Geotechnical Engineering Report
Soil Evaluation
Webster Ranch Parcel
Horseshoe Bend, Idaho

PREPARED FOR:
Katherine N. Dace
Horseshoe Bend, ID

PREPARED BY:
Innovate Geotechnical
Innovate Geotechnical Project No. 319023
October 10, 2019

IGEO INNOVATE GEOTECHNICAL

October 10, 2019

Attention: Katherine N. Dace

Subject: Geotechnical Engineering Report
Soil Evaluation
Webster Ranch Parcel
Boise, Idaho
Innovate Geotechnical Project No. 319023

Katherine N. Dace,

Submitted herewith is the report of our geotechnical engineering evaluation for the subject site. This report contains the results of our findings and an engineering interpretation of the results with respect to the available project characteristics.

On August30th, 2019, a Innovate Geotechnical engineer was on-site and three (3) hand auger holes and four (4) test pits up to eleven (11) feet. Soil samples were obtained during the field operations and were then transported to our office for further testing.

Based on the findings of the subsurface investigation and other information, site feasibility and improvements for the proposed construction of residences on the property. A detailed discussion of conditions is presented in this report.

We appreciate the opportunity to work with you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (208) 484-1090.

Sincerely,
Innovate Geotechnical

Seth Eisele

PROFESSIONAL ENGINEER
LICENSED
14307
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STATE OF IDAHO
SETH P. OLSEN

Seth Eisele
Geotechnical Engineer Intern

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1.0 INTRODUCTION

Innovate Geotechnical is pleased to present this report which presents the results of our geotechnical engineering evaluation for the proposed residential improvements, located at Webster Ranch in Horseshoe Bend, Idaho. The project area is located approximately as shown in the Vicinity Map, Figure 1.

2.0 PROJECT UNDERSTANDING

The proposed project consists of determining the feasibility of developing the approximately 28-acre site and providing recommendations for constructing two new residences. The parcel is 06N02E09014A and the current owners are considering subdividing the property into two parcels and constructing two residences. The area has historical landslide evidence and current landslide susceptibility.

If the construction conditions are different than we have anticipated, please notify us so that any appropriate modifications to our conclusions and recommendations contained herein may be made. A site plan is presented in Figure 2.

3.0 SCOPE OF SERVICES

The purpose of our geotechnical engineering evaluation was to provide recommendations for site foundation improvements based on our site evaluation, laboratory testing, and engineering analyses. Our specific scope of services included:

- Exploration of soil and groundwater conditions underlying the proposed homes by completing 2 hand auger, 2 Dynamic Cone Penetrometers, and 4 test pits on the site to depths of up to 11 feet below the existing ground surface.
- Laboratory testing to assess pertinent physical and engineering properties of the soil observed.
- Preparation of this report.

4.0 SITE CONDITIONS AND FIELD EVALUATION

Existing surface and subsurface conditions associated with the subject property are presented in this section.

4.1 Surface Conditions

The site is along Old Highway 55 and County Bypass Road in the foothills above Horseshoe Bend, Idaho (see Figures 1 and 2). Adjacent property to the south has an existing residence. County

Bypass Road traverses the property from the southwest and then upward toward the northeast and wraps around the hill before heading in a southern direction. Old Highway 55 forms the western boundary of the property. Topographically, the site roughly slopes downward toward the north and west toward Old Highway 55 with a portion of the property sloping downward toward the east. Evidence of soil movement on the slopes of the property was observed at various locations, but predominantly in the southwestern portion of the property. Additional discussion regarding the unstable slopes is presented in later portions of this report.

4.2 Field Evaluation

The subsurface soil conditions were determined by performing four (4) Test Pits (TP-1 through TP-4), two (2) hand auger (HA-1 and HA-2), and 2 Dynamic Cone Penetrometer (DCP-1 and DCP-3) at the locations shown on Figure 2. Test pits were advanced using a backhoe subcontracted to IGEO. Soil samples were obtained at significant changes of strata and in general accordance with ASTM D-420 and ASTM D-2488. A Soils Classification Sheet, defining the terms and symbols used on the log, is provided as Figure A-1 in Appendix A. The subsurface conditions observed during the field evaluation are discussed in Section 4.3. Logs of the explorations, including a description of all soil strata encountered, are presented in Figures A-2 through A-5, in Appendix A.

After completion of the field evaluation, soil samples were tested for their engineering properties. The results of the laboratory testing are presented in Appendix B and shown on the boring logs in Appendix A.

In addition, Dynamic Cone Penetrometer (DCP) testing was performed in to assess the in-situ bearing strength characteristics of the subgrade. Results of this testing are presented in Appendix C.

4.3 Subsurface Soil Profile

The results of our field evaluation and our laboratory testing indicate a varying subgrade across the site. Due to shallow cobbles, the hand auger borings met refusal within 1 foot of the ground surface, but similar soil conditions were observed as those described below.

In TP-1, the existing ground surface overlies firm to stiff, dark brown, clayey sand to a depth of approximately 3 feet below the existing ground surface. This layer is underlain by hard soil/soft rock claystone to the full depth explored (8 feet below the existing ground surface).

In TP-2 and TP-3, dark brown silty sand was observed to a depth of approximately 1.5 feet (TP-2) to 3.75 feet (TP-3) below the existing ground surface. This layer is underlain by moist clayey sandy soils to the full depth explored (11 feet below the existing ground surface). In addition, occasional cobbles were observed in each test pit.

In TP-4, dark brown silty sand with occasional cobbles and boulders was observed to a depth of 2.5 feet below the existing ground surface. This layer is underlain by dense indurated sand soils to a depth of approximately 8.5 feet below the existing ground surface. Below this depth, clayey sand was observed to the full depth explored (10 feet below the existing ground surface).

For a detailed description of the soil profiles observed in this evaluation, see the boring logs in Appendix A. See Figure 2 for the approximate boring locations.

4.4 Groundwater

Groundwater was not observed in our hand auger or test pits at the time of our field evaluation. Numerous factors such as heavy precipitation, irrigation practices, and other unforeseen factors may influence groundwater elevations at the site. The detailed evaluation of these and other factors, which may be responsible for groundwater fluctuations, is beyond the scope of this study.

4.5 Site Subsurface Variations

Based on the results of the subsurface exploration and our experience, variations in continuity and nature of subsurface conditions should be anticipated. Due to the heterogeneous characteristics of soils, care should be taken in interpolating or extrapolating subsurface conditions between or beyond the exploratory borings. Seasonal fluctuations in groundwater conditions may also occur.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our site exploration, laboratory testing, and engineering analyses, it is our opinion that the proposed site may be improved as envisioned. Specific recommendations for the proposed mitigation are presented in the following sections of this report.

5.1 Site Preparation and Earthwork

5.1.1 Initial Preparation

We recommend that proposed areas for improvements be prepared by clearing and grubbing of both the surface and subsurface of all debris, deleterious and organic matter, and roots greater than ½ inch diameter. We estimate that the depth of stripping required to remove organic topsoil will range from approximately 2 to 4 inches across the site.

5.1.2 Grading, Excavations, and Subgrade Preparation

Current site grades within the proposed improvements vary significantly. In order to provide uniform bearing conditions for the proposed structures, we recommend the following site preparation activities:

- Within foundation limits, the native soils are to be over-excavated a minimum of 12 inches below the final foundation elevation and structural fill is to be placed and compacted to establish final foundation elevations.
- Within floor-slab limits. The on-site soils should be proof-rolled before placing capillary break material. Floor-slab areas are to be supported by at least 4 inches of properly compacted capillary break material.

In the event earthwork activities cause excessive subgrade disturbance, replacement with structural fill may be necessary. A greater depth of disturbance of the subgrade soil may be expected if site preparation work is conducted during periods of wet weather when the moisture content of the soil exceeds optimum. Any soft, loose, wet or otherwise unsuitable soil encountered is to be over-excavated to firm soil, or a depth of 2 feet, whichever is less, and replaced with structural fill, as described below.

5.1.3 Temporary Excavations

For temporary excavations less than five feet deep, side slopes should not be made steeper than 0.5:1 (horizontal to vertical). Temporary excavations extending more than five feet and up to ten feet in depth should not be made steeper than 1:1. If unstable conditions or groundwater seepage are encountered, flatter slopes, shoring, or bracing may be required for all conditions. All excavations should be made following OSHA safety guidelines.

5.2 Structural Fill

Soil used to support the driveway is classified as structural fill for the purposes of this report.

5.2.1 Structural Fill

Structural fill shall consist of granular soils free of organics, debris, or other deleterious materials and no particles larger than four inches in maximum dimension. Structural fill shall meet the specifications described below:

- Structural fill placed below structural foundations should consist of well-graded, sand and gravel material with no more than 12% passing the #200 sieve. Equivalent specifications may be used if approved by the project geotechnical engineer.
- Structural fill placed as capillary break material below floor slabs should consist of 1 ½ -inch-minus, free-draining, crushed gravel with less than 10 percent passing the U.S. No. 4 sieve and the fines content should not exceed 3 percent.

5.2.2 Use of on-site Soil

The on-site clayey soils observed in our test pits may not be reused as structural fill.

5.3 Fill Placement and Compaction

The various types of compaction equipment have their limitations as to the maximum lift thickness that can be compacted. For example, hand operated equipment is limited to lifts of about four inches and most "trench compactors" have a maximum, consistent compaction depth of about six inches. Large rollers, depending on soil and moisture conditions can achieve compaction at eight to twelve inches. The full thickness of each lift should be compacted to at least the following percentages of the maximum dry density (MDD) as determined by ASTM D-1557:

1. Compacted fill, supporting foundations	95%
2. Compacted fill, below floor slabs	95%
3. Backfill of trenches	
a. Below foundations	95%
b. Below pavement	95%
c. Others	90%

Field density tests should be performed on each lift as necessary to ensure that compaction is being achieved.

Conditions of the structural fill and compacted native soil should be evaluated by in-place density tests, visual evaluations, probing and proof-rolling as these materials are prepared to determine compliance with the contract documents and recommendations in this report. Over compaction should be avoided as increased compaction effort will result in lateral pressures higher than those provided in this report.

5.4 Slope Stability

Evidence of soil movement was observed at various locations across the property, and predominantly in the southwestern portion of the site. This evidence included, uneven contours across the slope, slumps, head scarps, zones of increased moisture content, variable subsurface conditions among other things. These areas of the property can be expected to continue to move. We do not recommend constructing homes in areas where evidence of soil movement has been observed. Figure 3 indicates the areas where we observed soils movement as a part of our evaluation.

A generalized subsurface profile corresponding to the soils observed on the site was selected to evaluate the global stability analyses for the slopes on the property using the computer design software SLIDE 2018 (Rocscience, 2018). Limit equilibrium analysis using Bishop's, Janbu's, and Spencers methods were used in SLIDE to estimate the factor of safety against slope instability. In slope stability, a factor of safety above 1.0 indicates a stable condition, and a factor of safety below 1.0 indicates an unstable condition.

Our analysis of the existing slopes estimates a factor of safety of more than 1.5 for the 3H:1V slopes on site. This analysis is for dry conditions. Slopes with saturated conditions occurring near the top of the slope will result in factors of safety less than 1.0. This indicates a condition where dry conditions are stable, but increases in moisture content and/or loss of support through erosion can render the slope unstable. Failures can be expected to increase in depth and severity as saturated conditions increase. This is consistent with what was observed on the site during our evaluation with the areas of increased moisture indicating more evidence of historical soil movement.

For permanent re-worked slopes on the property, we recommend slopes of no more than 3Horizontal : 1Vertical. Shallower slopes may be needed where loose, soft, or otherwise unstable slopes are encountered. Where necessary, retaining walls may be used on site and we recommend utilizing the lateral earth pressures presented in Section 5.6 for the structural design of the walls.

5.5 Foundation Support

We anticipate that the proposed footings will be established at a minimum elevation of two feet below the existing ground surface. To establish uniform bearing conditions the proposed footings should be established entirely on a specific zone of compacted structural fill. We recommend a minimum of one foot of structural fill below all foundations, as describe previously.

Foundations may be designed using a maximum allowable bearing pressure of 2,000 psf. In addition to the fill recommendations presented previously in this report, the following recommendations should be implemented:

- Continuous footing width should be maintained at a minimum of 24 inches.
- Spot footings should be a minimum of 30 inches in width.
- Exterior footings should be placed a minimum of 24 inches below final grade for frost protection, and interior footing shall be placed a minimum of 16 inches below grade.
- Drainage around the site should be created so that water is not allowed to flow into the excavation during or after construction.

The allowable bearing pressure may be increased by 1/3 for temporary loads such as wind and seismic forces.

Based on the preliminary maximum foundation loads, as presented above, and given that the foundations are supported as described in this report, we estimate that total settlement will be less than about 1 inch. Differential settlement is estimated to be less than about ½ of the total settlement. Post-construction settlement should be minor. Loose soil or otherwise unsuitable soil not removed from footing excavations, or disturbance of soil at foundation grade during construction could result in larger settlements than estimated.

5.6 Lateral Pressures and Backfill

All granular backfill material used in the construction of the retaining wall should be free from organic and deleterious materials and should conform to structural fill requirements.

We recommend fill material to consist of free-draining granular material with a friction angle of 34 degrees or more and a moist unit weight of 125 pcf. The lateral earth pressure values for the proposed structure fill material are summarized in Table 1.

Table 1 – Lateral Earth Pressure Values

Earth Pressure State	Lateral Earth Coefficient		Equivalent Fluid Density (pcf)	
	Horizontal Backslope	3H:1V Backslope; Horizontal Foreslope	Horizontal Backslope	3H:1V Backslope; Horizontal Foreslope
Active	K_a – 0.28	K_a – 0.41	35	51
Passive	K_p – 3.54	K_p – 10.0	442	1250
At-rest	K_o – 0.44	K_o – 0.63	55	78

The passive pressure resistance should not be considered effective in the upper 24 inches of the subsurface soil profile. The estimated wall translation for active earth pressure conditions is 0.001H (where H is the height of the wall). The estimated wall translation for passive earth pressure conditions is 0.01H. If soil can be removed or eroded from the wall face, passive resistance should not be relied upon. The ultimate equivalent fluid densities provided in Table 1 are for properly drained backfill and do not include hydrostatic pressures that can develop if groundwater or surface water is trapped behind the retaining walls. In addition, no friction between the wall and the backfill material was used.

Additional earth pressures resulting from loads applied at the ground surface must also be included in the design of the retaining wall. These earth pressures may be generated by surface surcharge loads, point loads, line loads, hydrostatic forces, and strip loads. Seismic considerations may also need to be included in design.

The retaining wall backfill should be compacted to 95% compaction. Over compaction should be avoided as increased compaction effort will result in lateral pressures higher than those provided in this report. Heavy compaction equipment or other construction loads should not be allowed within 3 feet of the walls unless planned for in the structural design. Hand-held or lightweight compaction equipment, such as a vibrating plate, should be utilized within 3 feet of the structure walls and fill lift thickness reduced.

5.7 Floor Slabs

Floor slabs may be supported on structural fill overlying the on-site soils as recommended in the previous sections of this report. We recommend the slab be designed using a modulus of vertical subgrade reaction (k) of 90 pounds per cubic inch (pci).

To retard the upward wicking of moisture beneath the floor slab, we recommend that a capillary break be placed over the subgrade. Therefore, we recommend floor slabs be underlain by a minimum of 4 inches of free-draining crushed rock meeting gradation and compaction specifications described in the Section 5.2.1 of this report. Alternate gradation specifications may be used provided they meet the requirements outlined above and are accepted by the geotechnical engineer of record. To help control normal shrinkage and stress cracking, the floor slabs should have the following features:

- Adequate reinforcement for the anticipated floor loads with the reinforcement continuous through interior floor joints
- Frequent crack control joints
- Non-rigid attachment of the slabs to foundation walls and bearing slabs

5.8 Drainage

All soils can experience some volume change when exposed to water, particularly the clayey soils on the property. Therefore, adequate site drainage is always important. Site grading design and construction should be implemented to assure that all surface water is directed away from the foundation bearing soils. We recommend the following actions be taken:

1. All areas around the buildings should be sloped to provide drainage away from the structures. We recommend a minimum slope of 6 inches in the first 10 feet away from the structure.

2. All roof drainage should be collected in rain gutters with downspouts designed to discharge well beyond the backfill limits or the stormwater drainage system, if applicable.

3. Adequate compaction of the foundation backfill should be provided. We suggest a minimum of 90% of the maximum laboratory density as determined by ASTM D-1557. Water consolidation methods should not be used under any circumstances.

4. Sprinklers should be aimed away from the foundation walls. The sprinkling systems should be designed with proper drainage and be well-maintained. Over watering should be avoided.

5. Other precautions may become evident during construction.

In addition, to limit detrimental effects of water on the clay soils, we recommend the following actions be taken:

1. A **drainage trench** should be established around the perimeter of the footings with the following criteria.
    a. Extend a minimum of 1 foot below the bottom of foundation elevation.
    b. Be a minimum of 12 inches wide.

c. Separator fabric should be placed in the drainage trench with a minimum of 1 foot overlap and should extend to the surface on both sides of the trench.
d. Fill placed in the trench should be placed and should consist of 3 - inch-minus, free-draining, gravel with less than 4 percent passing the U.S. No. 4 sieve and the fines content should not exceed 2 percent.
e. Trench should be sloped with a minimum of 1% slope until daylighting well away from the structure.

6.0 QUALITY CONTROL

Our recommendations in this report are based on the assumption that adequate quality control testing and observations will be conducted during construction to verify compliance.

7.0 LIMITATIONS

The recommendations provided herein were developed by evaluating the information obtained from the subsurface investigation and our experience in the area. The exploration data reflects the subsurface conditions only at the specific locations at the particular time designated on the logs. Soil and ground water conditions may differ from conditions encountered at the actual exploration locations. The nature and extent of any variation in the explorations may not become evident until during the course of construction. If variations do appear, it may become necessary to re-evaluate the recommendations of this report after we have observed the variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

8.0 REFERENCES

ASTM, American Society for Testing and Materials

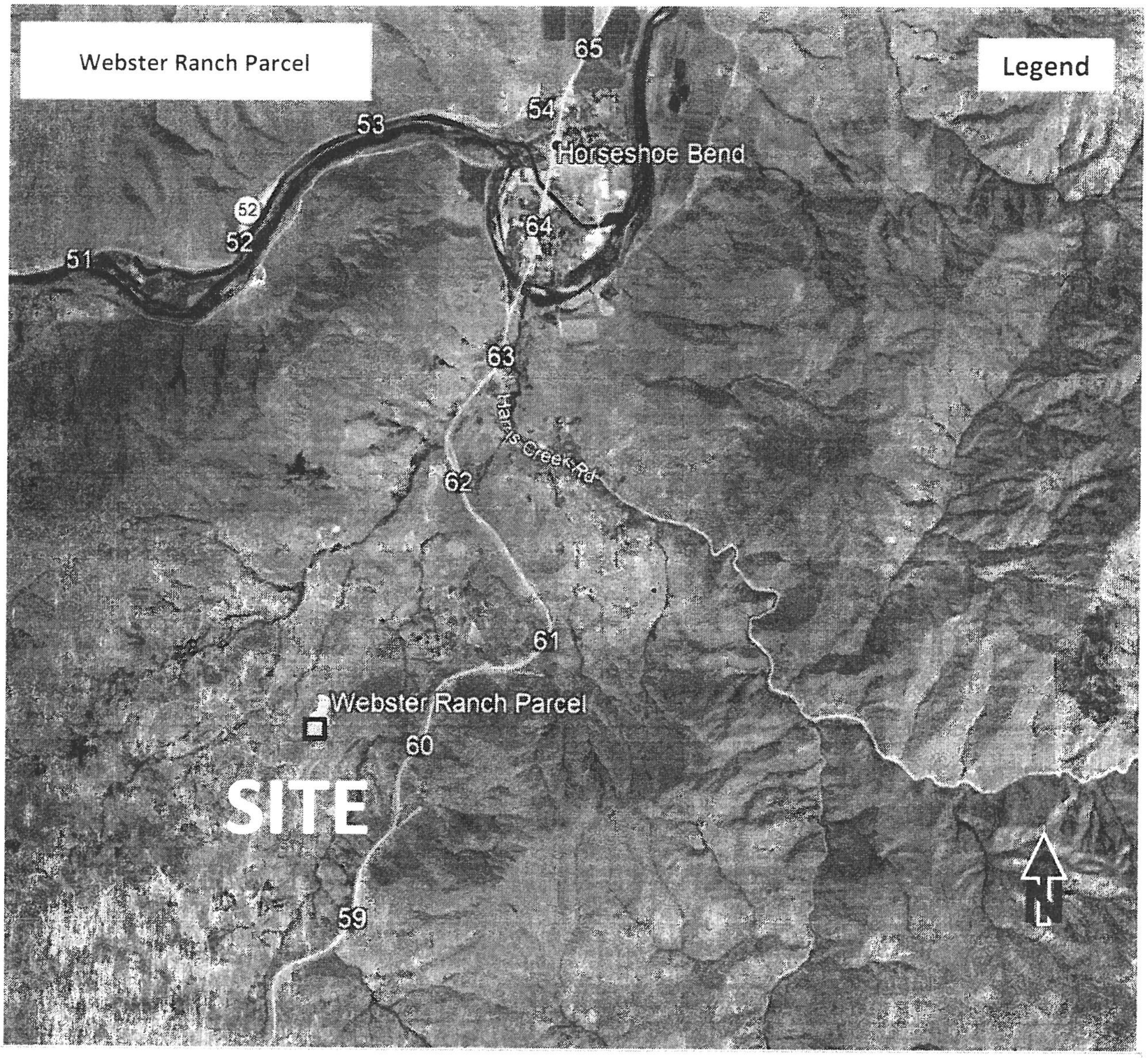
IRC, International Residential Code, 2015 Edition, International Code Council, Inc.

Idaho Standards for Public Works Construction 2017 Edition.

Fundamentals of Geotechnical Analysis – Dunn, Anderson, and Kiefer (1980)

Essentials of Soil Mechanics and Foundations – David F. McCarthy (2007)

Principles of Foundation Engineering – Braja M. Das (2004)



☐ Approximate Site Location

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Vicinity Map

Horseshoe Bend, Idaho

Webster Ranch Parcel

Date: 30-Aug-19
Proj: 319023
Owner: Katherine Dace
Client: Katherine Dace

Figure
1

◈ Approximate DCP Location
▲ Approximate TP Location
⊗ Approximate Hand Auger Location

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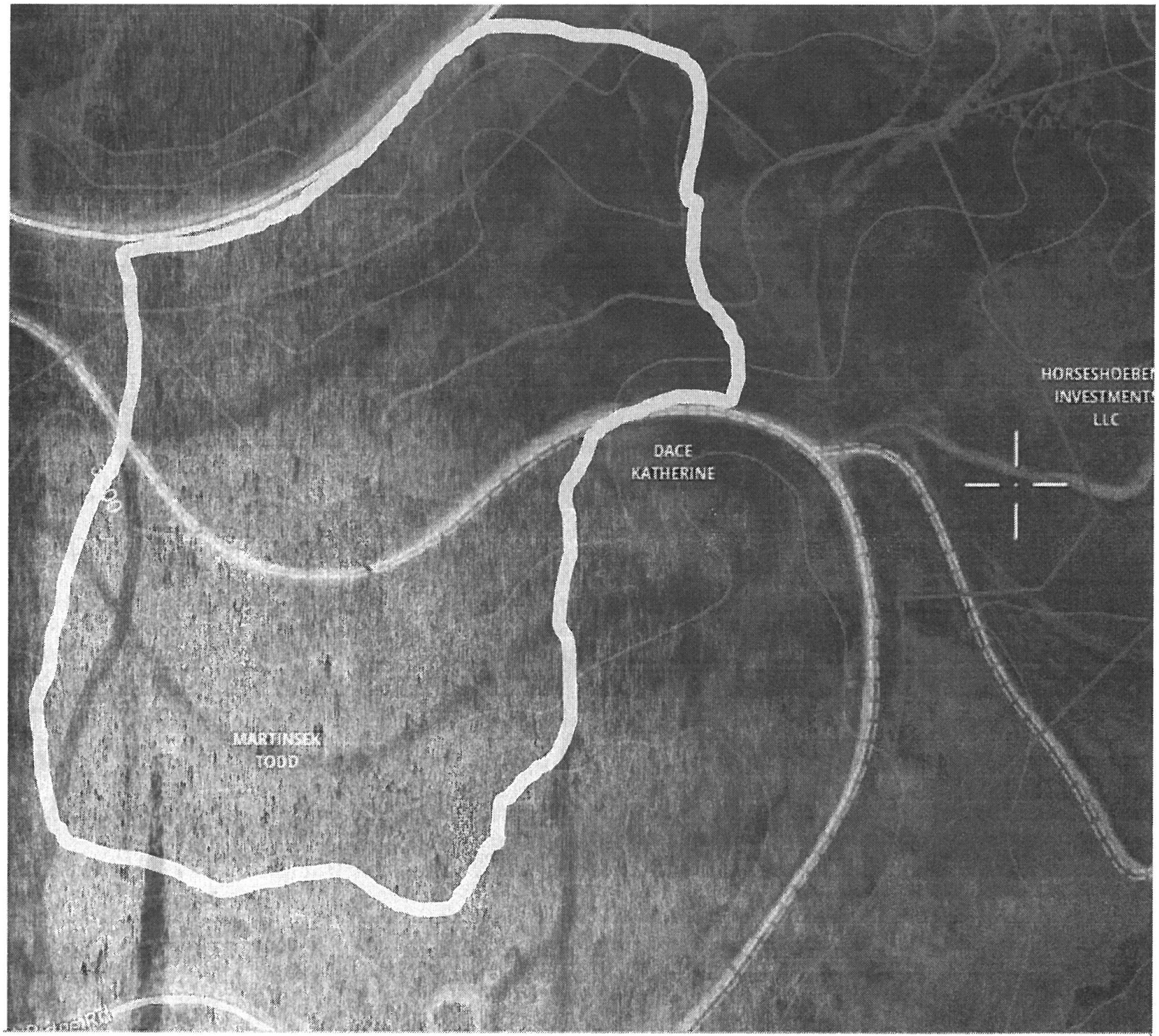
Site Map

Locations are Approximate

Webster Ranch Parcel

Date: 30-Aug-19
Proj: 319023
Owner: Katherine Dace
Client: Katherine Dace

Figure: 2



Approximate extent of evidence

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Evidence of Soil Movement

Extents are Approximate

Webster Ranch Parcel

Date: 30-Aug-19
Proj: 319023
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Client: Katherine Dace

Figure: 3

Appendix A

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROEDURES				Graphic Symbol	Letter Symbol	Typical Descriptions
Coarse Grained Soils More than half of material is larger than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to the naked eye)	Gravels More than half of coarse fraction is larger than a No. 4 sieve size (for visual classifications the 1/4" size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (little or no fines)	Wide range of grain size and substantial amounts of all intermediate particle sizes.	▒	GW	Well graded gravels, gravel-sand mixtures, little or no fines
			Predominantly one size of a range of sizes with some intermediate sizes missing.	▒	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravel with Fines (appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	▒	GM	Silty Gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).	▒	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures
	Sands More than half of coarse fraction is smaller than a No. 4 sieve size (for visual classifications the 1/4" size may be used as equivalent to the No. 4 sieve size)	Clean Sands (little or no fines)	Wide range of grain size and substantial amounts of all intermediate particle sizes.		SW	Well graded sands, gravelly sands, little or no fines
			Predominantly one size of a range of sizes with some intermediate sizes missing.	░	SP	Poorly graded sands, gravelly sands, little or no fines
		Sands with Fines (appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	▥	SM	Silty sands, poorly graded sand-silt mixtures
			Plastic fines (for identification procedures see CL below).	▨	SC	Clayey sands, poorly graded sand-clay mixtures

	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN NO. 4 SIEVE SIZE						
		Dry strength (Crushing Characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near plastic limit)			
Fine Grained Soils Less than half of material is larger than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to the naked eye)	Silts and Clays Liquid limit less than 50	None to Slight	Quick to slow	None	▥	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity
		Medium to High	None to Very Slow	Medium	▨	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		Slight to Medium	Slow	Slight	▤	OL	Organic silts and organic silt-class of low plasticity
	Silts and Clays Liquid limit greater than 50	Slight to Medium	Slow to none	Slight to Medium	▥	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		High to Very High	None	High	▨	CH	Inorganic clays of high plasticity, fat clays
		Medium to High	None to very slow	Slight to Medium	▦	OH	Organic clays of medium to high plasticity
High Organic Soils					▩	PT	Peat and other highly organic soils

1.) Boundary Classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder

2.) All sieve sizes on this chart are U.S. standard.

General Notes

1.)In general, Unified Soil Classification Designation presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory testing) may differ.

2.) Lines separating strata on the logs represent approximate boundaries only actual transitions may be gradual

3.) Logs represent general soil conditions observed at the point of exploration on the date indicated

4.) No warranty is provided as to the continuity of soil conditions between individual sample locations.

Modifiers

Fine-Grained Soils		Coarse-Grained Soils			
Granular Portion		Granular Portion		Fine Grained Portion	
Description	%	Description	%	Description	%
Trace	5 - 15	Trace	5 - 15	Trace	0 - 5
With	15 - 30	With	>15	With	5 -12
Use Modifier	>30			Use Modifier	>12

Coarse-Grained soils with 5 to 12 % fines require dual symbols

Moisture Content

Description:	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Damp	Apparent Moisture, but below optimum
Moist	Damp, no visible water; at or near optimum moisture
Very Moist	Above optimum moisture content
Wet	well above optimum moisture content

Cementation

Description:	Criteria
Weakly	Crumbles or breaks with handling of slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

Coarse Grained Soils

Apparent Density	SPT (blows/ft)	Relative Density (%)	Field test
Very Loose	<4	0 - 15	Easily penetrated with 1/2" reinforcing rod pushed by hand
Loose	4 - 10	15 - 35	Difficult to penetrate with 1/2" reinforcing rod pushed by hand
Medium Dense	10 - 30	35 - 65	Easily penetrated a foot with 1/2" reinforcing rod driven by a 5 lb. hammer
Dense	30 - 50	65 - 85	Difficult to penetrate a foot with 1/2" reinforcing rod driven by a 5 lb. hammer
Very Dense	>50	85 - 100	Penetrated only a few inches with 1/2" reinforcing rod driven by a 5 lb. hammer

Fine Grained Soils

Consistency	SPT (blows/ft)	Torvane	Pocket Penetrometer	Field Test
		Undrained shear strength (tsf)	Unconfined compressive strength (tsf)	
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by thumb. Squeezes through fingers
Soft	2 - 4	0.125 - 0.25	0.25 - 0.5	Easily penetrated 1" by thumb. Molded by light finger pressure
Firm	4 - 8	0.25 - 0.5	0.5 - 1.0	Penetrated over 1/2" by thumb with slight effort. Molded by strong finger pressur
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0	Indented about 1/2" by thumb but penetrated only with great effort
Very Stiff	15 - 30	1.0 - 2.0	2.0 - 4.0	Readily indented by thumbnail
Hard	>30	>2.0	>4.0	Indented with difficulty by thumbnail

Log Key Symbols

◪	Bulk/ Bag Sample
☒	Standard Penetration Split Spoon Sampler
⧗	2" Ø Penetration Split Spoon Sampler
■	Shelby Tube
☰	Ring Sample
◩	No Recovery
▼	Water level (after completion)
▽	Water level (where first encountered)

Stratification

Description	Thickness
Seam	1/16 - 1/2"
Layer	1/2 - 12"
Occasional	one or less per foot of thickness
Frequent	foot of thickness

Figure A-1

Webster Ranch Parcel

Boring Log

TP-1

Horseshoe Bend, Idaho

Excavation Type: Backhoe

Approx. 43.869656, -116.223813

Total Depth: 8'

Date: 30-Aug-2019

Job #: 319023

Depth (ft.)	Soil Description	Moisture (%)	Gravel %	Sand %	Fines %	LL	PL	PI	R-Value
0.5	Dark Brown, Dry, Clayey Sand (SC)	7.1			40	36	21	15	
1.0									
1.5									
2.0	DCP @ 2.0 feet								
2.5	increasing cementation								
3.0									
3.5	Lt. Brown, Dry, Hard, Claystone, Clays (CL)								
4.0	Mineral Stratification								
4.5									
5.0									
5.5									
6.0									
6.5									
7.0									
7.5									
8.0									
8.5	**Terminated @ 8 feet**								
9.0									
9.5									
10.0									

Remarks: 1.) Groundwater was not observed in the boring.
2.) Hard digging

Excavated By: Seth Eisele

Logged By: Seth Eisele

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Figure: A-2

Webster Ranch Parcel

Horseshoe Bend, Idaho

Boring Log

TP-2

Excavation Type: Backhoe

Approx. 43.870290, -116.225792

Total Depth: 9'

Date: 30-Aug-2019

Job #: 319023

Depth (ft.)	Soil Description	Sample type	Retained (in)	Blows /ft. (N) Total	Moisture (%)	Gradation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI	R-Value
0.5	Dark Brown, Dry, Silty Sand (SM) with cobbles											
1.0												
1.5					11			27				
2.0	Brown, Dry, Clay (CL)											
2.5												
3.0	Lt. Brown, Dry, Clayey Sand (SC)											
3.5												
4.0												
4.5												
5.0												
5.5	Moist				19			42				
6.0												
6.5												
7.0												
7.5												
8.0												
8.5												
9.0												
9.5	**Terminated @ 9 feet**											
10.0												

Remarks: 1.) Groundwater was not observed in the boring.

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Excavated By: Seth Eisele

Logged By: Seth Eisele

Figure

A-3

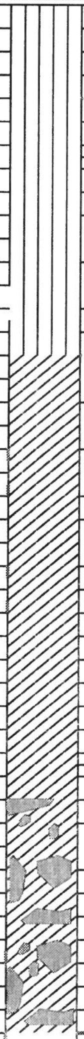
Webster Ranch Parcel

Horseshoe Bend, Idaho

Boring Log

TP-2

Excavation Type:	Backhoe
Approx.	43.871257, -116.224128
Total Depth:	11'
Date:	30-Aug-2019
Job #:	319023



Depth (ft.)	Soil Description	Sample type	Retained (in)	Blows /ft. (N) Total	Moisture (%)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI	R-Value
0.5 – 3.5	Dark Brown, Dry, Silty Sand (SM) DCP @ 2.5 feet											
4.0	Brown, Moist, Clayey Sand (SC), Hard				12			45				
6.0 – 6.5					16			49	31	19	12	
8.5 – 11.0	Large cobbles Approx. 8-12 inches diameter											
11.0	**Terminated @ 11 feet**											

Remarks: 1.) Groundwater was not observed in the boring.

Excavated By: Seth Eisele

Logged By: Seth Eisele

IGEO INNOVATE GEOTECHNICAL

Figure: A-4

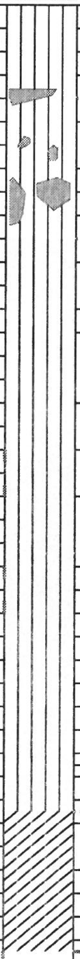
Webster Ranch Parcel

Horseshoe Bend, Idaho

Boring Log

TP-4

Excavation Type:	Backhoe	Total Depth:	10'
Approx. 43.871041, -116.223448		Date:	30-Aug-2019
		Job #:	319023



Depth (ft.)	Soil Description	Sample type	Retained (in)	Blows /ft. (N) Total	Moisture (%)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI	R-Value
0.5	Dark Brown, Dry, Silty Sand (SM)											
1.0												
1.5												
2.0	Occasional large rocks and cobbles				4.2	3	77	20				
2.5												
3.0	Indurated Sand (SP), Lt. Brown, Dense, Moist											
3.5												
4.0												
4.5												
5.0												
5.5												
6.0												
6.5												
7.0												
7.5												
8.0												
8.5												
9.0	Clayey Sand (SC), Moist				22			44				
9.5	Mineral Stratification, purple and gray											
10.0												
10.5												
11.0	**Terminated @ 10 feet**											

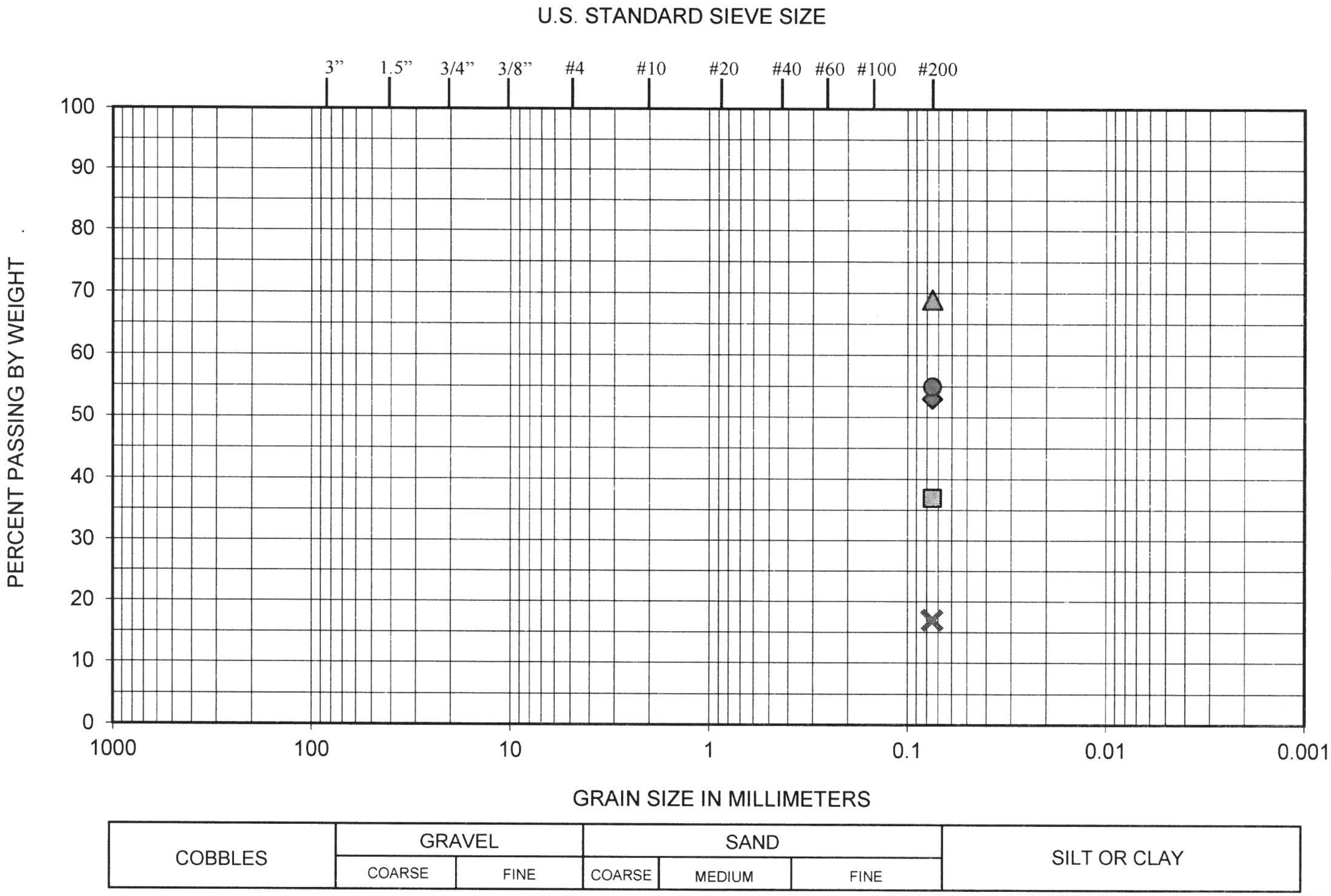
Remarks: 1.) Groundwater was not observed in the boring.
2.) Hard digging, large boulders, moved multiple times because of rocks

Excavated By: Seth Eisele
Logged By: Seth Eisele

IGEO INNOVATE GEOTECHNICAL

Figure:
A-5

Appendix B



Symbol	Boring/ Test Pit	Sample Depth (feet)	Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)	USCS Class	Soil Classification
◆	TP-1	0.5	7.1	-	-	40	SC	Clayey Sand
■	TP-2	1.5	11.0	-	-	27	SC	Clayey Sand
▲	TP-2	5.5	19.4	-	-	42	SC	Clayey Sand
X	TP-3	4	11.7	-	-	45	SC	Clayey Sand
●	TP-3	6	15.9	-	-	49	SC	Clayey Sand

IGEO INNOVATE GEOTECHNICAL

Sieve Analysis Results

Horseshoe Bend, Idaho

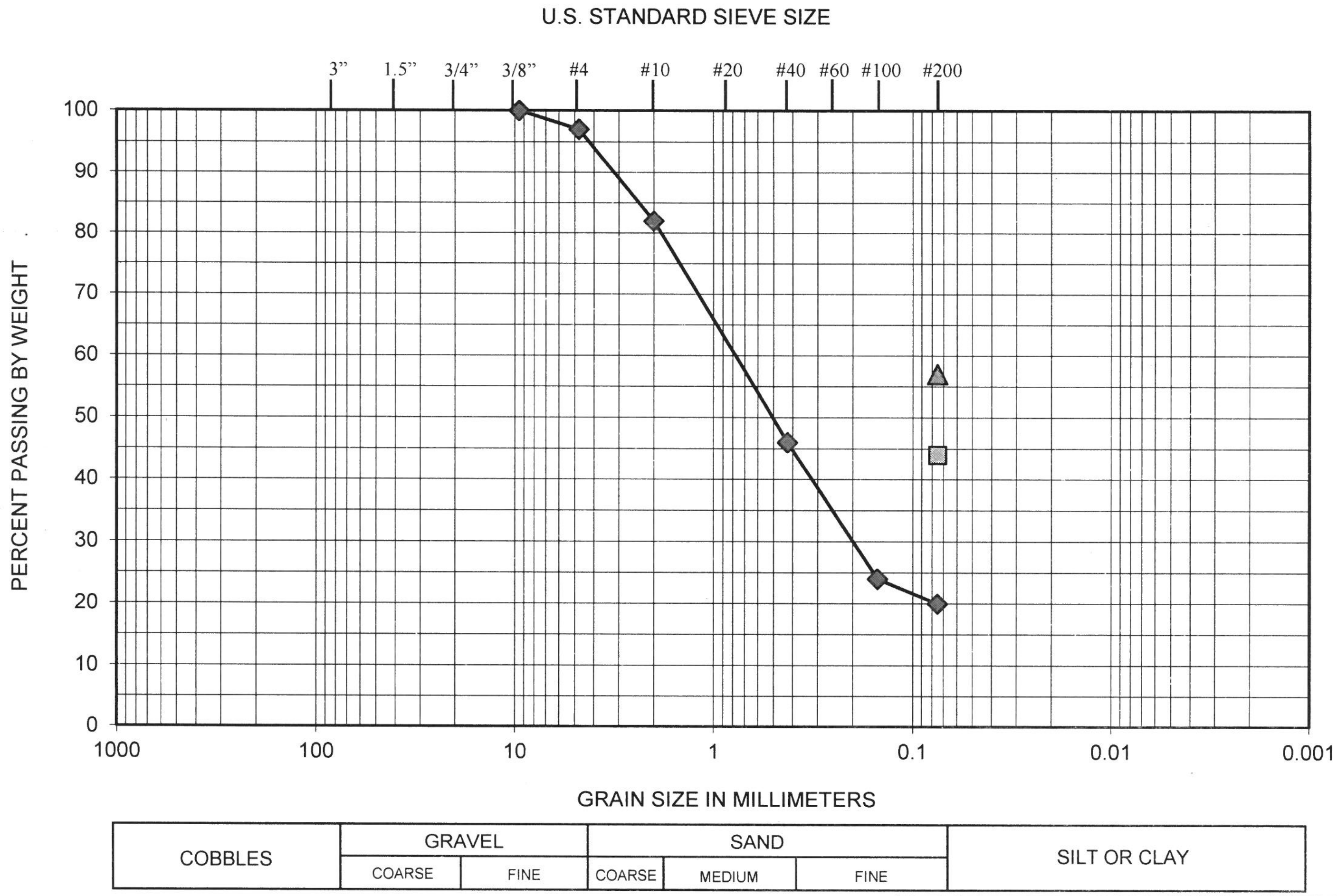
Webster Ranch Parcel

Date:
9/24/2019

Project:
319023

Client:
Katherine Dace

Figure:
B1



Symbol	Boring/ Test Pit	Sample Depth (feet)	Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)	USCS Class	Soil Classification
◆	TP-4	2	4.2	3	77	20	SM	Silty Sand
▢	TP-4	9	21.8	-	-	44	SC	Clayey Sand
▲	HA-2	0.5	10.7	-	-	57	CL	Sandy Clay

IGEO INNOVATE GEOTECHNICAL

Sieve Analysis Results

Horseshoe Bend, Idaho

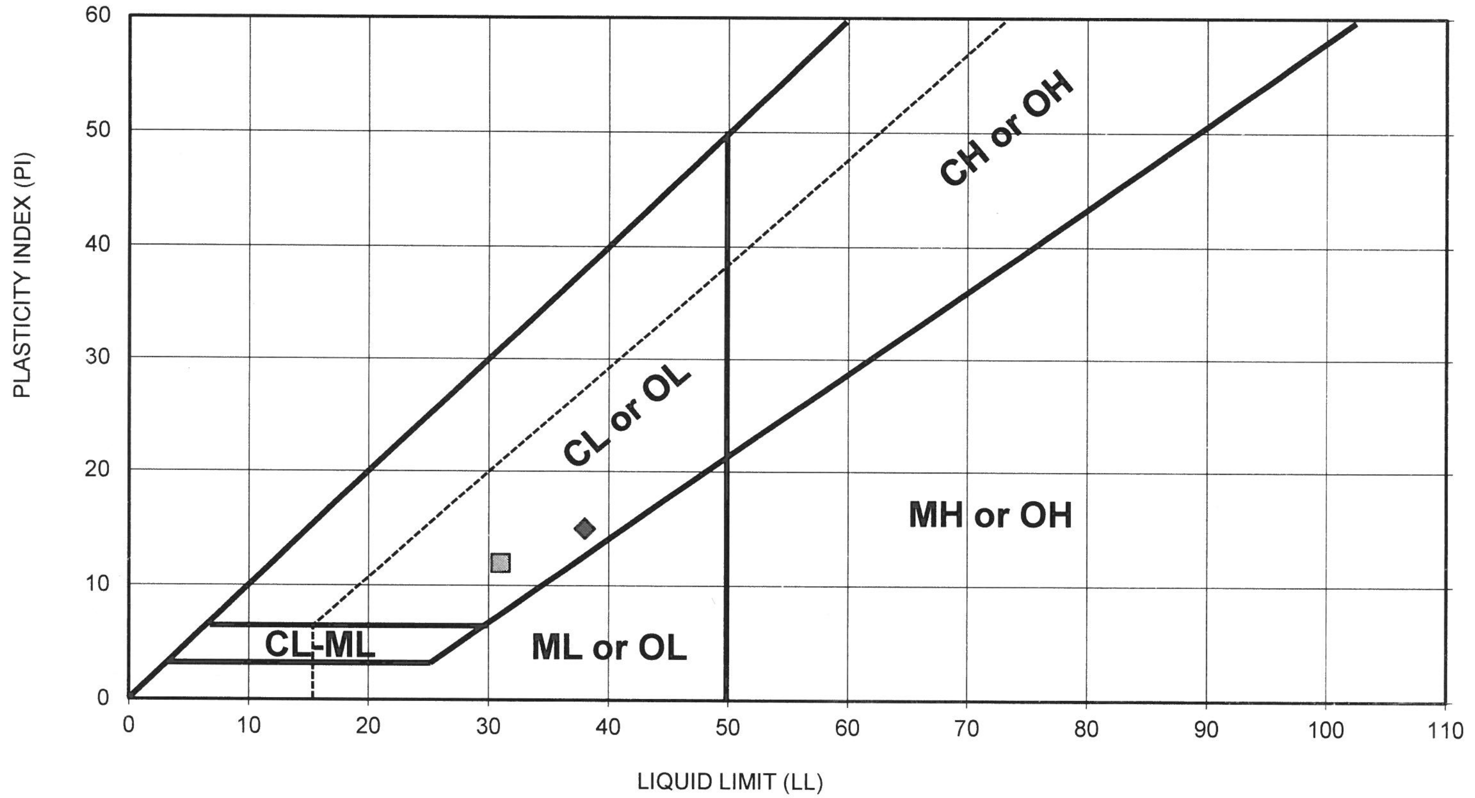
Webster Ranch Parcel

Date:
9/24/2019

Project:
319023

Client:
Katherine Dace

Figure:
B2



Symbol	Location	Sample Depth (feet)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	USCS Class	Soil Classification*
◆	TP-1	0.5	36	21	15	SC	Clayey Sand
■	TP-3	6	31	19	12	SC	Clayey Sand

* Based on Sieve Analysis Results

IGEO INNOVATE GEOTECHNICAL

Webster Ranch Parcel

Atterberg Limits Results

Horseshoe Bend, Idaho

Date:
9/24/2019

Project:
319023

Client:
Katherine Dace

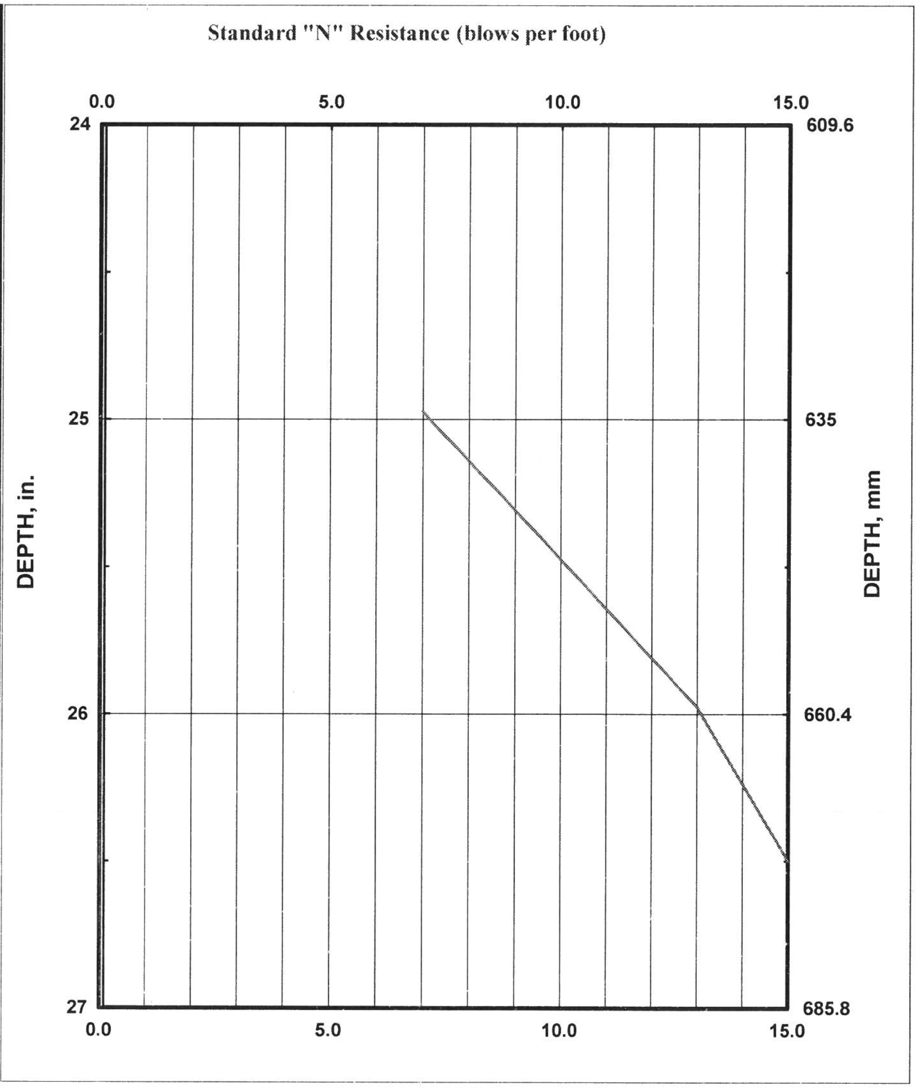
Figure:
B3

Appendix C

DCP TEST DATA - Sowers

Project: *Webster Ranch Parcel* **Date:** 30-Aug-19
Location: TP-1 @ 2.0' depth **Soil Type(s):** Clayey Sands (SC)

No. of Blows	Accumulative Penetration (mm)	Accumulative Penetration (inches)
0	609.6	24.0
5	634.365	25.0
20	659.765	26.0
20	673.1	26.5



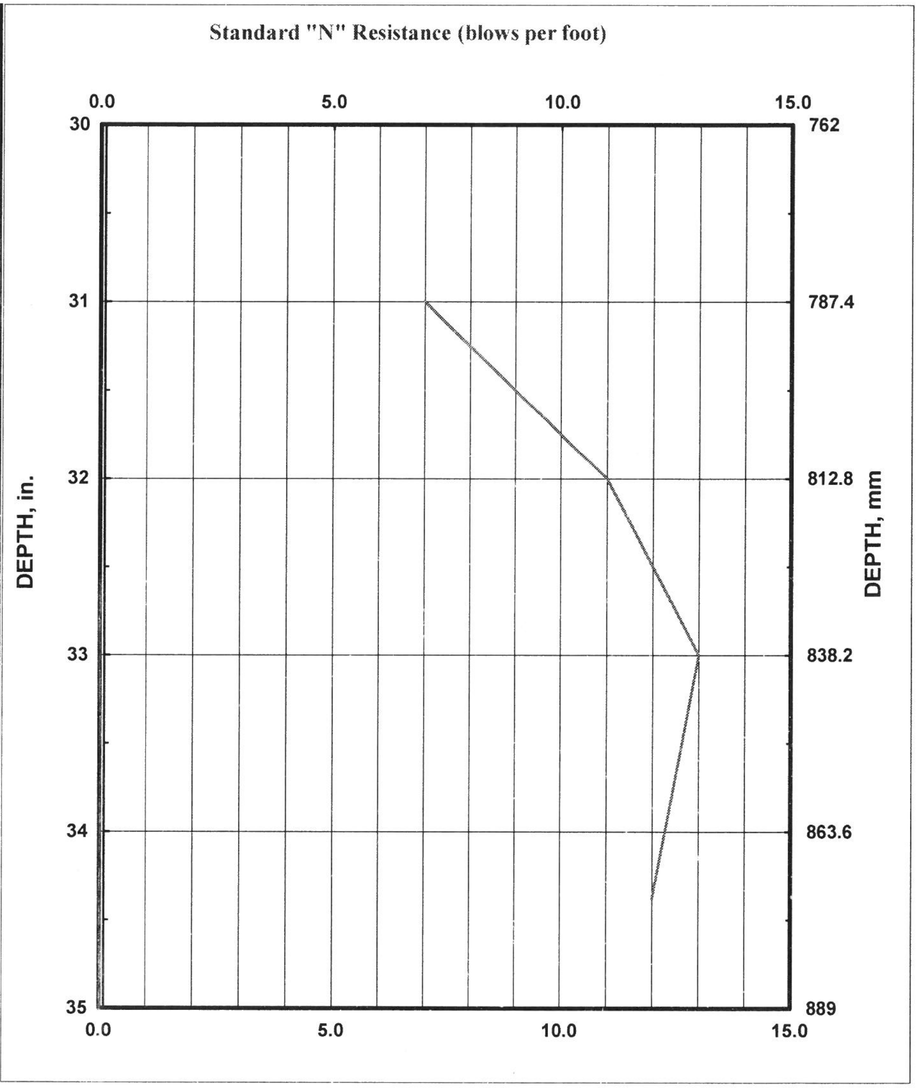
Reference: George F. Sowers and Charles S. Hedges. Dynamic Cone for Shallow In-Situ Penetration Testing, Vane Shear and Cone Penetrations Resistance Testing of In-Situ Soils, ASTM STP 399, American Society of Testing and Materials, 1966, pg. 29.

Figure C-1

DCP TEST DATA - Sowers

Project: *Webster Ranch Parcel* **Date:** 30-Aug-19
Location: TP-3 @ 2.5' depth **Soil Type(s):** Silty Sand (SM)

No. of Blows	Accumulative Penetration (mm)	(inches)
0	762	30.0
5	787.4	31.0
10	812.8	32.0
15	838.2	33.0
15	873.125	34.4



Reference: George F. Sowers and Charles S. Hedges. Dynamic Cone for Shallow In-Situ Penetration Testing, Vane Shear and Cone Penetrations Resistance Testing of In-Situ Soils, ASTM STP 399, American Society of Testing and Materials, 1966, pg. 29.

Figure C-2

IGEO INNOVATE GEOTECHNICAL