60-Lot Subdivision – Nettleson and Cochran
Spokane, WA

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BAI Project Number: H19903 *Date: January 13, 2020*

CONTENTS

EMBEDDED TABLES

ATTACHED FIGURES

CONTEXT

This report presents the results of geotechnical exploration and analysis for stormwater management at the proposed residential housing development. Our work was contracted with Spokane Townhomes, LLC., represented by Konstantin Vasilenko, and coordinated by Mamdouh El-Aarag, PE, of MHE Engineering.

Project Considerations

A 60-lot subdivision is planned in Spokane, Washington. The development will occupy approximately 12.5 acres and the lot sizes will range from 3,700 to 7,400 square feet. Cochran Street and Nettleton Lane will be extended approximately 700 feet towards the south to provide access to the lots. Current plans indicate that the site will be graded such that stormwater runoff from Cochran and Nettleton will be directed towards swales and drywells positioned at the north end of the site. Conversations with the building contractor indicated that stormwater runoff from rooflines will be captured in low-profile, grass swales for each lot. A geotechnical evaluation is necessary to characterize the subsurface conditions and provide recommendations to assist in design.

Location

The site is located at 2500 W. 17th Avenue.. It is bordered by the Fish Lake Trail on the east side, which runs parallel with Highway 195, and the Union Pacific Railway on the west side. The location of the site is illustrated in the *Vicinity Map* and *Site Plan*.

Scope

This geotechnical study involved interpretation of subsurface soil conditions to provide conclusions addressing the suitability of the proposed drainage area for stormwater infiltration and geotechnical parameters required for others to design and construct. We endeavored to conduct these services in accordance with generally accepted geotechnical engineering practices as outlined in the proposal, H19903, dated November 18, 2019. As proposed, the following scope was completed:

- The client marked the areas for utilities and notified locate services.
- Black Rock, LLC. excavated 6 test pits advanced to a maximum depth of 12 feet. A qualified geologist logged the subsurface conditions and collected representative samples of the soils encountered.
- Laboratory testing was conducted of representative soil characteristics including moisture content, pH, organic matter, cation exchange capacity (CEC), and fines percentages.
- Provided a characterization of surface and subsurface conditions relevant to the design of the proposed drainage areas in accordance with *Spokane Regional Stormwater Manual* (SRSM) Geotechnical site characterization (GSC) guidelines. We used the Spokane 200 Method for drywell outflow estimation.
- Soil permeability was analyzed and presented in a summary table. Drywell outflow rates were calculated. Recommendations for sizing infiltration structures are provided in this report.

Construction inherently entails risk and this project is not an exception. The purpose of this study is to reduce risks related to subjects in our scope to levels generally accepted for similar projects designed with the benefit of similar geotechnical study.

ENCOUNTERED CONDITIONS

Geologic Setting and USDA Soil Mapping

Geologic mapping of this area shows Miocene age basalt (*~~M~~wp*) belonging to the Priest Rapids Member of the Wanapum Basalt, Columbia River Basalt Group, overlying Miocene age Latah Formation. Mapping also illustrates areas of Quaternary age glacial flood deposits (*Qfg*) in superposed contact with the *~~M~~wp* and *~~M~~l* units.

The Glacial Lake Missoula Outburst Floods scoured away pre-existing rock and sedimentary formations in many areas while exposing previously buried formations near the margins of developed channels in other areas. The floods resulted in deposition of coarse-grained soil in the consequentially developed channels.

The *~~M~~wp* unit is described as *"Dark gray to black, fine-grained, dense basalt."* (WSDNR, 2004).

The *~~M~~l* unit is described as *"Lacustrine and fluvial deposits of finely laminated siltstone, claystone, and minor sandstone; light gray to yellowish gray and light tan; commonly weathers brownish yellow with stains, spots, and seams of limonite; poorly indurated… easily eroded and commonly blanketed by colluvium, talus, and residual soils."* (WSDNR, 2004).

The *Qfg* unit is described as *"Thick-bedded to massive mixture of boulders, cobbles, pebbles, granules, and sand; contains beds and lenses of sand and silt; gray, yellowish gray, or light brown; poorly to moderately sorted; both matrix and clast supported; locally composed of boulders in a matrix of mostly pebbles and coarse sand; boulders and cobbles consist predominantly of locally derived basalt; found mainly outside of the principal flood channels, which approximate the present courses of the Spokane and Little Spokane Rivers."* (WSDNR, 2004).

Soil types at the site, as mapped by the USDA Web Soil Survey, consist of *Xerolls silt loam, mass wasted, 8 to 25 percent slopes* (unit *7103*) (NRCS 2019). Unit *7103* is rated by the NRCS as hydrologic soil group C, which is characterized by low infiltration rate.

Surface Conditions

The land was undeveloped and moderately to densely vegetated with mature conifers, shrubs, and low-growing grasses and weeds. Overhead and underground utilities were not observed. The surficial soils were consistent with NRCS descriptions. The site generally sloped towards the east and slopes ranged from 7 percent to vertical. The steepest slopes were along the eastern margin of the site adjacent to the Fish Lake Trail (formerly the Union Pacific- Chicago, Milwaukee, St. Paul, and Pacific Railroad). The highest points of elevation were observed along the western margin of the site at 2,024 and 2,028 feet in the south and north, respectively, while the lowest point of elevation was observed in the northeast corner at 1,931 feet.

Slopes appeared generally stable, though Fish Lake Trail was cut into a portion of the east bluff where vertical slopes were observed. The vertical slopes consisted of basalt that may lie on erodible, lacustrine silt and clay. Dislodged basalt pieces were observed adjacent to the trail.

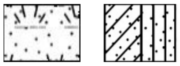
Imported fill material consisting of shot-rock and excavated soil from the existing development to the north was observed at the north end of the site at a maximum thickness of approximately 20 feet.

Subsurface Conditions

Conditions encountered are described in the *Test Pit Logs* in accordance with methods described in *Field Exploration*. The following groups of subsurface materials were differentiated based on characteristics relevant to this project:

surficial soil

Log symbol:



Topsoil consisting of silty sand with organics was encountered in the test pits beginning at the ground surface and extending to depths ranging from 6 to 12 inches below ground surface (BGS). Silty, clayey sand was encountered in test pits 1, 2, and 3 beginning beneath the topsoil and extending to depths ranging from 2 to 4.5 feet BGS. The soils were easily excavated.

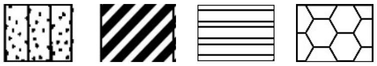
permeable soil

Log symbol

Coarse, permeable sand was encountered in test pits 1, 2, and 6 positioned beneath the *surficial soil* and extended to depths ranging from 6 to greater than 12 feet BGS. The *permeable soil* was least extensive in test pit 1 and most extensive in test pit 6. Fines content ranged from 3.6 to 5.1 percent and the soil was easily dug by the backhoe.

impermeable soil and basalt

Log symbol



Silty sand was encountered in test pit 1 beginning at 6 feet BGS, beneath *permeable soil*, and extended to depths greater than 10 feet BGS. The fines content for one representative sample was 39 percent. The silty sand required maximum effort from the backhoe to dig.

Clay was encountered in test pits 4 and 5 beginning beneath the topsoil and extending to depths greater than 6 feet BGS. The clay transitioned to weakly indurated claystone in test pit 4 at 5 feet BGS. The clay materials also required maximum effort from the backhoe to dig.

Basalt was encountered in test pit 3 beginning at approximately 3 feet BGS where the backhoe met immediate digging refusal.

Surface and Groundwater Hydrology

Surface waters were not observed on site. The nearest surface water was Latah Creek, approximately

1,400 lineal feet towards the northeast with surface water elevations approximately 190 feet lower in elevation than that of the lowest portion of the site.

Groundwater was not encountered in the explorations. A review of local well logs obtained from the Washington State Department of Ecology website indicate groundwater levels beginning at varying depths in the vicinity of the site and illustrate, in most cases, groundwater perched atop basalt. Deeper groundwater is primarily encountered as confined aquifers of basalt flow interbeds within a sequence of rock that extends to depths greater than 300 feet BGS in the vicinity of the site.

CONCLUSIONS

GSC criteria for use of rapid infiltration structures requires the presence of a suitable target soil with high permeability, wide horizontal extent, and suitable thickness above flow boundaries such as rock, impermeable soil horizons, or groundwater. These conditions were encountered in test pits 2 and 6 positioned towards the north end of the site.

Test pit 1, positioned in the northeast corner of the site, revealed *impermeable soil* beginning at 6 feet BGS which qualifies as a flow boundary. The elevation at which the impermeable soil was initially encountered is approximately 4 feet higher in elevation than that of the Fish Lake Trail. Subsurface infiltration of stormwater in this area creates the potential for groundwater to daylight from the hillside as it percolates downward and then moves laterally upon contact with the impermeable soil which could result in ponding of water at the ground surface down gradient. However, discussions with the project engineer and current plans indicate that this area will be filled to meet the proposed grades which will increase the soil thickness above the flow boundary and may reduce the chance for groundwater to daylight.

Test pits 3, 4, and 5 revealed flow boundaries beginning at depths of 3 feet or less BGS.

Although not observed in the test pits, *undocumented fill* was observed on the ground surface at the north end of the site, as previously mentioned in *Surface Conditions*, and is not suitable for infiltration of stormwater. Partial removal and replacement of the *undocumented fill* may be necessary depending upon the positioning of infiltration structures in order to avoid infiltration of stormwater into the *undocumented fill (SMMEW, 2019, Section 5.4.3, Site Suitability Criteria (SSC), SSC-6).*

Provided that suitable thickness above flow boundaries and avoidance of stormwater infiltration into *undocumented fill* can be achieved, we conclude that the north end of the site is suited for the proposed infiltration structures.

The type of drywells used should be limited to single-depth (Type-1) drywells (Spokane City Standard Plan B-102C). The use of double-depth (Type-2) drywells may be feasible in the northwest portion of the site but information of the subsurface conditions at depths greater than that obtained during this scope of work would be necessary to provide design recommendations.

RECOMMENDATIONS

The recommendations presented throughout this chapter are intended to provide economically feasible criteria at normally accepted risk levels. More conservative design parameters can be used if lower risks are preferred. Specifically, the design should incorporate the following recommendations concerning stormwater drainage:

Stormwater Drainage

We recommend grading surfaces to allow positive drainage away from structures and pavements. Roof and roadway runoff should be collected and disposed of such that water is not allowed to accumulate near the structures or pavements.

Due to the extent of the *coarse-grained, permeable soil* encountered in the explorations, we recommend the use of bio-infiltration swales (grassed percolation areas) in conjunction with Type-1 drywells. We recommend the drywells penetrate the *coarse-grained, permeable soil* a minimum of 2 feet.

Representative samples of surficial soils were tested for pH, organic content, and CEC. Results are presented in the *Laboratory Summary*. The SRSM lists criteria for bio-infiltration swale design in Chapter 6.7.1, Table 6-1. The samples were not composite samples and as such represent values for informational purposes to determine initial suitability. Amendments to the existing topsoil may be necessary in order to meet SRSM swale design criteria.

Gradation analysis was used to estimate permeability based on the percent passing the US#200 sieve from representative samples collected from the explorations. The results are summarized in *Table 1*, below.

Table 1. Drywell Design Outflow Rate Analysis

Boring ID	**Sample Depth (ft)**	**Fines (%)**	**Hydraulic Conductivity (in/hr)[1]**	**Normalized Outflow Rate (cfs/ft)[2]**	**Safety Factor[3]**	**Factored Outflow Rate (cfs)[4]**	**Infiltration Feasibility**
						Type-1, H=6	
TP-1	0.5-1	17	4.4	0.011	NS[5]	NS	no
TP-1	2-2.5	5.1	42	0.076	1.5	0.30	yes
TP-1	6.5-7	39	0.93	0.0028	NS	NS	no
TP-2	10-11	3.9	70	0.12	1.3	0.54	yes
TP-6	7-8	3.6	82	0.13	1.3	0.62	yes

1. in/hr – cubic inches per square inch per hour ($in^3/in^2/hr$)
2. cfs/ft - cubic feet per second per foot of active barrel depth
3. Safety Factors from SRSM Table 4A-1
4. cfs - cubic feet per second
5. NS (not suitable for drywell disposal per SRSM)

Typical sizing for Type-1 drywells is 0.3 cubic feet per second. Should a higher infiltration rate become desirable, we recommend full-scale permeability testing of a newly constructed drywell in accordance with methods defined in the SRSM. Drywells can “silt-up” over time and operation and maintenance guidelines in Section 3.3 (*WAUIC*) should be followed. We recommend setting aside sufficient area for eventual replacement.

Additional Services

Effective geotechnical services involve cooperation with the owner, designer, and constructor as follows:

1. Preliminary study to assist in planning and to economically adapt the project to its geologic environment.
2. Exploration and analysis to characterize subsurface conditions and recommend design criteria.
3. Consultation with the designer to adapt the specific design to the site in accordance with the recommendations.
4. Construction observation to verify the conditions encountered and to make recommendations for modifications as necessary.
5. Construction material testing, quality control, and special inspection.

This report satisfies requirements for infiltration design in the proposed swale area. We are eager to provide assistance with design and construction as appropriate to assist in completing a safe and economical project.

FIELD EXPLORATION

The fieldwork was conducted by staff geologist Jason Pritzl and supervised by geotechnical engineer John Finnegan, PE, on December 9, 2019. The field activities generally consisted of the following:

- Reconnaissance of the site and surrounding area;
- Logging subsurface conditions in the test pits;
- Obtaining bulk samples of the soils.

Results are presented in *Figures*.

Test Pits

Test pits were excavated utilizing a CAT 420 backhoe with a 24-inch-wide bucket by Black Rock, LLC. Criteria governing the depth to which test pits were excavated included limits of equipment reach, excessive embankment caving, identification of favorable soil zones, and equipment refusal on very dense soil and/or rock.

Soil Samples

Samples were obtained by capturing representative material from the bucket of the excavator or from within the excavation while less than 4 feet below grade.

Soil and Rock Classification

Field descriptions of soils and rock were completed in accordance with the current version of the Washington State Department of Transportation, Geotechnical Design Manual (GDM), M 46-03, except that fines (silt and clay) were described in accordance with ASTM D 2487. *Whereas, the GDM uses the terms 'silty' and 'clayey' to describe a very broad range of fines from 10 to 49 percent; ASTM D 2487 uses those terms for percentages greater than 12 and the term 'with' for fines ranging from 5 to 12 percent, which is typically necessary to describe variations relevant to soil permeability per the SRSM.* A key to the descriptions is provided in *Guide to Soil and Rock Descriptions.*

Location

Horizontal & vertical control. The *Site Plan* was reproduced from plans provided by the client and is based on measured offsets from existing site features at the time of exploration. Elevations presented on the *Test Pit Logs* were interpreted from topographic information illustrated on the provided plans.

Horizontal and vertical locations can be considered accurate to within 5-foot and 1-foot, respectively, relative to the information provided.

LABORATORY ANALYSIS

Laboratory testing was performed on representative samples of the soils encountered to provide data used in our assessment of soil characteristics.

Tests were conducted, where practical, in accordance with nationally recognized standards (ASTM, AASHTO, etc.), which are intended to model in-situ soil conditions and behavior. The results are presented in *Figures*.

Index Parameters

Moisture content – ASTM D2216. Moisture contents were determined by direct weight proportion (weight of water/weight of dry soil) determined by drying soil samples in an oven until reaching constant weight.

Gradation – ASTM D6913. Gradation analysis was performed by the mechanical sieve method. The mechanical sieve method is utilized to determine particle size distribution based upon the dry weight of sample passing through sieves of varying mesh sizes. The results of gradation are provided on the attached *Grain Size Distribution Results*.

Atterberg Limits – ASTM D4318. Atterberg limits describe the properties of a soil's fine-grained constituents by relating the water content to the soil's limits of engineering behavior. As the water content increases, the state of the soil changes from a brittle solid to a plastic solid and then to a viscous liquid.

The liquid limit (LL) is the water content above which the soil tends to behave as a viscous liquid. Similarly, the plastic limit (PL) is defined as the water content below which the soil tends to behave as a brittle solid. The plasticity index describes the range of water content over which a soil is plastic and is derived by subtracting the PL from the LL. The soil is classified as "non-plastic" if rolling a 1/8-inch bead is not possible at any water content.

Chemical Parameters

Organic Content – AASHTO T-267. Organic content is determined by measuring the weight loss after subjecting an appropriate mass of soil to burning off organic matter in an ignition muffle furnace. The loss is recorded as a percent of the dry soil content.

pH – AASHTO T-289. Certain clayey soils can contain excess acidity that attacks concrete and iron. Corrosive potential of embedded iron and steel can be quantified by determining the pH (acidity = pH <7) and minimum resistivity of soil. Buried conduit, culverts, and reinforcing will deteriorate rapidly under acidic conditions. Cathodic protection is used to protect such components. Neutral pH (7) represents the least corrosive potential with fewer recommended protection measures.

CEC – EPA 9081. Method 9081 is applicable to most soils, including calcareous and non-calcareous soils. The method of determining cation-exchange capacity by summation should be employed for distinctly acid soils. The soil sample is mixed with an excess of sodium acetate solution, resulting in an exchange of the added sodium cations for the matrix cations. The concentration of displaced sodium is then determined by atomic absorption, emission spectroscopy, or an equivalent means. The results are presented as milliequivalents per 100 grams (meq/100g).

LIMITATIONS

The conclusions and recommendations presented herein are based upon the results of field explorations and laboratory testing results. They are predicated upon our understanding of the project, its design, and its location as defined in by the client. We endeavored to conduct this study in accordance with generally accepted geotechnical engineering practices in this area. This report presents our professional interpretation of exploration data developed, which we believe meets the standards of the geotechnical profession in this area; we make no other warranties, express or implied. Attached is a document titled "*Important Information About Your Geotechnical Engineering Report*," which we recommend you review carefully to better understand the context within which these services were completed.

Unless test locations are specified by others or limited by accessibility, the scope of analysis is intended to develop data from a representative portion of the site. However, the areas tested are discreet. Interpolation between these discreet locations is made for illustrative purposes only but should be expected to vary. If a greater level of detail is desired, the client should request an increased scope of exploration.

REFERENCES

ASTM International, 2011, Standard Practice for Classification of Soils for Engineering Purposes, D 2487-11.

Natural Resources Conservation Service (NRCS), United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

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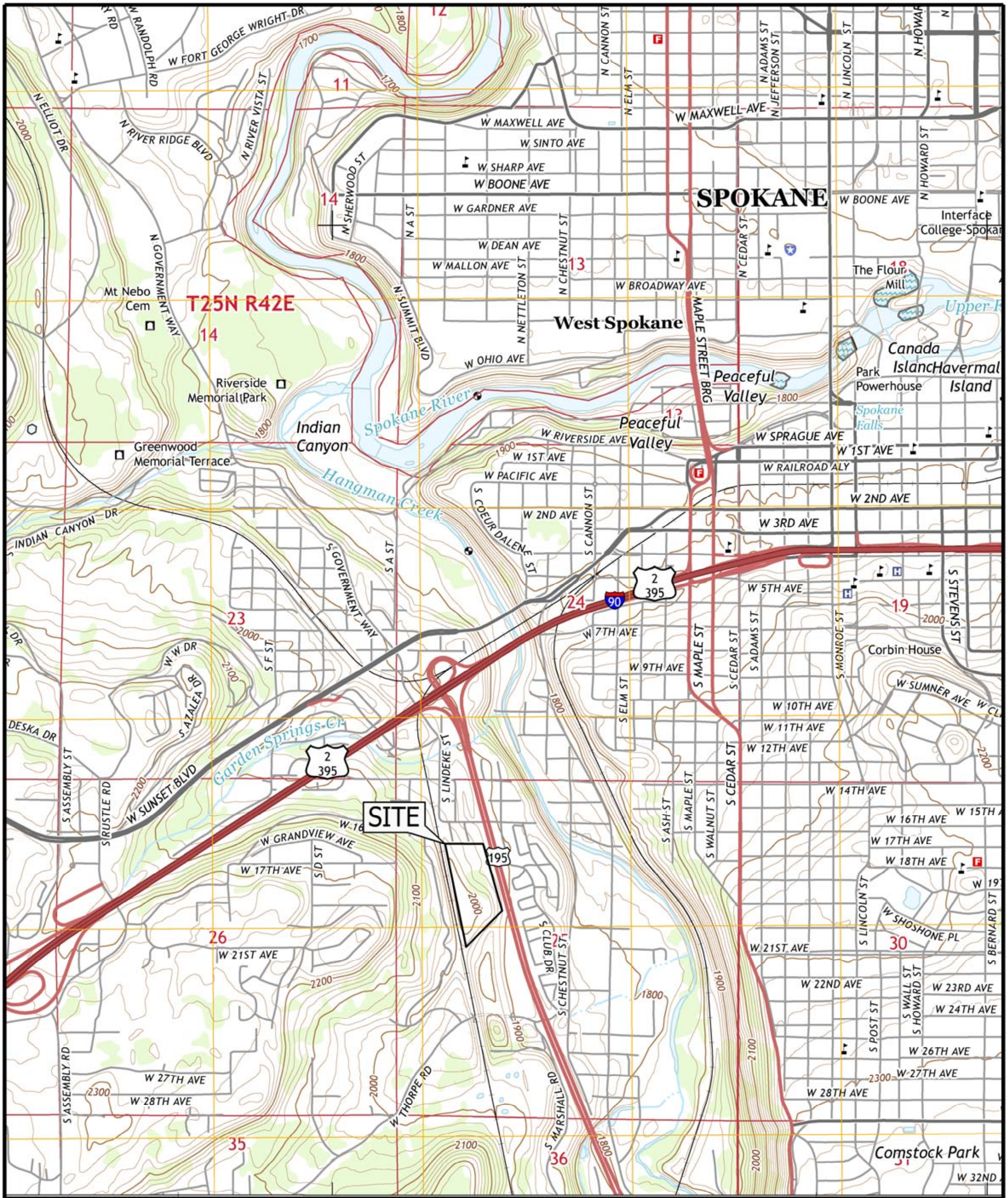

N

SCALE: 1"=2000'

0 1000 2000

SECTION 25
T25N R42E
SPOKANE NW, WA
USGS 2014

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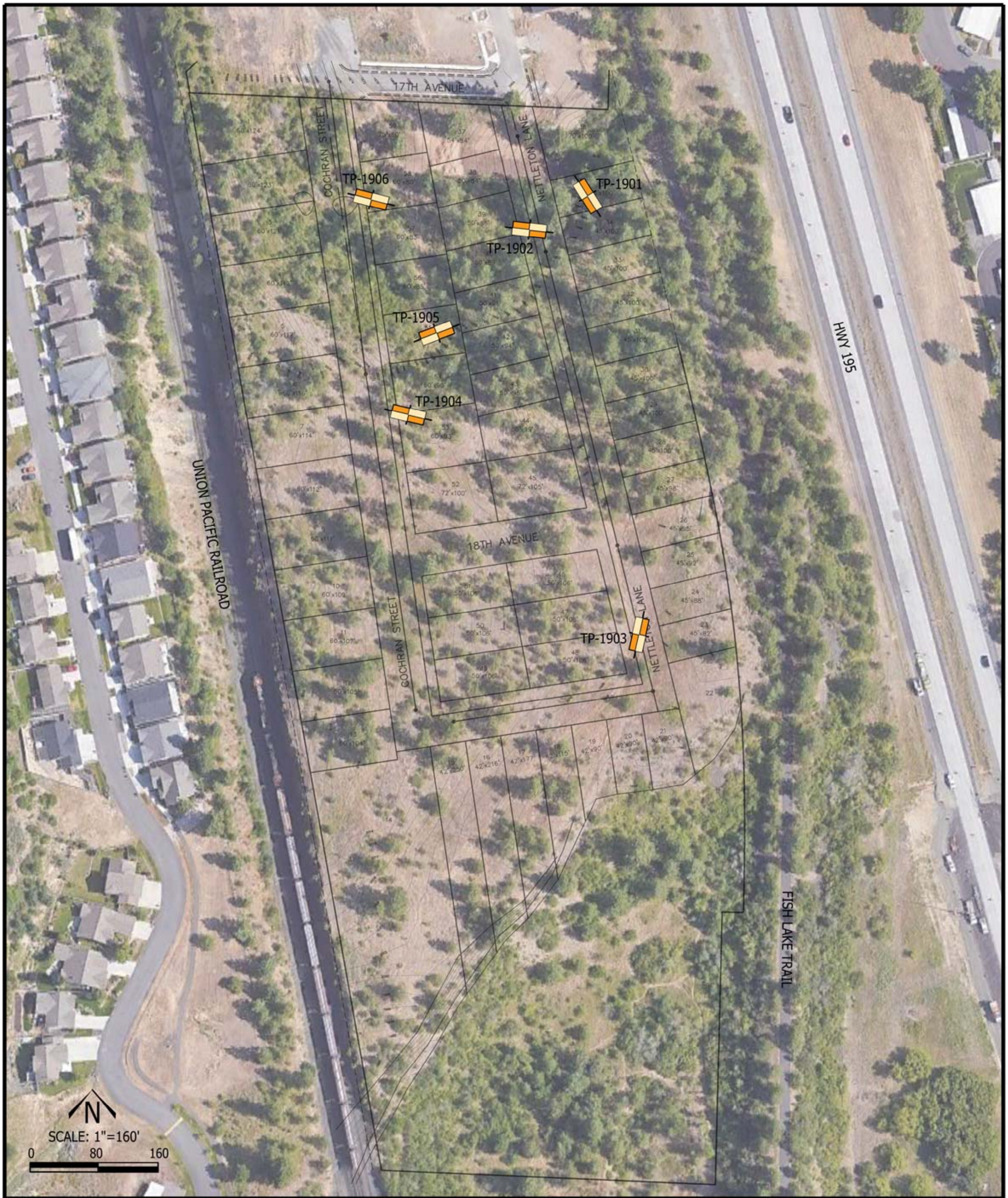
VICINITY MAP

60-LOT SUBDIVISION - NETTLETON & COCHRAN
SPOKANE, WASHINGTON

FIGURE 1

PROJECT NUMBER H19903

DATE: 12/2019



TEST PIT LOCATION (TP-1901)

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SITE PLAN

60-LOT SUBDIVISION - NETTLETON & COCHRAN
SPOKANE, WASHINGTON

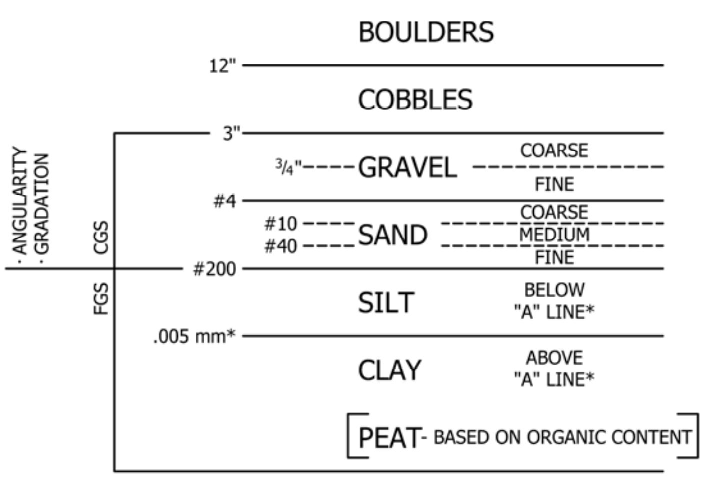
FIGURE 2

PROJECT NUMBER H19903

DATE: 12/2019

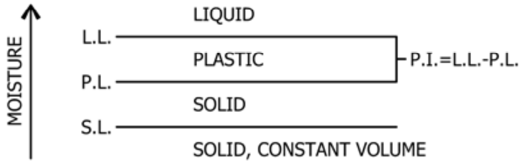
GUIDE TO SOIL & ROCK DESCRIPTIONS

SOIL CLASSIFICATION

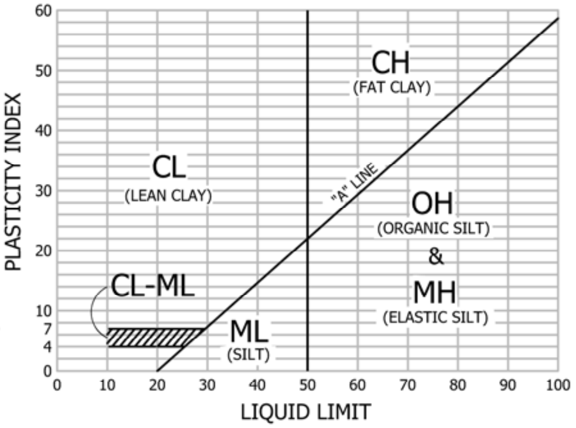


** SEE PLASTICITY CHART*
CGS - COARSE GRAINED SOIL - MORE THAN 50% RETAINED ON A #200 SIEVE
FGS - FINE GRAINED SOIL - 50% MORE PASSES, #200 SIEVE
FINES - PORTION FINER THAN #200 SIEVE

ATTERBERG LIMITS



PLASTICITY CHART



NOTE - CHART APPLIES TO FGS AND MINUS #40 SIEVE FRACTION OF CGS

GUIDE TO SOIL DESCRIPTION MODIFIERS, MOISTURE, AND CONDITION PRESENTED ON LOGS

MODIFIER	ESTIMATED PERCENTAGE OF MATERIAL
SUFFIX "LY" OR "Y".....................	30% OR MORE FOR COARSE PARTS IN FGS GREATER THAN 12% FOR FINES IN CGS
WITH	15% - 29% FOR COARSE PARTS IN FGS 6% - 14% FOR FINES IN CGS

NOTE - VISUAL ESTIMATES OF MATERIAL PERCENTAGES TYPICALLY VARY 0 TO 10% FROM THOSE DETERMINED BY LABORATORY TESTING.

MOISTURE
- DRY
- MOIST
- SATURATED OR WET

SOIL CONDITION
- CGS:
  - VERY LOOSE
  - LOOSE
  - MEDIUM DENSE
  - DENSE
  - VERY DENSE
- FGS:
  - VERY SOFT
  - SOFT
  - MEDIUM STIFF
  - STIFF
  - VERY STIFF
  - HARD

SAMPLES

◩	STANDARD 2" PENETRATION TEST SAMPLER WITH BLOWS PER FOOT
■	3" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT
□	DRILL CUTTING SAMPLE
▨	BULK SAMPLE
⧖	THIN-WALLED TUBE SAMPLE
⊥	DIAMOND CORE RUN WITH % RECOVERY & ROCK QUALITY DESIGNATION
⊠	2.5" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT
▧	CONTINUOUS SOIL SAMPLE
R	REFUSAL OF SAMPLE (50+ BLOWS PER 6")

ROCK WEATHERING
- FRESH
- SLIGHTLY WEATHERED
- MODERATELY WEATHERED
- HIGHLY WEATHERED
- COMPLETELY WEATHERED
- RESIDUAL SOIL

ROCK CONDITION
- EXTREMELY WEAK
- VERY WEAK
- MODERATELY WEAK
- MODERATELY STRONG
- STRONG
- VERY STRONG

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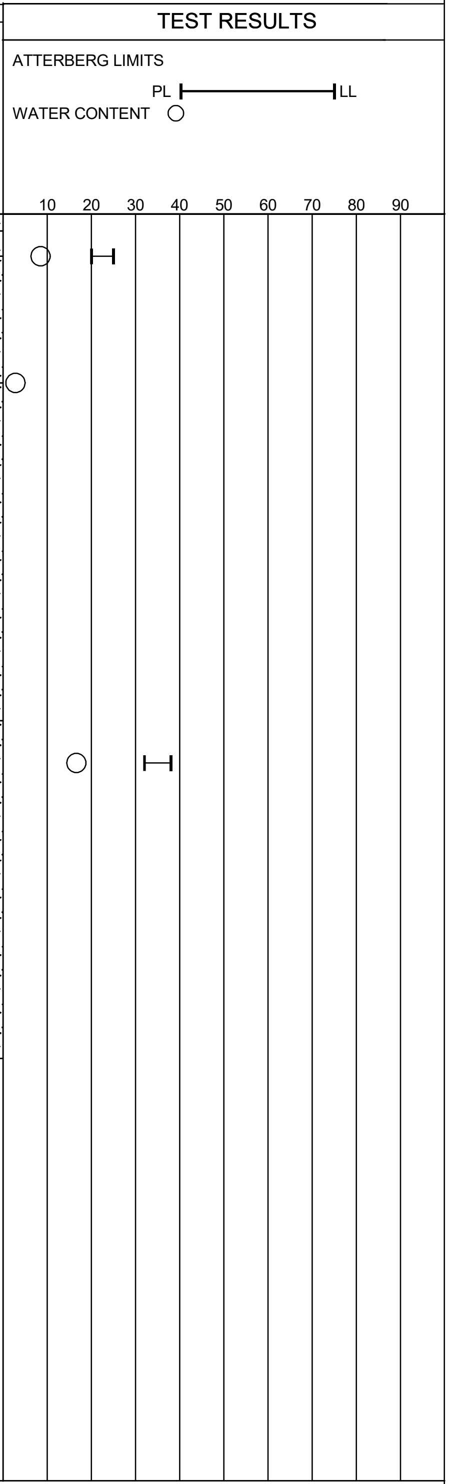
FIGURE 3

TEST PIT 1901

Date: 12-9-19
Excavator: Black Rock, LLC.
Equipment: CAT 420 Backhoe
Location: Proposed Lot 35 - center
Surface: pine needles and grass

Elevation: 1940 ft
Logged by: J. Pritzl
Size of hole: 3 X 9 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		slightly moist, dark brown	SILTY SAND with organics, small roots (TOPSOIL)	
		slightly moist, medium brown	SILTY, CLAYEY SAND, coarse to medium, angular to subrounded, slightly micaceous	
		dry, light brown	SAND, coarse to medium, angular to subrounded, micaceous	
5				
		dry, light orangish-yellowish brown	SILTY SAND, medium to fine, angular, micaceous (not easily dug by backhoe)	
10		no free groundwater observed	End of Excavation @ 10 ft	
15				



TEST PIT LOGS

FIGURE 4-1

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1101 North Fancher Road
Spokane Valley, WA 99212

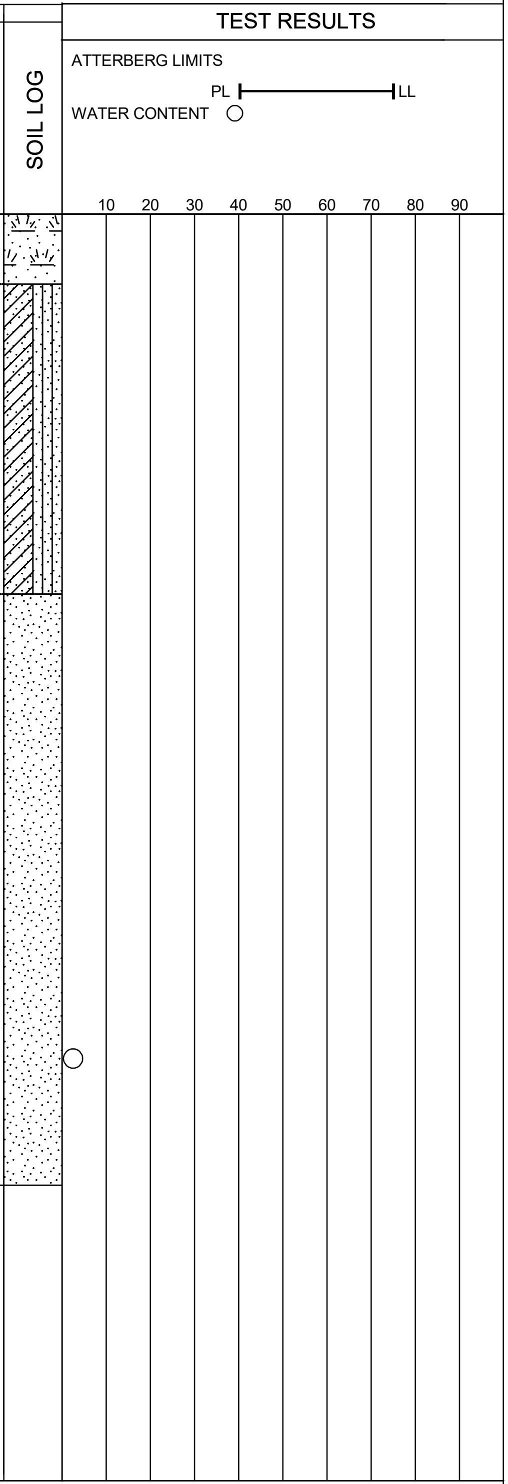
Project: 60-Lot Subdivision - Nettleton & Cochran
Location: Spokane, WA
Number: H19903

TEST PIT 1902

Date: 12-9-19
Excavator: Black Rock, LLC.
Equipment: CAT 420 Backhoe
Location: Southeast corner of Proposed Lot 39
Surface: pine needles and grass

Elevation: 1947 ft
Logged by: J. Pritzl
Size of hole: 3 X 11 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION
0	▨	slightly moist, dark brown	SILTY SAND with organics, small roots (TOPSOIL)
		slightly moist, light brown	SILTY, CLAYEY SAND with Gravel and Cobbles, angular to subrounded
5 10	▨ ▨	dry, gray	SAND, coarse to medium, angular to subrounded, slightly micaceous
15		no free groundwater observed	(digging refusal on large boulder) End of Excavation @ 11.5 ft



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TEST PIT LOGS

FIGURE 4-2

Project: 60-Lot Subdivision - Nettleton & Cochran
Location: Spokane, WA
Number: H19903

TEST PIT 1903

Date: 12-9-19
Excavator: Black Rock, LLC.
Equipment: CAT 420 Backhoe
Location: Proposed Nettleton Lane - east side of Proposed Lot 48
Surface: pine needles and grass

Elevation: 1996 ft
Logged by: J. Pritzl
Size of hole: 3 X 13 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS
0		slightly moist, dark brown	SILTY SAND with Cobbles and organics, small roots (TOPSOIL)		
		slightly moist, light brown	SILTY, CLAYEY SAND, coarse to fine		
		dark bluish gray	Basalt, slightly weathered		
		no free groundwater observed	(digging refusal on Basalt) End of Excavation @ 3 ft		
5					
10					
15					

TEST RESULTS

ATTERBERG LIMITS

PL ├──┤ LL

WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS

FIGURE 4-3

Project: 60-Lot Subdivision - Nettleton & Cochran

Location: Spokane, WA

Number: H19903

TEST PIT 1904

Date: 12-9-19
Excavator: Black Rock, LLC.
Equipment: CAT 420 Backhoe
Location: Northwest corner of Proposed Lot 53
Surface: pine needles and grass

Elevation: 1998 ft
Logged by: J. Pritzl
Size of hole: 3 X 8 feet

TEST RESULTS
ATTERBERG LIMITS
PL ⊢—⊣ LL
WATER CONTENT ○
10 20 30 40 50 60 70 80 90

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		slightly moist, dark brown	SILTY SAND with organics, small roots (TOPSOIL)	░
	▨	dry, dark bluish gray	CLAY, very thinly laminated	▨
5	▨	light gray	CLAYSTONE, poorly to moderately indurated (very hard to dig with backhoe)	▤
		no free groundwater observed	End of Excavation @ 6 ft	
10				
15				

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TEST PIT LOGS

FIGURE 4-4

Project: 60-Lot Subdivision - Nettleton & Cochran

Location: Spokane, WA

Number: H19903

TEST PIT 1905

Date: 12-9-19
Excavator: Black Rock, LLC.
Equipment: CAT 420 Backhoe
Location: Proposed Lot 55 - center
Surface: pine needles and grass

Elevation: 1982 ft
Logged by: J. Pritzl
Size of hole: 3 X 8 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		slightly moist, dark brown	SILTY SAND with organics, small roots (TOPSOIL)	⁘
		dry, orangish yellow	CLAY, exhibits very fine laminates (requires extra digging effort of backhoe)	▨
5				
		no free groundwater observed	End of Excavation @ 6 ft	
10				
15				

TEST RESULTS

ATTERBERG LIMITS

PL ⊢——⊣ LL

WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE 4-5**

Project: 60-Lot Subdivision - Nettleton & Cochran

Location: Spokane, WA

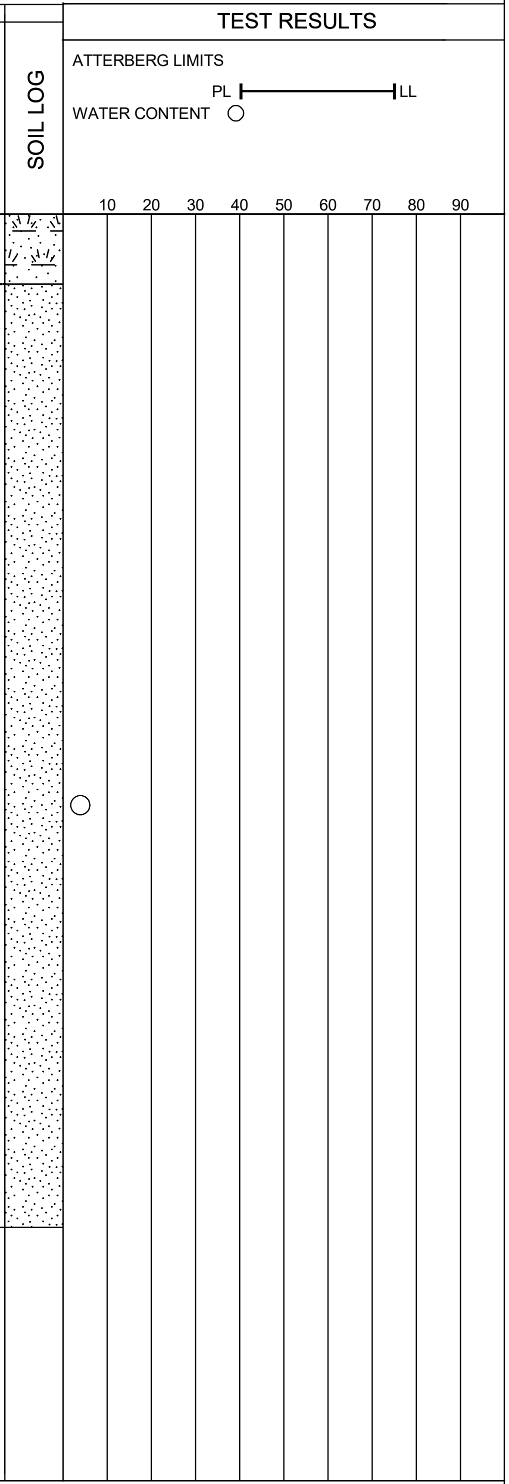
Number: H19903

TEST PIT 1906

Date: 12-9-19
Excavator: Black Rock, LLC.
Equipment: CAT 420 Backhoe
Location: Southwest corner of Proposed Lot 58
Surface: pine needles and grass

Elevation: 1979 ft
Logged by: J. Pritzl
Size of hole: 5 X 12 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION
0		slightly moist, dark brown	SILTY SAND with organics, small roots (TOPSOIL)
		dry, orangish brown	SAND, coarse to medium, angular to subrounded, micaceous
	▨		
5		gray	becoming more coarse-grained
	▨		
10			
		no free groundwater observed	End of Excavation @ 12 ft
15			



TEST PIT LOGS

FIGURE 4-6

Project: 60-Lot Subdivision - Nettleton & Cochran
Location: Spokane, WA
Number: H19903

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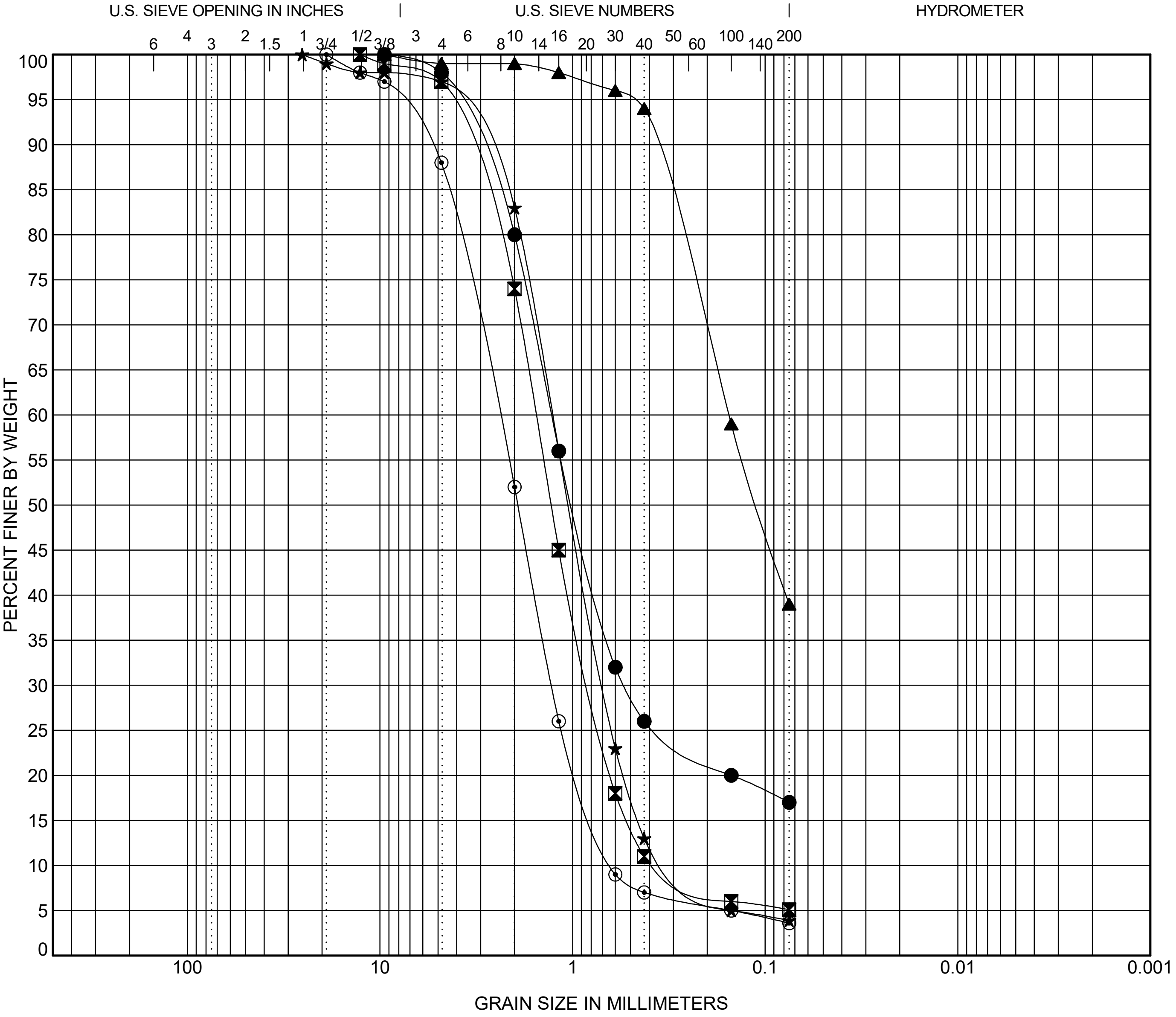
SOIL MECHANICS
LABORATORY SUMMARY

		Units	Test Methods							
LABORATORY NUMBER				19-5654	19-5655	19-5656	19-5657	19-5658	19-5659	19-5660
BORING NUMBER				TP-1901	TP-1902	TP-1901	TP-1901	TP-1902	TP-1906	TP-1901
DEPTH	TOP	feet		0	0	1/2	2	10	7	6 1/2
	BOTTOM	feet		1/2	1/2	1	2 1/2	11	8	7
STRATUM				*surficial soil*			*permeable soil*			*imp soil**
MOISTURE CONTENT		%	ASTM D2216			8.5	2.8	2.5	3.9	16.6
pH			AASHTO T289	5.5	6.1					
CATION EXCHANGE CAPACITY		meq/100g	EPA 9081	12.7	15.9					
ORGANIC CONTENT		%	AASHTO T267	3.1	4.0					
LIQUID LIMIT		%	ASTM D4318			25				38
PLASTIC LIMIT		%				20				32
PLASTICITY INDEX		%				5				6
UNIFIED CLASSIFICATION			ASTM D2487			SC-SM	SP-SM	SP	SP	SM
SIEVE ANALYSIS			ASTM D6913							
	3"									
	1 1/2"									
S	1"	%						100		
I	3/4"							99	100	
E	1/2"	P					100	98	98	
V	3/8"	A				100	99	98	97	100
E	#4	S				98	97	97	88	99
	#10	S				80	74	83	52	99
S	#16	I				56	45	56	26	98
I	#30	N				32	18	23	9	96
Z	#40	G				26	11	13	7	94
E	#100					20	6	5	5	59
	#200					17	5.1	3.9	3.6	39

imp soil = impermeable soil

Figure 5



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**1901**	**0.5**	**SILTY, CLAYEY SAND(SC-SM)**	**25**	**20**	**5**		
⧗	**1901**	**2.0**					**1.23**	**4.49**
▲	**1901**	**6.5**	**SILTY SAND(SM)**	**38**	**32**	**6**		
★	**1902**	**10.0**	**POORLY GRADED SAND(SP)**				**1.31**	**4.44**
⊙	**1906**	**7.0**	**POORLY GRADED SAND(SP)**				**1.08**	**3.89**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**1901**	**0.5**	**9.5**	**1.288**	**0.535**		**2.2**	**80.8**	**17.0**	
⧗	**1901**	**2.0**	**12.7**	**1.55**	**0.81**	**0.345**	**3.3**	**91.6**	**5.1**	
▲	**1901**	**6.5**	**9.5**	**0.155**			**1.0**	**60.0**	**39.0**	
★	**1902**	**10.0**	**25.4**	**1.276**	**0.693**	**0.288**	**3.2**	**92.9**	**3.9**	
⊙	**1906**	**7.0**	**19**	**2.43**	**1.28**	**0.624**	**12.4**	**84.0**	**3.6**	

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GRAIN SIZE DISTRIBUTION

Project: 60-Lot Subdivision - Nettleton & Cochran

Location: Spokane, WA

Number: H19903

Figure 6

GRAINSIZE WO FIGURE # H19903.GPJ BUDINGER.GDT 12/27/19

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GBC GEOTECHNICAL BUSINESS COUNCIL
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