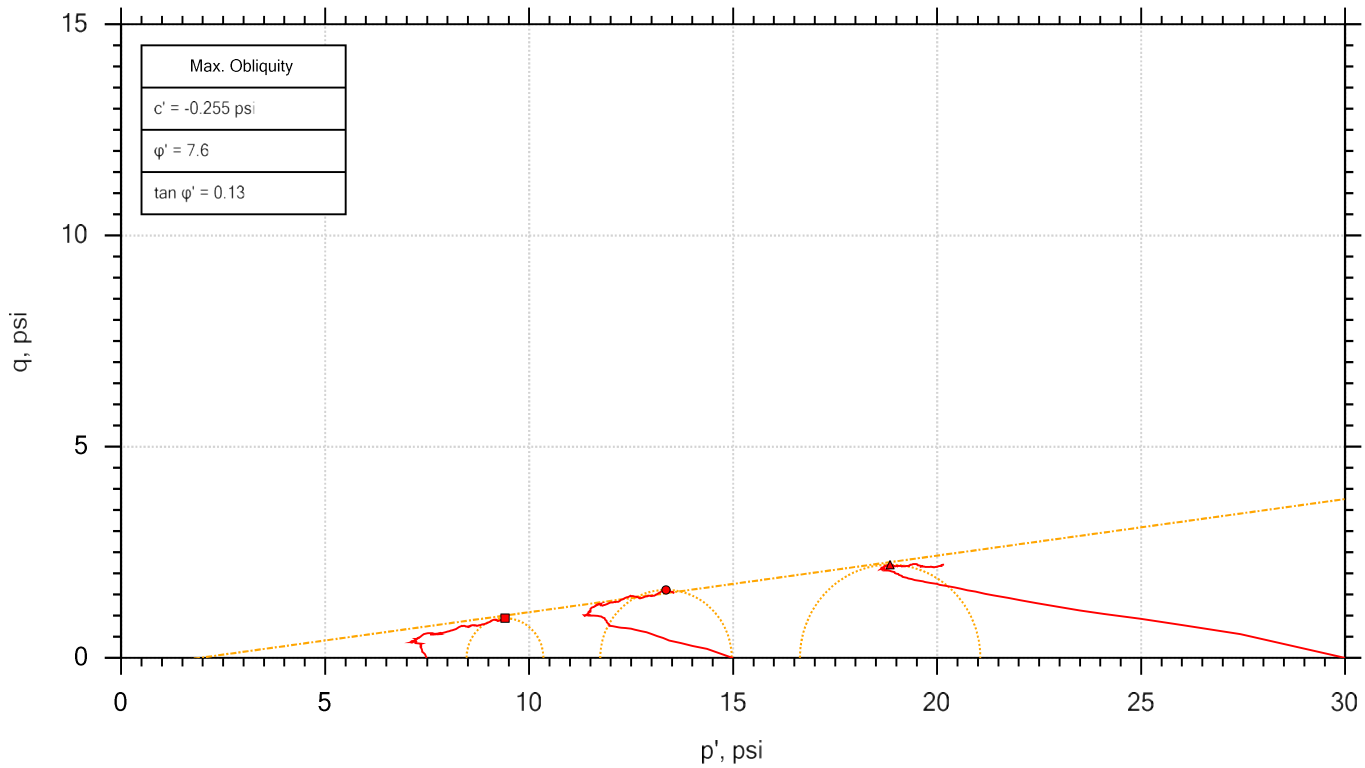
Remarks:

Upon extrusion, it was observed that the sample has some stratification and roots.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







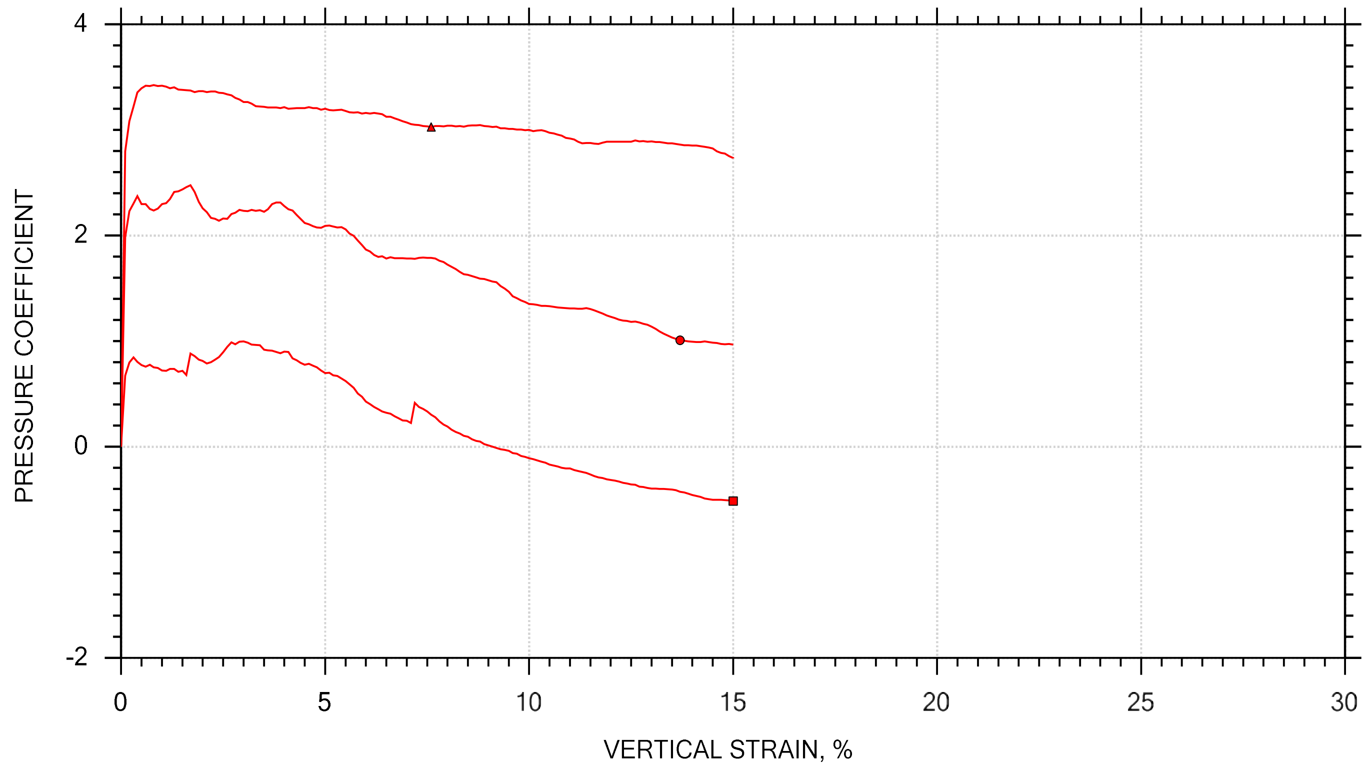
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	7	1	22-23.5	CZ	11/18/2022	MEK	11/19/2022	22-3943-S07_CU_7.5psi_Nov18_completed.dat
●	7	2	22-23.5	CZ	11/22/2022	MEK	11/23/2022	22-3943-S07_CU_15psi_Nov22_completed...dat
▲	7	3	22-23.5	CZ	12/6/2022	MEK	12/8/2022	22-3943-S07_CU_30psi_12.6.22_completed.dat

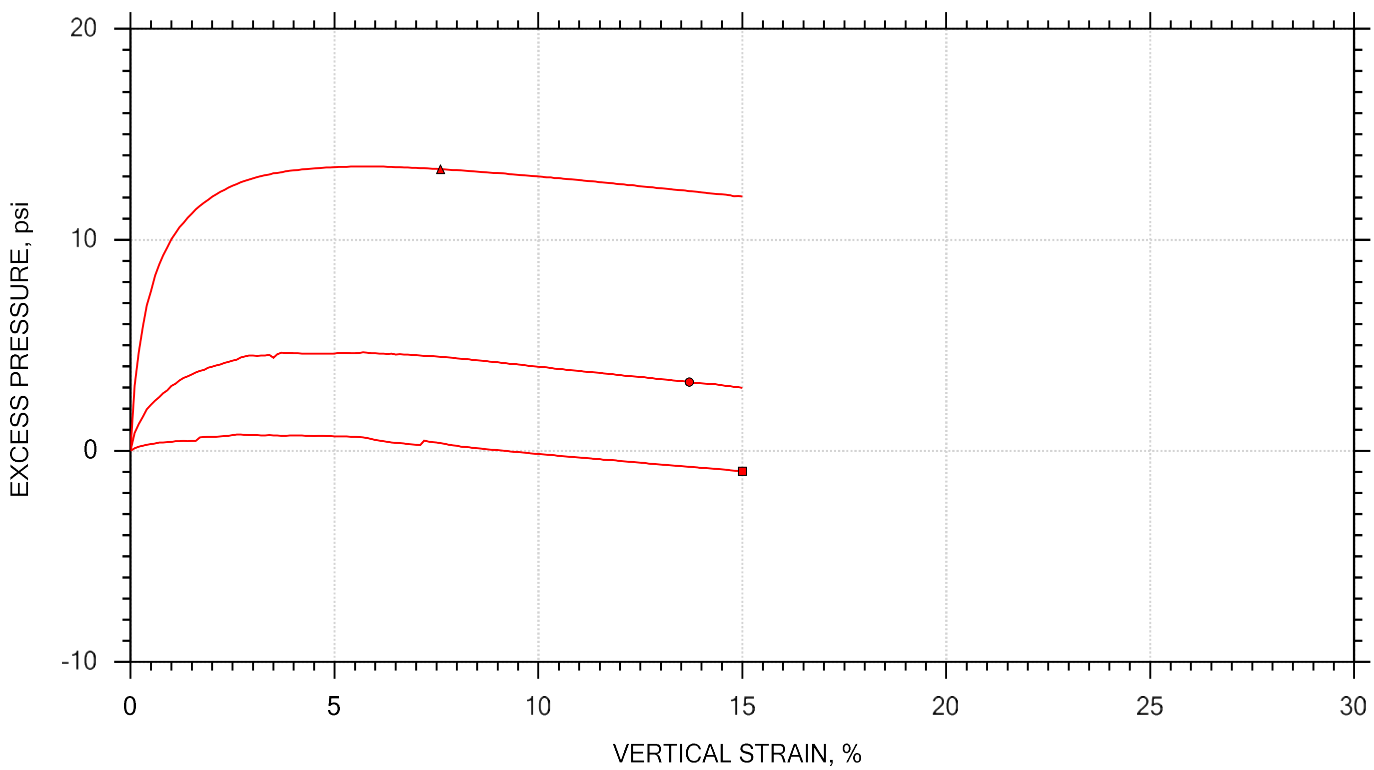
ATL Alaska Testlab

Reviewed By:

Project: Slope Stability	Location: Sample 7	Project No.: 220735
Boring No.: TB1	Sample Type: Remolded	
Description: Silt with sand, some roots and pebbles		
Remarks: Upon extrusion, it was observed that the sample has some stratification and roots.		

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	7	1	22-23.5	CZ	11/18/2022	MEK	11/19/2022	22-3943-S07_CU_7.5psi_Nov18_completed.dat
●	7	2	22-23.5	CZ	11/22/2022	MEK	11/23/2022	22-3943-S07_CU_15psi_Nov22_completed...dat
▲	7	3	22-23.5	CZ	12/6/2022	MEK	12/8/2022	22-3943-S07_CU_30psi_12.6.22_completed.dat

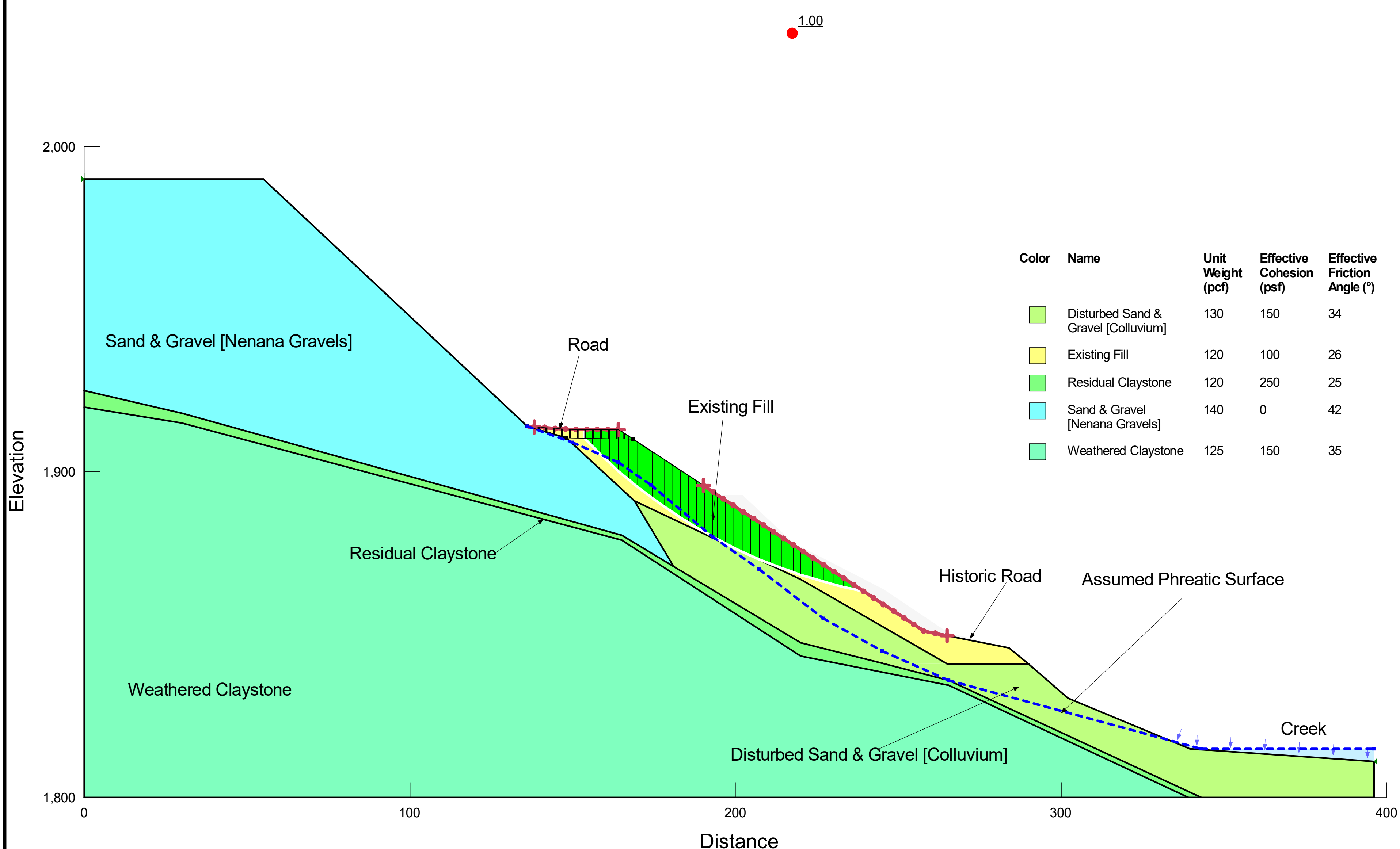
ATL Alaska Testlab

Reviewed by:

Project: Slope Stability	Location: Sample 7	Project No.: 220735
Boring No.: TB1	Sample Type: Remolded	
Description: Silt with sand, some roots and pebbles		
Remarks: Upon extrusion, it was observed that the sample has some stratification and roots.		

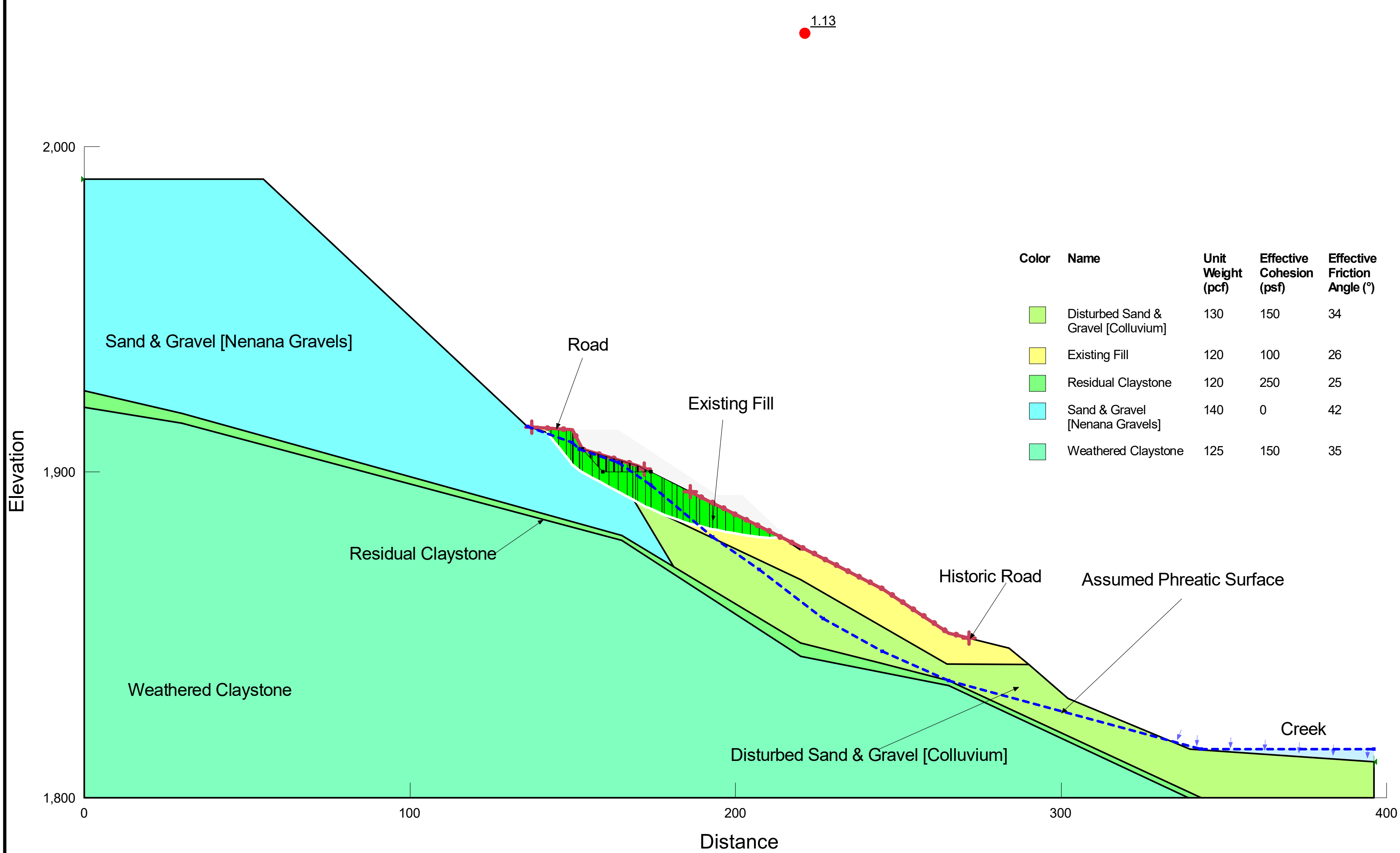
APPENDIX D

Slope Stability Figures and Seismic Data



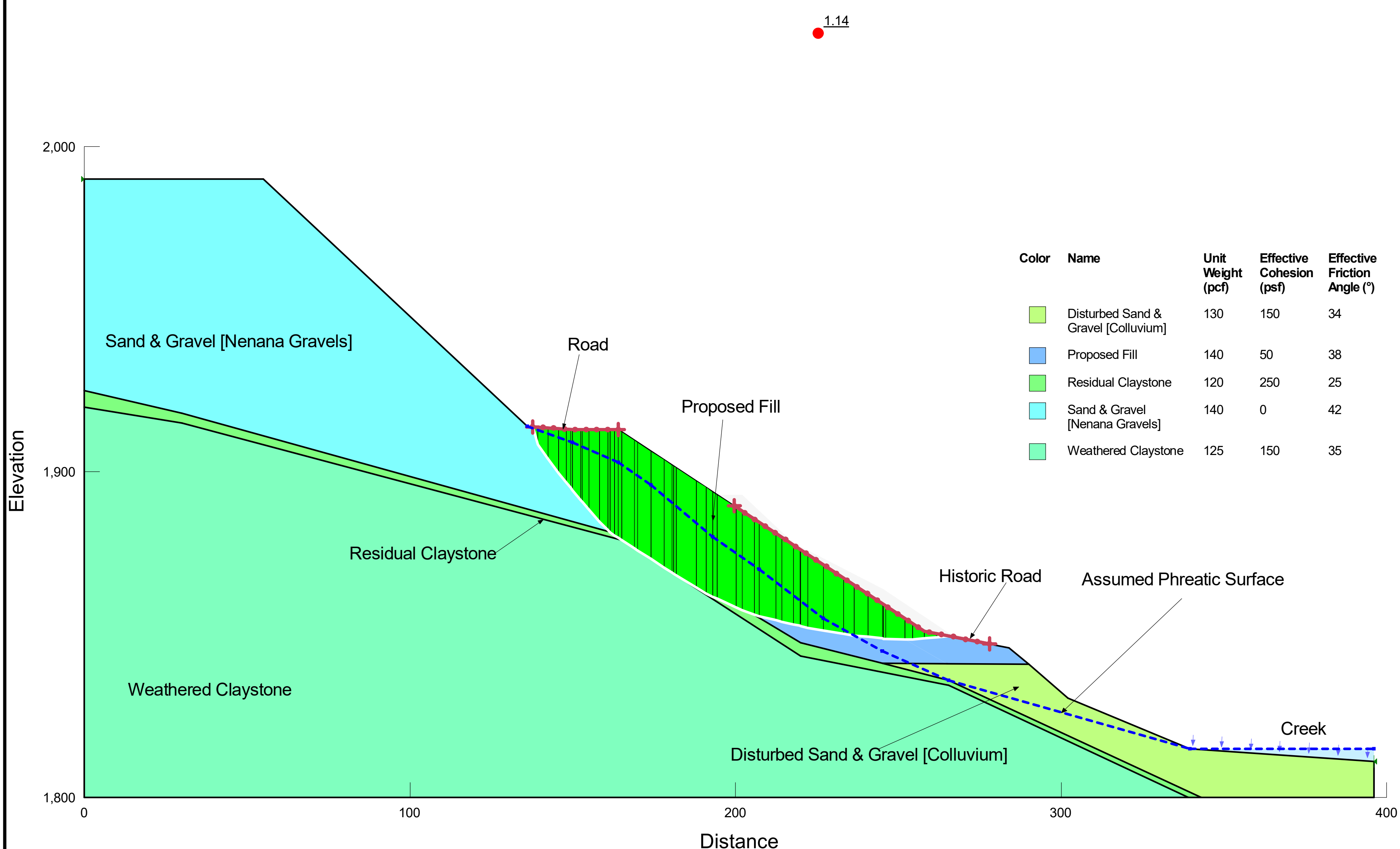
DOWL

Slope Stability - Original Ground and Calibration	Kind: SLOPE/W
Coal Creek Slope Stability - V2.gsz	Method: Spencer
12/07/2022	U.S. Customary Units



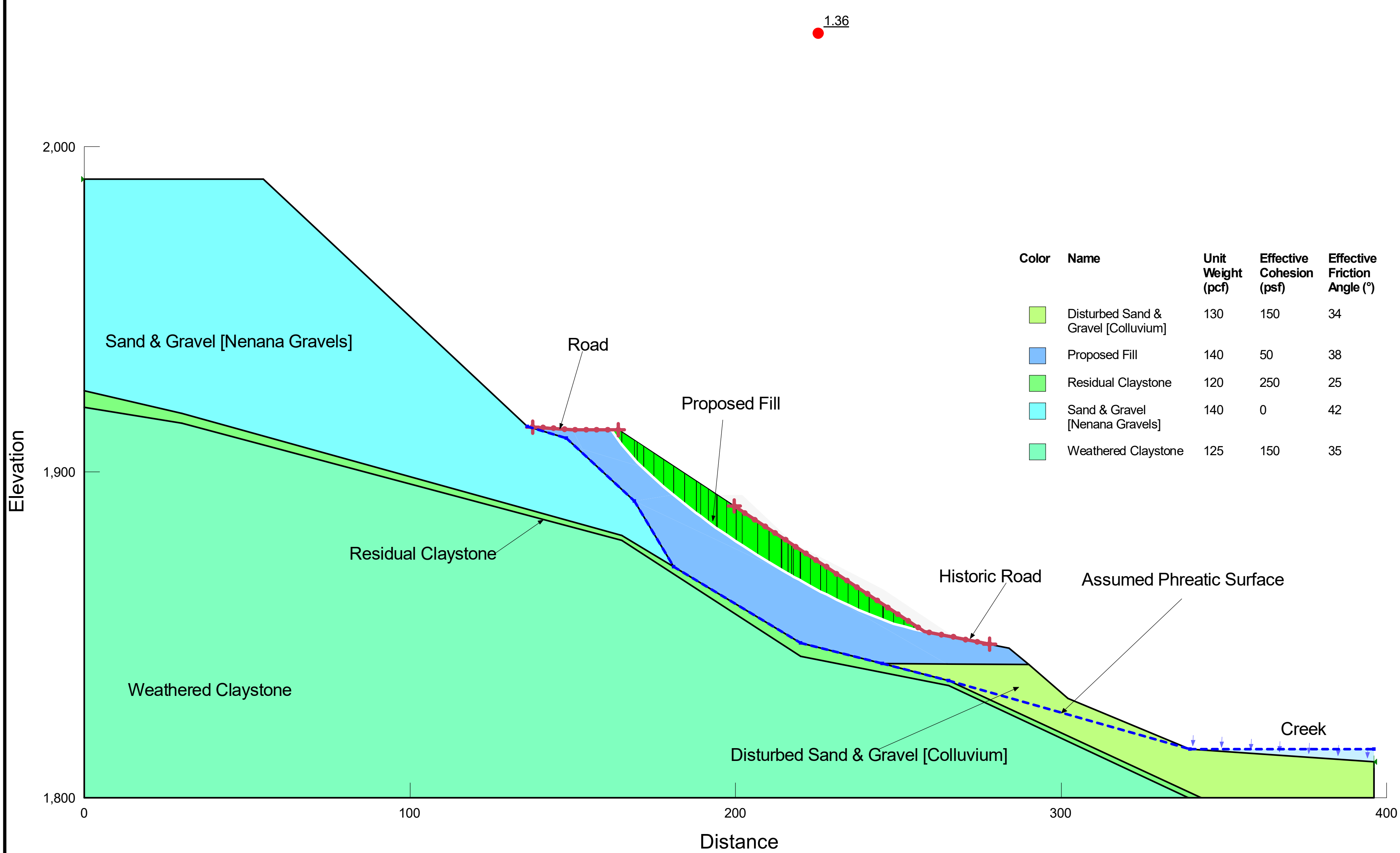
DOWL

Slope Stability - Existing	Kind: SLOPE/W
Coal Creek Slope Stability - V2.gsz	Method: Spencer
12/07/2022	U.S. Customary Units



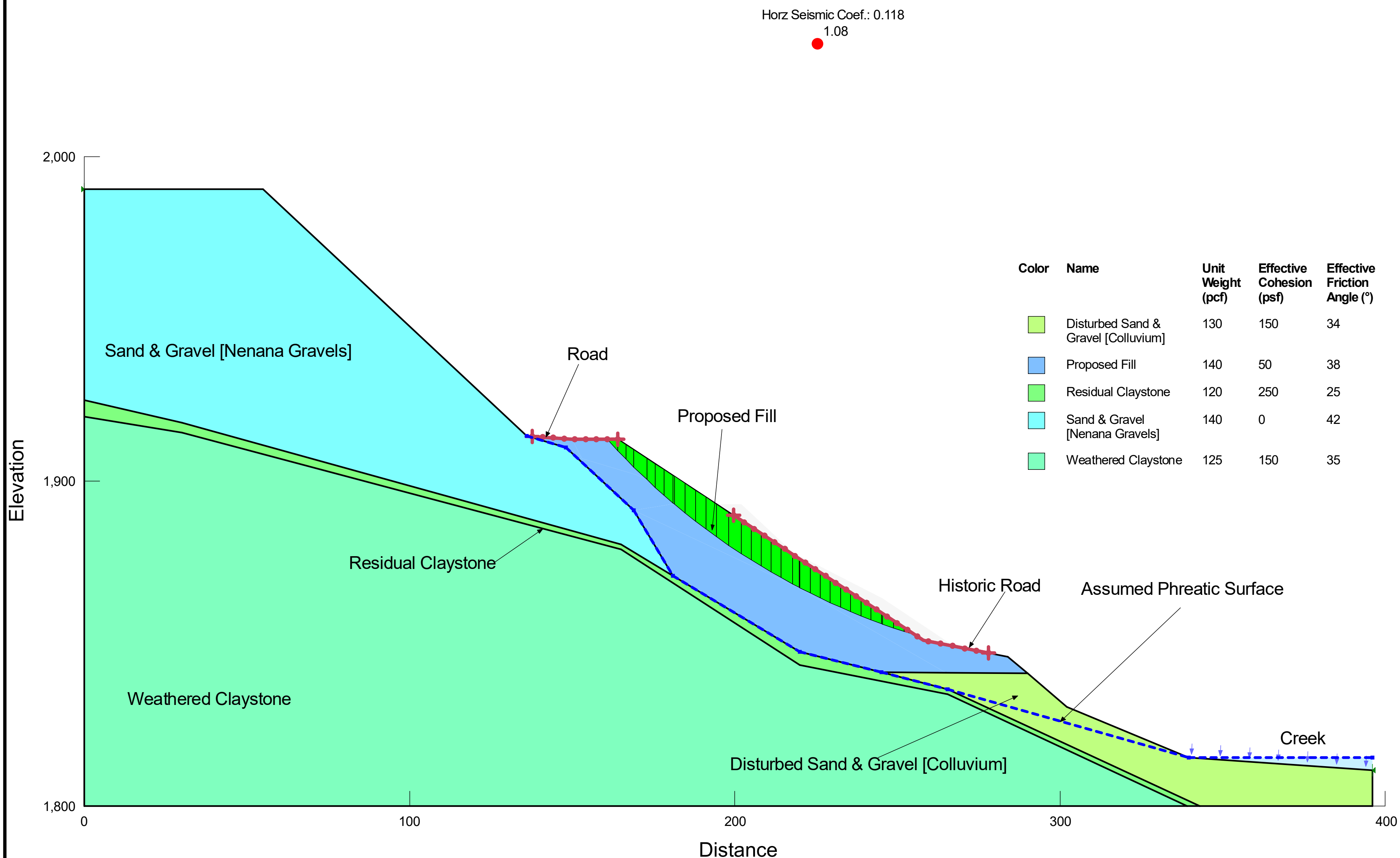
DOWL

Slope Stability - Recommended Mitigation w/o drain	Kind: SLOPE/W
Coal Creek Slope Stability - V2.gsz	Method: Spencer
12/07/2022	U.S. Customary Units

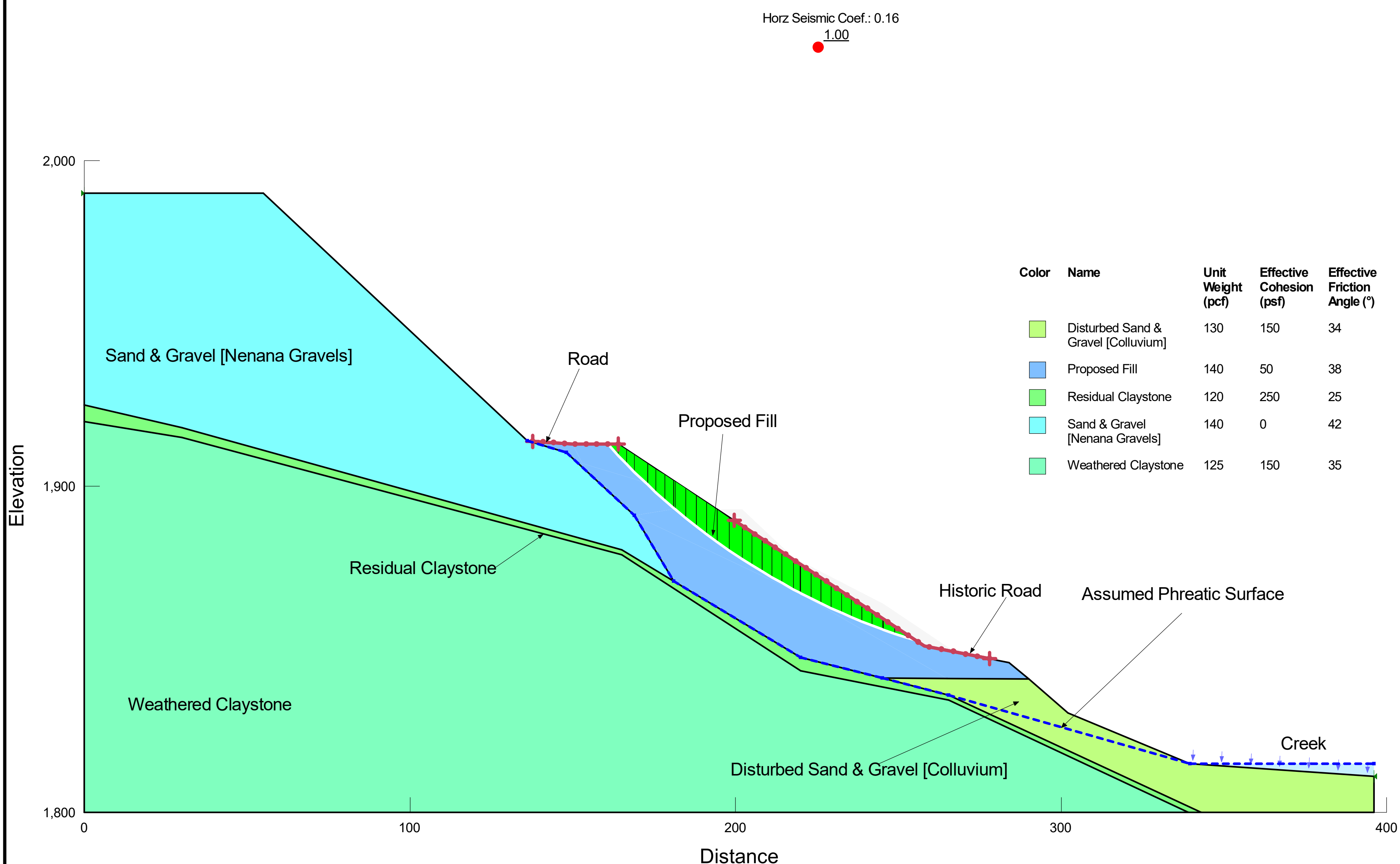


DOWL

Slope Stability - Recommended Mitigation	Kind: SLOPE/W
Coal Creek Slope Stability - V2.gsz	Method: Spencer
12/07/2022	U.S. Customary Units



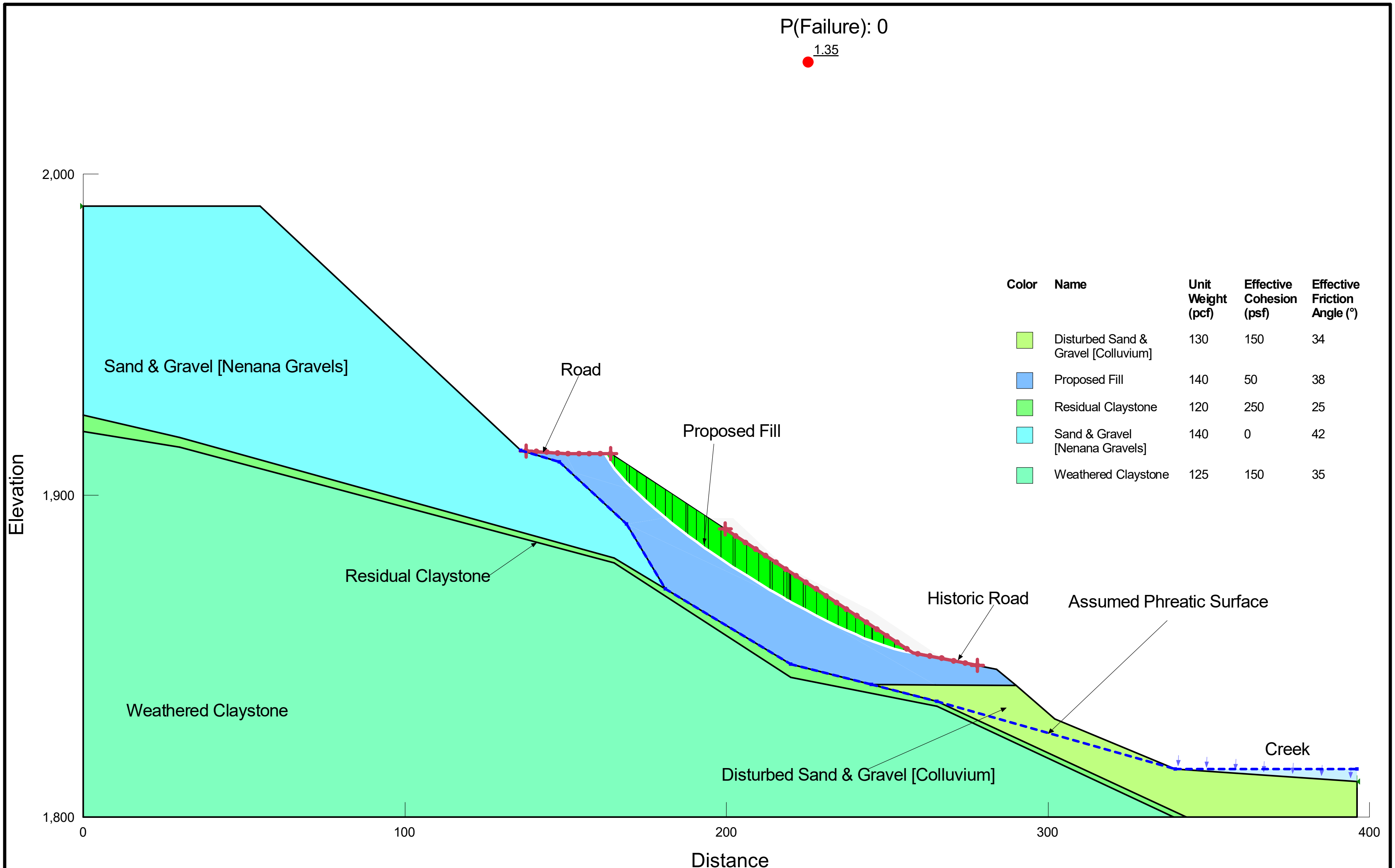
Slope Stability - Recommended Mitigation - 475-year	Kind: SLOPE/W
Coal Creek Slope Stability - V2A.gsz	Method: Spencer
12/14/2022	U.S. Customary Units



Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Disturbed Sand & Gravel [Colluvium]	130	150	34
	Proposed Fill	140	50	38
	Residual Claystone	120	250	25
	Sand & Gravel [Nenana Gravels]	140	0	42
	Weathered Claystone	125	150	35

DOWL

Slope Stability - Recommended Mitigation - Yield Accel	Kind: SLOPE/W
Coal Creek Slope Stability - V2.gsz	Method: Spencer
12/07/2022	U.S. Customary Units

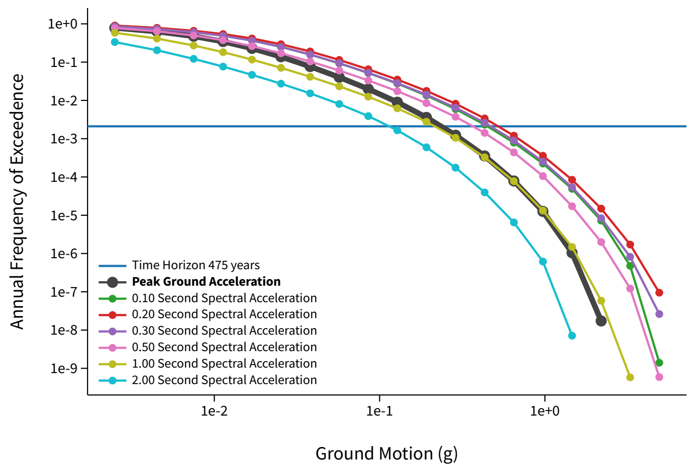


DOWL

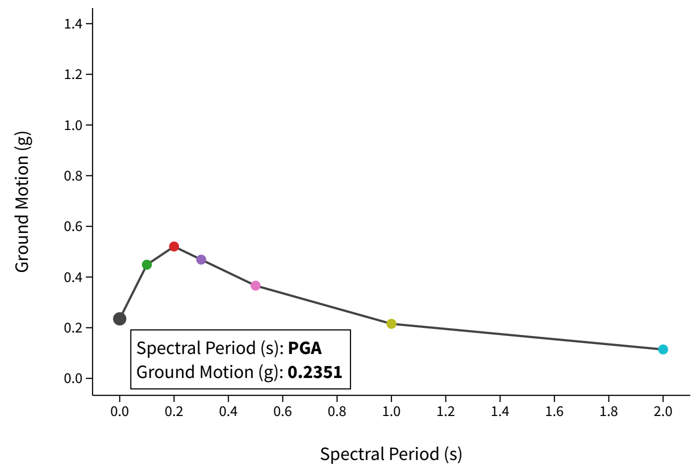
Slope Stability - Recommended Mitigation - Probability	Kind: SLOPE/W
Coal Creek Slope Stability - V2.gsz	Method: Spencer
12/07/2022	U.S. Customary Units

^ Hazard Curve

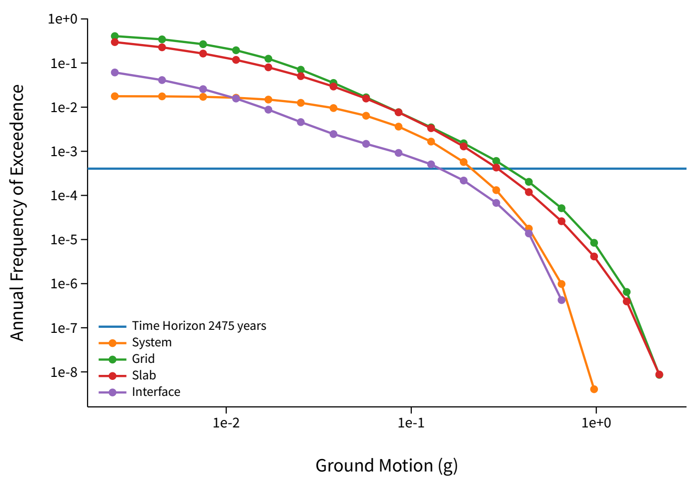
Hazard Curves



Uniform Hazard Response Spectrum



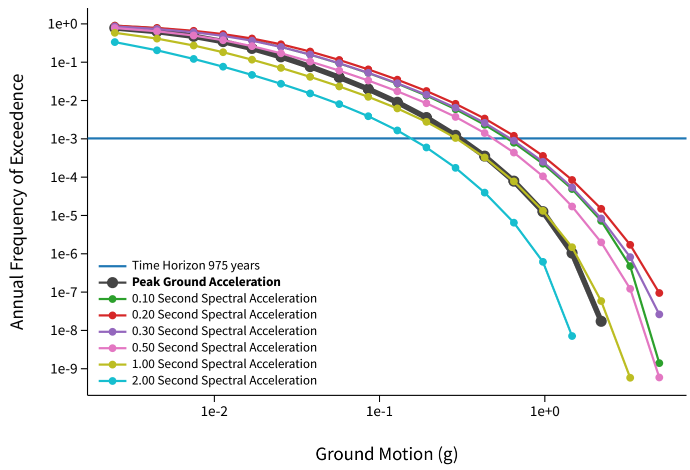
Component Curves for Peak Ground Acceleration



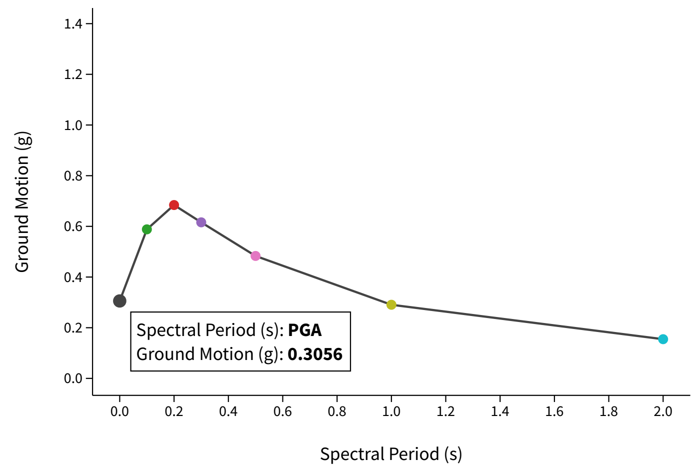
View Raw Data

Hazard Curve

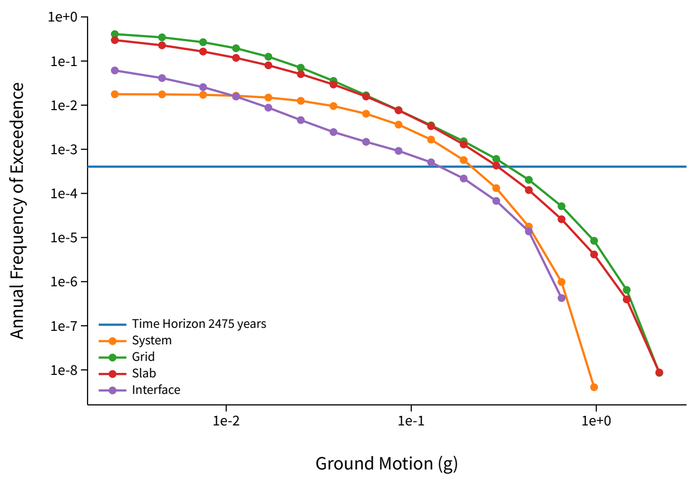
Hazard Curves



Uniform Hazard Response Spectrum



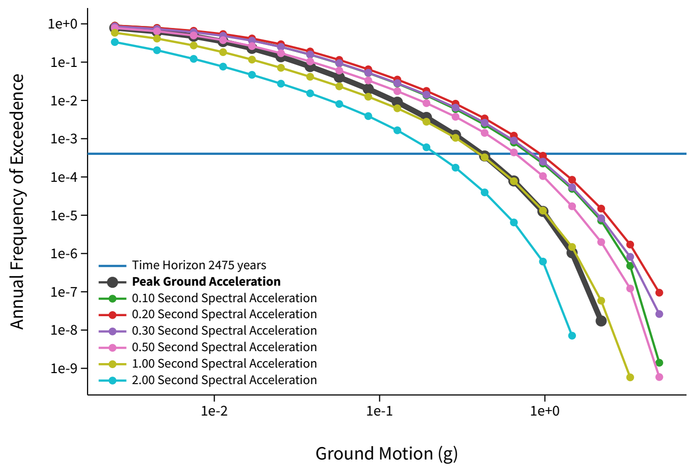
Component Curves for Peak Ground Acceleration



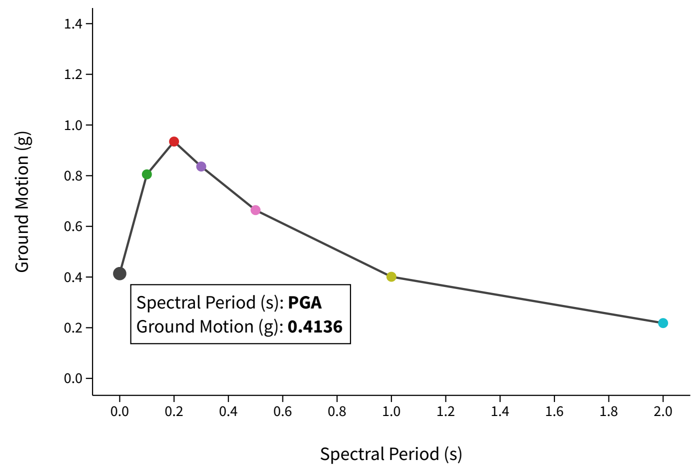
View Raw Data

Hazard Curve

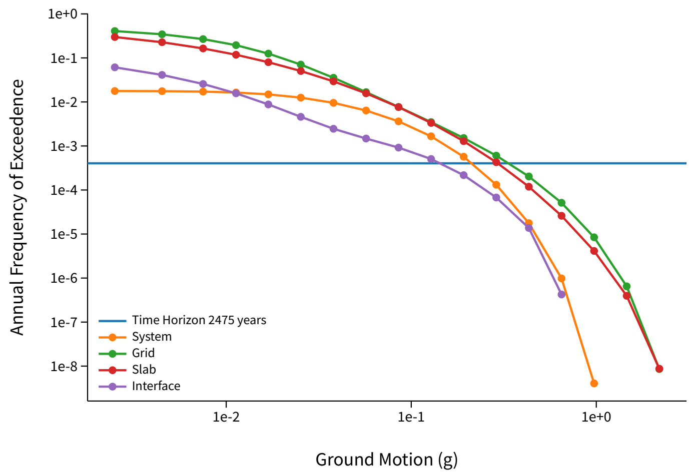
Hazard Curves



Uniform Hazard Response Spectrum



Component Curves for Peak Ground Acceleration



View Raw Data

APPENDIX E

Photographic Log

Coal Creek Slope Stability Project – Site Photographs

October 15 and 16, 2022. DOWL Field Crew: Paul Pribyl

Photo 1. Unstable Slope – Aerial View Southeast

Photo 2. Unstable Slope – Aerial View North-Northwest

Coal Creek Slope Stability Project – Site Photographs

October 15 and 16, 2022. DOWL Field Crew: Paul Pribyl

Photo 3. Unstable Slope – Aerial View West

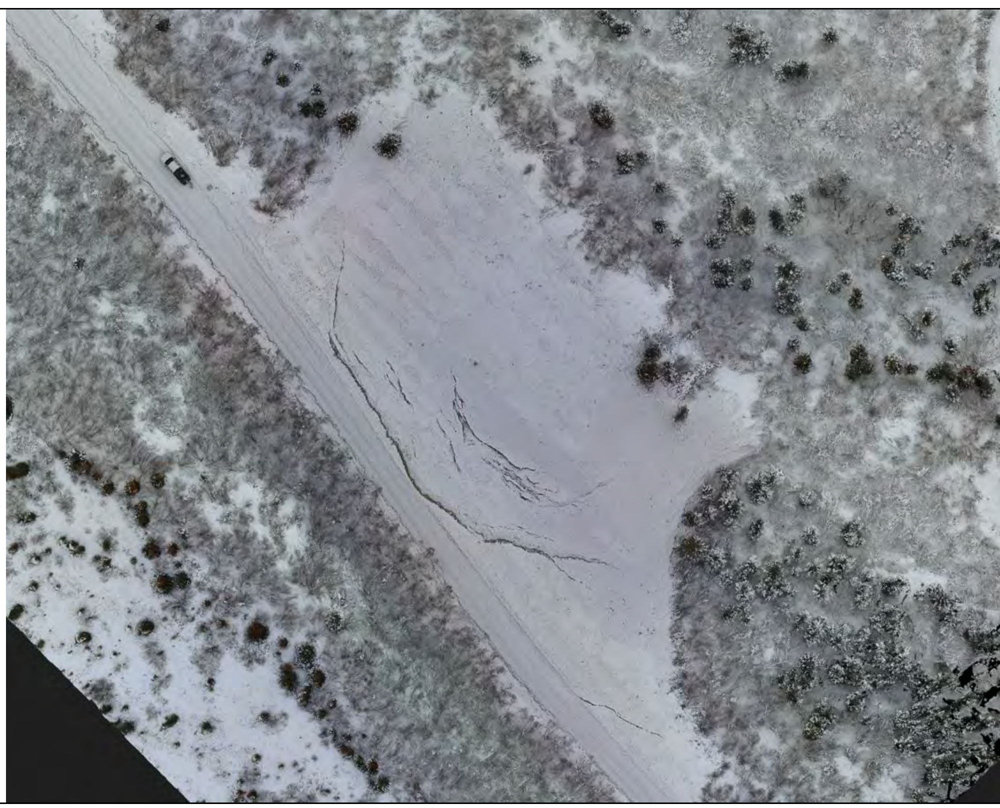


Photo 4. Unstable Slope – Aerial Nadir View

Coal Creek Slope Stability Project – Site Photographs

October 15 and 16, 2022. DOWL Field Crew: Paul Pribyl

Photo 5. Unstable Slope – Site Visit – View Southeast

Photo 6. Unstable Slope – Site Visit – View Northwest

Photo 7. Unstable Slope – Site Visit – View Northwest from Southeast Toe

Photo 8. Unstable Slope – Material Exposed in Scarp

Coal Creek Slope Stability Project – Site Photographs

October 15 and 16, 2022. DOWL Field Crew: Paul Pribyl

Photo 9. Slope Investigation – Aerial View South with Tests Boring Locations Shown

Photo 10. Slope Investigation – Nadir Aerial View with Tests Boring Locations Shown

Photo 11. Slope Investigation – Test Boring 1 Location

Photo 12. Slope Investigation – View Northwest of Access Path to Test Boring 2

Coal Creek Slope Stability Project – Site Photographs

October 15 and 16, 2022. DOWL Field Crew: Paul Pribyl

Photo 13. Slope Investigation – Test Boring 2 Location at Toe of Fill

Photo 14. Slope Investigation – View Southeast at Toe of Fill and Leaning Trees

Photo 15. Slope Investigation – Photo #1 of Toe Material Exposed Upslope of Test Boring 2

Photo 16. Slope Investigation – Photo #2 of Toe Material Exposed Upslope of Test Boring 2

Photo 17. Slope Investigation – Photo #3 of Toe Material Exposed Upslope of Test Boring 2

Photo 17. Slope Investigation – Claystone Material with Planar and Curved Discontinuities