December 11, 2024

Jake Hofeld
Waterways Consulting, Inc.
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Report of Geotechnical Services
Brush Creek Bridge
Yakima County, Washington
Project No. 22-001-1

INTRODUCTION AND PROJECT DESCRIPTION

Geotechnics LLC is pleased to submit this geotechnical report to support design and construction of a road bridge within forested lands of the Yakama Nation. The bridge will carry traffic across the stream channel of Brush Creek.

Brush Creek is a SW-flowing ephemeral stream, located 23 miles east-SE of Mt. Adams and in Yakima County (see Figure 1). The stream-flow is currently directed through an earth embankment within three parallel steel culverts. The culverts will be replaced with a bridge crossing to eliminate the fish passage restriction. The gravel-surfaced road is BIA 175 Road. The project administrator is the Yakama Nation and the designer is Waterways Consulting, Inc.

The following report provides our geological and geotechnical assessment of the site as well as our geotechnical engineering recommendations. Our work was completed in general accordance with our contract with Waterways Consulting dated June 21, 2024.

SCOPE OF SERVICES

The purpose of our services is to evaluate soil and groundwater conditions as a basis for developing geotechnical design and construction recommendations. We completed the following specific services:

- Reviewed existing available subsurface soil and groundwater information, geologic maps, and other information pertinent to the site.
- Performed a geologic reconnaissance to observe existing surficial slope, soil, ground, and surface water conditions.
- Explored subsurface soil and groundwater conditions by completing four test pits.
- Obtained samples at representative intervals from the explorations, observed soil and groundwater conditions, and maintained detailed logs. Performed laboratory tests on selected soil samples.
- Performed geotechnical evaluations and prepared the design recommendations presented in this geotechnical report.

SITE AND PROJECT DESCRIPTION

The fill embankment road surface is at about Elev. 2,759 ft and the base of the channel is approximately Elev. 2,745 ft, so the current embankment is about 14 ft in height. The side slopes of the fill embankment are inclined approximately 1.7H:1V (Horizontal:Vertical) on the downstream side (SW) and approximately 1.1H:1V on the upstream side (NE), which has a shotcrete slope-surfacing as seen in the first photo below. Figure 2 shows the existing embankment and 1-ft topographic contours, as well as locations of the three existing culverts. The culverts are corrugated steel and ovaloid (12'W x 8'H), with length of approximately 63 ft and drop of about 1.3 ft along their length. The center culvert has a slightly lower invert elevation than the other two, as illustrated on the Profile, Figure 3. There are scour holes and plunge pools at the downstream ends, with vertical drops of 20" to 30" from the culvert. There was not any stream flow during the summer months of our visits.

Upstream, looking NW

Downstream, looking east

The Yakama Nation plans to remove the earth embankment and construct a road bridge. The current design calls for a single span of 35 feet with a bridge width of 25 feet. The plan is to use geotextile-reinforced modular block walls (MSE - *Mechanically Stabilized Earth* walls). A specific method may be used, referred to as GRS – *Geosynthetic Reinforced Soil*. Interlocking concrete modular blocks will be used. Figure 2 show the proposed locations for wingwalls and abutment walls for both sides of the bridge. Plans are to move the crossing slightly SE, with flow centered near the southernmost culvert. All three culverts will be completely removed from the site and new graded channel slopes will be established. We assume the bridge must be designed to accommodate HL-93 AASHTO Vehicular Live Loading. A prefabricated concrete bridge deck will be placed upon the constructed abutment walls.

GEOLOGIC MAPPING

To research the geology and geologic setting of the site, we reviewed the following two publications:

- *Stratigraphy and Structure of the Yakima Indian Reservation, with emphasis on the Columbia River Basalt Group* (Bentley et al, 1980).
- *Geologic map of the Simcoe Mountains volcanic field, main central segment, Yakama Nation, Washington* (Hildreth and Fierstein, 2015).

The first is a smaller scale map with much less detail, with mapped near-surface rocks identified as the Yakima Basalt subgroup of the Columbia River Basalt (CRB). The more detailed mapping by Hildreth and Fierstein identifies the many basalt units that make up the Simcoe Mountains volcanic field. As explained, the volcanic field is largely from cinder cones that blanket the underlying and much older CRB. The first reference just describes all younger lava flows as a single entity without the detailed description that Hildreth and Fierstein added to make up for that lack of local mapping. Our further discussion is based on the second reference.

The site is within the central portion of the Simcoe Mountains volcanic field which is bounded structurally by two east-west trending anticlines, the Simcoe Mountains Anticline on the south and the Toppenish Ridge Anticline on the north. These anticlines are a feature of the more regional Yakima Fold Belt, of which the Simcoe Mountains field makes up the SW portion.

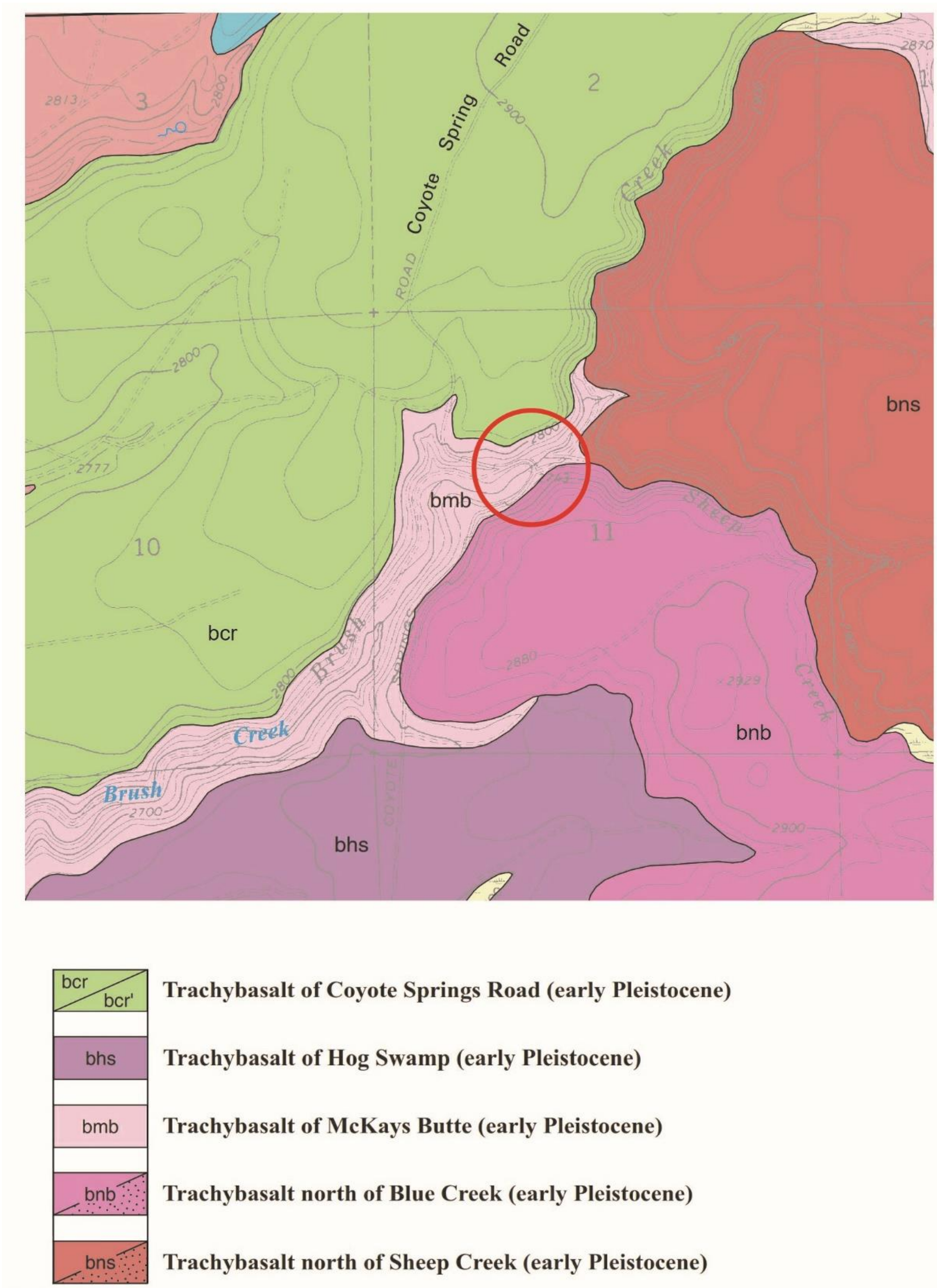
The following page contains a blown-up portion of the Hildreth & Fierstein map, along with abbreviated legend showing relative age of basalts. As noted, the majority of basalts at or near our site are early Pleistocene, generally aged 1.5 to 2 million years. All of these basalts result from extinct cinder cones and are much younger than the underlying Miocene-age CRB. The specific mapped cinder cone flow is the Trachybasalt of McKays Butte, unit bmb.

Due to the bedrock's relatively young age and the geomorphic setting, soil cover is limited in most areas. This is described in the second reference along with a description of the typical basalt flow units:

> *"Lava flows of the Simcoe Mountains volcanic field are generally covered by several feet of silty soil (loess), much of which was blown here by winds from barren areas of the Cascade Range during the ice ages (Pleistocene). Beneath such soils, however, tops of most flows are rubbly and porous, and interior parts typically contain abundant fractures. These properties make the Simcoe Mountains lava flows highly permeable, promoting infiltration of rainfall and snowmelt and favoring rapid lateral transport of groundwater."*

While the soil blanket may be thin in most areas, thicker soil deposits can be anticipated in alluvial areas and areas of manmade fill such as stream-crossing embankments. The pervasive shallow bedrock would suggest that existing fill embankments that have been sourced from nearby excavations will contain significant quantities of rock in varying sizes, most likely including cobble and boulder sizes.

Brush Creek geology detail (Hildreth and Fierstein, 2015):



EXPLORATIONS AND TESTING

We completed field explorations on July 26, 2024 consisting of four test pits (TP-1 through TP-4) at the approximate locations shown on Figure 2. The test pits were excavated with a trackhoe by Dan Fischer Excavating of Forest Grove, Oregon. Completion depths varied from 2.7 to 6.5 ft below ground surface. Detailed logs of the test pits are included as Figures A1 through A4.

Samples were collected from the test pits and returned to our soils laboratory for further examination and testing. Testing included Moisture Content (ASTM D2216) and Grain Size Distribution (ASTM D6913). Laboratory test results are provided on the individual test pit logs and on Figure A5.

In agreement with the geologic mapping described above, we encountered basalt at relatively shallow depth. The encountered soil units are described separately below. Figure 3 is a profile illustrating the soil, rock, and groundwater conditions in the road-profile direction, looking upstream.

FILL OR ALLUVIUM

In all test pits, the shallow soils consisted of unconsolidated silty gravel with abundant cobbles and some boulders (>12”). The material may be a combination of fill placed during culvert construction or prior crossing construction, and alluvial stream placement. Generally, the heterogenous mixture of angular and platey rock fragments interspersed with rounded cobbles suggests this is fill soil whereas alluvium is typically more uniform in roundedness. These soils contain about 5 to 15 percent silt by weight (see Grain Size Distributions, Figure A5). Largest boulders noted were a little over 24” in diameter/length. Cobbles and boulders are also present at the ground surface, on the embankments as well as within the channel. Relative density is loose to medium dense, and some caving of test pit sidewalls was noted.

ALLUVIUM

In three of the four test pits, we noted a layer of consistently rounded gravel which was definitely alluvium, overlying the basalt bedrock. The layer was less than a foot in thickness and saturated, with seepage noted. These soils are similar to the fill in low relative density, with relatively easy excavation anticipated.

BASALT

Immediately below the alluvium and/or fill, we encountered refusal on hard basalt bedrock. The contact was abrupt and the basalt is <u>not</u> decomposed. We did not observe the bedrock directly because it was under groundwater ponding within the test pits. We recommend assuming very intact rock with wide joint spacing and it should be considered very difficult to excavate with conventional equipment. The small trackhoe could not penetrate at all and only scraped the surface.

GROUNDWATER

Groundwater seepage was noted near the base of all four test pits, generally with about 0.5-ft of water perched upon the bedrock as subsurface flow. Groundwater elevation in all test pits was approximately 2,741 ft.

The following two pages are photographs taken during the field work on July 26th.

TP-1, groundwater perched on bedrock

TP-1, stockpile with cobbles and boulders

TP-2, stockpile with cobbles and boulders

TP-2, groundwater perched on bedrock within 2"-minus silty Gravel alluvium.

Field Photos – Test Pits TP-1 and TP-2

TP-3, looking SE

TP-3, boulders

TP-4, looking NE

TP-4, groundwater perched on bedrock

Field Photos – Test Pits TP-3 and TP-4

SEISMIC EVALUATION

EARTHQUAKE FAULTS

The USGS online Fault and Fold database (USGS, 2024) shows no known active or potentially active faults passing through the sites. No indications of the presence of faulting were noted during our field investigation. We consider the possibility of fault rupture and displacement to be remote.

GROUND SHAKING

Ground shaking is responsible for generating high inertial forces and excessive dynamic movements that can impart unacceptable damage to structures. Ground shaking is expected to be moderate at this site during the design seismic event ('no-collapse' event, see below). Ground shaking should be mitigated by using the design ground motions and site classification given below.

LIQUEFACTION/LATERAL SPREADING

Liquefaction is a phenomenon caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles, resulting in the sudden loss of shear strength in the soil. Granular soils, which rely on interparticle friction for strength, are susceptible to liquefaction until the excess pore pressures can dissipate. The alluvial materials, when saturated, may be liquefaction susceptible. However, based on their very limited thickness in the saturated zone, we consider the potential for liquefaction and lateral spreading at this site to be minimal to none.

DESIGN GROUND MOTIONS AND SITE CLASSIFICATION

We have developed appropriate seismic parameters for AASHTO level seismic design (AASHTO, 2020). We developed ground motion parameters for the 1,000 year 'no-collapse' event, typical for road bridges in Washington state. The recommended seismic design parameters are summarized in the following table. Seismic loads on MSE wall abutments and wingwalls should be evaluated using these parameters.

Seismic Design Parameters	
Soil Profile Site Class	B
Peak Ground Acceleration, PGA	0.152g
Site Coefficient, F_{pga}	1.00
Factored Peak Ground Acceleration	0.152g

Notes:

1. g = acceleration due to gravity
2. AASHTO seismic parameters are based upon an expected peak bedrock acceleration having a 7 percent probability of exceedance in 75 years, representing an approximately 1,000-year return period.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion Summary

Based on our explorations, testing, and analyses, we offer the following summary of conclusions:

- The bridge abutment and wingwalls will be supported on basalt bedrock. Proposed level of wall foundations are near the bedrock contact. Basal blocks should be placed on a leveling pad above the uneven bedrock surface.
- No elevated seismic hazards have been identified, as summarized above.
- Significant groundwater could be encountered within excavations for wingwalls and abutments. For this reason, we recommend scheduling the work for dry-season construction.

Retaining Walls and Abutments

Foundation Support

Bridge abutment and wall foundations will consist of the basal level of the MSE wall systems. Foundations should be assumed to bear on bedrock or leveling pads on bedrock. The leveling pad should consist of poured concrete or compacted crushed rock and can be as much as 3 feet in thickness provided enough geogrid support can be incorporated in the wall as required by the designer for support of lateral soil loads.

Minimum foundation depth below lowest adjacent final grade should be 2 feet for wingwall footings and 3 feet for bridge abutments. The slope-side bottom edge of wingwall foundations should have a minimum horizontal offset of 4 feet from the slope face. These embedment recommendations are for maintenance of slope stability, bearing capacity, and scour resistance.

For use in design of abutment and wingwall foundations, an allowable bearing pressure of 4,000 psf is recommended. We expect that foundations designed and constructed as recommended will experience settlements of less than ½-inch.

Lateral Loading and Resistance

Retaining walls should be designed to resist lateral pressures from soil, surcharge, and seismic loading.

MSE Wall: The modular block walls for abutments and wingwalls will require geogrid reinforcement, thus are MSE or GRS walls. Alternatively, high strength woven geotextiles may be used. The type of geosynthetic (geogrid or geotextile) and its tensile strength as well as required spacings and lengths, will be a function of the design by others. For such walls, we recommend use of imported crushed rock as fill within the reinforced zone of wall backfill. Based on this recommendation and on the soil conditions, we have prepared the table below of soil strength properties for use in design of MSE walls.

Soil Parameters			
Material Type	Friction Angle	Cohesion (psf)	Unit Weight (pcf)
Imported Select Structural Fill (reinforced zone)	38	0	135
Foundation soil (rock)	40	500	140
Retained Soils (alluvium and/or fill)	34	50	125

We recommend the following factors of safety for use in wall design:

Sliding:	1.5
Overturning:	2.0
Global Stability:	1.5, requirement met, see below.
Internal Stability:	1.5
Bearing Capacity:	2.0

If LRFD methods are used, appropriate load resistance factors can alternatively be used, as recommended in the AASHTO Bridge Design manual (AASHTO, 2020), Chapter 11.

To meet global slope stability requirement of FS=1.5, based on limit-equilibrium slope stability methods, a minimum basal geosynthetic length of 0.5*H (50% of wall height) should be provided. Length is measured from the inside face of the concrete modular blocks.

For lateral resistance of the abutment walls, we recommend neglecting any component of resistance from the streambed materials placed within the creek bed, assuming no passive soil resistance for wall design. However, this embedment on the stream-side of abutments should be required and we recommend at least 3 feet of embedment for abutments. For lateral resistance of wingwalls, passive soil resistance can be assumed as an equivalent fluid unit weight of 200 pcf. This value has been adjusted downward based on the descending slope condition.

EARTHWORK RECOMMENDATIONS

Subgrade Preparation

If soft or loose soils, or large boulders, are encountered at foundation subgrade elevation, the materials should be removed and replaced with compacted crushed rock as described below in the report section *Fill Materials and Compaction*. Similarly, if water infiltrates and pools in the excavation, the water, along with any disturbed soil should be removed and replaced with crushed rock. We recommend that Geotechnics observe the base of prepared foundation excavations before placing any concrete forms and reinforcing steel. We will evaluate whether the bearing surface has been adequately prepared and that the soil conditions are consistent with those observed during our explorations. Compaction effort should be applied to the exposed subgrade and replacement fill under the geotechnical engineer’s observation.

Dewatering and Dry Weather Construction

Groundwater is likely to occur within the depths of expected excavations, probably even during the dry season. Excavations that extend into saturated soils should be dewatered. Provided work is performed in the dry season, sump pumps placed in the excavations will likely be sufficient for dewatering. Although the need for drilled dewatering wells and/or wellpoints is unlikely at that time of year, the contractor should plan on dealing with groundwater to allow foundation construction to occur in the dry. To limit the amount of required pumping, we recommend earthwork be scheduled for the dry summer months.

Fill Materials and Compaction

Structural fill materials will be required for the reinforcement zone of the MSE walls, between the layers of geosynthetic. Additionally, some fill material may be needed for construction of foundation bearing pads or as replacement fill if foundation overexcavation is necessary (see *Subgrade Preparation* above).

Select Structural Fill: Imported Select Structural Fill should be used for all three of the uses listed above. Existing site soils (fill and alluvium) are inappropriate for re-use in these applications.

Select structural fill should consist of clean, durable, crushed angular rock. Such rock should be well-graded and have a maximum particle size of 1½ inches, and less than 7.5 percent passing the U.S. No. 200 Sieve. Such rock should conform to the WSDOT Specification 9-03.9(3) for Crushed Surfacing Base Course (WSDOT, 2025).

Other Soil and Rock Materials: Other materials such as rip-rap or quarry spalls may be required for scour protection.

Compaction: All structural fill material should be placed and compacted to a minimum of 95 percent of maximum dry density (MDD), as determined by ASTM D698 (Standard Proctor). Fill should also be placed and compacted in accordance with the following:

- Place all fill and backfill on a prepared subgrade that consists of firm native soils or approved structural fill. When placed on sloping ground, the ground should be benched and keyed such that soils are placed on a level surface.
- Place all fill or backfill in uniform horizontal lifts with a thickness appropriate for the material type and compaction equipment. Unless otherwise directed by the geotechnical engineer, maximum thickness of loose lifts shall be 8 inches.
- Place fill at a moisture content within about 3 percent of optimum as determined in accordance with ASTM Test Method D698. Moisture condition fill soil to achieve a uniform moisture content within the specified range before compacting.
- Do not place, spread, or compact fill soils during freezing or unfavorable weather conditions. Frozen or disturbed lifts should be removed or properly recompacted prior to placement of subsequent lifts of fill soils.
- Do not place fill and backfill until tests and evaluation of the underlying materials have been made and the appropriate approvals have been obtained.
- During fill placement and compaction, a sufficient number of in-place density tests should be completed to verify that the specified degree of compaction is being achieved. As an alternative to testing, the geotechnical engineer may elect to use the observational method, consisting of a method specification to achieve a level of compaction considered equivalent to 95% of ASTM D698.

Surface Drainage and Erosion Control

Surface runoff can be controlled during construction by careful grading practices. Typically, these include the construction of shallow, upgrade perimeter ditches or low earthen berms and the use of temporary sumps to collect runoff and prevent water from damaging exposed subgrades. Also, measures should be taken to avoid ponding of surface water during construction.

Some site soils may present a moderate erosion hazard. In our opinion, erosion at the site during construction can be minimized by judicious use of straw bales, silt fences and plastic sheets. The erosion control devices should be in place and remain in place throughout site preparation and construction. Maintaining appropriate erosion control is the responsibility of the contractor and should be carried out in accordance with the project plans and specifications and applicable regulations.

DOCUMENT REVIEW AND CONSTRUCTION SUPPORT

Satisfactory foundation and earthwork performance depends to a large degree on quality of construction. Sufficient monitoring of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions observed during construction should be compared with those encountered during the exploration program. Recognition of changed conditions often requires experience; therefore, the project geotechnical engineer or their representative should visit the site with sufficient frequency to detect whether conditions differ significantly from those anticipated. In particular, foundation excavations should be observed by Geotechnics prior to constructing bridge abutments and wingwalls, and prior to placing leveling pads for concrete blocks. If observational-method compaction verification is selected, Geotechnics personnel should be on-site during all compaction activities. Geotechnics should also review the final plans and specifications to verify that the recommendations presented herein have been interpreted as intended.

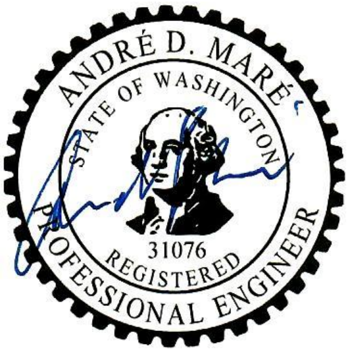
LIMITATIONS

We have prepared this report for the exclusive use of Waterways Consulting, The Yakama Nation,, and the design team for this project. Our report is intended to provide our opinion of geotechnical parameters for design and construction of the proposed project based on exploration locations that are believed to be representative of site conditions. However, conditions can vary significantly between exploration locations and our conclusions should not be construed as a warranty or guarantee of subsurface conditions or future site performance. If soil conditions are encountered during construction that differ from those described herein, we should be notified immediately to assess the implications and provide any necessary design supplements or modifications. If the scope of proposed construction changes from that described herein, our recommendations should also be reviewed.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty, expressed or implied, should be understood.

We appreciate the opportunity to submit this report. Please contact us if you have any questions or need additional information.

Sincerely,



RENEWS: 9-22-2026

André D. Maré, P.E., G.E.
Geotechnical Engineer

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Attachments:

Figure 1:	Vicinity Map
Figure 2:	Site and Exploration Plan
Figure 3:	Profile A-A’
Key to Log Symbols and Terms	
Figures A1 - A4:	Test Pit Logs
Figure A5:	Grain Size Distribution

REFERENCES

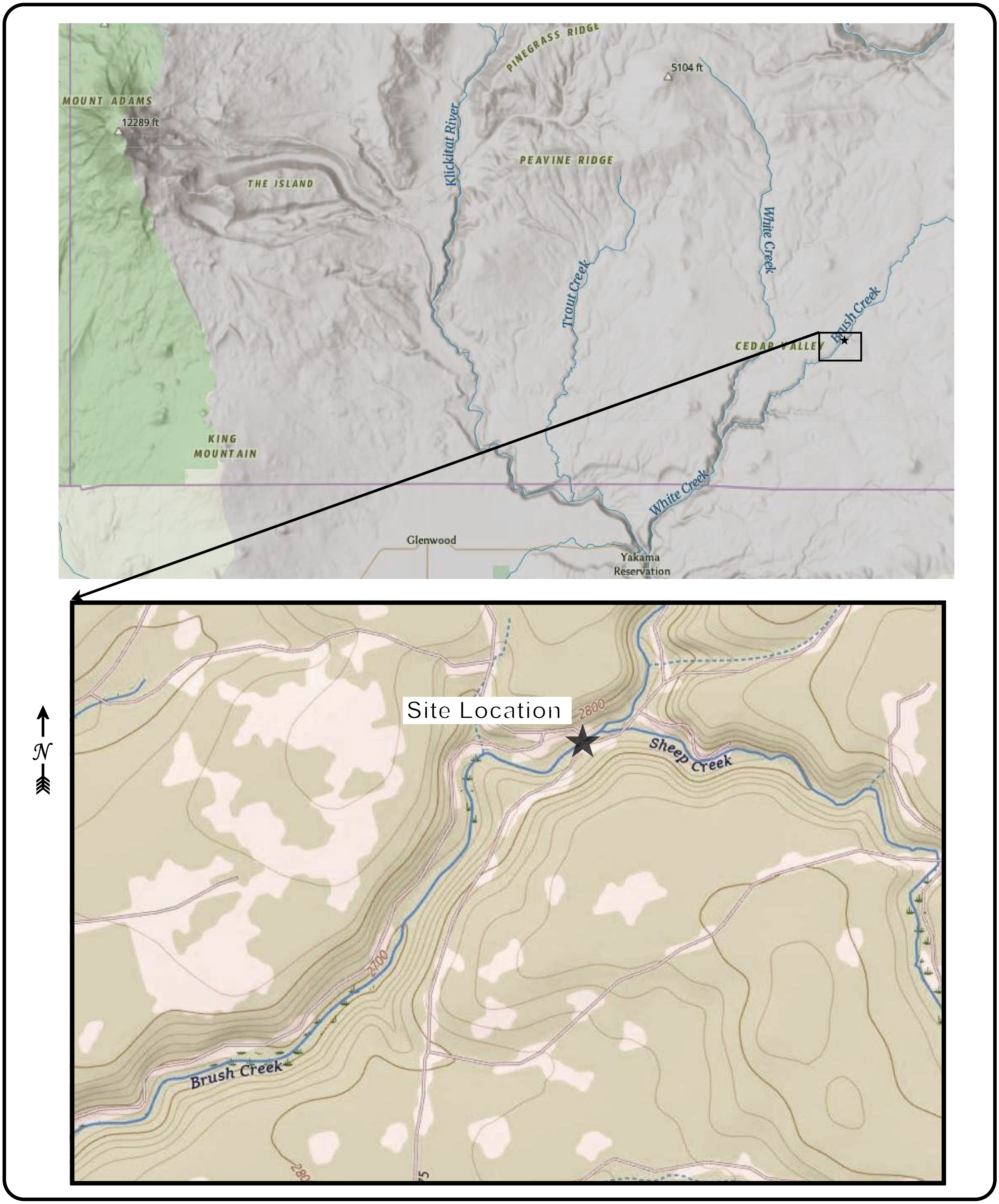
American Association of State Highway and Transportation Officials (AASHTO), 2020. *LRFD Bridge Design Specifications, 9th Edition*.

Bentley, R.D., Anderson, J.L., Campbell, N.P., and Swanson, D.A., 1980, *Stratigraphy and Structure of the Yakima Indian Reservation, with emphasis on the Columbia River Basalt Group*, U.S. Geological Survey Open File Report OF-80-200.

Hildreth, W. and Fierstein, J., 2015, *Geologic map of the Simcoe Mountains volcanic field, main central segment, Yakama Nation, Washington*, U.S. Geological Survey Scientific Investigations Map 3315, scale 1:24,000, 3 sheets, pamphlet 76 p., https://pubs.usgs.gov/sim/3315/.

U.S. Geological Survey, 2024, *Quaternary fault and fold database for the United States*, website: https://www.usgs.gov/programs/earthquake-hazards/faults.

WSDOT, 2025, *Standard Specifications for Road, Bridge, and Municipal Construction*, Publication No. M41-10.



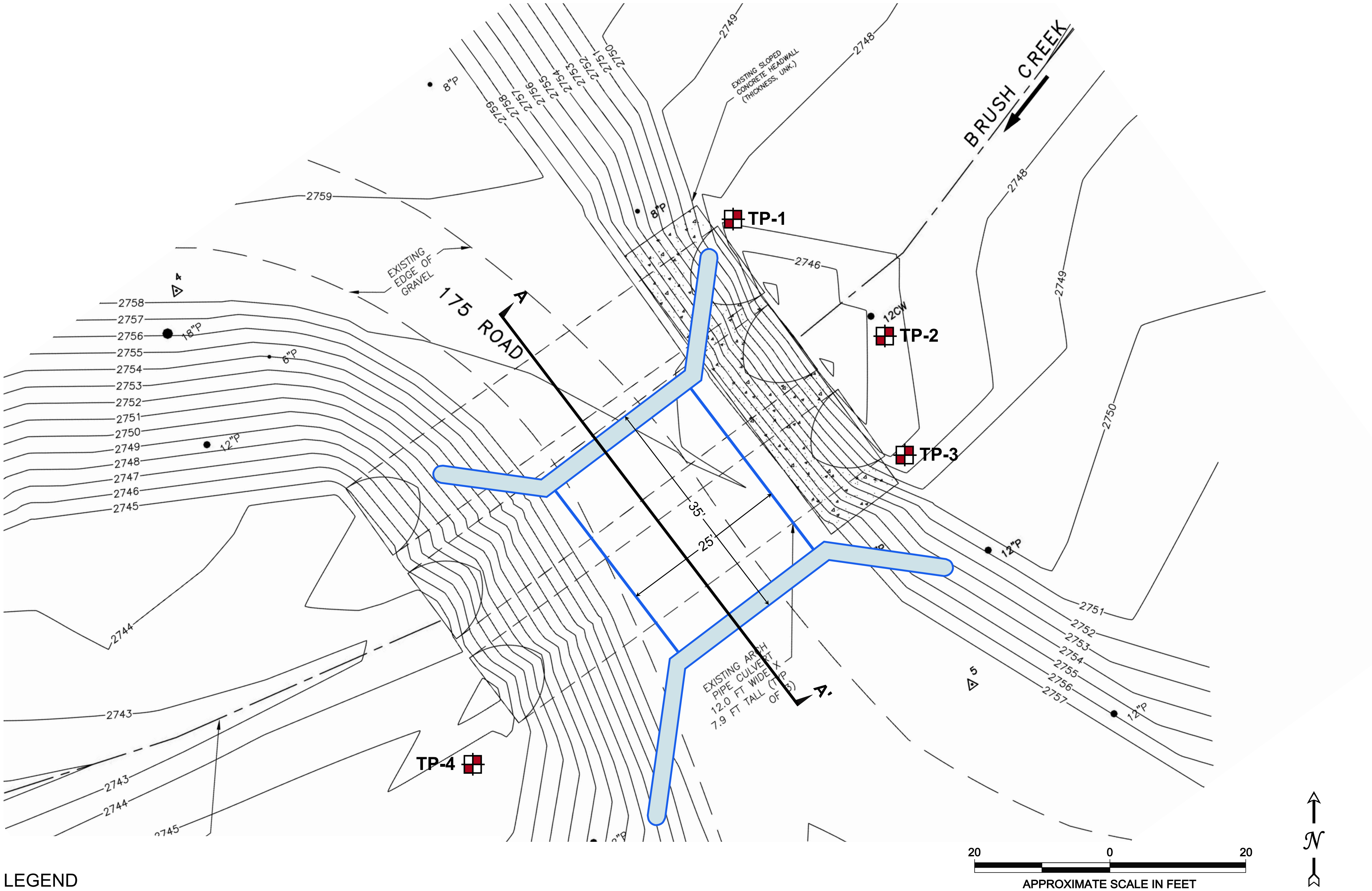
GEOTECHNICS

VICINITY MAP

Brush Creek Bridge
Yakima County, Washington

Project No. 22-001-2

Figure 1



LEGEND

TP-4 Test Pit

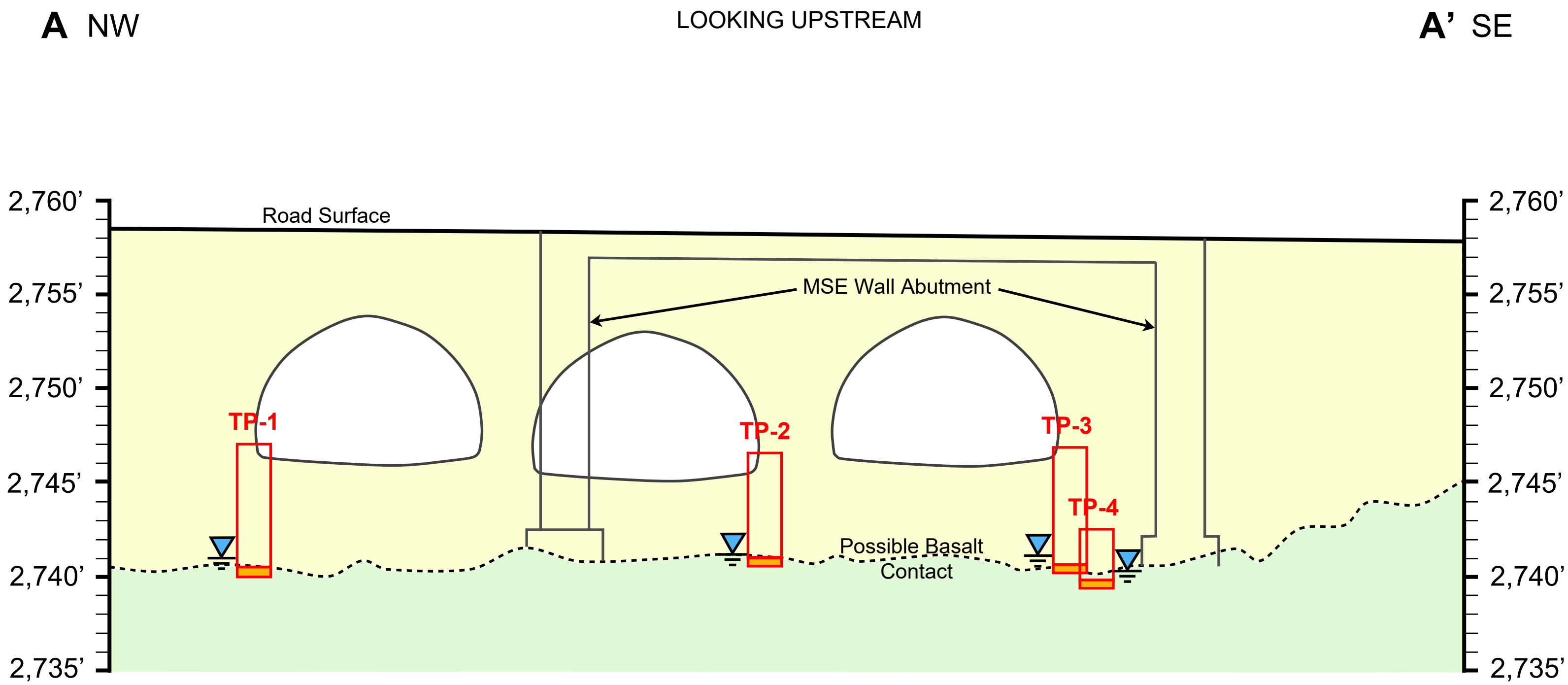
A A' Profile, see Figure 3

SITE AND EXPLORATION PLAN

Brush Creek Bridge
Yakima County, Washington

Project No. 22-001-1

Figure 2



Seepage level, July 26, 2024

Fill and Alluvium - Silty GRAVEL with Cobbles & Boulders

Basalt - Hard bedrock.

HORIZONTAL AND VERTICAL SCALE: 1" = 10'

0 10 20

See Figure 2 for Profile Location
TP-1, TP-2, and TP-3 are projected southwest. TP-4 is projected northeast.
Basalt contact is uncertain and anticipated to be highly variable.

GEOTECHNICS

PROFILE A-A'

Brush Creek Bridge
Yakima County, Washington

Project No. 22-001-1

Figure 3

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density (%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 to 15	Very Soft	0 to 2	<250
Loose	5 to 10	15 to 35	Soft	3 to 4	250 - 500
Medium Dense	11 to 30	35 to 65	Medium Stiff	5 to 8	500 - 1000
Dense	31 to 50	65 to 85	Stiff	9 to 15	1000 - 2000
Very Dense	over 50	85 to 100	Very Stiff	16 to 30	2000 - 4000
			Hard	over 30	>4000

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP DESCRIPTIONS		
Coarse Grained Soils More than 50% Retained on No. 200 Sieve Size	**Gravel and Gravelly Soils** More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravel (<5% fines)		GW	Well-graded GRAVEL
				GP	Poorly-graded GRAVEL
		Gravel with Fines (>12% fines)		GM	Silty GRAVEL
				GC	Clayey GRAVEL
	Sand and Sandy Soils 50% or More of Coarse Fraction Passing No. 4 Sieve	Clean Sand (<5% fines)		SW	Well-graded SAND
				SP	Poorly-graded SAND
		Sand with Fines (>12% fines)		SM	Silty SAND
				SC	Clayey SAND
Fine Grained Soils 50% or More Passing No. 200 Sieve Size	**Silt and Clay**	Liquid Limit Less than 50%		ML	SILT
				ML	Sandy SILT
				CL	Lean CLAY
				CL	Sandy CLAY
	Silt and Clay	Liquid Limit 50% or More		MH	Elastic SILT
				CH	Fat CLAY

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to #4 (5 mm)
Coarse Gravel	3 in to ¾ in
Fine Gravel	¾ in to #4 (5 mm)
Sand	#4 (5 mm) to #200 (0.075 mm)
Coarse Sand	#4 (5 mm) to #10 (2 mm)
Medium Sand	#10 (2 mm) to #40 (0.4 mm)
Fine Sand	#40 (0.4 mm) to #200 (0.075 mm)
Silt and Clay	Smaller than #200 (0.075 mm)

ABBREVIATIONS

Laboratory Tests:

- AL Atterberg Limits
  - PL Plastic Limit
  - LL Liquid Limit
- %F Fines Content
- GSD Grain Size Distribution
- DD Dry Density
- MD Moisture/Density Relationship
  - -S Standard Proctor (ASTM D-698)
  - -M Modified Proctor (ASTM D-1557)
- SG Specific Gravity
- CBR California Bearing Ratio
- RM Resilient Modulus
- K Permeability
- CN Consolidation
- DS Direct Shear
- TX Triaxial Shear
  - -UU Unconsolidated Undrained
  - -CU Consolidated Undrained

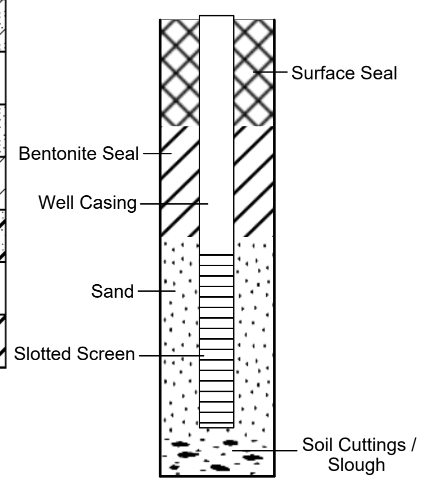
Field Tests:

- PP Pocket Penetrometer
- TV Torvane

Sample Type:

- SPT Standard Penetration Test (2.0" OD)
- CMOD California Modified Sampler (3.0" OD)
- SH Thin-Walled Shelby Tube (3.0" OD)
- GRAB Disturbed Sample collected from auger cuttings or test pit

WELL DETAIL



NOTES

Soil descriptions are based on the general approach presented in ASTM D-2488 (Visual-Manual Procedure). Where laboratory data are available, soil classifications are in accordance with ASTM D-2487.

Solid lines between soil unit descriptions indicate change in interpreted geologic unit. Dashed lines indicate stratigraphic change within the geologic unit.

Blowcount (N) is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted) per ASTM D-1586. See exploration log for hammer weight and drop.

Please also refer to the discussion in the report for a general description of subsurface conditions.

GEOTECHNICS

KEY TO LOG SYMBOLS AND TERMS

COMPANY:	Dan Fischer Excavating, Inc.	DATE:	07-26-24
METHOD:	Trackhoe w/ 2-ft bucket	ELEVATION (FT):	2,747.0
EQUIPMENT:	CAT 302.7	STATE PLANE EAST:	1,508,123
LOGGED BY:	ADM	STATE PLANE NORTH:	283,709

SAMPLE ID	SAMPLE TYPE	SAMPLE	MOISTURE CONTENT (%)	DYNAMIC CONE PENETROM	DEPTH (FT)	GRAPHIC SYMBOL	MATERIAL DESCRIPTION	OTHER TESTS & NOTES
					0		Grayish Brown, Silty GRAVEL with Sand (GM), dry to slightly moist, medium dense. Abundant cobbles and few boulders to 24", predominantly 6"-12", mostly angular. (FILL or ALLUVIUM)	
					1			
					2			
S-1	Grab	■	7.5					
					3		@3'-5', fewer boulders.	
					4		@4.5'-6.5', 24" boulder, becomes moist.	
S-2	Grab	■	9.5					GSD, %F=13.6
					5			
S-3	Grab	■	12.3	▼	6		@6', becomes very moist to wet, fast seepage from both sides.	
					7		@6.5', refusal on BASALT BEDROCK. Total Depth = 6.5 feet. Groundwater at 6.0 feet. No caving.	
					8			
					9			
					10			
					11			
					12			
					13			
					14			

NOTES:

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GEOTECHNICS

TEST PIT TP-1

Brush Creek Bridge
Yakima County, Washington

Project Number 22-001-1

COMPANY:	Dan Fischer Excavating, Inc.	DATE:	07-26-24
METHOD:	Trackhoe w/ 2-ft bucket	ELEVATION (FT):	2,746.5
EQUIPMENT:	CAT 302.7	STATE PLANE EAST:	1,508,145
LOGGED BY:	ADM	STATE PLANE NORTH:	283,692

SAMPLE ID	SAMPLE TYPE	SAMPLE	MOISTURE CONTENT (%)	DYNAMIC CONE PENETROM	DEPTH (FT)	GRAPHIC SYMBOL	MATERIAL DESCRIPTION	OTHER TESTS & NOTES
					0–5		Grayish Brown, Poorly Graded GRAVEL with Silt and Sand (GP-GM), slightly moist, medium dense. Rounded and angular gravel and small cobbles to 3½ inches. (FILL or ALLUVIUM)	
					1.5		@1.5', more cobbles, to 6"	
S-1	Grab	■	7.4		3.25			GSD, %F=11.9
S-2	Grab	■	7.5		4.25		@4', becomes very moist, abundant cobbles and boulders, 4" to 18", angular and rounded.	
S-3	Grab	■	13.4	▼ (groundwater)	5–5.5		Brown mottled reddish brown, Silty GRAVEL with Sand (GM), very moist, medium dense. Predominantly rounded gravel, 2" minus. (ALLUVIUM)	GSD, %F=13.1
					5.5		@5.5', refusal on BASALT BEDROCK.	

Total Depth = 5.5 feet.
Groundwater at 5.4 feet.
Moderate caving from 2' to 4', boulders from sidewall.

NOTES:

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GEOTECHNICS

TEST PIT TP-2

Brush Creek Bridge
Yakima County, Washington

Project Number 22-001-1

Figure A2

COMPANY:	Dan Fischer Excavating, Inc.	DATE:	07-26-24
METHOD:	Trackhoe w/ 2-ft bucket	ELEVATION (FT):	2,746.9
EQUIPMENT:	CAT 302.7	STATE PLANE EAST:	1,508,148
LOGGED BY:	ADM	STATE PLANE NORTH:	283,674

SAMPLE ID	SAMPLE TYPE	SAMPLE	MOISTURE CONTENT (%)	DYNAMIC CONE PENETROM	DEPTH (FT)	GRAPHIC SYMBOL	MATERIAL DESCRIPTION	OTHER TESTS & NOTES
					0–2		Grayish Brown, Silty GRAVEL with Sand (GM), slightly moist, medium dense. Predominantly angular gravel and cobbles, 8" to 20". (FILL or ALLUVIUM)	
					2		@2', mostly rounded to subrounded gravel and cobbles.	
S-1	Grab	■	11.0					
					4		@4', becomes moist to very moist. More abundant large angular, platey rocks.	
S-2	Grab	■	9.7					
				▼	5.75		@5.75', fast seepage from west side.	
S-3	Grab	■	13.5				Brown mottled gray and reddish brown, Well Graded GRAVEL with Silt (GW-GM), wet, medium dense. Predominantly rounded gravel, 2" minus. (ALLUVIUM)	
					6.25		@6.25', refusal on BASALT BEDROCK.	
							Total Depth = 6.25 feet. Groundwater at 5.75 feet. Minor caving from 3' to 6'.	

Depth scale (ft): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

NOTES:

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GEOTECHNICS

TEST PIT TP-3

Brush Creek Bridge
Yakima County, Washington

Project Number 22-001-1

COMPANY:	Dan Fischer Excavating, Inc.	DATE:	07-26-24
METHOD:	Trackhoe w/ 2-ft bucket	ELEVATION (FT):	2,742.7
EQUIPMENT:	CAT 302.7	STATE PLANE EAST:	1,508,088
LOGGED BY:	ADM	STATE PLANE NORTH:	283,629

SAMPLE ID	SAMPLE TYPE	SAMPLE	MOISTURE CONTENT (%)	DYNAMIC CONE PENETROM	DEPTH (FT)	GRAPHIC SYMBOL	MATERIAL DESCRIPTION	OTHER TESTS & NOTES
					0–1.7		Grayish Brown mottled reddish brown, Silty GRAVEL with Sand (GM), slightly moist to moist, medium dense. Predominantly rounded gravel and cobbles. (FILL or ALLUVIUM)	
S-1	Grab	■	13.5					
S-2	Grab	■	14.9	▼	1.7–2.7		Brown, Poorly Graded GRAVEL with Silt and Sand (GP-GM), moist to wet, medium dense. Predominantly rounded 2" minus gravel. (ALLUVIUM)	GSD, %F=7.1
					2.7		@2.7', refusal on BASALT BEDROCK. Total Depth = 2.7 feet. Groundwater at 2.2 feet. No caving.	

NOTES:

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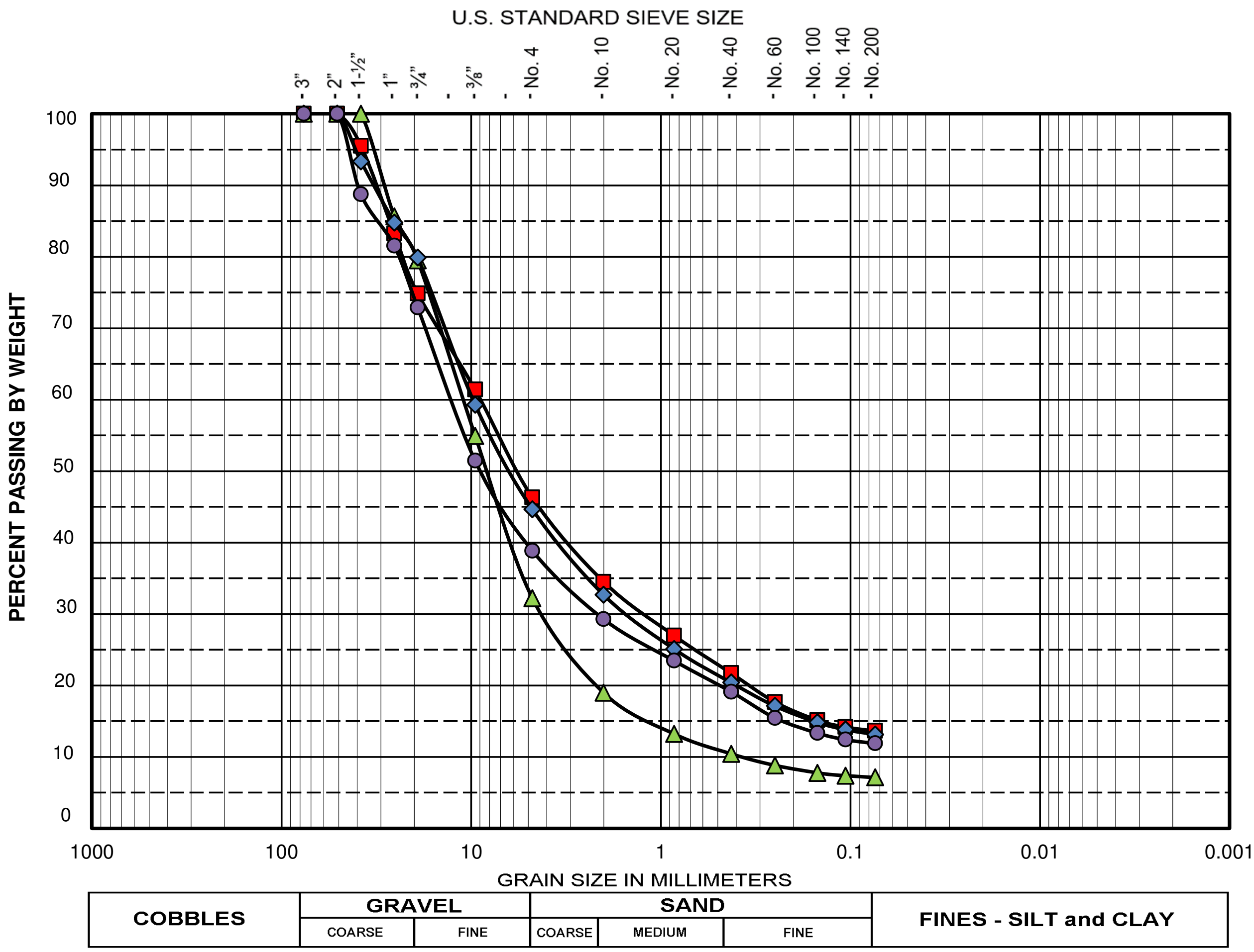
GEOTECHNICS

TEST PIT TP-4

Brush Creek Bridge
Yakima County, Washington

Project Number 22-001-1



Symbol	Sample Location	% MC	% Gravel	% Sand	%Fines	Classification
■	TP-1 4.5' - 5.0'	9.5	53.7	32.7	13.6	Silty GRAVEL with Sand (GM)
●	TP-2 3.0' - 3.5'	7.4	61.2	26.9	11.9	Poorly Graded GRAVEL with Silt and Sand (GP-GM)
◆	TP-2 5.25' - 5.5'	13.4	55.4	31.5	13.1	Silty GRAVEL with Sand (GM)
▲	TP-4 2.0' - 2.5'	14.9	67.8	25.1	7.1	Poorly Graded GRAVEL with Silt and Sand (GP-GM)

Testing in accordance with ASTM D6913

GEOTECHNICS

GRAIN SIZE DISTRIBUTION

Brush Creek Stream Crossing
Yakima County, Washington

Project No. 22-001-1

Figure A5