Geotechnical Engineering Report

Deer Flat Caldwell Canal Bridge
SH-55, Farmway Road to Middleton Road
ITD Project No. A022(715); Key No. 22715
Canyon County, Idaho

April 28, 2022
Terracon Project No. 62185117A

Prepared for:

Horrocks Engineers
Meridian, Idaho

And

Idaho Transportation Department
Boise, Idaho

Prepared by:

Terracon Consultants, Inc.
Boise, Idaho

April 28, 2022

Horrocks Engineers
2775 W. Navigator Drive, Ste 210
Meridian, Idaho 83642

Attn: Mr. John Stone, P.E.
E: johnst@horrocks.com

Re: Geotechnical Engineering Report
Deer Flat Caldwell Canal Bridge
SH-55, Farmway Road to Middleton Road
ITD Project No. A022(715); Key No. 22715
Canyon County, Idaho
Terracon Project No. 62185117A

Dear Mr. Stone:

In accordance with our agreement dated November 2, 2021, we have prepared this Geotechnical Engineering Report for the above referenced project. The accompanying report presents findings of the subsurface exploration and recommendations for the design of foundations for the proposed reconstruction and widening of the existing Deer Flat Caldwell Canal stiff-leg bridge structure. This report was prepared in general accordance with the Idaho Transportation Department (ITD) Materials Manual.

This report incorporates comments from ITD on the draft version, dated March 4, 2022. Responses to the comments are included in the Bluebeam session of this report.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service assistance to you in any way, we are available at your convenience.

Sincerely,
Terracon Consultants, Inc.

4/29/2022

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April 28, 2022

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230.01 INTRODUCTION

The proposed project on SH-55 is approximately 9½ miles in length and extends from Pear Lane (MP 6.2) to Middleton Road (MP 15.6) in Canyon County, Idaho. The project will include reconstruction and widening of SH-55 mainline, shared used path construction, intersection improvements, irrigation facilities, four bridge replacements, and four sound walls construction. Project design consists of two phases. Phase 1 is the SH-55 segment between Farmway Road (MP 10.6) and Middleton Road (MP 15.6), and Phase 2 is the segment between Pear Lane (MP 6.2) and Farmway Road (MP 10.6).

The purpose of this investigation is to provide geotechnical engineering recommendations for the reconstruction and widening of the existing Deer Flat Caldwell Canal stiff-leg bridge structure. The structure is located at about MP 12.56, which is approximately 0.06 miles west of the intersection of Indiana Avenue and SH-55. A Site Location Map showing the location of the structure is provided in **Appendix A**.

Currently, SH-55 crosses over the Deer Flat Caldwell Canal via a stiff-leg bridge structure consisting of cast-in-place (CIP) and pre-cast concrete sections. The CIP sections were constructed in 1973 with the original bridge, and the pre-cast sections were constructed in 2017 to extend the original bridge 66 feet to the north. The existing structure has a clear span of 18 feet, an opening height of 7.58 feet, a footing embedment depth ranging from about 5 to 6 feet below bottom of canal invert elevation of 2495.8 feet, and out-to-out length of approximately 124 feet.

Based on information provided in the Deer Flat Caldwell Canal Draft Type, Size, and Location Report, dated January 10, 2022, prepared by Horrocks, the preferred alternative for reconstruction of the existing structure will consist of removing and replacing all the original CIP bridge section (approximately 59 feet), and extending the existing pre-cast section, 96 feet to the north, and 68 feet to the south with a new stiff-leg bridge structure. The new stiff-leg bridge structure will be pre-cast with a total length of 228 feet. We understand the new extension will have the same span as the existing precast structures. Cast-in-place wingwalls will be constructed at each end of the new structure. Preliminary analysis provided by Horrocks indicates foundation loads will be approximately 17.2 kip/ft for the maximum Services I Factored Load and 23.5 kip/ft for the maximum Strength I Factored Load.

New embankments associated with the planned widening and construction will be placed along the north and south side of SH-55. The road profile at the center line of SH-55 will be raised to finish grade elevation of approximately 2507.5 feet. Embankment height along the north side of SH-55 will range between about 8 to 12 feet above existing grade, and on the south side of SH-55 embankment height is expected to be less than about 4 feet. Fill heights ranging between about 2.5 to 4 feet will also be placed over the new structure.

The recommendations in this report are based on the following publications:

- *AASHTO LRFD Bridge Design Specifications,* 9th Edition, 2020 (*AASHTO LRFD*).
- *ITD Materials Manual,* 2020.
- *ITD Standard Specifications for Highway Construction, 2018,* and the 2021 *Supplemental Specifications*.

Terracon previously prepared a Phase 1 Materials Report, dated May 21, 2020, that was completed under ITD Key No. 21906. Terracon has prepared a Roadway Materials Report for the proposed pavements and embankments (dated April 20, 2022) and Geotechnical Engineering Reports for the other bridges that are a part of the first phase of the project. Terracon will prepare a Geotechnical Engineering Report for the sound walls that are included in the first phase of this project.

230.02 FIELD EXPLORATION AND LABORATORY TESTING

230.02.01 Borings

Terracon drilled 2 borings (borings S-8 and S-9) to depths of approximately 36.5 feet below the existing ground surface. Ground surface elevation was surveyed as 2504.7 feet at boring S-8 and 2502.4 feet at boring S-9. These borings were located on each side of the proposed bridge. The borings were drilled using a truck-mounted drill rig equipped with hollow-stem augers. A Terracon field engineer/geologist recorded logs of the borings during the drilling operations.

The boring locations were selected by Terracon based on site access, utility, and safety considerations. After drilling, the project team surveyed the boring locations and elevations. Boring locations and elevations, as well as boring logs, are shown on the Foundation Investigation Plat. The Foundation Investigation Plat was prepared by Horrocks and incorporates geotechnical information provided by Terracon. A reduced size copy of the Foundation Investigation Plat (11 inches by 17 inches) is included in **Appendix A**. Individual boring logs are also included in **Appendix A**.

Elevations shown on the Foundation Investigation Plat are based on the North American Vertical Datum of 1988 (NAVD 88).

230.02.02 Field Tests

Disturbed samples were collected from the borings using a 2-inch-outside-diameter split-spoon sampler following Standard Penetration Test (SPT) methods in general accordance with ASTM D1586. Encountered soils were visually classified at the time of drilling per ASTM D2488.

The SPT N-value provides a reasonable estimate of the relative in-place density of non-cemented sandy type materials. However, the N-value only provides an indication of the relative stiffness of cohesive materials, since the penetration resistance of these soils may be affected by the moisture content. Considerable care must be exercised in interpreting the N-value in gravelly soils, particularly where the size of the gravel particles exceeds the inside diameter of the sampling spoon.

An automatic SPT hammer was used to advance the split-spoon sampler in the borings performed for this project. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the cathead and rope method. The higher efficiency of the automatic hammer affects the standard penetration resistance blow count (N-value) by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

230.02.03 Geophysical Exploration

Geophysical studies were not conducted at this site.

230.02.04 Laboratory Tests

Soil samples collected were visually classified in the field (ASTM D2488) , taken to the laboratory where soils were classified in general accordance with the Unified Soil Classification System (ASTM D2487) described in **Appendix C** based on resulting laboratory test data. Representative samples were selected for testing to determine the engineering and physical properties of the soils. The following table lists the tests performed and provides a brief description of the purpose of each.

Table 1. Laboratory Testing

Tests Conducted	To Determine
Moisture Content (ASTM D2216)	Moisture content of the soil sample.
Gradation Analysis (ASTM D6913)	Particle size distribution of the sample.
Atterberg Limits (ASTM D4318)	Plasticity index, liquid limit, and plastic limit of the soil sample

Results of the field and laboratory tests are generally summarized on the boring logs. Graphical results of the gradation analyses are included in **Appendix B**. The laboratory test data, along with the field information, were used to prepare the boring logs included in **Appendix A**.

230.03 SURFACE CONDITIONS

Deer Flat Caldwell Canal crosses beneath SH-55 between Montana Avenue and Indiana Avenue south of Caldwell in Canyon County, Idaho. The project is generally in an area of agricultural fields except for a residence located adjacent to the southeast corner of the bridge.

Based on information provided by Horrocks, the canal invert elevation is about 2498.5 feet, and finish road grade elevation at centerline is about 2507.5 feet. Existing canal slopes varies between approximately 1H:1V to 1.5H:1V. At the project location, SH-55 is paved with hot mix asphalt surfacing. Unpaved access roads are located on each side of the canal and some weeds and grasses on the canal banks. Near the structure, the Deer Flat Caldwell Canal generally flows to the northwest, and the existing stiff-leg bridge structure crosses SH-55 at an approximate 40-degree skew. Based on information available at the time of this report, the highwater elevation at the structure location is reported to be 2,500.8 feet. Canal elevation information is preliminary and approximate and may change. Water was not flowing in the canal at the time of our field exploration. Overhead power lines are located on the north side of SH-55. An aerial photograph showing the boring/bridge location is attached in **Appendix A.**

230.04 SUBSURFACE CONDITIONS

Subsurface conditions encountered at the boring locations are indicated on boring logs S-8 and S-9 included in **Appendix A**. Stratification boundaries shown on the boring logs represent the approximate locations of changes in the soil. In-situ, the transition between materials may be gradual.

Native soils encountered in borings S-8 and S-9 generally consisted of medium stiff to hard silt to clay with varying amounts of sand to depths ranging from about 10 to 13 feet (approximate elevations between 2491.5 and 2492.5 feet) below the existing ground surface. Within boring S-8 an interbedded layer of very dense gravel with sand was encountered from about 7½ to 9 feet, corresponding to approximately elevations of 2497 feet and 2495.5 feet. Soil encountered below elevations 2491.5 and 2492.5 in borings S-8 and S-9, respectively, generally consisted of medium dense to very dense sand and gravel with varying amounts of silt and some cobbles. The boring logs are presented in **Appendix A**.

The borings were monitored for the presence of groundwater. Water was not flowing in the canal and groundwater was not encountered within the borings at the time of drilling. Water levels shown on the logs of wells that are in the vicinity of the structure that are available from the Idaho Department of Water Resources showed recorded groundwater levels greater than 50 feet below the ground surface. Fluctuations of the groundwater level may occur due to water flow in the canal and variations in the amount of rainfall, runoff, irrigation, and other factors not evident at the time of exploration. The evaluation of these factors was beyond the scope of this report. Depending on the time of year that construction occurs, dewatering may be required for foundation excavations of the new stiff-leg structure.

230.05 CONCLUSIONS AND RECOMMENDATIONS

230.05.01 General

We recommend that the proposed bridge be supported on spread footings.

230.05.02 Foundations

230.05.02.01 Spread Footings

Existing fill and disturbed soils should be removed down to undisturbed native soils in foundation areas. A smooth bucket should be used during excavation to reduce disturbance of native soil at the bottom of foundation excavations. Foundations should be supported on a minimum 12-inch thick layer of ¾ inch Type B Aggregate for Untreated Base. Prior to placing ¾ inch Type B Aggregate for Untreated Base the bottom of the foundation excavation should be compacted with a minimum of 5 overlapping passes with an approved compactor, in accordance with Section 210.03.B of the 2021 Supplemental Specifications for the 2018 Standard Specifications for Highway Construction.

To match the existing structure construction, the layer of ¾ inch Type B Aggregate for Untreated Base should extend laterally from the foundation edges at least 24 inches. The ¾ inch Type B Aggregate for Untreated Base should be compacted to Class A Compaction. Geotechnical design parameters for proposed foundations are presented in the subsection below.

We understand the existing pre-cast sections of the structure will be lengthened to extend the bridge to the north and south. Foundations for the new pre-cast extensions are planned to match the existing bridge foundations. Settlement effects of new and widened embankment between proposed precast extension and existing structure footings were evaluated using the computer program Settle3 using elastic soil properties based on N1(60) correlations from AASHTO LRFD table C10.4.6.3. Results indicate approximately ½ inch of settlement will occur at the connection between the existing and the new precast extension, with differential settlement of approximately 0.05 inch/foot away from the connection. The existing structure may experience similar differential settlement due to adjacent loading from the new precast extension.

Table 2. Foundations

Description	Criteria
Foundation type	Conventional spread footings.
Bearing material	At least 12 inches of compacted (Class A Compaction) ¾ inch Type B Aggregate for Untreated Base supported on compacted native soils, as described above.
Minimum embedment depth	Bottom of footing depth should be at least 2 feet below anticipated scour depth; or 3-feet below

Description	Criteria
	the channel invert (elevation of 2498.5 feet) to the top of footing, whichever is greater.
Minimum footing width	3.0 feet
Scour depth[1]	1.2 feet
Nominal (ultimate, unfactored) bearing capacity	See the figure and discussion below.
Recommended resistance factor to be used with the nominal (ultimate, unfactored) bearing capacity for strength limit state design[2]	0.45
Service limit bearing capacity for settlement less than 1 inch	See the figure and discussion below.
Recommended resistance factor to be used with the bearing capacity for service limit state design[1]	1.0
Ultimate coefficient of friction to resist sliding	Cast-in-place footings: 0.65 Precast footings: 0.50
Recommended resistance factors when designing resistance to sliding[2]	Cast-in-place footings: 0.80 Precast footings: 0.90

1. Provided by Horrocks via email.
2. Recommended resistance factors are based on AASHTO LRFD (2020)

Results of the field exploration and laboratory testing, including SPT results from the borings were used to evaluate the strength of the foundation soil for bearing capacity. The nominal (ultimate, unfactored) bearing capacity is shown as a function of effective footing width in the figure below. This bearing resistance is based on a friction angle of 35 degrees, an undrained shear strength of 0 psf and total unit weight of 110 pcf. The resistance factor shown in the table above should be applied to the bearing values presented in the plots below.

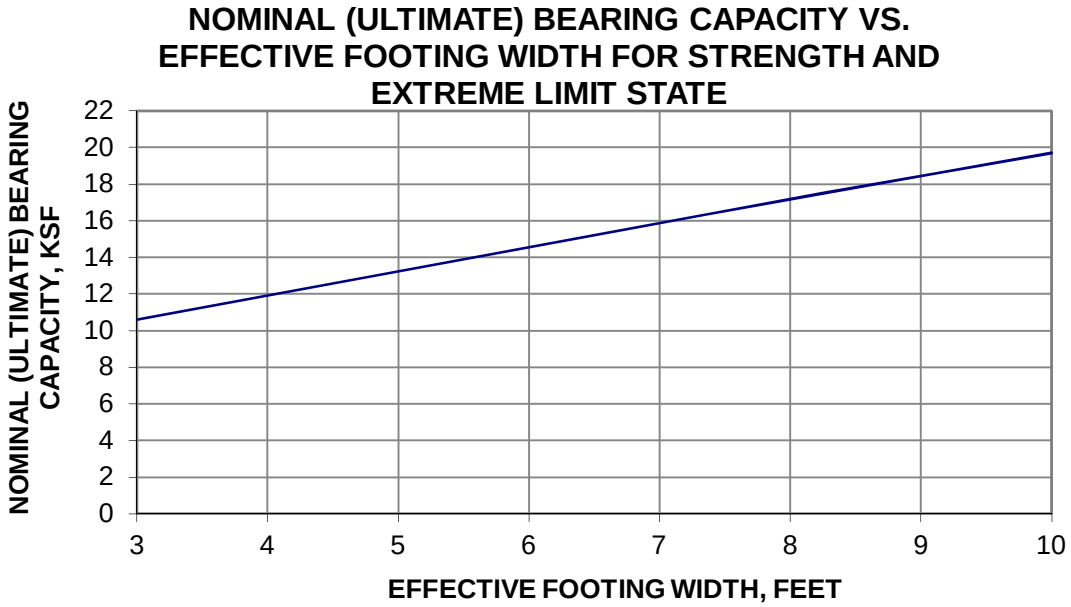


Figure 1. Nominal (Ultimate, Unfactored) Bearing Capacity

The bearing capacity versus footing width at the service limit state for a total estimated settlement of approximately 1 inch is presented on the graph below. Settlement estimates of new precast extension footings were calculated based on the empirical Hough method described in AASHTO LRFD section 10.6.2.4.2, and the native soils encountered in our borings. The settlement curve below is the net bearing pressure (i.e., pressures greater than the existing overburden pressure).

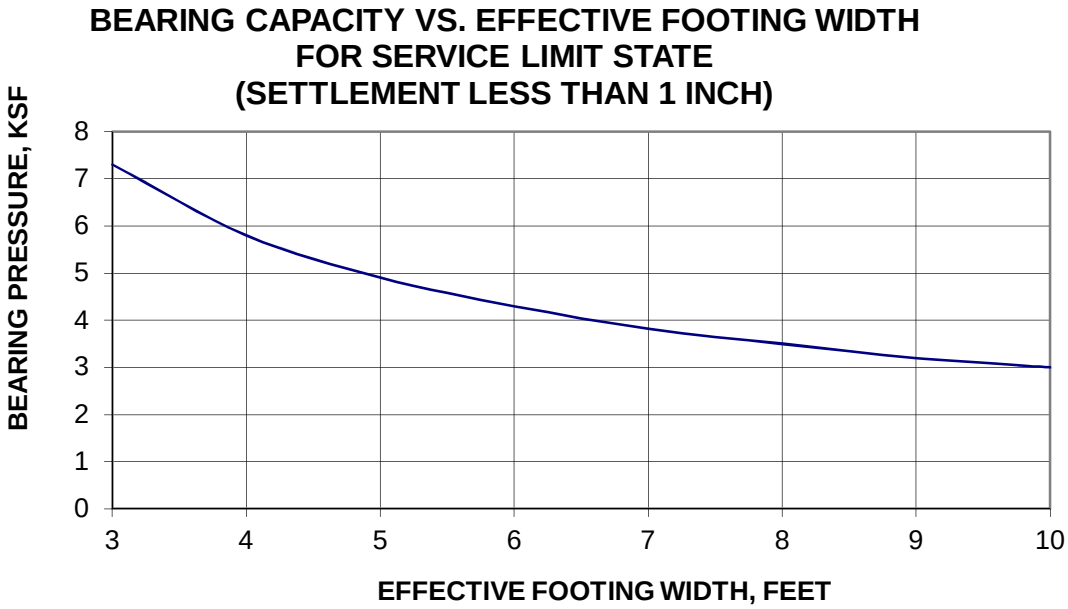


Figure 2. Service Limit Bearing Capacity

230.05.02.02 Deep Foundations

Deep foundations are not recommended for support of the proposed structure.

230.05.03 Lateral Pressures and Backfill

Unfactored lateral earth pressures are presented in the following table for compacted Granular Subbase backfill. As indicated in the generalized diagram below, the zone of backfill should extend out horizontally at least two feet from the base of the foundation and upwards at an angle of 60 degrees from horizontal or flatter for the active values to apply, upwards at an angle 45 degrees from horizontal or flatter for the at-rest values to apply, and upwards at an angle of 30 degrees from horizontal or flatter for the passive values to apply. Unless temporary shoring is used, flatter slopes than those listed above may be required during construction for excavation safety.

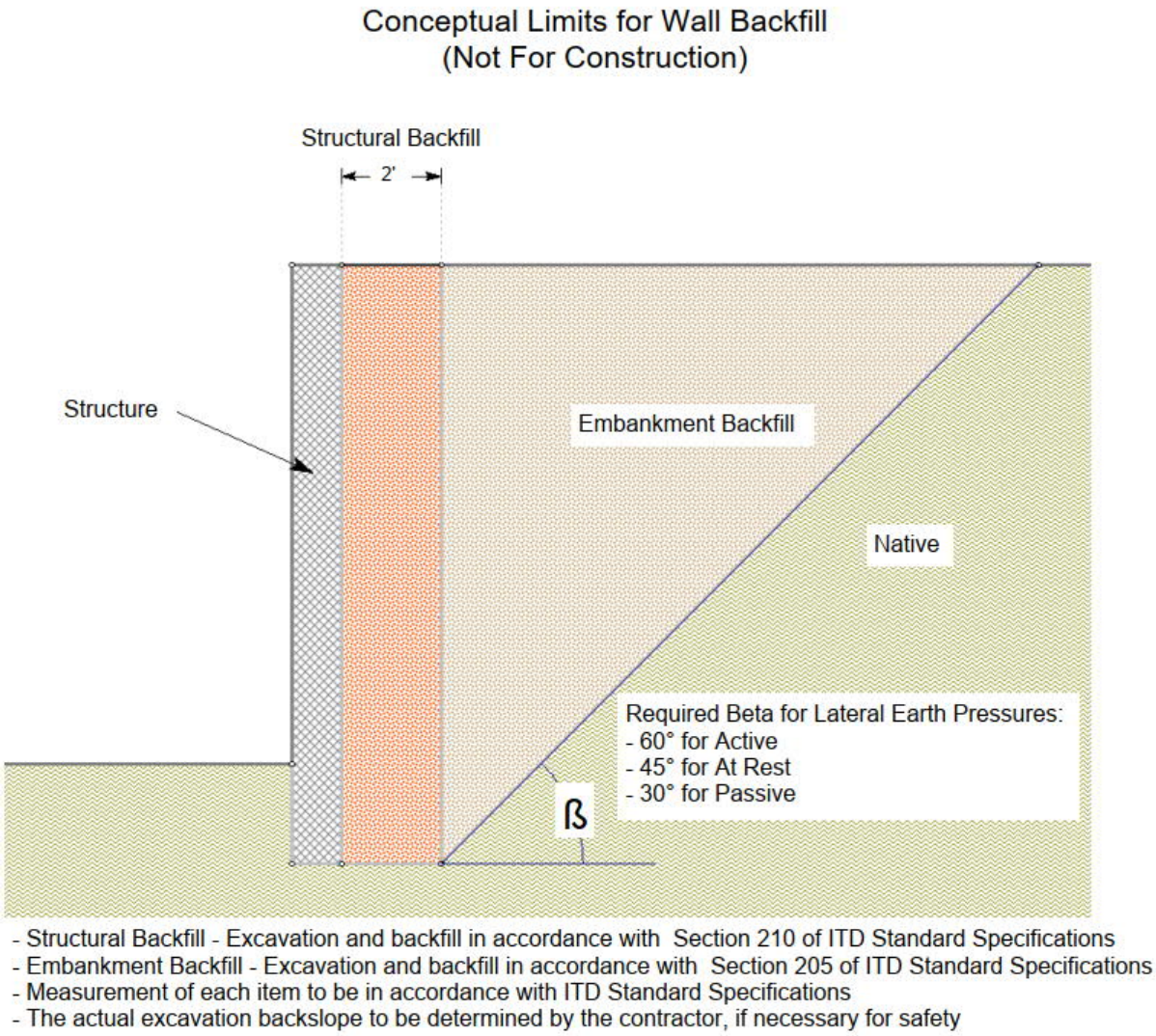


Figure 3. Conceptual Limits for Wall Backfill

Table 3. Lateral Earth Pressures

Parameter	Slope Above Wall	Pressure Coefficient	Equivalent Fluid Density (pcf)	
			Fully Drained Condition Above Groundwater [1]	Soil Below Groundwater Condition [1, 2]
Total Unit Weight, pcf	-	-	125	130
Friction Angle, Degrees	-	34	34	34
Active Earth Pressure Condition	Horizontal	0.28	35	81
	6.0(H):1(V)	0.29	37	82
	4.0(H):1(V)	0.31	38	83
	2.0(H):1(V)	0.41	51	90
At-Rest Earth Pressure Condition	Horizontal	0.44	55	92
	6.0(H):1(V)	0.51	64	97
	4.0(H):1(V)	0.55	68	99
	2.0(H):1(V)	0.64	80	106
Passive Earth Pressure Condition	Horizontal	3.54	442	239

1. These are ultimate values that assume compacted granular backfill with an estimated moist and saturated unit weights and internal friction angle as shown above.
2. For the active and at-rest earth pressures, the values presented for the soil-below-groundwater condition include water pressure. The passive earth pressure for the soil-below-groundwater condition does not include water pressure.

Lateral earth pressures on the abutment walls due to seismic shaking were estimated based on the Mononobe-Okabe method. If abutments will generally behave as non-yielding walls, a seismic equivalent fluid pressure of 9 pcf for backfill should be applied. For retaining walls that are free to rotate, a seismic equivalent fluid pressure of 5 pcf for backfill should be applied. These values are based on horizontal backfill above the abutment walls. The seismic pressure resultant load should be applied 1/2 H above the base of the wall.

We anticipate the proposed wing walls may be constructed with backfill that is either horizontal or upward sloping. The proposed stiff-leg bridge structure will have horizontal backfill above the proposed abutment walls. Permanent backfill slopes should be constructed no steeper than 2(H):1(V). The unfactored lateral earth pressure values presented above only apply to the specified slope inclination.

Active earth pressures are applicable for a wall that is free to rotate and are only appropriate for cohesionless soils. The amount of movement relative to the wall height to develop active earth pressures is presented in AASHTO LRFD Table C3.11.1-1. At-rest earth pressures are appropriate for a wall that is restrained at the top and for cohesive soils. We anticipate the proposed stiff-leg bridge will be a rigid structure, so at-rest earth pressure will apply. At-rest earth pressure conditions will also apply to wing walls that are structurally attached to the abutments. Otherwise, active earth pressures may be used for wing walls that are able to move the required distance. Some movement of the structure would be required to mobilize the full passive pressure. Relative movements to develop passive resistance are provided in AASHTO LRFD Table 3.11.1-1. In accordance with AASHTO LRFD Table 10.5.5.2.2-1, the resistance factor for the passive earth pressure component of sliding resistance should be 0.50. As described in AASHTO LRFD C10.6.3.4, this resistance factor is based on the lateral foundation movement being less than what is needed to mobilize the full passive pressure. Passive pressure should not be used to resist the sliding of walls towards the canal or other downward slopes. The passive resistance should be neglected in the scour zone or the upper 2 feet of the soils profile, whichever is deeper.

Lateral earth pressures should be adjusted for hydrostatic pressures, surcharge loads including the weight of soil above the top of the structure, sloping fill, live loads near the walls (including compaction equipment and traffic), and/or seismic loads as appropriate. The live load surcharge for vehicular loads is often modeled as being equivalent to 2 feet of soil with a unit weight of at least 125 pcf, but these loads should be determined in accordance with Tables 3.11.6.4-1 and 3.11.6.4-2 of AASHTO LRFD

Fill, debris, and loose soil should be removed before placing backfill behind walls. ITD Class A compaction is recommended for backfill. Compaction near walls should be in accordance with ITD Standard Specification Section 210.03.A.

230.05.04 Anchors

We do not anticipate that anchors will be used.

230.05.05 Drainage

Surface water runoff should be prevented from discharging or infiltrating behind or over the face of the structure, wing walls, or slopes. Surface water from the roadway should be collected and discharged to a safe location away from the structure. Project design should provide for drainage of the roadway and maintenance of existing drainage patterns. For a discussion regarding erosion control, see Section 230.05.07 of this report.

Stiff-leg bridge structure should be designed to resist hydrostatic pressures. Wing walls should either be designed to resist hydrostatic pressures or should include a drainage layer extending to appropriate outlet locations to reduce the potential for hydrostatic pressure on the walls. The drainage layer should consist of drain rock composed of ITD Coarse Aggregate for Concrete No. 2B or 5. The drain rock layer should be a minimum of 24 inches thick and should be separated from

other soils with a Drainage Geotextile. The drain rock layer should extend vertically from the base of the structure to within 3 feet of the ground surface. Weep holes in the wing walls may also be used in conjunction with the drainage layer to reduce the potential for hydrostatic pressures. As an alternative to drain rock, manufactured drainage panels installed in accordance with the manufacturer's recommendations may be used.

230.05.06 Embankments

Based on the information provided by Horrocks Engineers, new embankments fill associated with the project vary in height across the length of the structure. Embankment fill heights along SH-55 widening range between about 8 to 12 feet on the north side and between 0 to 4 feet on the south side. Embankments should be constructed with granular borrow and have 2(horizontal):1(vertical) or flatter side slopes. Prior to fill placement, existing undocumented fill soils, and disturbed soils should be removed from areas that will receive fill so that embankments are placed on undisturbed native or existing compacted embankment soils. Embankment fill placed on slopes steeper than 3(horizontal):1(vertical) must be keyed in per Section 205.03.F in the ITD Standard Specifications. For estimating purposes, the depth of stripping is assumed to be 6 inches.

Settlement of the embankments is estimated to be about 1 to 2 inches, and less than 1 inch on the north and south side of SH-55, respectively. Based on the depth to water and the predominately granular soil encountered, settlement is expected to be elastic and will occur during construction. Class A compaction is recommended for the embankments associated with the project.

230.05.07 Erosion Control

Erosion protection should be provided, as needed, to protect the embankments and structure foundations from erosion and scour. Scour protection will be designed by Horrocks Engineers based on approved hydraulics report. Any ground surface disturbed during construction of the stiff-leg bridge structure and its foundation should be restored and erosion protection provided. Roadway runoff should be collected and discharged away from the bridge and embankment slopes to reduce the potential of erosion of the fill slopes. Erosion control measures, such as vegetation or mulching, should be taken in accordance with ITD Best Management Practices (BMP) Manual to protect slopes and drainage areas from storm water runoff. Discharge areas should be protected with riprap underlain by a Riprap/Erosion Control Geotextile per Section 718.06 of *ITD Standard Specifications for Highway Construction.* Riprap protection will be designed by Horrocks Engineers.

230.05.08 Seismic Design

Seismic ground motion parameters were developed for the project based on Section 3.10 of *AASHTO LRFD* and Section 630 of the *ITD Materials Manual*. These seismic parameters were obtained from the USGS Seismic Design Web Service for the 2009 AASHTO Guide Specification. These values are presented in the following table and are for an earthquake having a probability of exceedance of 7 percent in 75 years (approximately 1000-year return period).

Table 4. Seismic Ground Motion Parameters

Ground Motion Parameter	Value
Site Soil Classification	D
PGA, Peak Ground Acceleration Coefficient on Rock (Site Class B)	0.076 g
Ss, Horizontal Response Spectral Acceleration Coefficient at 0.2-sec Period on Rock (Site Class B)	0.177 g
S1, Horizontal Response Spectral Acceleration Coefficient at 1.0-sec Period on Rock (Site Class B)	0.064 g
FPGA, Site Factor for PGA,	1.6
FA, Site Factor for Ss	1.6
FV, Site Factor for S1	2.4
A_S, Modified PGA for Project Site (Site Class D)	0.122 g
S_{DS}, Modified Ss for Project Site (Site Class D)	0.283 g
S_{D1}, Modified S1 for Project Site (Site Class D)	0.154 g

Seismic design of stiff leg structures should be based on Site Class D. Based on Figure 630.05.01.1 of the *ITD Materials Manual*, the nearest active fault to the site is mapped approximately 25 to 30 miles to the northeast. Therefore, the risk of fault rupture at the site is low. Due to relatively deep groundwater and the SPT blow counts of the native soils, the risk of liquefaction at the site is low.

230.05.09 Construction

We recommend that reconstruction of the proposed Deer Flat Caldwell Canal stiff-leg bridge structure occur when the canal is not carrying water, generally fall to winter, after irrigation season. Depending on the time of year that construction occurs and the depth of excavations, groundwater may be encountered during construction. If construction occurs soon after water is drained from the canal, elevated groundwater levels may be encountered due to bank storage and a seasonally elevated perched groundwater level. If groundwater is encountered during construction, a positive means of construction dewatering will be required to complete the excavations and placement of the foundations and backfill in the dry. Fill and concrete should not be placed in standing water.

Soils are likely to be wet after water is taken out of the canal. The Contractor should anticipate soft and/or wet soils, particularly within the excavations for the proposed structure. Wet soils will be prone to rutting or pumping under construction machinery. Soils that rut, pump, or are too wet to be compacted are not suitable for support of the proposed stiff leg structure or the wing walls and should be repaired or excavated and replaced in accordance with Section 205.03.E of the Standard Specifications for Highway Construction. The success in drying the wet soils will depend on the weather, and in the late fall or winter months when this construction is most likely to occur, weather conditions can be wet.

If temporary retaining structures are used during replacement of the bridge, these structures should be designed by a professional engineer licensed in the State of Idaho.

Construction site safety is solely the responsibility of the Contractor who selects and directs the means, methods, and sequencing of the construction operations. The Contractor must be familiar with, and comply with all applicable federal, state, and local regulations, including OSHA regulations for excavation.

230.06 APPENDICES

The appendices contain a vicinity map, exploration plan, Foundation Investigation plat, boring logs, laboratory test data, and other supporting information.

230.07 FOUNDATION INVESTIGATION PLAT

Horrocks prepared the Foundation Investigation Plat with geotechnical information provided by Terracon. A reduced size copy of the Foundation Investigation Plat (11 inches by 17 inches) is presented in **Appendix A** of this report.

230.08 CURRENT SPECIFICATIONS AND MINIMUM TESTING REQUIREMENTS

This Geotechnical Engineering Report is based on the following ITD documents:

- 2018 *Standard Specifications for Highway Construction*
- 2021 *Supplemental Specifications for the 2018 Idaho Standard Specifications for Highway Construction*
- *2019 Quality Assurance Manual*

230.09 SPECIAL PROVISION ITEMS

No new special provisions are needed for construction of this structure.

The following modification of existing specification should be included:

ON PAGE 47 OF 93 OF THE 2021 SUPPLEMENTAL SPECIFICATIONS, SUBSECTION 210.03 – CONSTRUCTION REQUIREMENTS

Add the following to the end of the first sentence of the second paragraph of Part B:

Use a smooth blade bucket to excavate fine-grained soils at the bottom of foundation excavations.

The following Note to Contractor should be included:

SOFT SUBGRADE SOILS. The Contractor should anticipate soft and moisture-sensitive subgrade soils, which could occur throughout this project. These soils will be prone to rutting or pumping under construction equipment, especially if they become wetter than optimum moisture content at the time of construction.

The Contractor must protect these soils during construction activities, and the Contractor determines how best to achieve this requirement. No separate measurement or payment will be made for any excavation or replacement of excavated material below subgrade elevation made necessary from construction activities.

230.10 REFERENCES

American Association of State Highway and Transportation Officials, *AASHTO LRFD Bridge Design Specifications*, 9th Edition, 2020.

Idaho Transportation Department, *Materials Manual*, October 2020.

Idaho Transportation Department, *Standard Specifications for Highway Construction*, 2018.

Idaho Transportation Department, *2021 Supplemental Specifications for the 2018 Idaho Standard Specifications for Highway Construction*, 2021.

GENERAL COMMENTS

The analysis and recommendations presented in this report are based upon the data obtained from the boring performed at the indicated location and from other information discussed in this report. This report does not reflect variations that may occur beyond the boring location, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in

the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

Site Location Map – Deer Flat Caldwell Canal

SH-55, Farmway Road to Middleton Road ■ Canyon County, Idaho

Terracon Project No. 62185117A

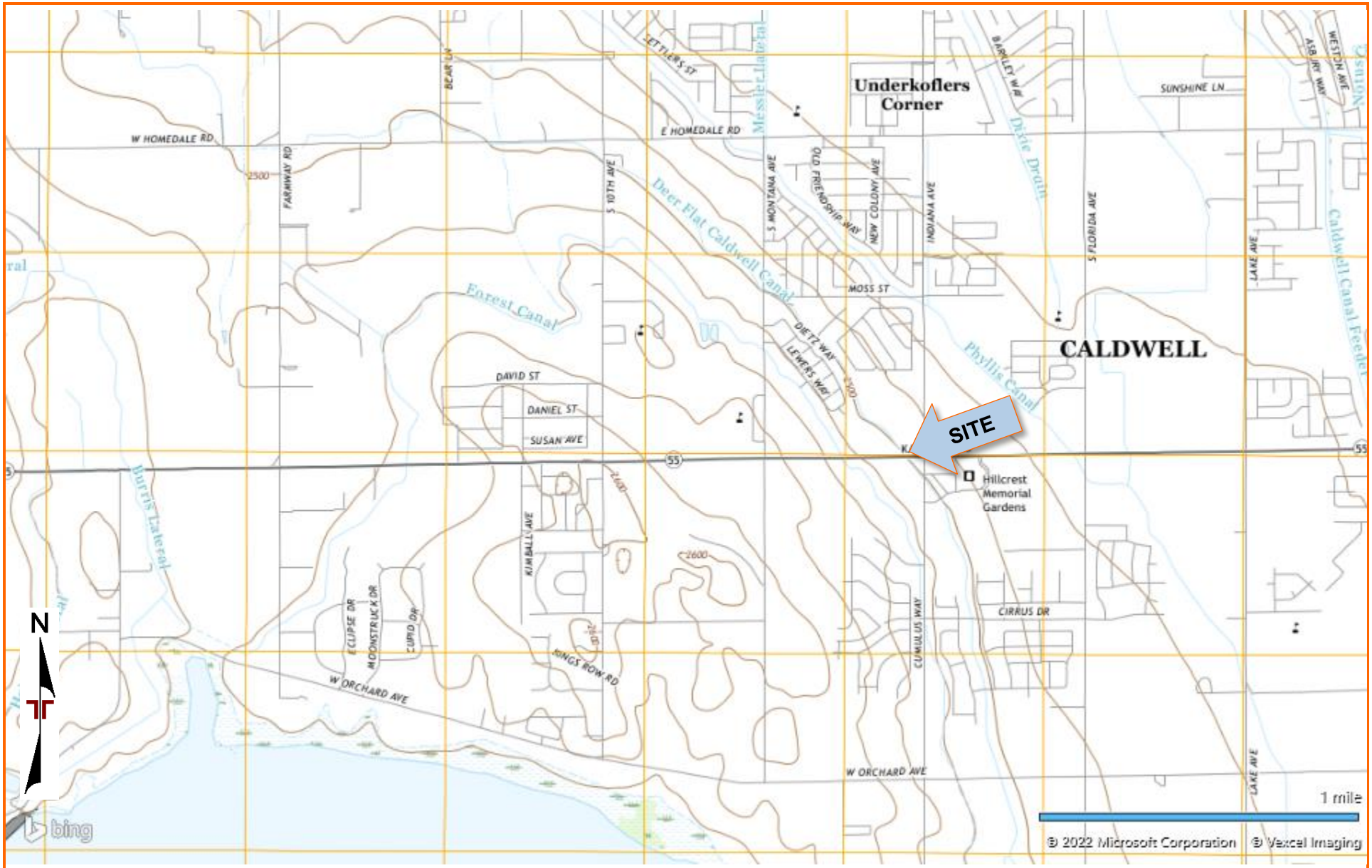


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

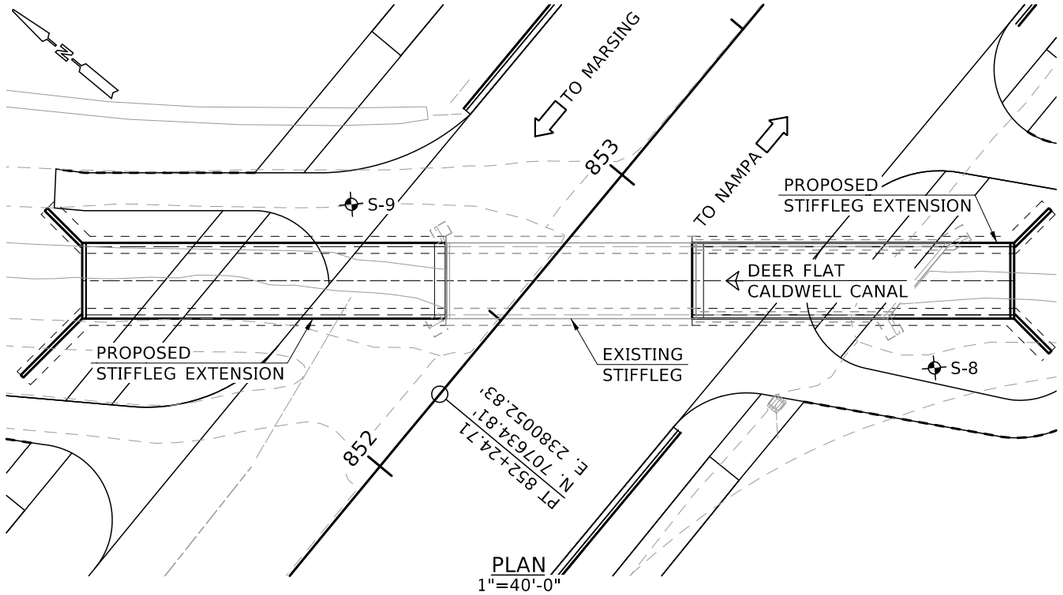
Boring Exploration Plan – Deer Flat Caldwell Canal

SH-55, Farmway Road to Middleton Road ■ Canyon County, Idaho

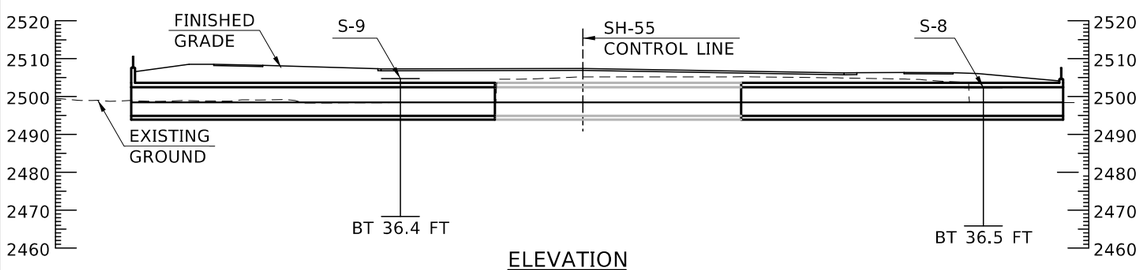
Terracon Project No. 62185117A

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

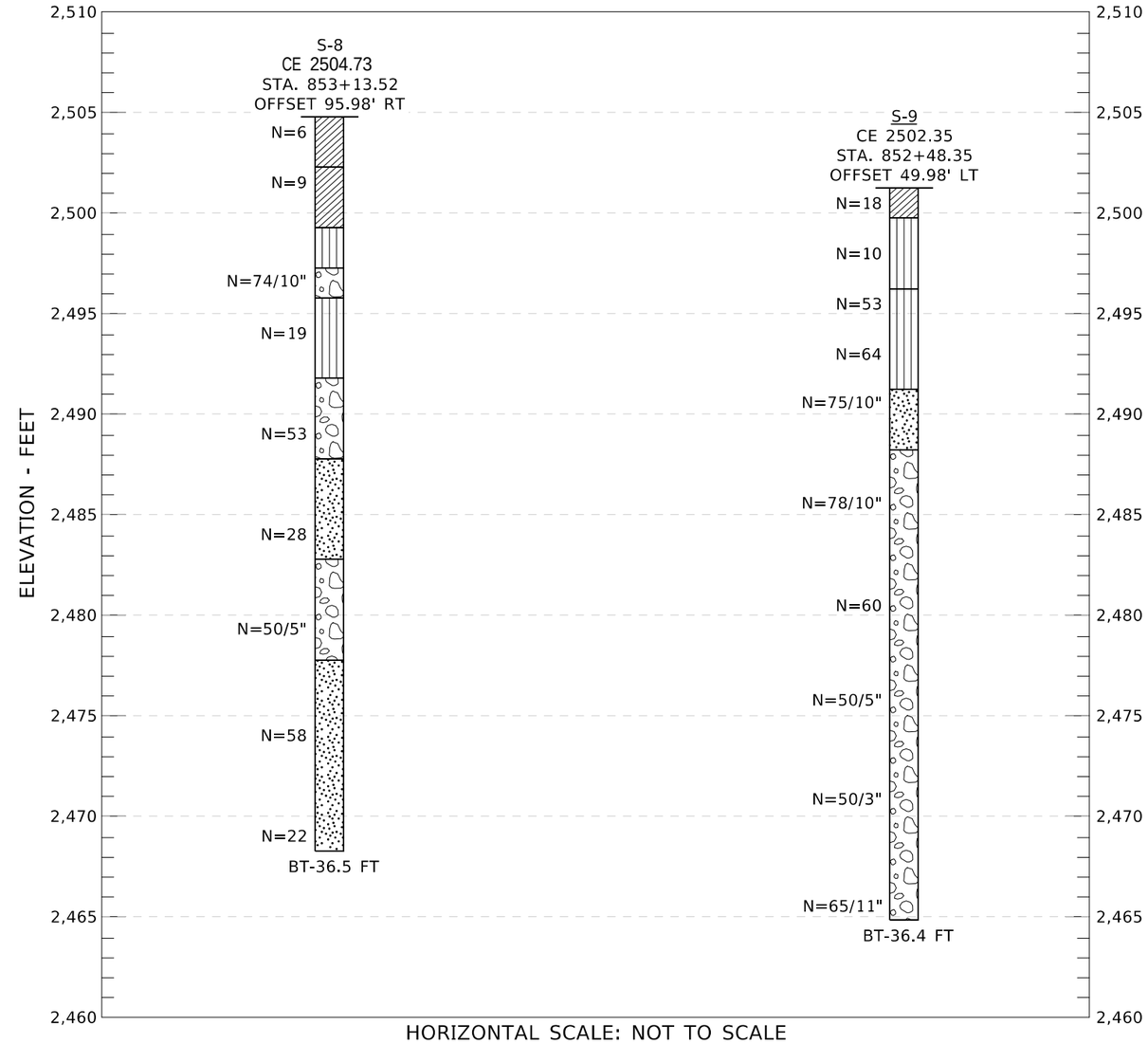
MAP PROVIDED BY MICROSOFT BING MAPS



PLAN
1"=40'-0"



ELEVATION
1"=40'-0"



HORIZONTAL SCALE: NOT TO SCALE

LEGEND

- SAND, SAND WITH SILT AND GRAVEL
- SILT, SANDY SILT
- LEAN CLAY, LEAN CLAY WITH SAND, SILTY CLAY WITH SAND
- GRAVEL WITH SAND
- WATER LEVEL READING AT TIME OF DRILLING.
- BT BORING TERMINATION
- CE COLLAR ELEVATION
- N N-VALUE (ASTM D1586)

NOTES:

1. N - BLOWS OF A 140 LB. HAMMER FALLING 30" TO DRIVE A 2" O.D. STANDARD SPLIT SPOON PENETROMETER A DISTANCE OF 1.0' OR THE DISTANCE SHOWN.
2. STRATIFICATION BOUNDARIES REPRESENT THE APPROXIMATE DEPTHS OF CHANGES IN SOIL TYPES. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL. CLASSIFICATION OF INTERVALS BETWEEN SAMPLES WAS INFERRED BASED ON OBSERVATIONS OF THE DRILL RIG AND SOIL CUTTINGS.
3. GROUNDWATER LEVELS SHOULD BE EXPECTED TO FLUCTUATE WITH TIME.
4. THE GEOTECHNICAL ENGINEERING REPORT, AND OTHER INFORMATION RELATED TO THE FOUNDATION INVESTIGATION FOR THIS PROJECT ARE AVAILABLE AT THE ITD DISTRICT OFFICE IN BOISE.

I, RYAN J. OLSEN, HAVE REVIEWED THE GEOTECHINCAL INFORMATION ON THIS DRAWING AND FIND IT TO BE IN ACCORDANCE WITH THE GEOTECHNICAL ENGINEERING REPORT PREPARED FOR THE PROJECT BY TERRACON CONSULTANTS, INC.

NOT APPROVED
PRELIMINARY
FOR CONSTRUCTION

REVISIONS			
NO.	DATE	BY	DESCRIPTION

DESIGNED
DESIGN CHECKED
DETAILED C. SOBOTKA
DWG. CHECKED R, OLSEN
CORRECTIONS

SCALES SHOWN ARE FOR 11" X 17" PRINTS ONLY
CADD FILE NAME D3\prj22715\ProjDev\Bridge\Plans 22715 brdf 006.dgn
DRAWING DATE: APRIL 2022

IDAHO TRANSPORTATION DEPARTMENT
YOUR Safety→YOUR Mobility→YOUR Economic Opportunity
Terracon

ENGLISH
PROJECT NO.
A022(715)

FOUNDATION INVESTIGATION
26' CONCRETE STIFFLEG BRIDGE EXTENSION
SH-55 OVER DEER FLAT CANAL
M.P. 12.56 STA. 852+63.62

BRIDGE PLANS
BRIDGE KEY NO. 14705
COUNTY CANYON
KEY NO. 22715
BRIDGE DWG. NO. 14558-B
SHEET 6 OF 6

ORIGINAL STORED AT: ITD BRIDGE SECTION - Boise, Idaho
22715 brdf 006.dgn
27-APR-2022

BORING LOG NO. S-8

PROJECT: SH-55, Farmway Rd to Middleton Rd, Canyon Co

CLIENT: Horrocks Engineers Meridian, Idaho

SITE: SH-55 Pear Lane to Middleton Road Canyon County, Idaho

LOCATION Deer Flat Caldwell Canal

Latitude: 43.604249° Longitude: -116.674033°
Northing: 707538.7 Easting: 2380141.5

Approximate Surface Elev.: 2504.7 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
		LEAN CLAY (CL), dark brown, medium stiff
2.5	2502+/-	
		SILTY CLAY WITH SAND (CL-ML), dark brown, stiff, trace cemented particles
5.5	2499+/-	
		SILT (ML), dark brown, medium stiff
7.5	2497+/-	
		POORLY GRADED GRAVEL WITH SAND (GP), light brown, very dense, fine to coarse grained sand, fine to coarse gravel
9.0	2495.5+/-	
		SANDY SILT (ML), brown, very stiff, trace cemented particles
13.0	2491.5+/-	
		POORLY GRADED GRAVEL WITH SAND (GP), light brown, very dense, fine to coarse grained sand, fine to coarse gravel, trace cobbles
17.0	2487.5+/-	
		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM), light brown, medium dense, fine to coarse grained sand, fine to coarse gravel
22.0	2482.5+/-	
		POORLY GRADED GRAVEL WITH SAND (GP), light brown, very dense, fine to coarse grained sand, fine to coarse gravel
27.0	2477.5+/-	
		POORLY GRADED SAND (SP), light brown, medium dense to very dense, fine to coarse grained sand, trace fine to coarse gravel
36.5	2468+/-	
		Boring Terminated at 36.5 Feet

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		0.3	1-1-5 N=6			
		0.3	3-4-5 N=9	17.3	27-20-7	
5						
		0.2	4-24-50/4"			
10		1	6-11-8 N=19			
15		0.7	10-27-26 N=53			
20		0.5	6-12-16 N=28	5.4		9
25		0.3	18-50/5"			
30		0.8	12-16-42 N=58			
35		0.7	3-7-15 N=22			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite chips

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
11849 W Executive Dr Ste G
Boise, ID

Boring Started: 12-17-2021 | Boring Completed: 12-17-2021
Drill Rig: CME 75 | Driller: Haztech Drilling, Inc.
Project No.: 62185117A | Exhibit: A-8

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 62185117A SH-55, FARMWAY RD.GPJ TERRACON_DATATEMPLATE.GDT 2/10/22

BORING LOG NO. S-9

PROJECT: SH-55, Farmway Rd to Middleton Rd, Canyon Co

CLIENT: Horrocks Engineers Meridian, Idaho

SITE: SH-55 Pear Lane to Middleton Road Canyon County, Idaho

LOCATION Deer Flat Caldwell Canal

Latitude: 43.604647° Longitude: -116.674284°
Northing: 707684.7 Easting: 2380076.6

Approximate Surface Elev.: 2502.4 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	RECOVERY (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1.5	2501+/-	**LEAN CLAY WITH SAND (CL)**, dark brown, very stiff, trace cemented particles	0.8	3-10-8 N=18	15.9	29-21-8	
		SILT (ML), dark brown, stiff, trace cemented particles	0.5	3-5-5 N=10			
5.0	2497.5+/-	**SANDY SILT (ML)**, dark brown, hard, trace cemented particles	0.8	11-30-23 N=53			
			0.5	24-28-36 N=64			
10.0	2492.5+/-	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, light brown, very loose, fine to coarse grained sand, fine to coarse gravel	0.3	16-25-50/4"	3.1		6
13.0	2489.5+/-	**POORLY GRADED GRAVEL WITH SAND (GP)**, light brown, very dense, fine to coarse grained sand, fine to coarse gravel, trace cobbles	0.5	15-28-50/4"			
			0.3	19-40-20 N=60			
			0.5	21-50/5"			
			0.3	29-50/3"			
36.4	2466+/-		0.3	10-15-50/5"			
		Boring Terminated at 36.4 Feet					

DEPTH (Ft.): 5, 10, 15, 20, 25, 30, 35

WATER LEVEL OBSERVATIONS

SAMPLE TYPE

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite chips

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
11849 W Executive Dr Ste G
Boise, ID

Boring Started: 12-17-2021 | Boring Completed: 12-17-2021

Drill Rig: CME 75 | Driller: Haztech Drilling, Inc.

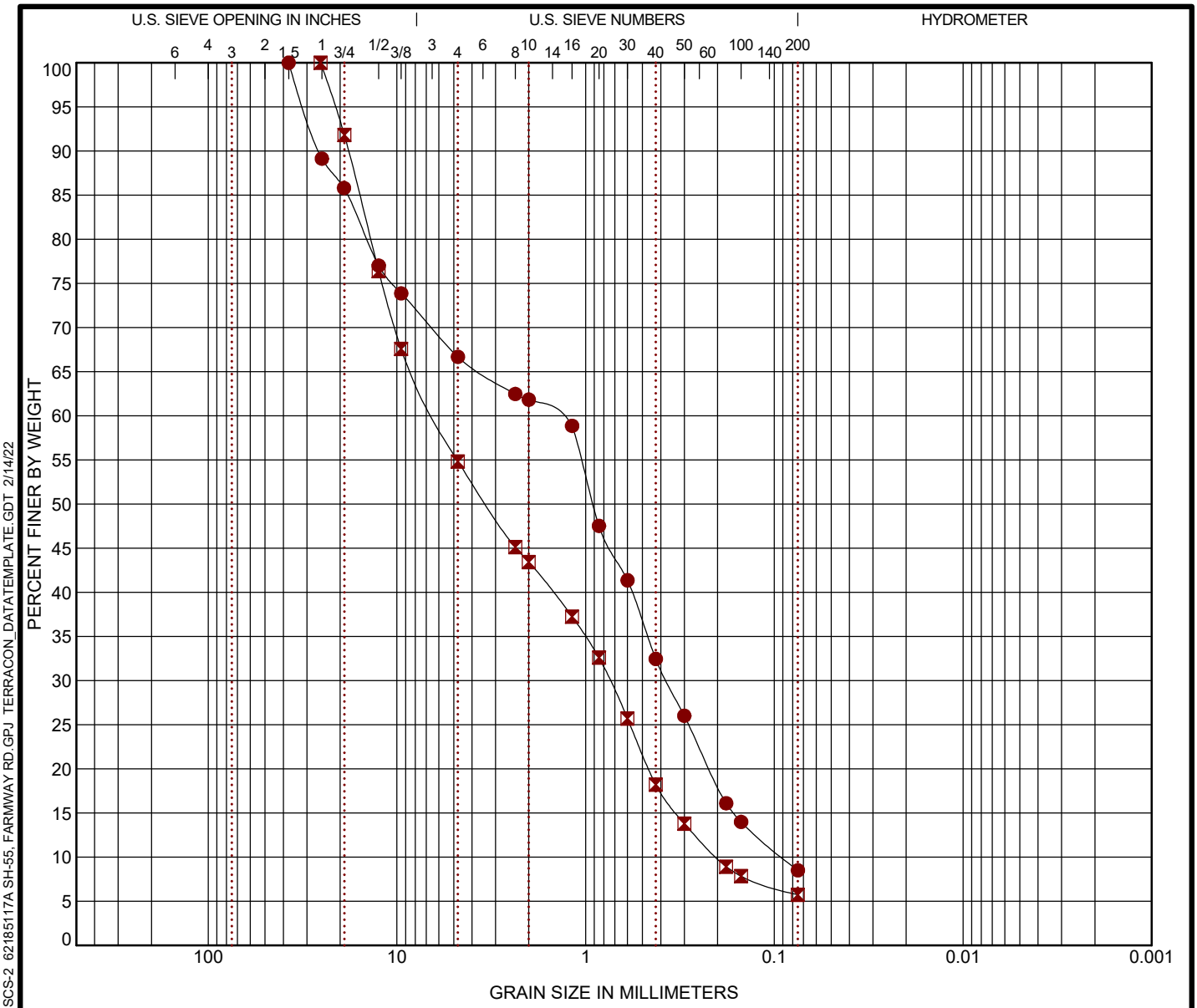
Project No.: 62185117A | Exhibit: A-9

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 62185117A SH-55, FARMWAY RD.GPJ TERRACON_DATATEMPLATE.GDT 2/10/22

APPENDIX B

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	S-8	20 - 21.5	WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)	5.4				1.06	15.95
⊠	S-9	10 - 11.3	POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)	3.1				0.44	31.21

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	S-8	20 - 21.5	37.5	1.446	0.372	0.091	0.0	33.3	58.2		8.5	
⊠	S-9	10 - 11.3	25.4	6.292	0.746	0.202	0.0	45.2	49.1		5.7	

PROJECT: SH-55, Farmway Rd to Middleton Rd, Canyon Co

SITE: SH-55 Pear Lane to Middleton Road Canyon County, Idaho

Terracon
11849 W Executive Dr Ste G
Boise, ID

PROJECT NUMBER: 62185117A

CLIENT: Horrocks Engineers
Meridian, Idaho

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 62185117A SH-55, FARMWAY RD.GPJ TERRACON_DATATEMPLATE.GDT 2/14/22

APPENDIX C

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E]		GW	Well-graded gravel [F]
			Cu < 4 and/or [Cc<1 or Cc>3.0] [E]		GP	Poorly graded gravel [F]
		Gravels 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 No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]		SW	Well-graded sand [I]
			Cu < 6 and/or [Cc<1 or Cc>3.0] [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 No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A"		CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OL	Organic clay [K, L, M, N]
						Organic silt [K, L, M, O]
	Silts 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 / Liquid limit - not dried	< 0.75	OH	Organic clay [K, L, M, P]
						Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) 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% fines 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% fines 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] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[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 shaded area, soil is a 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.

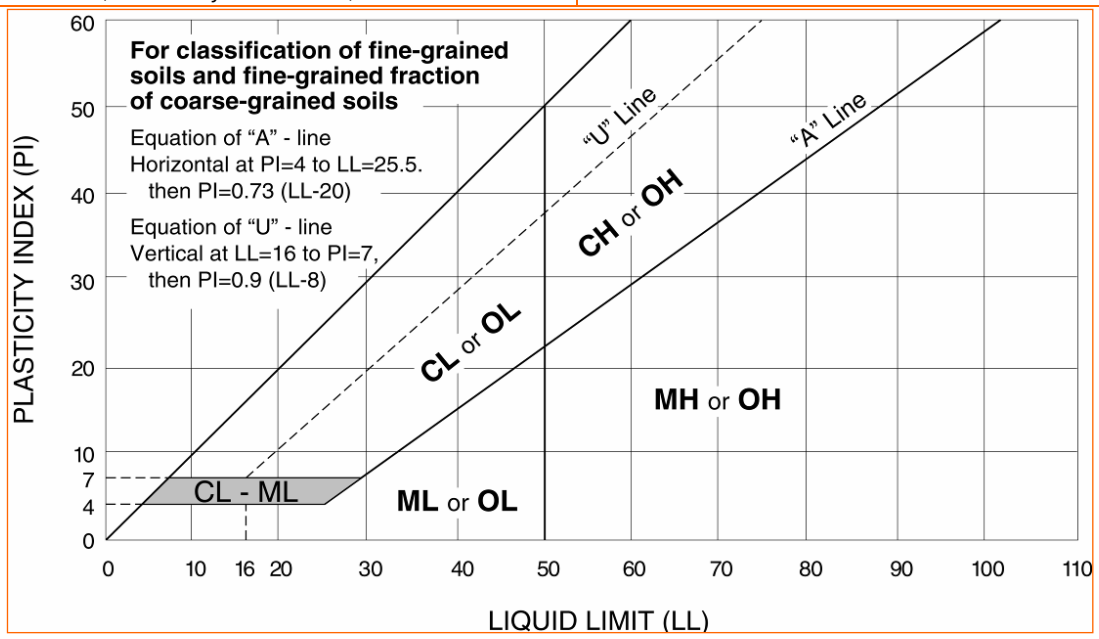
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



GENERAL NOTES

SAMPLING	WATER LEVEL	FIELD TESTS
Auger Cuttings Auger Cuttings Ring Sampler Shelby Tube Standard Penetration Test	**Water Initially Encountered** **Water Level After a Specified Period of Time** **Water Level After a Specified Period of Time** **Cave In Encountered** Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	**N** **Standard Penetration Test Resistance (Blows/Ft.)** **(HP)** **Hand Penetrometer** **(T)** **Torvane** **(DCP)** **Dynamic Cone Penetrometer** **UC** **Unconfined Compressive Strength** **(PID)** **Photo-Ionization Detector** **(OVA)** **Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

Terracon