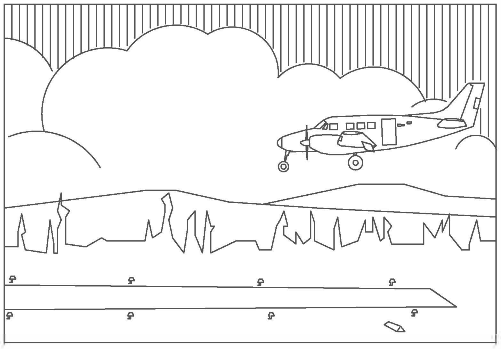
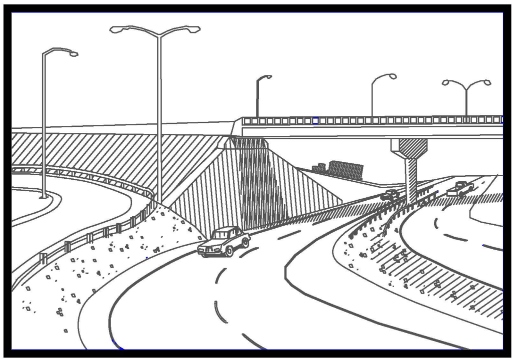
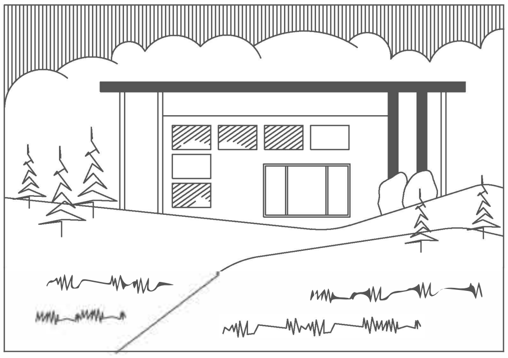
Geotechnical Report

PARKS HIGHWAY MILEPOST 315-325 RECONSTRUCTION: PHASE 3

PROJECT NO. Z606570000   FEDERAL NO. 0A45028







STATE OF ALASKA

Department of Transportation
and Public Facilities

NORTHERN REGION

AUGUST 2021

GEOTECHNICAL REPORT
PARKS HIGHWAY MIILEPOST 315-325
RECONSTRUCTION: PHASE 3

PROJECT NO: Z606570000
FEDERAL NO: 0A45028
AUGUST 2021

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TABLE OF CONTENTS

LIST OF FIGURES iii
LIST OF TABLES iii
INTRODUCTION 2
SUMMARY 2
OTHER REPORTS AND INVESTIGATIONS 3
PHYSICAL SETTING 4
  Climate 4
  Physiography and Topography 5
  Geology 5
  Seismicity 5
FIELD INVESTIGATION 8
SUBSURFACE FINDINGS 8
    Realignment/Cut (Figures 4 and 5) 8
    Seismic Refraction Survey Correlation to Realignment/Cut Test Holes: 12
    Realignment/Fill (Figure 6): 14
COMMENTS AND RECOMMENDATIONS 17
    Realignment/Cut 17
    Realignment/Fill 17
REFERENCES 19
APPENDIX A-TEST HOLE LOGS 20
APPENDIX B-GEOPHYSICS: SEISMIC REFRACTION SURVEY 48
    2019 Seismic Refraction Surveys: 49
    2021 Seismic Refraction Survey: 53
    Seismic Refraction Survey Correlation to Realignment/Cut Test Holes: 55
APPENDIX C-SYMBOLS AND DEFINITIONS 58

LIST OF FIGURES

Figure 1. Phase 3 Test Hole Locations 1
Figure 2. Geologic Map of Project Area..6
Figure 3. Seismic Map of Project Area..7
Figure 4. Realignment/Cut TH21-015 Location..10
Figure 5. Realignment/Cut TH21-016 to TH21-018 Locations..11
Figure 6. Realignment/Fill TH21-006 to TH21-014 Locations..15

LIST OF TABLES

Table 1. Climate Summary Data for Nenana, Alaska from 1981 to 2010..4
Table 2. Thawing and Freezing Indices for Nenana, Alaska..4
Table 3. Realignment/Cut Test Hole Descriptions 9
Table 4. Realignment/Fill Test Hole Descriptions 16

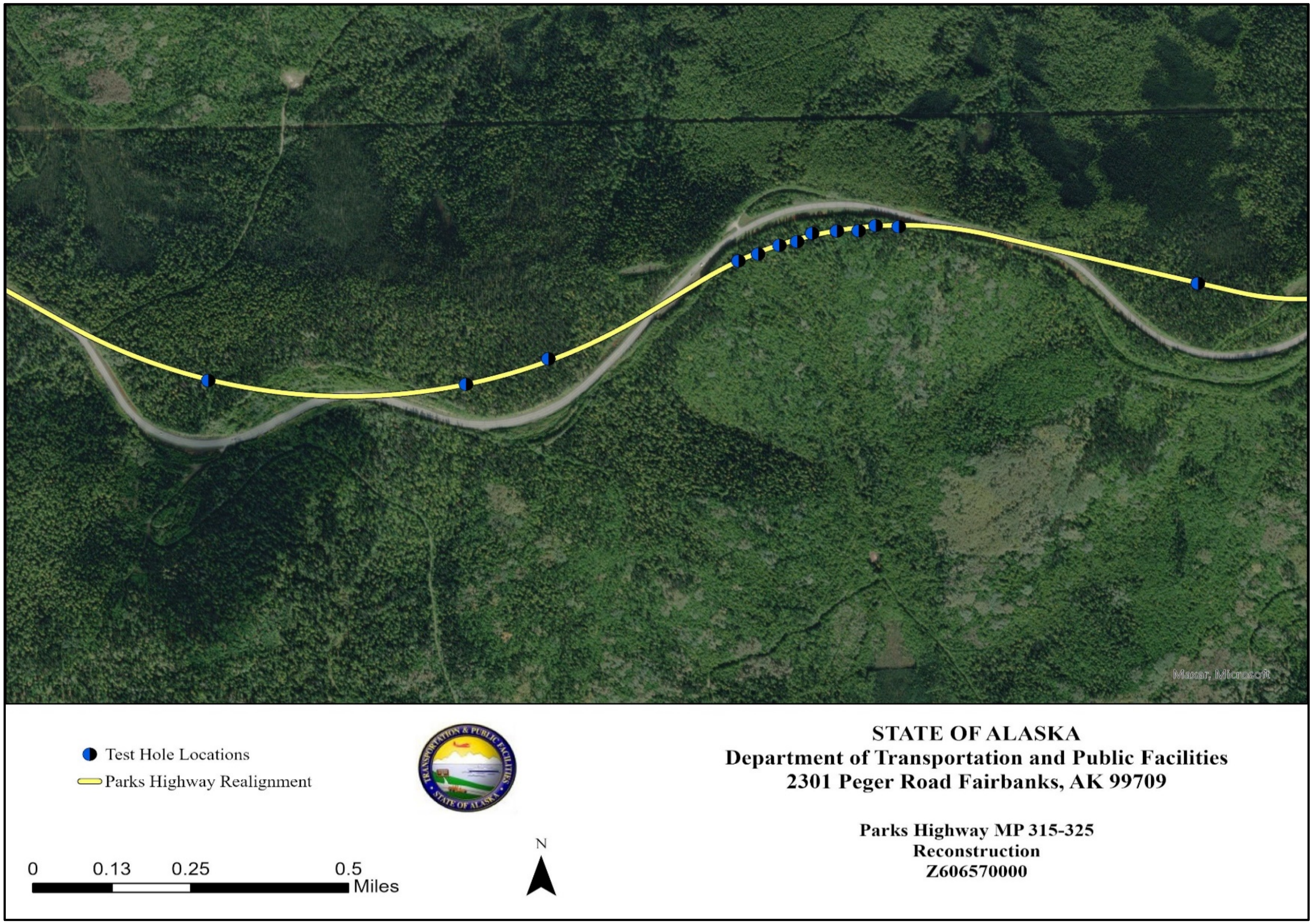


Figure 1. Phase 3 Test Hole Locations.

INTRODUCTION

This report documents physical site and subsurface conditions, provides interpretation of anticipated site conditions, and recommends design and construction criteria for the project. This report is intended to serve as a geotechnical guide during project design and a geotechnical reference during construction.

The Alaska Department of Transportation and Public Facilities (DOT&PF) is planning to reconstruct the Parks Highway from MP 315 to 325. This project will include construction of major realignments involving deep cuts and fills, along with grade changes and drainage improvements. This preliminary memorandum has been prepared to summarize the third phase of a geotechnical investigation for this project.

This phase of the investigation was performed to gather more detailed information where the major realignments will occur (Figure 1). These realignments have changed slightly since 2019 when the first phase of the investigation took place. Northern Region Material Sections cored four test holes where large cuts will take place in bedrock to confirm the presence of non-rippable bedrock seen in seismic refraction surveys performed in 2019 and 2021. Nine test holes were also drilled to determine the thickness of silt overburden in an area of the realignment where large amounts of fill will be placed.

SUMMARY

This geotechnical investigation took place in June and July 2021 and included coring several test holes in the large bedrock cut areas and drilling several shallow test holes in a large fill area. During Phase 1 of this investigation in 2019, both the large cut and fill areas were drilled. Since the first investigation, these realignments have changed slightly, and it was determined additional drilling would be beneficial for the following reasons:

1. Large cuts in bedrock are planned in three areas of the realignment. During the 2019 investigation, rock coring took place in the three areas where the deepest cuts were planned. TH19-022 experienced difficult drilling before reaching depth, the core tooling then became lodged in the test hole at approximately 138 feet. TH19-023 was able to reach the depth needed, 90 feet. TH19-024 started experiencing the same difficult drilling as seen in TH19-022 before depth was reached and drilling was stopped. Seismic refraction surveys were performed along sections of the realignment for TH19-022 and TH19-023 in 2019. The location of these surveys were on the previous realignment between former Station 1553+00 to 1570+00 and former Station 1577+00 to 1590+00. The results of these surveys showed TH19-022 terminated in bedrock that increased in seismic velocity. This higher seismic velocity may indicate more competent bedrock which is believed to be what caused the difficult drilling. Seismic velocities in the bedrock where TH19-023 was drilled were consistent, as the coring results confirmed; however, the survey did show higher seismic velocity in bedrock surrounding the test hole. An additional seismic refraction survey was performed in June 2021 along the realignment where TH19-024 was drilled. The results of this survey showed the difficult drilling experienced in this test hole location was most likely for the same reason as in TH19-022, a transition into more competent, higher seismic velocity bedrock from the

highly weathered, lower seismic velocity schist that the rest of the test hole encountered. The higher seismic velocity bedrock identified by the seismic refraction survey is considered marginally rippable to non-rippable material. NRMS felt additional coring in these areas would be beneficial in confirming the presence of potentially non-rippable material.

2. There are two areas of this realignment where large fills will be constructed. In the final Geotechnical Report that included data and recommendations for Phase 1 and 2 of this investigation recommendations for these large fills included removal of the loose, relatively high moisture-content silty overburden as it may be susceptible to consolidation, lateral spreading, and downslope movement in areas with steep gradients. Revisions of the realignment have moved one section of the large fill slightly downslope. Due to this revision, NRMS drilled additional test holes using a Tanaka hand auger to verify whether the thickness of the silty overburden was consistent with what was encountered on the previous realignment.

The following summarizes the subsurface conditions encountered in this investigation:

Realignment/Cut (Stations 1485+00 to 1509+00 and 1550+00 to 1592+00, Figures 4 and 5):

Four test holes, TH21-015 to TH21-018, were cored in the bedrock cuts for the realignment. These test holes encountered 2 to 3 inches of organic mat, 3 inches to 1.75 feet of silt, and schist bedrock. The mineral composition of the schist bedrock included varying mixtures of muscovite, graphite, garnet, and biotite. The presence of non-rippable material was confirmed with this coring and the seismic refraction surveys performed in 2019 and 2021.

Realignment/Fill (Station 1520+00 to 1540+00, Figure 6):

Nine test holes, TH21-006 to TH21-014, were drilled to determine the thickness of silty soil overlying weathered bedrock. These test holes encountered 2 to 6 inches of organic mat underlain by 2 to 5 feet of silt. The silt overlies highly to completely weathered micaceous schist. The results of this drilling are consistent to the drilling performed in Phase 1 of this investigation.

OTHER REPORTS AND INVESTIGATIONS

Simpson, J., 2021, Parks Highway Milepost 315-325 Reconstruction Project No. Z7606570000, Federal No. 0A45028. Geotechnical Report, Alaska Department of Transportation and Public Facilities, 214p.

Speeter, G., 2021, Rippability and Shrink/Swell Estimate: Parks Highway Milepost 315-325 Reconstruction. Memorandum, Alaska Department of Transportation and Public Facilities, 3p.

PHYSICAL SETTING

Climate

The project site is located within the continental subarctic climatic zone of Alaska (Hartman and Johnson, 1984), characterized by short, warm summers, long, very cold winters, and low precipitation and humidity. Climate data for Nenana, Alaska was obtained from the Western Region Climate Center (https://wrcc.dri.edu) (Table 1). Air freezing and thawing indices were calculated based on data also obtained from WRCC. The air thawing index, or degree-days above freezing, can be used to calculate the depth of thaw during the year. The air thawing index listed below takes the annual thawing-degree-days (TDD) for the last thirty years and averages them. The design thawing index takes the average of the three warmest (highest) TDD over the last twenty-five years. Likewise, the air freezing index, or degree-days below freezing, can be used to calculate the depth of ground freezing during winter. The air freezing index listed below averages the annual freezing-degree-days (FDD) for the past thirty years. The design freezing index averages the three coldest (highest) FDD for a shorter period, 1986 to 2010, due to missing data prior to 1986. This data is summarized in Table 2.

Table 1. Climate Summary Data for Nenana, Alaska from 1981 to 2010.

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (F)	2.9	8.3	24.2	42.2	60.6	71.7	72.8	65.6	52.4	30.1	9.8	5.9	37.3
Average Min. Temperature (F)	-14.7	-12.4	-1.2	17.5	34.7	44.9	49.2	44.0	33.4	14.4	-6.2	-11.6	16.1
Average Total Precipitation (in.)	0.45	0.37	0.25	0.13	0.51	1.01	1.93	1.83	1.10	0.74	0.72	0.55	9.59

Table 2. Thawing and Freezing Indices for Nenana, Alaska.

Index	**Value**
Air Thawing Index	3261 Fahrenheit Degree-days[1]
Air Freezing Index	5429 Fahrenheit Degree-days[1]
Design Thawing Index	3752 Fahrenheit Degree-days[2]
Design Freezing Index	6334 Fahrenheit Degree-days[2]

1) Calculated from 1981 through 2010 daily average temperatures
2) Calculated from monthly average temperatures from 1986 through 2010 due to missing data prior to 1986

Physiography and Topography

The project is located in the Northern Plateau province called the Yukon-Tanana Upland (Wahrhaftig, 1965). The Upland is characterized by rounded ridges, with gentle side-slopes. Compact, rugged mountains are located in the western and eastern part of the Upland. Valleys are generally flat, alluvium floored, and one-quarter to one-half mile wide. Most streams follow the structural trends of the bedrock, which includes sharp bends and direction reversals around ridges and hard rock. The few lakes in the Upland are mainly thaw lakes in valley floors and low passes. Discontinuous permafrost underlies the entire Upland. There is active periglacial mass-wasting at high altitudes. Ice wedges and pingos are common in valley floors and lower hill slopes (Wahrhaftig, 1965).

Geology

The geology of the Yukon-Tanana Upland in the vicinity of the project site is mainly schist and gneiss of possibly Precambrian age. Small, scattered granitic intrusions are present in the northwest portion of the Upland, and large, irregular batholiths make up much of the southeastern part. Thick deposits of windblown silt overlie the lower slopes of hills and deeper stream gravels in valleys. Alluvial deposits of gold and other metals are common throughout the Upland (Wahrhaftig, 1965). In 2015, the United States Geological Survey (USGS) published a compiled geology map for the state of Alaska. This map shows unconsolidated surficial deposits and pelitic schist and quartzite bedrock in the immediate project vicinity (Figure 2).

Seismicity

The project area is located within the Minto Flats seismic zone, an area of high seismic activity. In the Fairbanks vicinity, a series of north-northeast-trending, left-lateral strike-slip seismic zones have been identified (Rampart, Minto Flats, Fairbanks, Salcha), which are the source of numerous earthquakes each year. Each zone is capable of producing earthquakes greater than magnitude 6.0. The Minto Flats seismic zone is associated with two distinct lineaments of seismicity across the Nenana basin. Figure 3 illustrates USGS reported earthquakes in the last 100 years. According to the USGS Earthquake Hazards Program, a peak ground acceleration of 0.272 g can be expected for the project site.

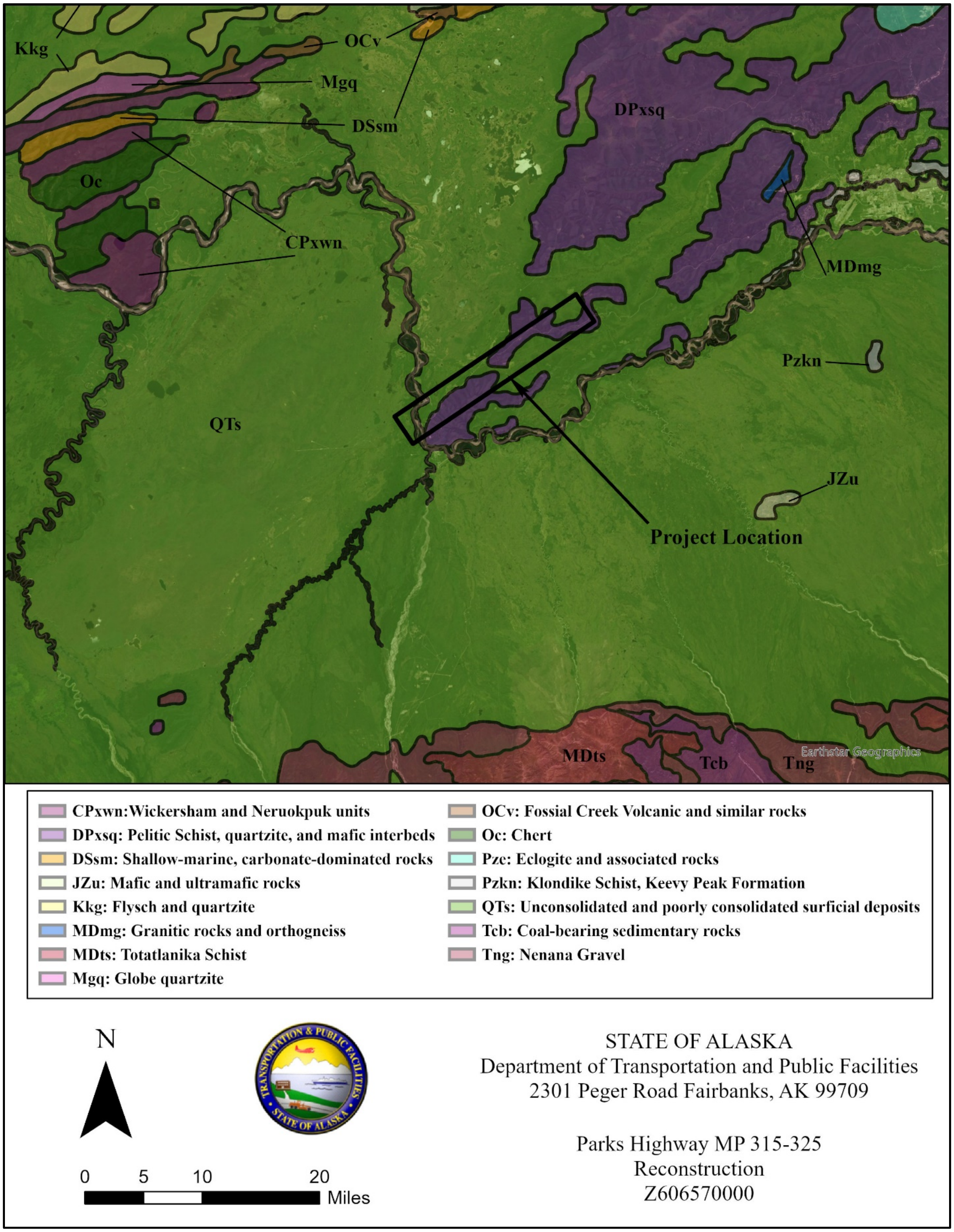
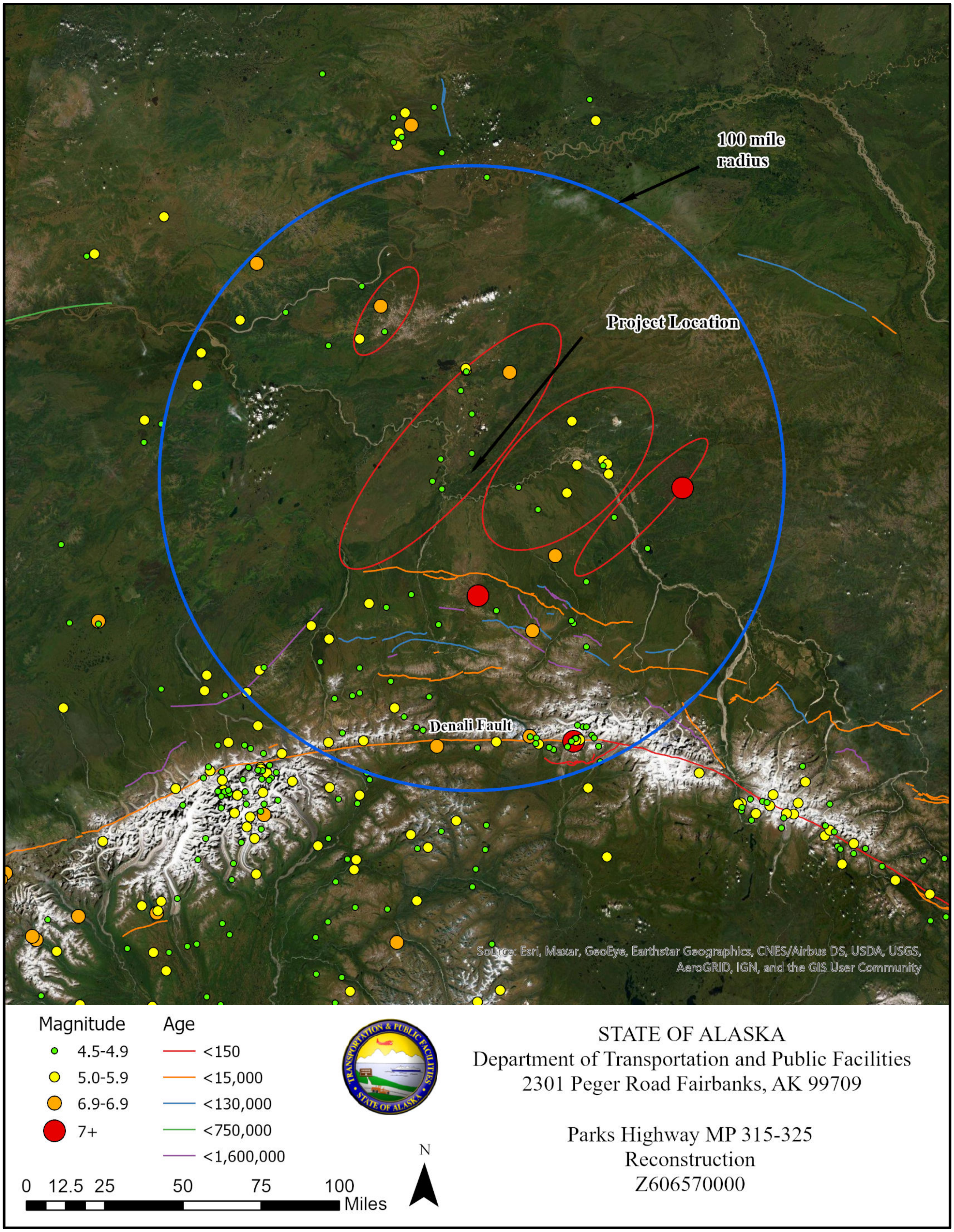


Figure 2. Geologic Map of Project Area.



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3. Seismic Map of Project Area.

FIELD INVESTIGATION

Fieldwork was conducted between in June and July of 2021 by Northern Region Materials Section (NRMS) Engineering Geologist J. Simpson and Drillers P. Lanigan, M. Sousa, T. Hartford, T. Babin, and G. Nelson. Drilling was conducted utilizing a track-mounted CME 850 drill rig with rotary-wash tri-cone and 2 inch rock-core barrels and a Tanaka hand auger with 2 inch solid augers. Samples were collected from split-spoons samplers and rock core barrels. Test hole conditions were logged in the field in accordance with the Unified Soil Classification System (USCS). Test hole locations were recorded with a handheld Garmin GPS 64st, using the North American Datum (NAD) 83, with an accuracy of 50 feet.

Other field investigations included a seismic refraction survey where a realignment of the highway will require large cuts in the bedrock. The survey took place between from approximate Station 1493+40 to 1502+90. This survey was completed by Logic Geophysics and Analytics.

SUBSURFACE FINDINGS

A total of 13 test holes were drilled for this investigation. This included 4 cored test holes and 9 shallow test holes. Figures 2 and 3 show the locations of the cored test holes for the large cut areas and Figure 4 shows the shallow test holes for the large fill areas. Table 3 outlines the subsurface findings from the test holes cored in bedrock. Table 4 outlines the subsurface findings for the shallow test holes showing the amount of silt overlying bedrock.

Realignment/Cut (Figures 4 and 5):

Four test holes were cored to determine the bedrock conditions and confirm the presence of non-rippable material along the revised realignment. These test holes were drilled to depths from 81 to 111 feet below ground surface (bgs). All test holes encountered schist bedrock composed of varying amounts and combinations of graphite, garnet, muscovite, and biotite. Table 3 describes these test holes and Figures 4 and 5 show their locations.

Table 3. Realignment/Cut Test Hole Descriptions.

Test Hole Number	**Depth (ft)**	**Description**	**Comments**
TH21-015	111	• 3" organic mat • 4" silt • ~110.5' schist bedrock	• bedrock composition consisted of varying combinations of graphite, muscovite, quartz, and biotite • biotite and quartz contents increased with depth • bedrock was slightly to completely weathered and generally weak with close fracture spacing • RQD ranged from very poor to good
TH21-016	93.66	• 2" organic mat • 1.67' silt • ~92' schist bedrock	• bedrock composition consisted of varying combinations of graphite, muscovite, garnet, quartz, and biotite • bedrock was slightly to completely weathered and generally medium weak to weak with close fracture spacing • RQD ranged from very poor to fair
TH21-017	81	• 2" organic mat • 1.8' silt •79' schist bedrock	• bedrock composition consisted of varying amounts of muscovite and graphite • majority of bedrock was highly to completely weathered with small areas of slightly to completely weathered • generally very weak with very to extremely close fracture spacing • RQD ranged from very poor to poor
TH21-018	81	• 3" • 15" silt • 79.5' schist bedrock	• bedrock composition consisted of varying combinations of muscovite, quartz, graphite and garnet • bedrock was slightly to completely weathered, generally medium weak to weak with close fracture spacing • RQD ranged from very poor to fair

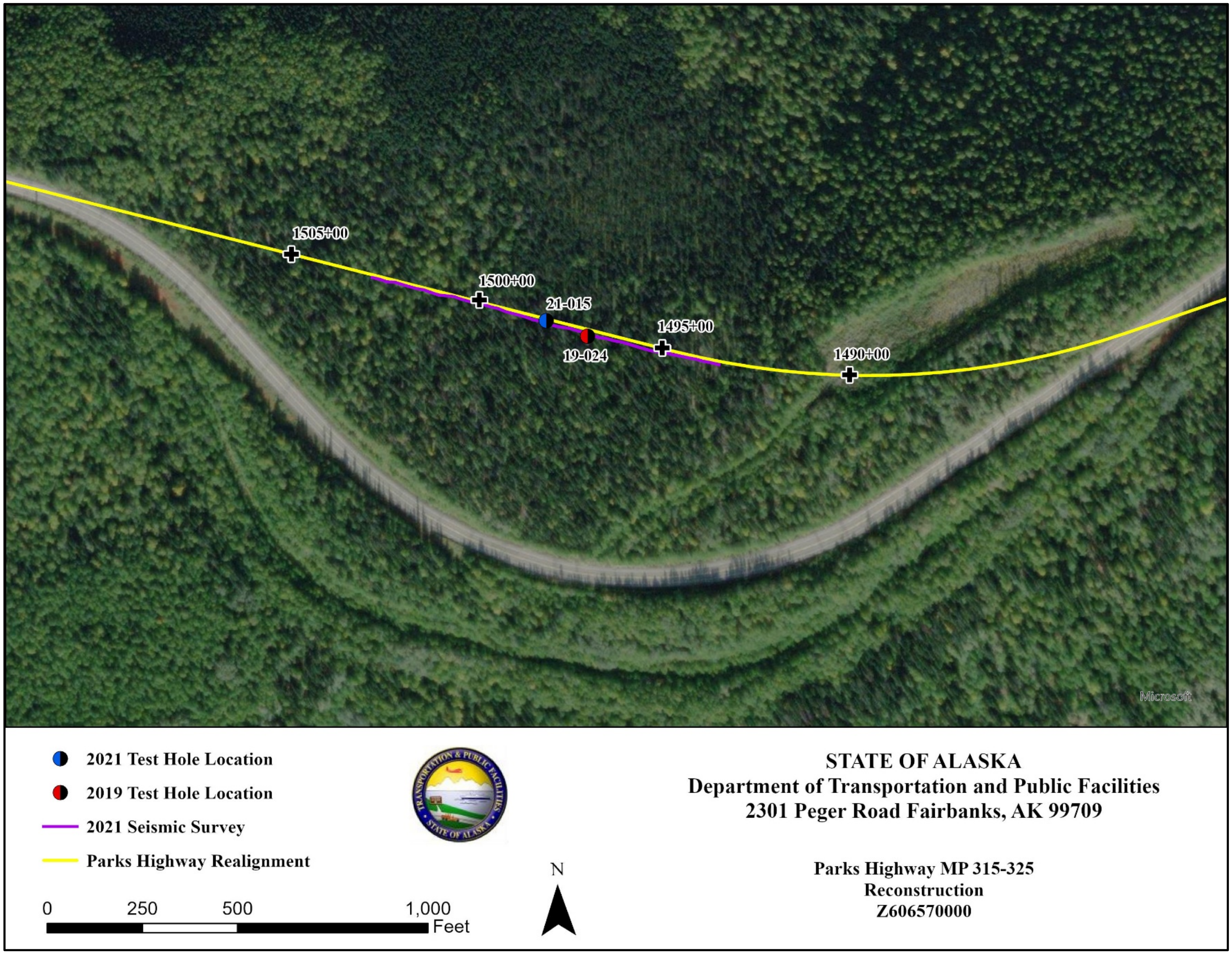


Figure 4. Realignment/Cut TH21-015 Location.

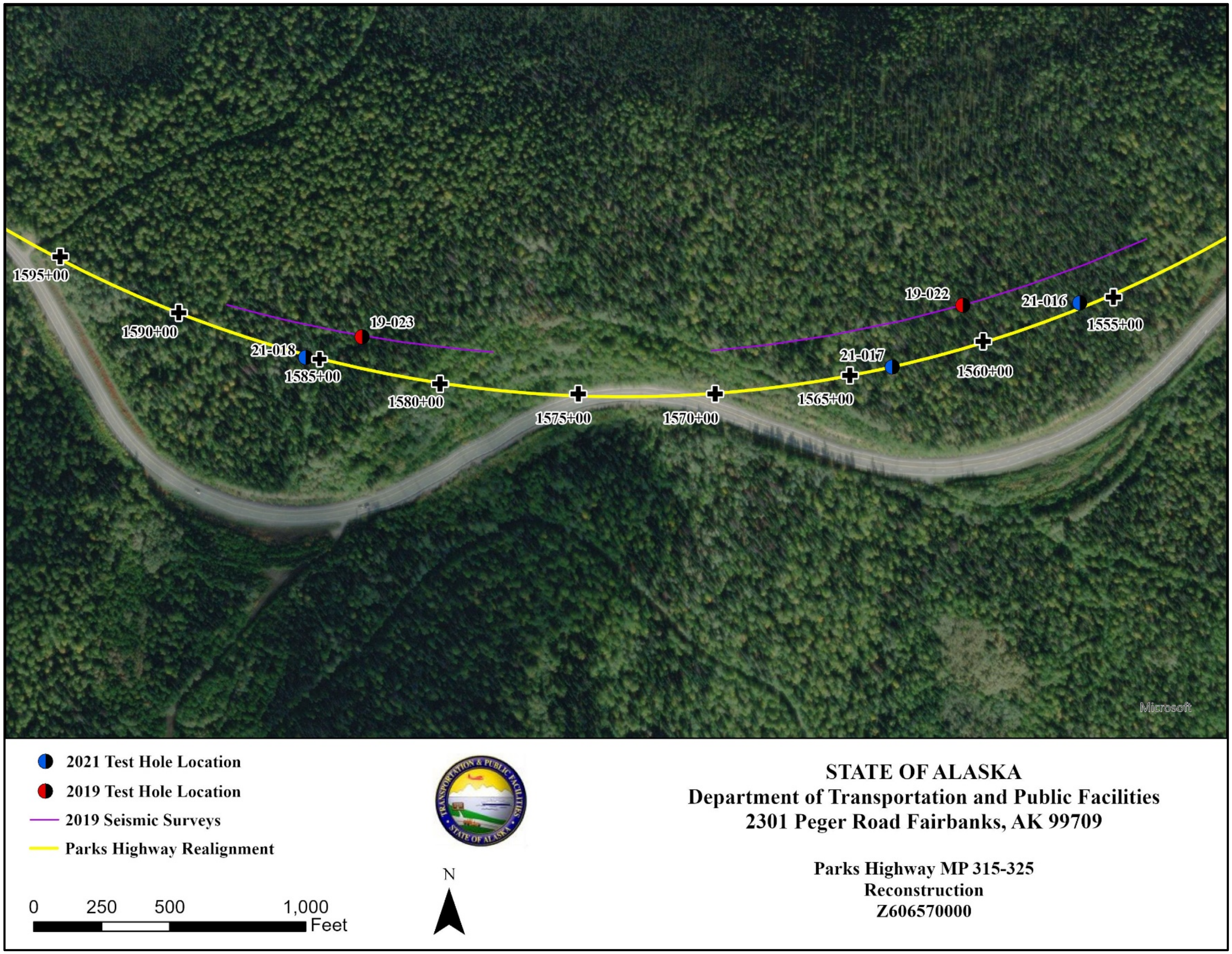


Figure 5. Realignment/Cut TH21-016 to TH21-018 Locations.

Seismic Refraction Survey Correlation to Realignment/Cut Test Holes:

Three seismic refraction surveys were performed for this project. The most recent survey, performed in June 2021, was located where TH19-024 and TH21-015 were drilled (Figure 4). The current realignment in this area only slightly differs from its original location. This survey showed that TH19-024, which was terminated early due to difficult drilling conditions, showed a transition into relatively more competent material with higher seismic velocity material at this depth. Two seismic refraction surveys were performed in 2019 on portions of the previous alignment where TH19-022 and TH19-023 were drilled (Figure 5). These surveys showed a high correlation with what was encountered in these test holes, lower seismic velocities in highly to completely weathered and weak to extremely weak bedrock. The survey performed where TH19-022 was terminated due to difficult drilling conditions which resulted in the tooling getting lodged in the test hole also showed a transition into relatively more competent material with a higher seismic velocity at this depth. While these survey locations no longer reflect the current realignment location, an attempt was made to locate higher seismic velocity material, which will likely be non-rippable, along the current realignment based on these surveys (Figure 3, TH21-016 to TH21-017). The seismic refraction survey results including test hole locations can be found in Appendix B.

In an effort to correlate the subsurface findings in the four test holes cored in July 2021 with the seismic refraction surveys, the characterizations of the rock core properties (weathering, strength, fracture spacing, and RQD (rock quality designation)) were assigned values, e.g. completely weathered was given a value of 1, highly weathered a value of 2, etc. Seismic velocity contours from the surveys were matched with the corresponding depths from the test holes. A weighted average of the properties characterized in the rock core was then calculated for the depth ranges associated with the seismic velocities. These values were then graphed to determine what correlations exist between the rock core properties and the seismic velocities. The assigned values for the rock core properties and the graphs are included in Appendix B.

TH21-015 was drilled along the current realignment and the seismic refraction survey line. The survey showed steadily increasing seismic velocities with depth. The characterization of the rock core properties were slightly variable in the lower seismic velocities (4000-6000 ft/s); however, once marginally rippable (6000-8000 ft/s) and non-rippable (8000+ ft/s) seismic velocity depths were encountered a relatively steady increase of characterization values and competency of the rock was seen. At these depths and higher seismic velocities there was less weathering, less fracturing, and higher RQD values indicating that the seismic refraction data correlates well with the drilling data and can reliably assess the rippability of material in the subsurface.

TH21-016 was drilled on the current realignment, slightly downhill and to the east of TH19-022. This test hole was drilled in an attempt to locate higher seismic velocity material that appears at a shallower depth according to the seismic refraction survey performed in 2019 along the former realignment. The rock core properties that correspond to lower seismic velocities were variable, especially weathering and fracture spacing. In the approximate marginally rippable to non-rippable seismic velocity zones all properties showed higher values associated with competency until the transition into a zone of ~8000 ft/s. At this depth the core barrel suddenly dropped approximately one foot, followed by intense shaking and another sudden one foot drop. At this time, water circulation ceased as all water was lost in the test hole and was no longer being recovered. Recovery from this core run was minimal, however; the recovery was sufficient enough to show a significant decrease in the rock core properties. The drill reaction experienced at the bottom of this test hole was the same reaction experienced in TH19-022 at depths also corresponding to ~8000 ft/s seismic velocities. Since this reaction caused the core tooling to become lodged and unrecoverable in TH19-022, drilling of TH21-016 was stopped. The cause of this reaction is unknown.

In order to avoid rippability versus non-rippability disputes during construction, TH21-017 was drilled in an attempt to find a localized shallow anomaly of higher seismic velocity material, located slightly downhill and to the west of TH19-022. NRMS geologists attempted to extrapolate the location of TH19-022 downtrend to the current alignment to drill this through anomaly of higher velocity material. To accomplish this, NRMS personnel attempted to project the high velocity anomaly in the seismic data down the structural trend to where it would be located beneath the current realignment. However, TH21-017 appears to have been drilled on the outside margin of this anomaly because it encountered rock properties consistent with mid-range seismic velocity values that extend out of this anomaly of higher seismic velocity values. Since this test hole was not drilled on the exact survey location, small, localized areas should still be expected on the current alignment but may differ in depth, thickness, etc.

TH21-018 was drilled on the current realignment, slightly downhill and to the west of TH19-023. This location was anticipated to have shallower non-rippable material based on seismic data. Characterization of rock core properties showed a trend of less weathering and fracturing with increasing seismic velocities while the strength of the rock core was relatively consistent and the RQD was variable. This material was relatively competent and could generally be considered non-rippable.

To further expand on the correlation of the seismic refraction surveys, test hole findings, and rippability, the seismic velocities at any one point as presented in this report reflect the lithological properties (lithology/composition) and the physical properties (weathering, strength, fracture spacing, and RQD) of the rock. To achieve the higher seismic velocities, generally greater than 8000 ft/s, the rock would need to have relatively competent lithological and physical properties. Lower seismic velocities, generally less than 6000 ft/s, can be achieved by a combination of the conditions of these properties, either lithological properties that are moderately competent with less competent physical properties or less competent lithological properties and more competent physical properties. Mid-range seismic velocities, generally 6000-8000 ft/s, can reflect a relatively wide range of lithological or physical property conditions that are uniform in at least one aspect and this may result in rippable material. In summary, as the seismic velocities reflect combinations of the lithological and physical properties of the rock, when considering the areas to be cut as a whole it should not be assumed that all low seismic velocities suggest completely to highly weathered rock or that strength will always notably increase with an increase in seismic velocity, etc.

Realignment/Fill (Figure 6):

Nine shallow test holes were drilled to determine the silt overburden thickness in this section of the revised realignment. Table 4 describes these test holes and Figure 6 shows their locations.

Table 4. Realignment/Fill Test Hole Descriptions.

Test Hole Number	Depth (ft)	Description	Comments
TH21-006	7	• 3" organic mat • 4.75' silt • 2' bedrock	• silt was moist or moist to wet and may have contained some seasonal frost • bedrock was micaceous schist that was highly to completely weathered to silty/sandy soil with some small gravel sized pieces
TH21-007	5	• 6" organic mat • 3' silt • 1.5' bedrock	
TH21-008	4.5	• 3" organic mat • 3.75' silt • 0.5' bedrock	
TH21-009	6	• 3" organic mat • 4.75' silt • 1' bedrock	
TH21-010	4.5	• 3" organic mat • 3.25' silt • 1' bedrock	
TH21-011	7	• 3" organic mat • 4.75' silt • 2' bedrock	
TH21-012	6	• 3" organic mat • 3.25' silt • 2.5' bedrock	
TH21-013	4	• 3" organic mat • 2.25' silt • 1.5' bedrock	
TH21-014	6.5	• 3" organic mat • 5.25' silt • 1' bedrock	

Overburden thickness in these test holes was consistent with the findings from the test holes drilled in 2019 along the former realignment.

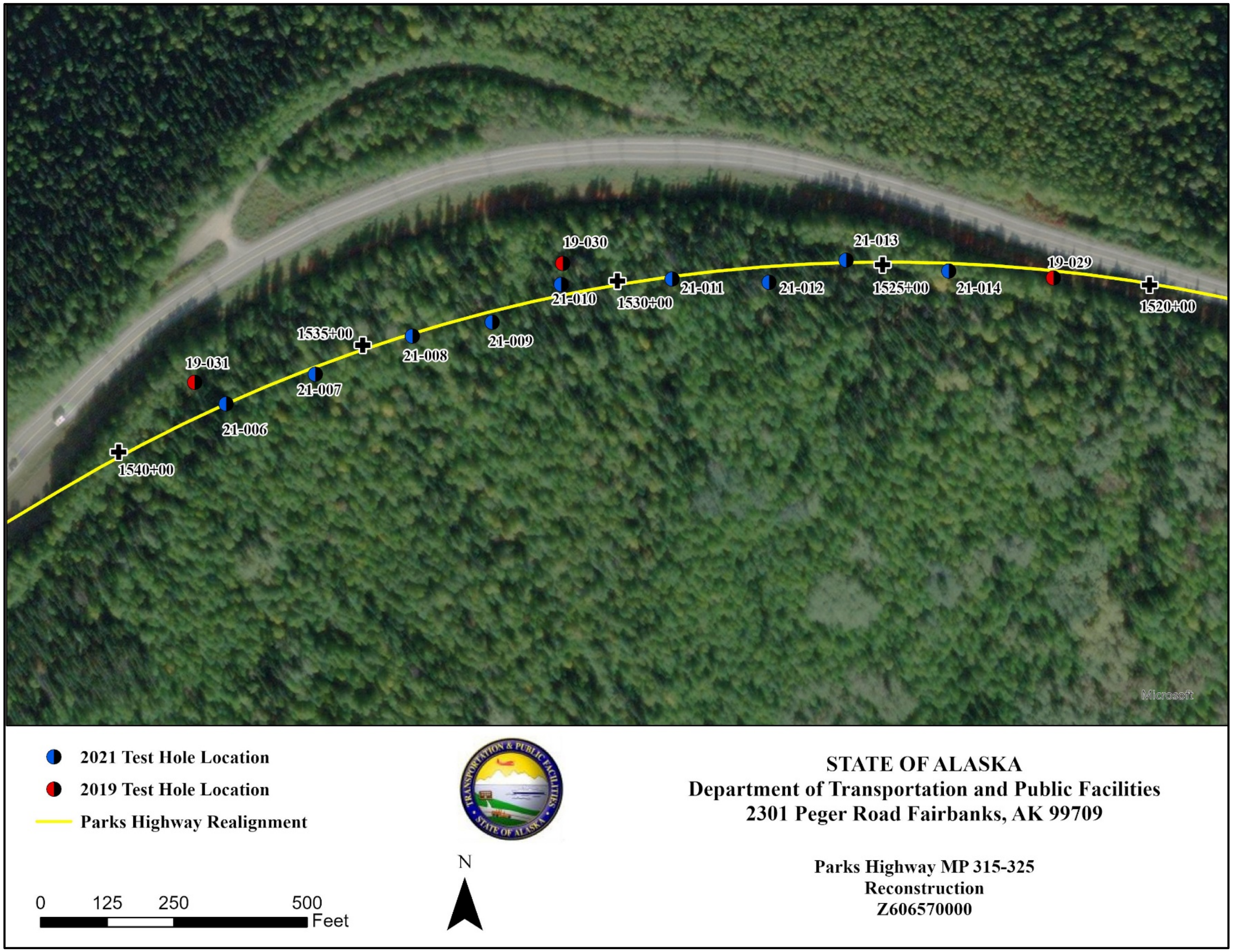


Figure 6. Realignment/Fill TH21-006 to TH21-014 Locations.

COMMENTS AND RECOMMENDATIONS

This investigation took place to gather additional information due to the revised realignment with both large cut and fill areas. Recommendations for the large cut and fill portions of the realignment are as follows:

Realignment/Cut:

Drilling on the realignment cut sections in 2019 encountered mostly highly weathered schist bedrock. While construction equipment used on large excavations is expected to be able to excavate most of this material without ripping, seismic refraction survey results showed more competent material is some of these areas. The seismic velocities indicated (per Caterpillar rippability tables) some material will require ripping and the remainder may require blasting. An additional seismic refraction survey and drilling performed in this investigation confirmed the presence of this more competent material that will be marginally rippable to non-rippable. Consider including a pay item for Unclassified Excavation and one for Rock Excavation, with note in Plans that Rock Excavation is expected to require drilling and blasting.

The seismic survey completed in June 2021 is the only seismic data that reflects the current realignment and therefore is the only area where percentages of rippable versus non-rippable material can be determined. This survey was completed between approximate Stations 1493+40 and 1502+90. The percentage of rippable, marginally rippable, and non-rippable material in this cut section has been estimated at:

Rippable: 56%
Marginally Rippable: 25%
Non-Rippable: 19%

Field and seismic data show weathered to highly weathered schist bedrock in this area that would likely be considered 75% rock and 25% earth. Based on this data and referencing Federal Highway Administration Shrink/Swell Factors (FHWA, 2020), we estimate approximately 30% swell of the bedrock once excavated.

Realignment/Fill:

The investigation performed in 2019 indicated the foundation soils in the sections of the realignment requiring large fills (approximate Stations 1462+00 and 1483+00, and 1524+00 and 1539+00) consisted of loose, relatively high moisture-content silty soils underlain by highly weathered schist bedrock. The thickness of this silty overburden ranged from 3 feet to 5 feet. One section of this realignment was revised and has shifted slightly downslope from its original location. Additional test holes were drilled along this revised section and the thickness of the overburden was consistent to the findings from the previous investigation.

We believe this relatively wet, loose silt may be susceptible to consolidation and lateral displacement under the load of a large fill. In addition, we believe loading such foundation soils on a hillslope may lead to down-slope movement.

The previous recommendations for these large fills stated that if the geometry of the existing ground was relatively flat, embankment distress would be partially mitigated by placing one or more layers of geotextile, reinforcement low in the embankment and excavating silty overburden prior to backfilling where the geometry is relatively steep to mitigate downslope movement. However, following a review of historic data on similar projects, we believe these recommendations should be revised. We now recommend removing all the silt overburden in the large fill sections of the realignment, regardless of the geometry and slope of the existing ground, to avoid consolidation and lateral displacement under the load of a large fill.

The percentage of shrink/swell of the in-situ silt was estimated using blow counts and moisture contents obtained from Phase 1 of this investigation in 2019. Laboratory tests that determine the maximum density and optimum moisture contents (Proctor testing) from nearby projects wre used to assist in these calculations. Based upon the value obtained in the field and the relationship between the in-place density and maximum density for silt, we estimate that the maximum consolidation for the silt is approximately 30% and the maximum swell is approximately 15%.

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APPENDIX A-TEST HOLE LOGS

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project	Parks Highway MP 315-325 Reconstruction	Test Hole Number	21-006
Project Number	Z606570000	Total Depth	7 feet
Field Geologist	J. SIMPSON	Dates Drilled	6/9/2021 - 6/9/2021
Field Crew	M. Sousa, G. Nelson	Station, Offset	
Equipment Type	Hand Auger	Latitude, Longitude	N64.70112°, W148.73405°
Weather	Cloudy, 55F	Elevation	1316.0
TH Finalized By	J. Simpson		
Vegetation			

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Fill Silt Overburden Thickness

Drilling Method	Depth in (Feet)	Casing Blows / ft	Sample Data: Method	Sample Data: Number	Sample Data: Blow Count (raw)	Sample Data: Sample Interval	Sample Data: Uncorrected N-Value	Embankment Height	Frozen	Graphic Log	SUBSURFACE MATERIAL	TEST RESULTS
Hand Auger	0									≈	ORG MAT 3" organic mat	
										▨	Tn-Bn SILT moist	
	1											
	2											
	3											
	4											
	5									˅	Tn Soft BEDROCK, soft(Muscovite Schist) highly/completely weathered micaceous bedrock	
	6											
	7										BOH	

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project: Parks Highway MP 315-325 Reconstruction
Project Number: Z606570000
Field Geologist: J. SIMPSON
Field Crew: M. Sousa, G. Nelson
Equipment Type: Hand Auger
Weather: Cloudy, 55F
TH Finalized By: J. Simpson
Vegetation:
Test Hole Number: 21-007
Total Depth: 5 feet
Dates Drilled: 6/9/2021 - 6/9/2021
Station, Offset:
Latitude, Longitude: N64.70128°, W148.7333°
Elevation: 1250.0

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Fill Silt Overburden Thickness

Drilling Method	Depth in (Feet)	Casing Blows / ft	Sample Data: Method	Sample Data: Number	Sample Data: Blow Count (raw)	Sample Data: Sample Interval	Sample Data: Uncorrected N-Value	Embankment Height	Frozen	Graphic Log	SUBSURFACE MATERIAL	TEST RESULTS
Hand Auger	0										ORG MAT 6" organic mat	
											Tn-Bn SILT moist	
	1											
	2											
	3											
											Tn Soft BEDROCK, soft(Muscovite SChist) highly/completely weathered, micaceous bedrock	
	4											
	5										BOH	

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project Parks Highway MP 315-325 Reconstruction
Project Number Z606570000
Field Geologist J. SIMPSON
Field Crew M. Sousa, G. Nelson
Equipment Type Hand Auger
Weather Cloudy, 55F
TH Finalized By J. Simpson
Vegetation
Test Hole Number 21-008
Total Depth 4.5 feet
Dates Drilled 6/9/2021 - 6/9/2021
Station, Offset
Latitude, Longitude N64.70149°, W148.73186°
Elevation 1205.0

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Fill Silt Overburden Thickness

Drilling Method	Depth in (Feet)	Casing Blows / ft	Method	Number	Blow Count (raw)	Sample Interval	Uncorrected N-Value	Embankment Height	Frozen	Graphic Log	SUBSURFACE MATERIAL	TEST RESULTS
Hand Auger	0										ORG MAT 3" organic mat	
											Tn-Bn SILT moist	
	1											
	2											
	3											
	4										Tn Soft BEDROCK, soft(Muscovite Schist) highly/completely weathered micaceous bedrock	
											BOH	

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project: Parks Highway MP 315-325 Reconstruction
Project Number: Z606570000
Test Hole Number: 21-009
Total Depth: 6 feet
Field Geologist: J. SIMPSON
Dates Drilled: 6/9/2021 - 6/9/2021
Field Crew: M. Sousa, G. Nelson
Equipment Type: Hand Auger
Station, Offset:
Weather: Cloudy, 55F
Latitude, Longitude: N64.70158°, W148.7309°
TH Finalized By: J. Simpson
Vegetation:
Elevation: 1178.0

Drilling Method | Depth in (Feet) | Casing Blows / ft | Sample Data: Method | Number | Blow Count (raw) | Sample Interval | Uncorrected N-Value | Embankment Height | Frozen | Graphic Log

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Fill Silt Overburden Thickness

Drilling Method: Hand Auger

Depth (ft)	SUBSURFACE MATERIAL	TEST RESULTS
0	ORG MAT 3" organic mat	
	Bn SILT moist	
3	Tn	
5	Tn Soft BEDROCK, soft(Muscovite Schist) highly/completely weathered micaceous bedrock	
6	BOH	

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

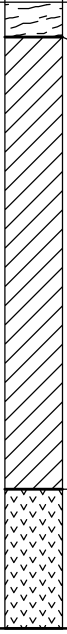
FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project: Parks Highway MP 315-325 Reconstruction
Project Number: Z606570000
Test Hole Number: 21-010
Total Depth: 4.5 feet
Field Geologist: J. SIMPSON
Dates Drilled: 6/9/2021 - 6/9/2021
Field Crew: M. Sousa, G. Nelson
Equipment Type: Hand Auger
Station, Offset:
Weather: Cloudy, 55F
Latitude, Longitude: N64.70177°, W148.73069°
TH Finalized By: J. Simpson
Vegetation:
Elevation: 1164.0

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Fill Silt Overburden Thickness

Drilling Method	Depth in (Feet)	Casing Blows / ft	Sample Data					Embankment Height	Frozen	Graphic Log	SUBSURFACE MATERIAL	TEST RESULTS	
			Method	Number	Blow Count (raw)	Sample Interval	Uncorrected N-Value						
Hand Auger	0										ORG MAT 3" organic mat		0
											Tn-Bn SILT moist		
	1												1
	2												2
	3												3
											Tn Soft BEDROCK, soft(Muscovite Schist) highly/completely weathered bedrock		
	4												4

BOH

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Field Geologist	J. SIMPSON	Project	Parks Highway MP 315-325 Reconstruction
Field Crew	M. Sousa, G. Nelson	Project Number	Z606570000
TH Finalized By	J. Simpson	Equipment Type	Hand Auger
		Weather	Cloudy, 55F
		Vegetation	

Test Hole Number	21-011
Total Depth	7 feet
Dates Drilled	6/9/2021 - 6/9/2021
Station, Offset	
Latitude, Longitude	N64.70182°, W148.72876°
Elevation	1161.0

Ground Water Data

	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Fill Silt Overburden Thickness

Drilling Method	Depth in (Feet)	Casing Blows / ft	Sample Data: Method	Number	Blow Count (raw)	Sample Interval	Uncorrected N-Value	Embankment Height	Frozen	Graphic Log	SUBSURFACE MATERIAL	TEST RESULTS
Hand Auger	0										ORG MAT 3" organic mat	
											Bn SILT moist to wet	
	1											
	2										Tn moist	
	3											
	4											
	5										Tn Soft BEDROCK, soft(Muscovite Schist) highly/completely weathered micaceous bedrock	
	6											
	7										BOH	

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project: Parks Highway MP 315-325 Reconstruction
Project Number: Z606570000
Test Hole Number: 21-012
Total Depth: 6 feet
Field Geologist: J. SIMPSON
Dates Drilled: 6/9/2021 - 6/9/2021
Field Crew: M. Sousa, G. Nelson
Equipment Type: Hand Auger
Station, Offset:
Weather: Cloudy, 55F
Latitude, Longitude: N64.70182°, W148.7276°
TH Finalized By: J. Simpson
Vegetation:
Elevation: 1155.0

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Fill Silt Overburden Thickness

Drilling Method	Depth in (Feet)	Casing Blows / ft	Sample Data: Method	Sample Data: Number	Sample Data: Blow Count (raw)	Sample Data: Sample Interval	Sample Data: Uncorrected N-Value	Embankment Height	Frozen	SUBSURFACE MATERIAL	TEST RESULTS
Hand Auger	0									ORG MAT 3" organic mat	
										Bn-Tn SILT moist	
	1										
	2										
	3										
										Tn Soft BEDROCK, soft(Muscovite Schist) highly/completely weathered micaceous bedrock	
	4										
	5										
	6									BOH	

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project: Parks Highway MP 315-325 Reconstruction
Project Number: Z606570000
Test Hole Number: 21-013
Total Depth: 4 feet
Field Geologist: J. SIMPSON
Dates Drilled: 6/9/2021 - 6/9/2021
Field Crew: M. Sousa, G. Nelson
Equipment Type: Hand Auger
Station, Offset:
Weather: Cloudy, 55F
Latitude, Longitude: N64.70194°, W148.72668°
TH Finalized By: J. Simpson
Vegetation:
Elevation: 1163.0

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Fill Silt Overburden Thickness

Drilling Method	Depth in (Feet)	Casing Blows / ft	Sample Data: Method	Sample Data: Number	Sample Data: Blow Count (raw)	Sample Data: Sample Interval	Uncorrected N-Value	Embankment Height	Frozen	Graphic Log	SUBSURFACE MATERIAL	TEST RESULTS
Hand Auger	0										ORG MAT 3" organic mat	
											Tn-Bn SILT moist	
	1											
	2											
											Tn Soft BEDROCK, soft(Muscovite Schist) highly/completely weathered micaceous bedrock	
	3											
	4										BOH	

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

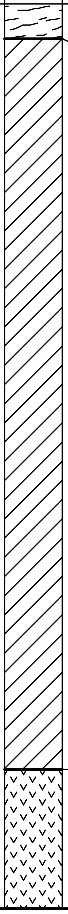
STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project	Parks Highway MP 315-325 Reconstruction	Test Hole Number	21-014
Project Number	Z606570000	Total Depth	6.5 feet
Field Geologist	J. SIMPSON	Dates Drilled	6/9/2021 - 6/9/2021
Field Crew	M. Sousa, G. Nelson	Station, Offset	
Equipment Type	Hand Auger	Latitude, Longitude	N64.7019°, W148.72545°
Weather	Cloudy, 55F	Elevation	1163.0
TH Finalized By	J. Simpson		
Vegetation			

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Fill Silt Overburden Thickness

Drilling Method	Depth in (Feet)	Casing Blows / ft	Sample Data: Method	Sample Data: Number	Sample Data: Blow Count (raw)	Sample Data: Sample Interval	Sample Data: Uncorrected N-Value	Embankment Height	Frozen	Graphic Log	SUBSURFACE MATERIAL	TEST RESULTS
Hand Auger	0										ORG MAT 3" organic mat	
											Bn-Tn SILT moist	
	1											
	2											
	3										high amount of orgaincs (wood shavings) in cuttings	
	4											
	5											
											Tn Soft BEDROCK, soft(Muscovite Schist) highly/completely weathered micaceous bedrock	
	6											



BOH

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

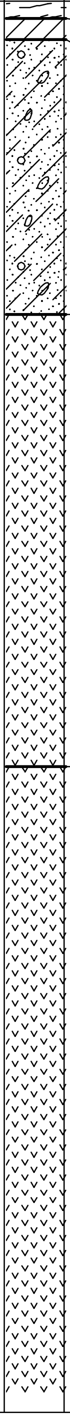
STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project	Parks Highway MP 315-325 Reconstruction	Test Hole Number	21-015
Project Number	Z606570000, AKSAS	Total Depth	111 feet
Field Geologist	J. SIMPSON	Dates Drilled	7/7/2021 - 7/10/2021
Field Crew	P. Lanigan, T. Hartford	Station, Offset	
Equipment Type	CME 850	Latitude, Longitude	N64.70034°, W148.70952°
Weather	partly cloudy, 60-65F	Elevation	1379.0
TH Finalized By	J. Simpson		
Vegetation			

Ground Water Data

	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Cut



Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Sample Data: Method	Number	Blow Count	Sample Interval	N-Value	Run Data: Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	SUBSURFACE MATERIAL
Tri-cone & Casing	0		SPT		1										ORG MAT
					2										Tn SILT moist, *sl Org*
	1				3										
					5										Tn Silty SAND w/ Gravel muscovite schist completely weathered to silty sand with 1/2"- gravel sized pieces, highly micaceous
	4		SPT		7										
					11										Tn-Gy Soft BEDROCK(Graphite Muscovite Schist)
	5				15										
					13										
	9		SPT		3										
					28										
	10				55										
Coring	11														Tn-Gy Soft BEDROCK(Graphite Biotite Muscovite Schist) moderately to highly weathered, weak, close to extremely close fracture spacing
	13.5							1	10.75	24	76.7	6.5			
	16														highly weathered, close to very close fracture spacing
	18.5							2	7.8	30	25	4.5			
	20														

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

Sheet 2 of 5

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Test Hole Number 21-015

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
	20															
	21															Gy-Tn Soft BEDROCK(Graphite Muscovite Biotite Schist) highly weathered, weak, close to extremely close fracture spacing
	22															
	23															
								3	7.6	0	20	3.75				
	24															
	25															
	26															Gy-Tn Soft BEDROCK(Muscovite Biotite Schist) moderately weathered, weak, moderate to close fracture spacing
	27															
	28															
								4	7.25	79.3	48.3	10.75				
	29															
	30															
Coring	31															moderately to highly weathered, close to extremely close fracture spacing
	32															
	33															
								5	7.6	10.4	88.3	5.5				
	34															
	35															minor quartz
	36															weak to very weak, moderate to extremely close fracture spacing, slight increase in quartz content
	37															
	38															
								6	7.75	35	80.8	11.5				
	39															
	40															
	41															
	42															

Sheet 3 of 5

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Test Hole Number 21-015

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
Coring	43							7	9.5	21.6	85	5.75				
	44															
	45															1" quartz vein
	46															very weak, very close to extremely close fracture spacing
	47															
	48							8	8	10.5	75	4.75				
	49															
	50															Gy-Tn Soft BEDROCK(Biotite Muscovite Schist) highly to completely weathered, extremely weak, extremely close fracture spacing
	51															
	52															
	53							9	10.6	0	41.7	2.5				
	54															Gy-Tn Soft BEDROCK(Graphite Muscovite Biotite Schist) moderately to highly weathered, very weak, very close fracture spacing
	55															
	56															
	57															
	58							10	14.4	0	85.8	3.75				
	59															
	60															
	61															
	62															
	63							11	10.6	50.4	90	11.75				Tn-Gy Soft BEDROCK(Biotite Muscovite Schist) highly weathered, very weak, very close to extrememly close fracture spacing
	64															
	65															

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Test Hole Number 21-015

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
	66															
	67															thin layer of graphite
	68							12	10.6	0	91.7	3.75				
	69															thin quartz veining
	70															
	71															small areas with increase in biotite and quartz veining moderately weathered and slightly stronger than areas with higher muscovite content
	72															
	73							13	8.5	7.1	100	4.25				
	74															
	75															
	76															Tn-Gy Soft BEDROCK(Muscovite Schist)
Coring	77															
	78							14	7.75	18.6	91.7	5.25				Gy Soft BEDROCK(Quartz Biotite Schist) minor amounts of muscovite, moderately weathered, weak, close to very close fracture spacing
	79															
	80															
	81															slightly to moderately weathered, medium weak to weak, moderate to close fracture spacing
	82															
	83							15	12.75	38.3	100	6.5				
	84															
	85															
	86															moderately weathered, weak, moderate to very close fracture spacing
	87															
	88							16	10.8	26.7	100	11.25				

FINAL TEST HOLE LOG

Sheet 5 of 5

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Test Hole Number 21-015

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
Coring	89															
	90															
	91															slightly to moderately weathered, 3/4" to 1" quartz veins
	92															
	93							17	13	37.1	100	14.25				
	94															
	95															
	96															close to extremely close
	97															
	98							18	12.5	10	96.7	5.75				
	99															
	100															
	101															Gy Soft BEDROCK(Graphite Biotite Schist) slightly to highly weathered, weak to very weak, close to very close fracture spacing
	102															
	103							19	14.25	56.2	100	9.5				
	104															
	105															Gy-Tn Soft BEDROCK(Graphite Quartz Muscovite Biotite Schist) slightly to highly weathered, weak to extremely weak
	106															
	107															
	108							20	12.2	52.5	98.3	15				Gy Soft BEDROCK(Quartz Biotite Schist) slightly to moderately weathered, weak, close fracture spacing
	109															
	110															small graphitic section
	111														BOH	

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project	Parks Highway MP 315-325 Reconstruction	Test Hole Number	21-016
Project Number	Z606570000, AKSAS	Total Depth	93.66 feet
Field Geologist	J. SIMPSON	Dates Drilled	7/12/2021 - 7/13/2021
Field Crew	G. Nelson, T. Hartford	Station, Offset	
Equipment Type	CME 850	Latitude, Longitude	N64.69874°, W148.74434°
Weather	mostly sunny, 60-75F	Elevation	1338.0
TH Finalized By	J. Simpson		
Vegetation			

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Cut

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Sample Data: Method	Number	Blow Count	Sample Interval	N-Value	Run Data: Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
Tri-cone & Casing	0		SPT		1 2											ORG MAT Tn-Bn SILT moist
	1				2 2											
	2															Tn Soft BEDROCK(Muscovite Schist) completely weathered to silt/sand with 1/2" gravel pieces
	3															
	4		SPT		5											
	5				5 12											
	6				12											
	7															
	8															
	9		SPT		12											
	10				21 14											
	11				20											
	12															
	13															
	14		SPT		15											
	15				26 37											
Coring	16				62											Tn-Gy Soft BEDROCK(Graphite Quartz Garnet Schist) highly to completely weathered, weak to very weak, close to extremely close fracture spacing
	17															
	18							1	4.1	26.5	26.7	4.25				
	19															
	20															

NR AKDOT TEST CORE LOG - USCS PARKS 315-325_2021.GPJ NR_AKDOT_PRECON_USCS_06_28_07.GDT 8/19/21

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

FINAL TEST HOLE LOG

Test Hole Number 21-016

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
	20															
	21															
	22															
	23							2	6	0	51.7	3				3" quartz vein
	24															Tn-Gy Soft BEDROCK(Graphite Garnet Muscovite Schist) highly weathered, medium weak to weak, very close to extremely close fracture spacing
	25															
	26															
	27															
	28							3	9.3	0	55	3.5				
	29															
	30															2" quartz vein
	31															Tn Soft BEDROCK(Garnet Quartz Muscovite Schist) moderately weathered, weak, close to very close fracture spacing
Coring	32															
	33							4	10.3	0	90	3.75				
	34															
	35															
	36															Tn-Gy Soft BEDROCK(Quartz Graphite Muscovite Schist) highly weathered, weak to very weak, close to extremely close fracture spacing
	37															
	38							5	4.9	0	45	3.25				
	39															
	40															
	41															Tn Soft BEDROCK(Quartz Muscovite Schist) highly to moderately weathered, weak, close to very close fracture spacing
	42															

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

FINAL TEST HOLE LOG

Sheet 3 of 5

Test Hole Number 21-016

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
	43							6	6.3	10.6	70.8	4.5				Tn Soft BEDROCK(Quartz Garnet Muscovite Schist) highly weathered, weak, very close to extremely close fracture spacing
	44															
	45															
	46															Tn Soft BEDROCK(Garnet Muscovite Schist) highly weathered, weak to very weak, very close to extremely close fracture spacing
	47															
	48							7	5.6	0	75	3.5				Tn-Gy Soft BEDROCK(Graphite Quartz Muscovite Schist) moderately to highly weathered, medium weak to weak, close to very close fracture spacing
	49															
	50															
	51															
	52															highly weathered, weak, very close fracture spacing
	53							8	5	7.1	100	4.25				
Coring	54															
	55															Tn Soft BEDROCK(Quartz Garnet Muscovite Schist) moderately to highly weathered, medium weak to weak, moderate to very close fracture spacing
	56															
	57															
	58							9	6.5	32.1	93.3	7				
	59															
	60															
	61															
	62															small amount of biotite
	63							10	5.5	23.7	80.8	11.5				
	64															highly weathered, very close fracture spacing
	65															Tn-Gy Soft BEDROCK(Garnet Biotite Quartz Muscovite Schist)

FINAL TEST HOLE LOG

Sheet 4 of 5

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Test Hole Number 21-016

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
	66															moderately to highly weathered, medium weak to weak, moderate to very close fracture spacing
	67															
	68							11	6.5	19.5	91.7	6				
	69															
	70															
	71															
	72															
	73							12	5.6	30.5	94.2	9.5				
	74															
	75															
	76															
Coring	77															
	78							13	6.3	34.2	100	11				
	79															Gy-Tn Soft BEDROCK(Garnet Quartz Muscovite Biotite Schist) slightly to moderately weathered, weak, moderate to very close fracture spacing, altered biotite
	80															
	81															
	82															
	83							14	8.6	35.5	97.5	7				Gy-Tn Soft BEDROCK(Garnet Quartz Muscovite Biotite Schist) moderately weathered, medium weak to weak, moderate to close fracture spacing
	84															
	85															
	86															
	87															
	88							15	7	60.4	100	11				

FINAL TEST HOLE LOG

Sheet 5 of 5

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Test Hole Number 21-016

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL	
Coring	89																89
	90																90
	91															Gy-Tn Soft BEDROCK(Biotite Muscovite Schist) highly weathered, weak, close to very close fracture spacing	91
	92							16	4	0	69.4	3.9					92
	93																93
																BOH	

Drilling Notes: At approximately 91.5 feet bgs a void was encountered and the core barrel dropped at least 2 feet and we began losing all of our water. This is the same reaction that was experienced in TH19-022 when tooling became stuch in the test hole. To avoid the same situation, drilling was stopped.

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Project Parks Highway MP 315-325 Reconstruction
Project Number Z606570000, AKSAS
Test Hole Number 21-017
Total Depth 81 feet
Field Geologist J. SIMPSON
Dates Drilled 7/14/2021 - 7/15/2021
Field Crew P. Lanigan, T. Babin
Equipment Type CME 850
Station, Offset
Weather cloudy, rainy, windy, 60F
Latitude, Longitude N64.69814°, W148.74876°
TH Finalized By J. Simpson
Vegetation
Elevation 1296.0

Ground Water Data	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Cut

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Sample Data: Method	Number	Blow Count	Sample Interval	N-Value	Run Data: Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
Tri-cone & Casing	0		SPT		0.5 2 2 3											ORG MAT Tn SILT moist
	2															Tn Soft BEDROCK(Muscovite Schist) completely weathered to silty and clay-like soil, small graphite content
	4				8 6 5 6											
	9		SPT		5 5 11 18											
	14		SPT		41 50											
Coring	16															Tn Soft BEDROCK(Muscovite Schist) very thin quartz veins, completely weathered
	18.5							1	11.2	0	6.7	1.5				
	20															

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

NR AKDOT TEST CORE LOG - USCS PARKS 315-325_2021.GPJ NR_AKDOT_PRECON_USCS_06_28_07.GDT 8/19/21

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

FINAL TEST HOLE LOG

Test Hole Number 21-017

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
Coring	20															
	21															Tn-Gy Soft BEDROCK(Graphite Muscovite Schist) highly to completely weathered, weak to extremely weak, very close to extremely close fracture spacing
	22															
	23							2	7.2	0	70	3.75				
	24															
	25															
	26															
	27															
	28							3	8.4	0	20	2.5				
	29															
	30															
	31															completely weathered
	32															
	33							4	6.6	0	0.8	0.5				
	34															
	35															
	36															
	37															
	38							5	3.5	0	33.3	1				
	39															
	40															
	41															
	42															

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Test Hole Number 21-017

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
	43							6	6	0	69.2	3.25				moderately to highly weathered, close to extremely close fracture spacing
	44															
	45															
	46															Tn Soft BEDROCK(Muscovite Schist) completely weathered
	47															
	48							7	7.33	0	0.8	0.5				
	49															
	50															
	51															
	52															
	53							8	4.5	0	23.3	0				
Coring	54															
	55															
	56															
	57															
	58							9	4.5	0	40	0				
	59															
	60															
	61															recovery included 3 intact pieces (1", 2.5", 5") highly weathered, all other recovery was completely weathered to soil
	62															
	63							10	5	13.9	60	5				
	64															
	65															

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

FINAL TEST HOLE LOG

Sheet 4 of 4

Test Hole Number 21-017

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
	66															completely weathered except 2- 1" pieces
	67															
	68							11	5.8	0	15	1				
	69															
	70															
	71															Tn-Gy Soft BEDROCK(Graphite Muscovite Schist) moderately to highly weathered, weak, close to very close fracture spacing
	72															
Coring	73							12	5.66	38	70	6.75				
	74															
	75															
	76															highly to completely weathered, weak to very weak, close to extremely close fracture spacing
	77															
	78							13	6.2	25	30	4.5				
	79															
	80															
	81															BOH

FINAL TEST HOLE LOG

Sheet 1 of 4

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

		Project	Parks Highway MP 315-325 Reconstruction	Test Hole Number	21-018
		Project Number	Z606570000, AKSAS	Total Depth	81 feet
Field Geologist	J. SIMPSON			Dates Drilled	7/17/2021 - 7/19/2021
Field Crew	P. Lanigan, T. Hartford	Equipment Type	CME 850	Station, Offset	
		Weather	sunny, 70s	Latitude, Longitude	N64.69828°, W148.76253°
TH Finalized By	J. Simpson	Vegetation		Elevation	1189.0

Ground Water Data

	While Drilling	After Drilling
Depth in (ft.)		
Time		
Date		
Symbol		

GENERAL COMMENTS:
Realignment/Cut

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Sample Data: Method	Number	Blow Count	Sample Interval	N-Value	Run Data: Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	SUBSURFACE MATERIAL
Tri-cone & Casing	0		SPT		2										ORG MAT
	0.5				2										Tn-Bn SILT moist, *sl Org*
	1				2										
	1.5				7										
	1.7														Tn Soft BEDROCK(Muscovite Schist) highly to completely weathered to silt
	4.5		SPT		54										
Coring	6							1	11.6	0	41.7	2.25			Gy-Tn Soft BEDROCK(Quartz Muscovite Graphite Schist) highly to completely weathered, weak, very close to extrememly close fracture spacing
	11							2	8.1	18.2	98.3	6.25			
	13														Tn-Gy Soft BEDROCK(Garnet Graphite Muscovite Schist) highly weathered, very weak, close to very close fracture spacing
	16							3	9.75	9.6	100	5.75			Gy-Tn Soft BEDROCK(Quartz Muscovite Graphite Schist) slightly to moderately weathered, weak, close to very close fracture spacing
	20														

Note: Unless otherwise noted, all samples are taken with 1-3/8-in. ID Standard Penetration Sampler driven with 140 lb. hammer with 30-in. drop. ☐ CME Auto Hammer ☐ Cathead Rope Method

FINAL TEST HOLE LOG

Test Hole Number 21-018

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL	
Coring	20															3" section with small biotite content	20
	21							4	9.4	57.9	100	9.25				moderate to close fracture spacing	21
	22																22
	23																23
	24																24
	25																25
	26							5	9.5	53.8	98.3	7.5					26
	27																27
	28															increase in quartz content	28
	29																29
	30																30
	31							6	8	30	100	5				medium to very weak	31
	32																32
	33																33
	34																34
	35																35
	36							7	7.1	41.7	96.7	6.5					36
	37																37
	38																38
	39																39
	40																40
	41															slight increase in muscovite	41
	42																42

FINAL TEST HOLE LOG

STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

Test Hole Number 21-018

Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
Coring	43															
								8	8.8	49.6	100	6				
	44															
	45															
	46															close to very close fracture spacing
	47															
	48															
								9	8.9	27.1	100	6.5				
	49															
	50															
	51															
	52															
	53															moderately to highly weathered, moderate to very close fracture spacing
								10	7.5	55.8	100	8.25				
	54															
	55															
	56															slightly to highly weahtered, medium weak to weak
	57															
	58															
								11	9.9	64.2	100	9.25				
	59															
	60															
	61															slightly to completely weathered, medium weak to very weak, close fracture spacing
	62															
	63															
								12	7	63.3	100	7.5				
	64															
	65															

FINAL TEST HOLE LOG

Sheet 4 of 4

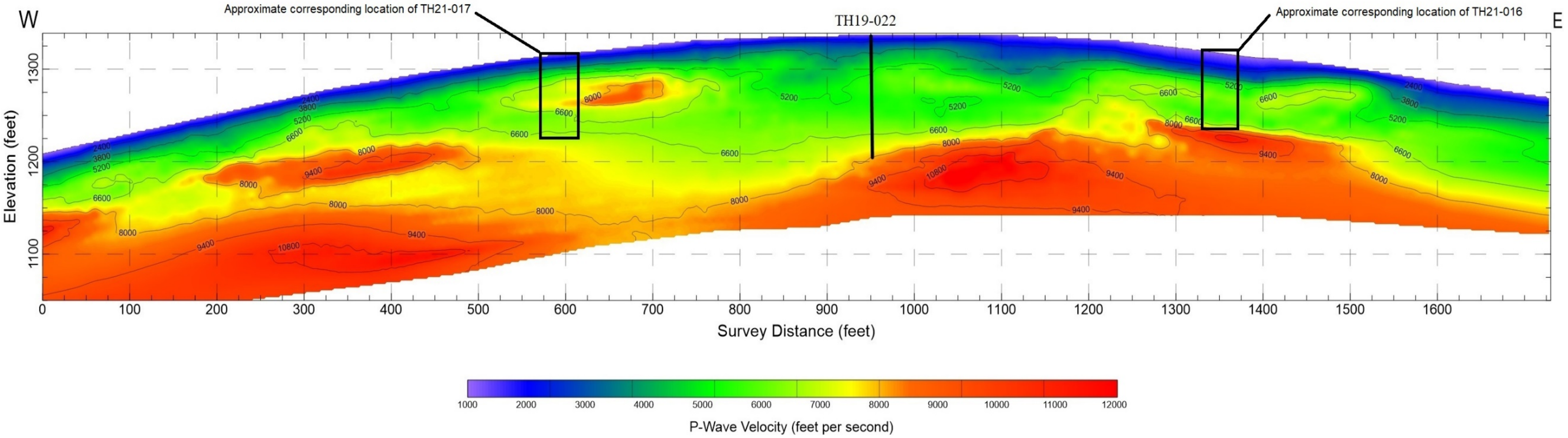
STATE OF ALASKA DOT/PF
Northern Region Materials
Geology Section

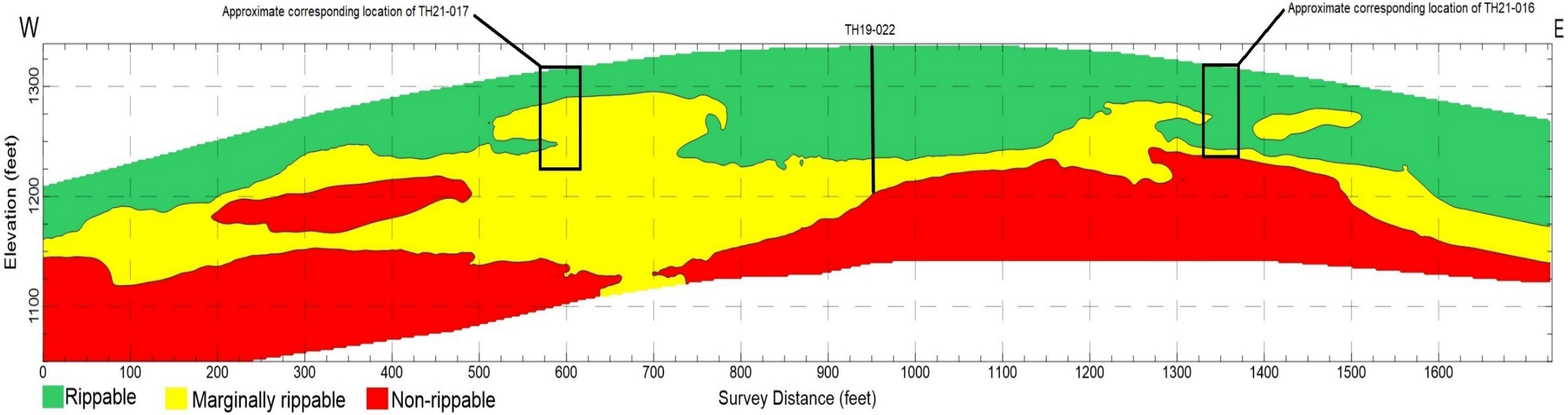
Test Hole Number 21-018

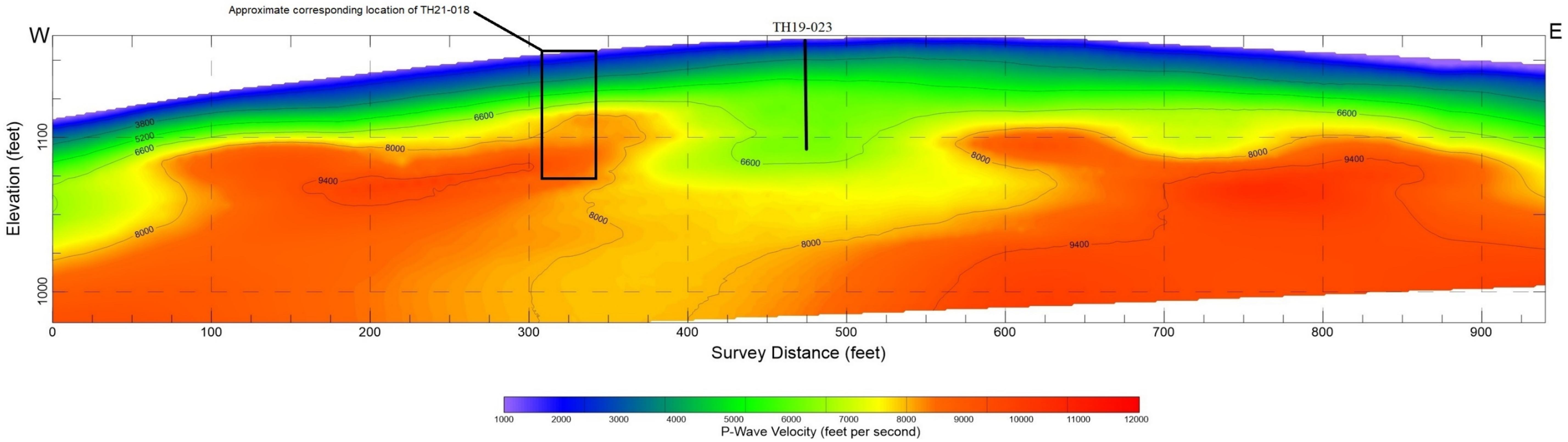
Drilling Method	Depth in (Feet)	Casing Size Blows / ft	Method	Number	Blow Count	Sample Interval	N-Value	Run Number	Time (minutes)	RQD	Recovery	Longest Pc. (in.)	Structural Data	Frozen	Graphic Log	SUBSURFACE MATERIAL
	66															moderately to completely weathered, weak to very weak, moderate to very close fracture spacing
	67															
	68															
								13	8.5	63.3	87.5	16.5				
	69															
	70															
	71															
	72															
Coring	73															
								14	6.5	0	55	3.5				
	74															Tn-Gy Soft BEDROCK(Graphite Muscovite Schist) highly to completely weathered, weak to very weak, close to extremely close fracture spacing
	75															
	76															
	77															
	78															
								15	7.9	0	71.7	3.75				
	79															
	80															
	81														BOH	

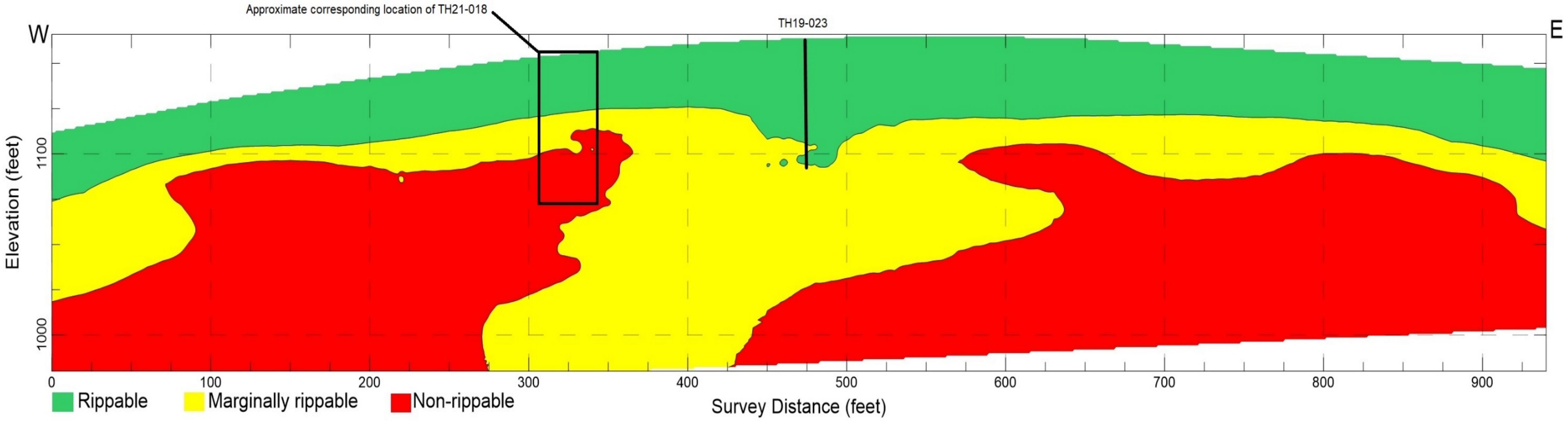
APPENDIX B-GEOPHYSICS: SEISMIC REFRACTION SURVEY

2019 Seismic Refraction Surveys:

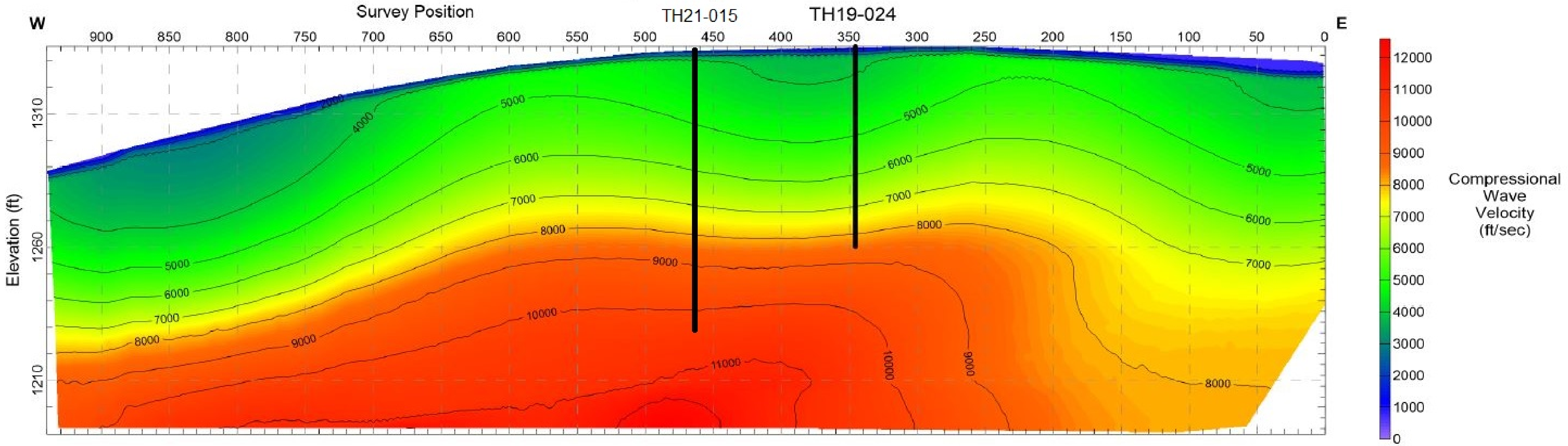


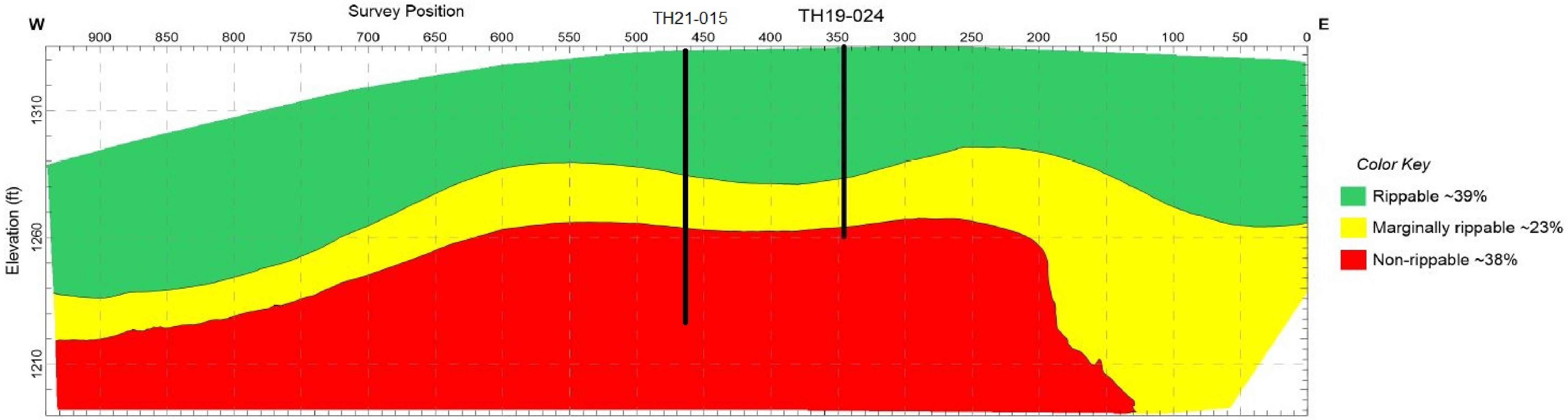

W
Approximate corresponding location of TH21-017
TH19-022
Approximate corresponding location of TH21-016
E
Elevation (feet)
1300
1200
1100
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
Survey Distance (feet)
🟩 Rippable
🟨 Marginally rippable
🟥 Non-rippable


Approximate corresponding location of TH21-018
TH19-023
W
E
Elevation (feet)
1100
1000
3800
5200
6600
8000
9400
6600
8000
8000
6600
8000
8000
9400
8000
6600
8000
9400
9400
0
100
200
300
400
500
600
700
800
900
Survey Distance (feet)
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
P-Wave Velocity (feet per second)


Approximate corresponding location of TH21-018
TH19-023
W
E
Elevation (feet)
1100
1000
0
100
200
300
400
500
600
700
800
900
Survey Distance (feet)
🟩 Rippable
🟨 Marginally rippable
🟥 Non-rippable

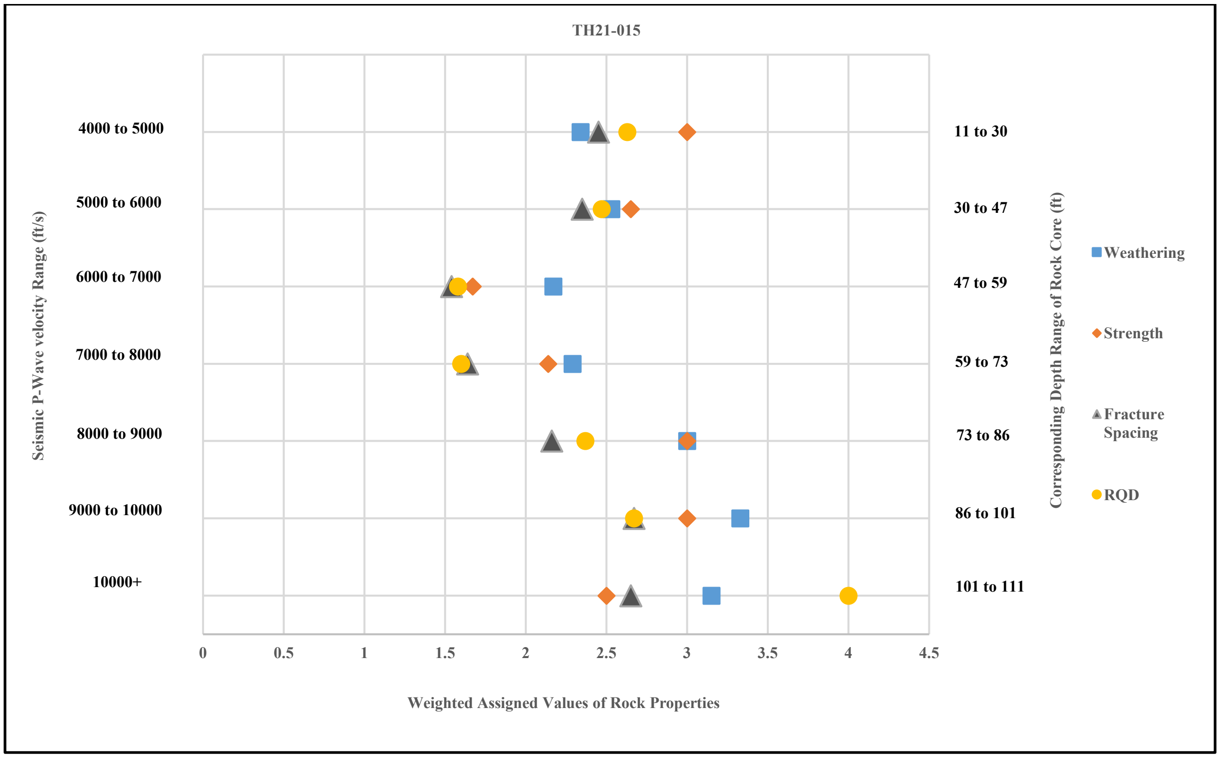
2021 Seismic Refraction Survey:

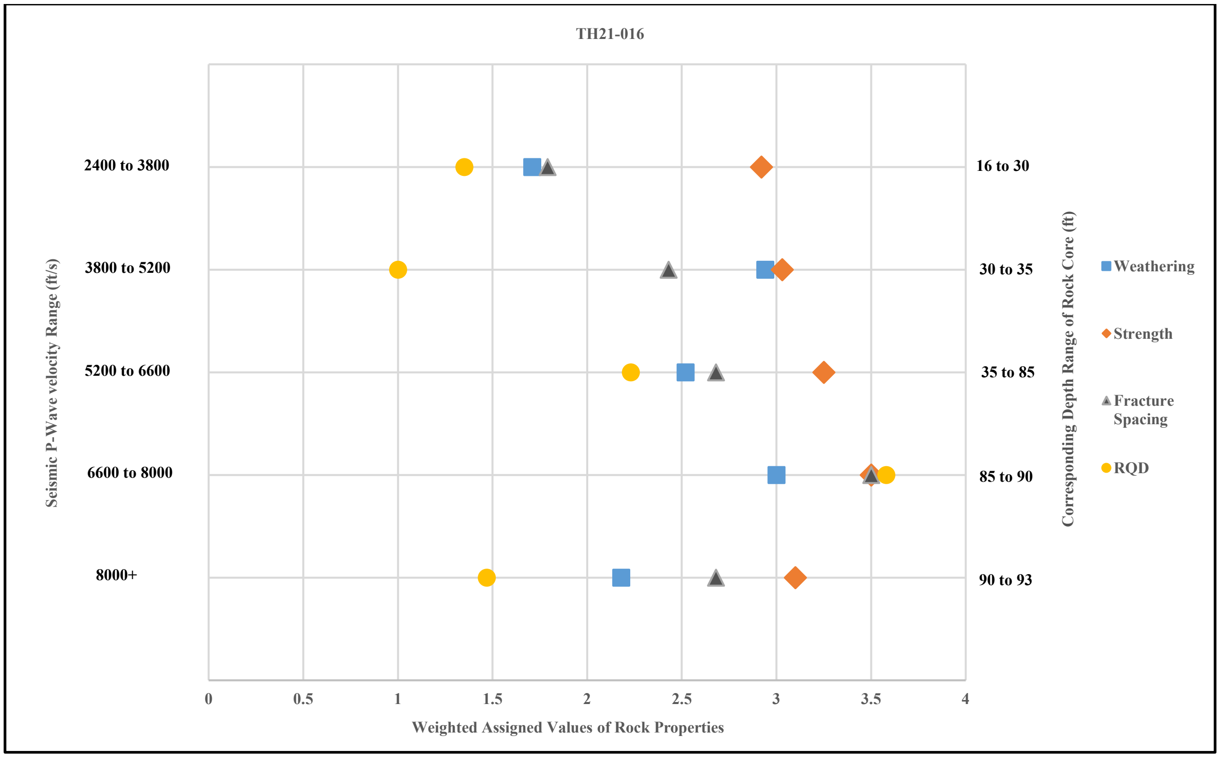


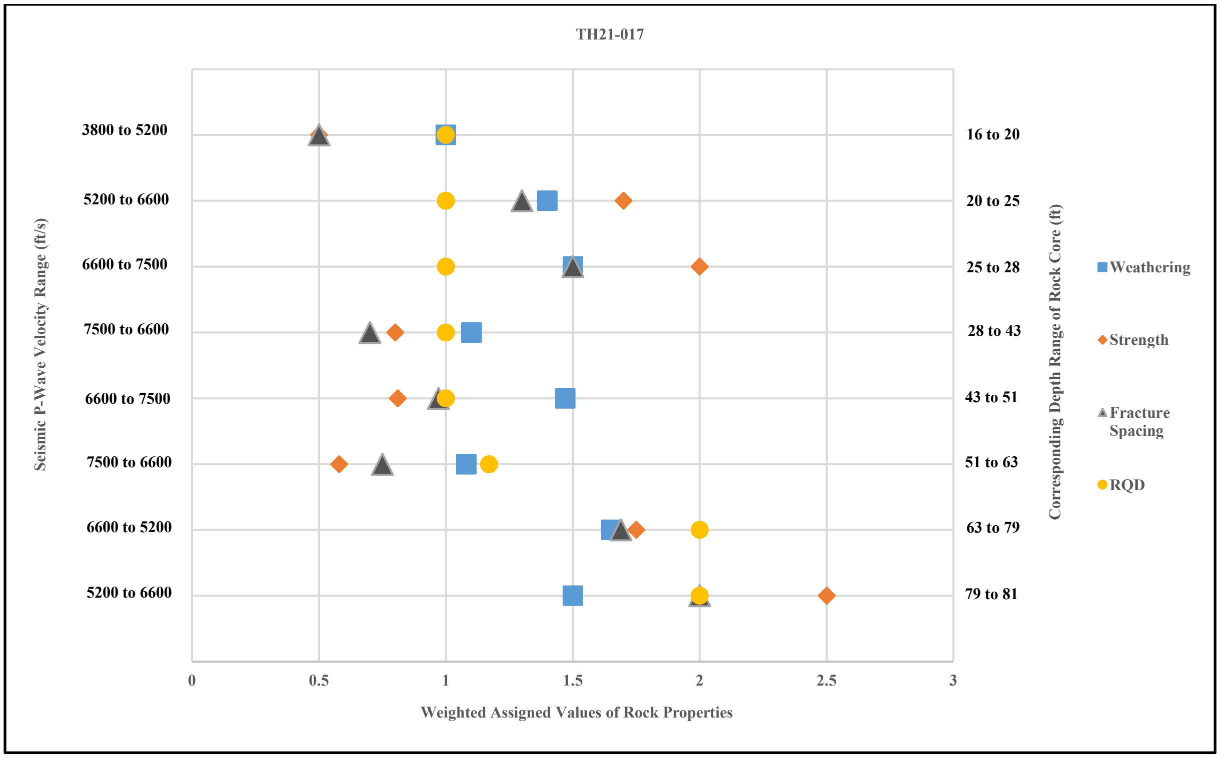

W
Survey Position
TH21-015
TH19-024
E
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Elevation (ft)
1310
1260
1210
Color Key
🟩 Rippable ~39%
🟨 Marginally rippable ~23%
🟥 Non-rippable ~38%

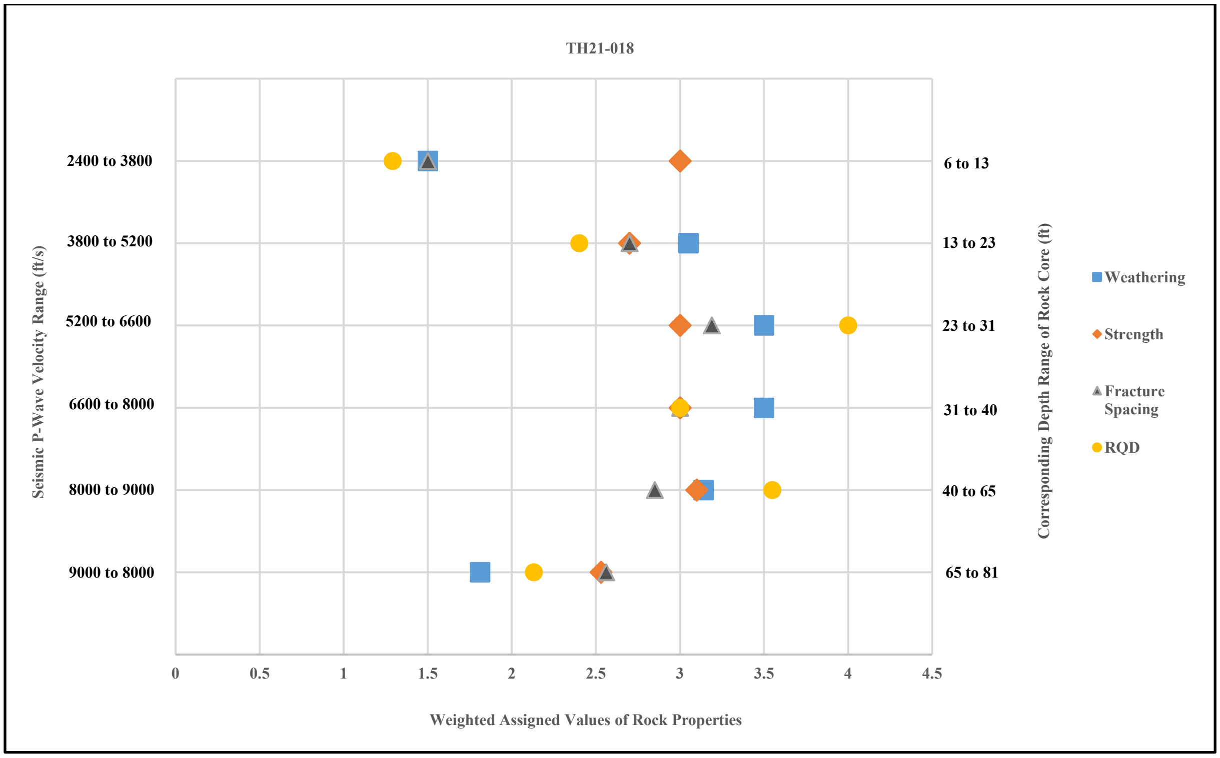
Seismic Refraction Survey Correlation to Realignment/Cut Test Holes:

Rock Core Properties				AssignedValue
Weathering	Strength	Fracture Spacing	RQD	
Completely	Extremely Weak	Extremely Close	0	1
Highly	Very Weak	Very Close	1-25% Very Poor	2
Moderately	Weak	Close	25-50% Poor	3
Slightly	Medium Weak	Moderate	51-75% Fair	4




TH21-016
Seismic P-Wave velocity Range (ft/s)
2400 to 3800
3800 to 5200
5200 to 6600
6600 to 8000
8000+
Corresponding Depth Range of Rock Core (ft)
16 to 30
30 to 35
35 to 85
85 to 90
90 to 93
Weathering
Strength
Fracture Spacing
RQD
0
0.5
1
1.5
2
2.5
3
3.5
4
Weighted Assigned Values of Rock Properties

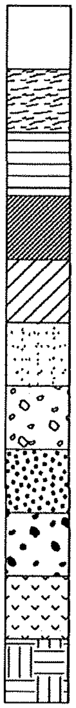

TH21-017
Seismic P-Wave Velocity Range (ft/s)
3800 to 5200
5200 to 6600
6600 to 7500
7500 to 6600
6600 to 7500
7500 to 6600
6600 to 5200
5200 to 6600
Corresponding Depth Range of Rock Core (ft)
16 to 20
20 to 25
25 to 28
28 to 43
43 to 51
51 to 63
63 to 79
79 to 81
Weathering
Strength
Fracture Spacing
RQD
0
0.5
1
1.5
2
2.5
3
Weighted Assigned Values of Rock Properties


TH21-018
Seismic P-Wave Velocity Range (ft/s)
2400 to 3800
3800 to 5200
5200 to 6600
6600 to 8000
8000 to 9000
9000 to 8000
Corresponding Depth Range of Rock Core (ft)
6 to 13
13 to 23
23 to 31
31 to 40
40 to 65
65 to 81
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Weighted Assigned Values of Rock Properties
Weathering
Strength
Fracture Spacing
RQD

APPENDIX C-SYMBOLS AND DEFINITIONS

SYMBOLS AND DEFINITIONS

BASIC MATERIAL SYMBOLS



- ASPHALT
- PEAT
- CLAY (Cl)
- ICE
- SILT (Si)
- POORLY GRADED SAND (Sa)
- POORLY GRADED GRAVEL (Gr)
- WELL GRADED SAND
- WELL GRADED GRAVEL
- BEDROCK (Bx), soft(Type)
- BEDROCK (Bx), hard(Type)

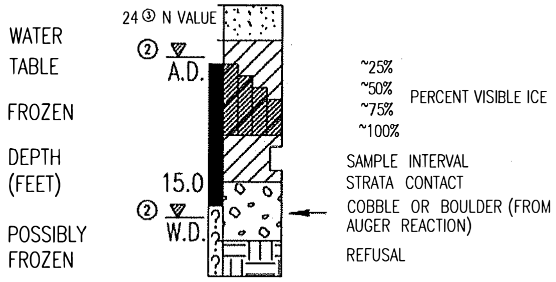
SOFT OR HARD BEDROCK BASED ON DRILLING RATE

NOTE

MAIN COMPONENT (UPPER CASE ... SOLID LINES)
MINOR COMPONENT (Title Case ... DASHED LINES OR SPARSER PATTERN)

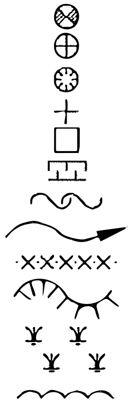
TYPICAL LOG

YEAR–HOLE NUMBER	05–41
LAT/LONG OR STATION, OFFSET	① Sta 210+53, Lt 3
ELEVATION (ft)	Elev 375
DATE LOGGED	16 JUN



① Station value may also be on centerline e.g. Sta 210+53, CL or lat–long format e.g. N64.56789°, W145.67890°
② W.D.= WHILE DRILLING, A.D.= AFTER DRILLING
③ "N VALUE" INDICATES STANDARD PENETRATION TEST (1.4" I.D., 2.0" O.D. SAMPLER DRIVEN WITH 140 LB. HAMMER, 30" FREE FALL) AND IS SUM OF 2nd AND 3rd 6" OF PENETRATION.

PLAN VIEW SYMBOLS



- POWER AUGER TEST HOLE (TH)
- HAND AUGER TEST HOLE (TH)
- EXPOSED MATERIAL
- PROBE
- HAND DUG TEST PIT (TP)
- DOZER/BACKHOE TEST TRENCH (TT)
- BODY OF WATER
- FLOW DIRECTION
- WASTE BERM
- BANK
- SWAMP
- TREELINE

USCS SIZE DEFINITIONS

BOULDERS (Boulders)	12"+
COBBLES (Cobbles)	3" TO 12"
GRAVEL	#4 TO 3"
ANGULAR FRAGMENTS	#10 +
SAND	#200 TO #4
SILT	#200 TO 0.005 mm
CLAY	MINUS 0.005 mm

TEST RESULTS

_._%-200 = % PASSING #200 SIEVE
NM _._% = NATURAL MOISTURE
ORG _._% = ORGANIC CONTENT
SSc _ = SODIUM SULFATE LOSS(coarse)
SSf _ = SODIUM SULFATE LOSS(fine)
LA _ = LOS ANGELES ABRASION
DEG _ = DEGRADATION
LL _ = LIQUID LIMIT (NV = no value)
PI _ = PLASTIC INDEX (NP = non–plastic)

MISC.

Tr = TRACE
sl = SLIGHTLY
hi = HIGHLY
w/_ = WITH UNSPECIFIED AMOUNT
X'tls = CRYSTALS
TH = TEST HOLE
TT = TEST TRENCH
TP = TEST PIT

SOIL DENSITY/CONSISTENCY DESCRIPTORS

NON–COHESIVE		COHESIVE	
RELATIVE DENSITY	BLOWS/FOOT (N) VALUE	CONSISTENCY	BLOWS/FOOT (N) VALUE
VERY LOOSE	< 4	VERY SOFT	< 2
LOOSE	5–10	SOFT	2–4
MEDIUM DENSE	11–30	FIRM	5–8
DENSE	31–50	STIFF	9–15
VERY DENSE	> 50	VERY STIFF	16–30
		HARD	> 30

COLOR

Bk = BLACK
Bl = BLUE
Bn = BROWN
Gn = GREEN
Gy = GRAY
Or = ORANGE
Rd = RED
Tn = TAN
Wh = WHITE
Yw = YELLOW

MOISTURE

dry	= < OPTIMUM*	DUSTY, DRY TO THE TOUCH
moist	~ OPTIMUM*	DAMP, NO VISIBLE WATER
wet	= > OPTIMUM*	VISIBLE FREE WATER

* OPTIMUM MOISTURE FOR MAXIMUM DENSITY

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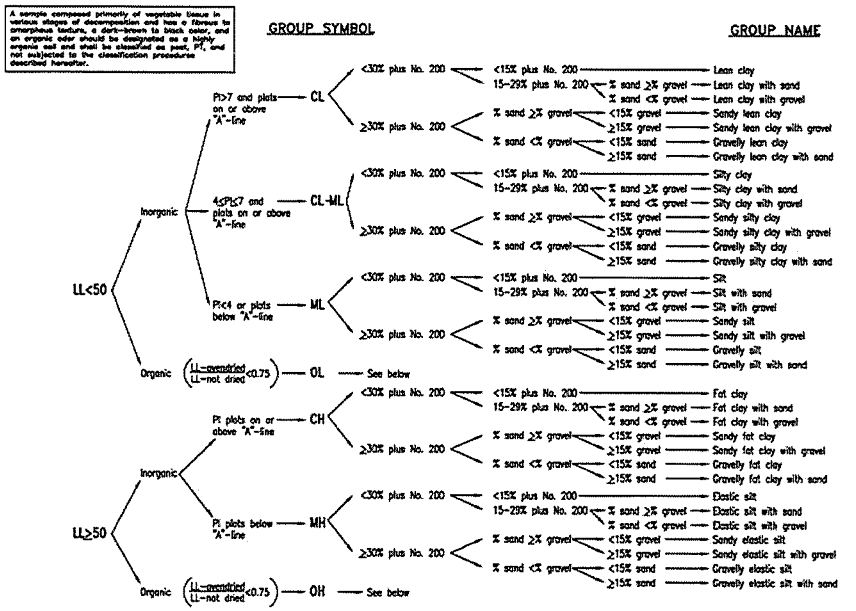
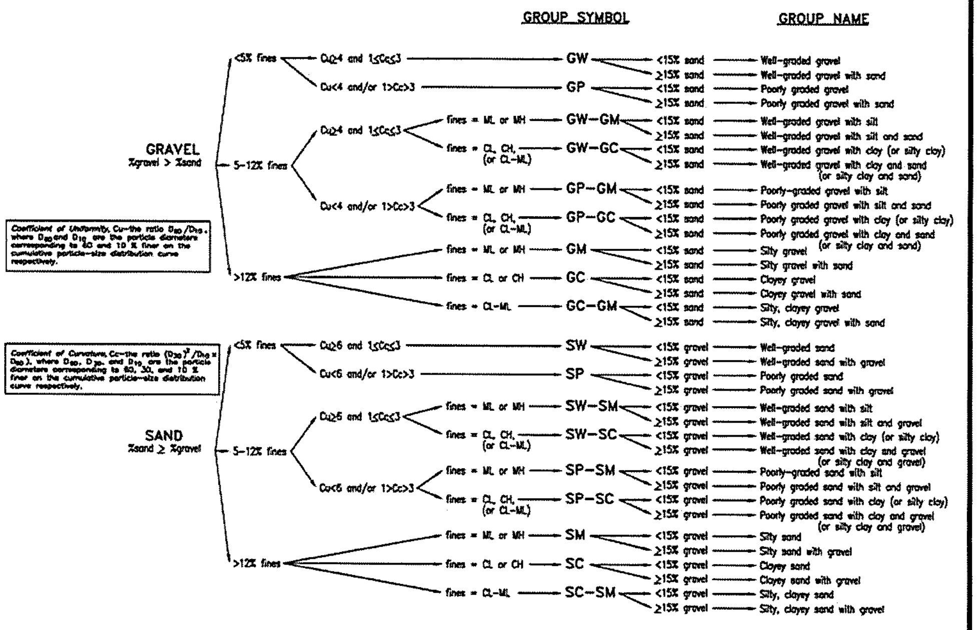
Classification of Soils for Engineering Purposes (Unified Soil Classification System)

A sample composed primarily of vegetable tissue in various stages of decomposition and has a fibrous to amorphous texture, a dark-brown to black color, and an organic odor should be designated as a highly organic soil and shall be classified as peat, PT, and not subjected to the classification procedures described hereafter.



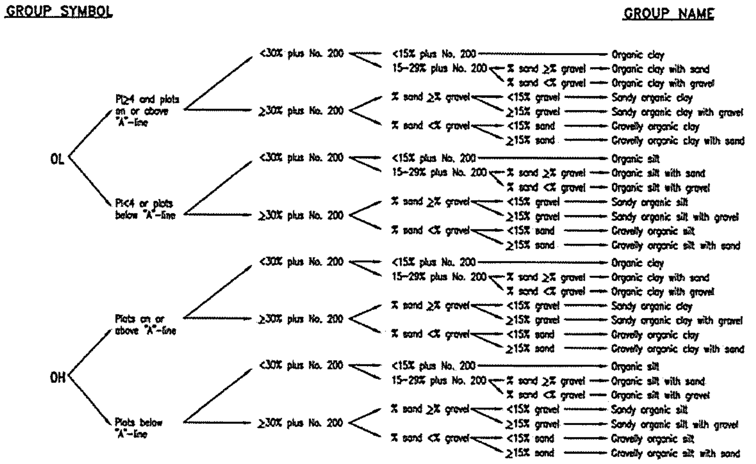
Flow Chart for Classifying Fine-Grained Soil (50% or More Passes No. 200 Sieve)



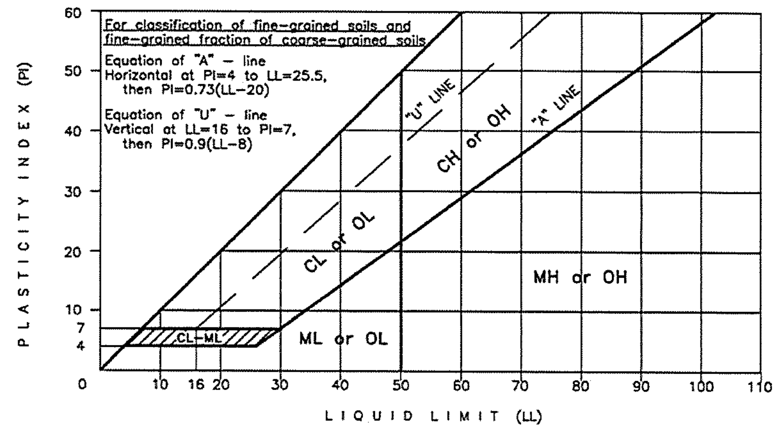
Coefficient of Uniformity, Cu—the ratio D_{60}/D_{10}, where D_{60} and D_{10} are the particle diameters corresponding to 60 and 10 % finer on the cumulative particle-size distribution curve respectively.

Coefficient of Curvature, Cc—the ratio $(D_{30})^2/(D_{10} \times D_{60})$, where D_{60}, D_{30}, and D_{10} are the particle diameters corresponding to 60, 30, and 10 % finer on the cumulative particle-size distribution curve respectively.

Flow Chart for Classifying Coarse-Grained Soil (More Than 50% Retained on No. 200 Sieve)



Flow Chart for Classifying Organic Fine-Grained Soil (50% or More Passes No. 200 Sieve)



Plasticity Chart

DESCRIPTION AND CLASSIFICATION OF FROZEN SOILS

Part I Description of Soil Phase (a) (Independent of Frozen State)	Major Group		Sub-Group		Field Identification (6)	Pertinent Properties of Frozen Materials which may be measured by physical tests to supplement field identification. (7)	Guide for Construction on Soils Subject to Freezing and Thawing	
	Description (2)	Designation (3)	Description (4)	Designation (5)			Thaw Characteristics (8)	Criteria (9)
Part II Description of Frozen Soil	Segregated ice is not visible by eye (b)	N	Poorly Bonded or Friable	Nf	Identify by visual examination. To determine presence of excess ice, use procedure under note (c) below and hand magnifying lens as necessary. For soils not fully saturated, estimate degree of ice saturation: Medium, Low. Note presence of crystals, or of ice coatings around larger particles.	In-Place Temperature Density and Void Ratio a) In Frozen State b) After Thawing in Place Water Content (Total H_2O, including ice) a) Average b) Distribution Strength a) Compressive b) Tensile c) Shear d) Adfreeze	Usually Thaw-Stable	The potential intensity of ice segregation in a soil is dependent to a large degree on its void sizes and may be expressed as an empirical function of grain size as follows: Most inorganic soils containing 3 percent or more of grains finer than 0.02 mm in diameter by weight are frost-susceptible. Gravels, well-graded sands and silty sands, especially those approaching the theoretical maximum density curve, which contain 1.5 to 3 percent finer than 0.02 mm by weight without being frost-susceptible. However, their tendency to occur interbedded with other soils usually makes it impractical to consider them separately.
			No excess ice	n				
			Well Bonded	Nb				
			Excess ice	e				
	Segregated ice is visible by eye. (Ice 1 inch or less in thickness) (b)	V	Individual ice crystals or inclusions	Vx	For ice phase, record the following as applicable: Location Size Orientation Shape Thickness Spacing Pattern of arrangement Length Hardness } Structure } per part III Below Color } Estimate volume of visible segregated ice present as percent of total sample volume		Usually Thaw-Unstable	Soils classed as frost-susceptible under the above criteria are likely to develop significant ice segregation and frost heave if frozen at normal rates with free water readily available. Soils so frozen will fall into the thaw-unstable category. However, they ma also be classed as thaw-stable if frozen with insufficient water to permit ice segregation.
			Ice coatings on particles	Vc		Elastic Properties Plastic Properties Thermal Properties		
			Random or irregularly oriented ice formations	Vr				
			Stratified or distinctly oriented ice formations	Vs		Ice Crystal Structure (using optional instruments.) a) Orientation of Axes b) Crystal size c) Crystal shape d) Pattern of Arrangement		Soils classed as non-frost-susceptible (*NFS) under the above criteria usually occur without significant ice segregation and are not exact and may be inadequate for some structure applications: exceptions may also result from minor soil variations.
Part III Description of Substantial Ice Strata	Ice (Greater than 1 inch in thickness)	Ice	Ice with soil inclusions	Ice + Soil Type	Designate material as ICE (d) and use descriptive terms as follows, usually one item from each group, as applicable:			
			Ice without soil inclusions	Ice		Same as Part II above, as applicable, with special emphasis on Ice Crystal Structure.		In permafrost areas, ice wedges, pockets, veins, or other ice bodies may be found whose mode of origin is different from that described above. Such ice may be the result of long-time surface expansion and contraction phenomena or may be glacial or other ice which has been buried under a protective earth cover.

Hardness	Structure	Color	Admixtures
Hard Soft (mass, not indi- crystals)	Clear Cloudy Porous Candled Granular Stratified	e.g.: Colorless Gray Blue	e.g.: Contains Thin Silt Inclusions

DEFINITIONS:

Ice Coatings on Particles are discernible layers of ice found on or below the larger soil particles in a frozen soil mass. They are sometimes associated with hoarfrost crystals, which have grown into voids produced by the freezing action.

Ice Crystal is a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in a combination with other ice formations.

Clear ice is transparent and contains only a moderate number of air bubbles.**(e)**

Cloudy Ice is translucent, but essentially sound and non-pervious

Porous Ice 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.

Candled ice is ice which has rotted or otherwise formed into long columnar crystals, very loosely bonded together.

Granular Ice is composed of coarse, more or less equidimensional, ice crystals weakly bonded together.

Ice Lenses are lenticular ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss and commonly in repeated layers.

Ice Segregation is the growth of ice as distinct lenses, layers, veins and masses in soils, commonly but not always oriented normal to direction of heat loss.

Well-bonded signifies that the soil particles are strongly held together by the ice and that the frozen soil possesses relatively high resistance to chipping or breaking.

Poorly-bonded signifies that the soil particles are weakly held together by the ice and that the frozen soil consequently has poor resistance to chipping or breaking.

Friable denotes a condition in which material is easily broken up under light to moderate pressure.

Thaw-Stable frozen soils do not, on thawing, show loss of strength below normal, long-time thawed values nor produce detrimental settlement.

Thaw-Unstable frozen soils show on thawing, significant loss of strength below normal, long-time thawed values and/or significant settlement, as a direct result of the melting of the excess ice in the soil.

Modified from: Linell, K. A. and Kaplar, C. W., 1966, *Description and Classification of Frozen Soils*, Proc. International Conference on Permafrost (1963), Lafayette, IN, U.S. National Academy of Sciences, Publ. 1287, pp 481-487.

NOTES:

(a) When rock is encountered, standard rock classification terminology should be used.

(b) 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. However, the impression to the unaided eye is that none of the frozen water occupies space in excess of the original voids in the soil. The opposite is true of frozen soils in the V group.

(c) When visual methods may be inadequate, a simple field test to aid evaluation of volume of excess ice can be made by placing some frozen soil in a small jar, allowing it to melt and observing the quantity of supernatant water as a percent of total volume.

(d) Where special forms of ice, such as hoarfrost, can be distinguished, more explicit description should be given.

(e) Observer should be careful to avoid being misled by surface scratches or frost coating on the ice.