Geotechnical Engineering Report

1230 W. Cora
Spokane, WA

Prepared for:

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10/4/19

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Budinger
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BAI Project Number: S19202

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CONTEXT

This report presents the results of geotechnical exploration and analysis for the development of the proposed apartment complex. Our work was contracted with Legacy Properties Spokane, LLC., represented by Eline Helm, Co-Manager, and coordinated by Bowie McCanna, P.E.

Project Considerations

Residential development is proposed at the northwest corner of the intersection between N. Jefferson Street and W. Cora Avenue in Spokane, WA. The site is bisected by Cora towards the center and the northern portion consists of slopes ranging from 30 to 60 percent. As such, a geohazards evaluation is warranted. The proposed structures include up to 4-story, single-family homes positioned along the northern slope, provided that zoning requirements are met. The estimated average daily traffic (ADT) is 123 vehicles. A geotechnical evaluation is necessary to characterize the subsurface conditions and provide recommendations to assist in design.

Location

The address currently associated with the site is 1230 W. Cora Avenue. The site consists of parcels 35063.2601, .2816, .2823, .2822, and .2817. 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 site to support proposed structures and provide 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, S19202, dated July 31, 2019. As proposed, the following scope was completed:

1. Explored subsurface conditions with 2 test borings and 5 test pits;
2. Conducted limited laboratory testing on representative soil samples, including moisture content, pH, Atterberg Limits, and gradation;
3. Characterized the subsurface conditions encountered including:
    - Layering (stratification);
    - Relative density;
    - Soil strength and compressibility;
    - Soil texture and classification;
    - Risks from expansive and fill soils;
    - Soil moisture, capillarity, and groundwater; and,
    - Seismic considerations.
4. Prepared calculations of bearing capacity, settlement, earth pressures, pavement thickness, and stormwater infiltration. Prepared this report presenting the exploration results along with conclusions and recommendations addressing:
    - Site surface preparations, fill placement, and materials;
    - Slope inclinations for temporary and permanent conditions;

- Discussion of foundation types and foundation considerations;
- Recommended bearing strata and sizing parameters;
- Estimated settlements including total and differential;
- Seismic design parameters including Site Class and liquefaction susceptibility;
- Drainage considerations including recommended drywell sizing criteria; and,
- Corrosion potential.

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 shows Pleistocene age glacial flood-channel deposits (*Qfcg*) underlying the site. During the last period of glaciation, repeated occurrences of large-scale and widespread flooding, resulting from rapid drainage of Glacial Lake Missoula, inundated and reshaped the landscape in the Spokane area. The floods scoured away pre-existing rock and sedimentary formations in the Spokane River channel and deposited coarse-grained sediments; ultimately leading to the formation of the Spokane Valley-Rathdrum Prairie Aquifer.

The *Qfcg* unit is described as *"Thick-bedded to massive mixture of boulders, cobbles, pebbles, granules, and sand; may contain beds and lenses of sand and silt. This unit differs from unit Qfg in that it fills the deep, ancestral channel of the Spokane River, which now forms the Spokane Valley–Rathdrum Prairie aquifer. The flood deposits filling the channels are known to be several hundred feet thick. Boundaries between this unit and unit Qfg are based on location of these channels rather than clast-size differences"* (WSDNR, 2004).

Soil types at the site, as mapped by the USDA Web Soil Survey, consist of unit 3143, *"Spens very gravelly loamy coarse sand, 30 to 65 percent slopes"* (NRCS, 2019). Unit 3143 is listed as hydrologic soil group A which is defined as *"Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission."* The reported saturated hydraulic conductivity for unit 3143 is approximately 60 inches per hour.

The NRCS rates the Erosion Factor Kw (whole soil) for unit 3143 at 0.05. *Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.*

The encountered surficial soils were consistent with NRCS descriptions.

Surface Conditions

The site consisted primarily of undeveloped land. The ground surface was covered with low-growing vegetation and sparsely populated by mature conifers. Various forms of anthropogenic debris were observed throughout the surface of the site and heavily concentrated in some areas. Evidence of fill material was observed at the ground surface towards the center of the site in the form of multiple, 3 to 5-foot tall piles of soil.

An existing retaining wall composed of small boulders was positioned towards the northeast corner of the site and appeared to be in good condition. The wall was approximately 12 feet high towards the center and 100 feet long, tapering into the ground surface at each end.

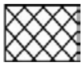
The ground surface generally sloped towards the south. Slopes in the northern portion of the site ranged from approximately 30 to 60 percent with the steepest slopes occurring adjacent to the existing retaining wall. Slopes in the southern portion were much more gradual, averaging approximately 8 percent. Signs of soil instability or substantial erosion were not observed although thick vegetation obscured our view of the surface soils in most places.

Subsurface Conditions

Conditions encountered in the explorations are described in the *Test Boring* and *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:

undocumented fill

Log symbol:



Fill soil consisting of sand with varying amounts of silt, gravel, and anthropogenic debris (brick, metal, wood) was encountered in test boring 2 (B-2) and test pits 3 (TP-3) and 4 beginning at the ground surface and extended to a maximum depth of 1 foot below ground surface (BGS). Although not observed in the explorations, additional *undocumented fill* was observed at the ground surface as described in *Surface Conditions*.

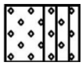
gravel

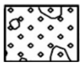
Log symbol

Coarse gravel with cobbles and boulders was encountered in B-1 and TP-7 beginning at the ground surface and extended to depths of 11 and 5 feet BGS, respectively. The condition was loose to medium dense. Dynamic cone penetrometer (DCP) tests met refusal at approximately 2 feet BGS in TP-7 however, the presence of coarse soil particles affected advancement of the probe and tended to overstate the relative density of the soil. The *gravel* was not observed in other explorations and appeared to be colluvium (material transported downslope by gravity) of a superposed formation.

sand

Log symbol





Sand with gravel was encountered in B-1 and TP-7 beginning below the *gravel* and extended to depths greater than 25 feet BGS. The condition was medium dense and the fines content for one representative sample tested was 5.4 percent.

Explorations B-2, TP-3, TP-4, TP-5, and TP-6 encountered sand with varying amounts of silt and gravel beginning at the ground surface and extended to depths greater than 25 feet BGS. The condition was generally medium dense although intermittent loose zones were encountered at depths of up to 5 feet BGS. The fines content ranged from 5.3 to 17 percent with the highest fines percentages observed in TP-4. The *sand* appeared to be stratified with alternating sequences of clean and silty sand but appeared to consist chiefly of clean, coarse material. B-2 encountered clean, coarse sand extending from 16 to beyond 25 feet BGS.

Surface and Groundwater Hydrology

Surface waters were not observed. The right bank of the Spokane River is observable approximately 1 lineal mile to the southwest. The surface water elevation at this reach of the river is approximately 1,680 feet and greater than 200 feet lower in elevation than that of the southern portion of the site. Groundwater was not encountered during explorations. A review of local groundwater levels (Campbell, 2005) indicate groundwater levels beginning at depths greater than 140 feet BGS in the vicinity of the site.

GEOLOGIC HAZARDS

Spokane County's Critical Areas Ordinance (CAO) requires evaluation of geologically hazardous areas, principally erosion and landslide hazards (Section 11.20.030 Table A, and 11.20.070 d.2). The purpose of the ordinance is to discourage development in geologically hazardous areas unless proponents demonstrate that such areas can be developed consistent to acceptable standards for public health and safety. The following characteristics define geo-hazard areas:

- Slopes of 30 percent or greater;
- Natural Resource Conservation Service severe potential for soil erosion, per criteria;
- Hydraulic factors such as existing on-site surface and groundwater that create a severe potential for erosion or landslide hazard;
- Areas historically prone to land sliding or with one of the following geologic formations: alluvium, landslide deposits, Latah Formation;
- Areas of uncompacted fill; or,
- Areas that are unstable as a result of rapid stream or stream bank erosion.

Reconnaissance of the site revealed that slopes greater than 30 percent are present. Evidence of other characteristics that define geo-hazard areas per the CAO were not observed.

The slopes appeared to be stable as evidence of hillside failure (slumps, scarps, separation fissures) and excessive soil erosion were not observed. The explorations revealed that the subsurface soil profile is continuous and comprised of coarse-grained materials of low susceptibility to erosion. Inclined rock strata, impermeable soil zones, and shallow groundwater that would otherwise compromise slope stability were not encountered in the deep explorations.

CONCLUSIONS

Based on the encountered conditions described above, we conclude that the site is suited for the proposed development, provided that loose soil is treated properly.

Although not observed in the explorations, additional *undocumented fill* consisting of sand and gravel with variably mixed characteristics was observed on-site at thicknesses ranging from 3 to 5 feet and may pose risks to foundations with respect to subsidence and differential settlement. Due to the minimal extent and position of which the *undocumented fill* was observed, removal during preliminary grading activities is likely the most expedient way to mitigate hazards associated with constructing upon *undocumented fill*.

The *sand* was encountered in a loose to medium dense condition and may pose a subsidence as well as total and differential settlement hazard to foundations. Hazards to foundations can be mitigated by over-excavating the proposed footing depths by a minimum of 4 feet, densifying the subgrade soil with an excavator-attached wheel roller, then replacing the over-excavated material with compacted structural fill where proposed footing elevations are positioned within loose *sand*. Risk to pavement and slabs can likely be mitigated by proof-rolling with a large (18-ton or larger) roller.

Coarse, permeable *sand* is present in the subsurface profile and is suitable for conventional stormwater disposal systems such as drywells in conjunction with biofiltration swales (grass-lined percolation areas). Imported soil for lining swales that meets *Spokane Regional Stormwater Manual* (SRSM) swale design criteria (Table 6-1) will likely be needed.

Conventional soil retaining structures designed by a licensed engineer will be of adequate support in areas requiring substantial cut and fill to mitigate hazards related to steep slopes.

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 earthwork, foundations, floor slabs, pavement, and drainage.

Seismic Considerations

The recommended seismic site class designation is Site Class D, "*stiff soil*." Spectral response acceleration parameters, adjusted for Site Class D, were calculated using USGS, U.S. Seismic Design Web Services through the Applied Technology Council website (ATC, 2019). The values of predicted earthquake ground motion for short period structural elements (0.2 second spectral response acceleration, Ss) and for long period structural elements (1.0 second spectral response acceleration, S1) are provided in the table below. The design parameters (SDS and SD1) are equal to ⅔ of the maximum earthquake spectral response accelerations (SMS and SM1).

Peak ground acceleration equals 0.144g. Due to the presence of coarse-grained soil and deep groundwater levels, the liquefaction potential is very low.

Table 1. Seismic Design Parameters

Site Class	Latitude	Longitude	Ss	S_1	S_{DS}	S_{D1}
D	47.69 N	-117.43 W	0.333g	0.115g	0.340g	0.180g

Earthwork

Excavation. Existing fill is undocumented. We recommend mitigating the potential hazard as described in *Conclusions.*

Slopes. Permanent cut and fill slopes should be no steeper than 2 horizontal:1 vertical (2H;1V) unless evaluated by a geotechnical engineer on a case by case basis. Slopes with flatter inclinations will be easier to vegetate and maintain. Slopes of 3H:1V or flatter should be used for swale embankments.

Consider the soils Type C materials when applying OSHA Regulations for which the maximum temporary slope inclination is 1½ horizontal:1 vertical (1½H:1V).

Preparation of surfaces to receive fill. Excavate surfaces to receive fill and backfill to nearly level (8 percent maximum slope), scarify, moisture-condition, if necessary, and compact surfaces to receive fill to at least 92 percent of maximum dry unit weight.

Compact the subgrade with at least 6 passes of a large (18-ton minimum) vibrating pad-foot roller such as a Caterpillar CP68B. Compaction should include scarifying, such as by ripping with a dozer; moisture-conditioning, if necessary, to within approximately 2 percent of optimum moisture, and compacting to 92 percent of maximum unit weight. If soft areas are encountered, over-excavation and replacement may be required.

Protection of subgrade. Following compaction of subgrade, protect surfaces from degradation during inclement weather. Protection measures include erosion control maintenance, preventing tracking soil and rock offsite, and preventing driving on wet subgrade soil. Prevent frost penetration in freezing weather by placing a temporary insulating layer of soil on top, such as overnight.

Fill material. The soils produced during excavations will likely be appropriate for re-use as structural fill provided that unsuitable materials and oversize particles, if encountered, are removed. Excavated soil should be evaluated by the geotechnical engineer prior to re-use.

Naturally occurring pit run gravel meeting WSDOT Gravel Borrow specification is acceptable for additional imported structural fill.

Fill Placement. Place fill in lifts of thickness suited to the compaction equipment, after moisture conditioning where necessary to near optimum moisture content, and compact to at least 92 percent of maximum dry unit weight. Determine maximum dry unit weight and optimum moisture contents for fill material in accordance with the Modified Proctor Method (ASTM D-1557).

Verification and application. These earthwork recommendations apply to structural fill, backfill against footings, and backfill of utility trenches. Retain a qualified earthwork technician present during fill and backfill operations to observe and test each lift of fill. Frequency of testing should be 2 tests per 2,000 square feet or fraction thereof per lift. A representative of the Geotechnical Engineer is best suited to provide such testing.

Foundations

Estimated structural loads were not provided at the time of this report. We recommend founding the proposed structure on continuous footings bearing in the *sand* or on approved structural fill after mitigating risk from the loose soil condition as previously described. Do not bear foundations loose sand. Either extend footings below it or remove and replace it with compacted structural fill following procedures defined in *Conclusions* and *Earthwork*.

Estimated maximum total and differential settlement are 1 inch and 1/2-inch, respectively, based on maximum bearing pressure as described above and anticipated maximum loads.

Floor Slabs

Moisture protection for floor slabs with moisture sensitive covering is recommended. A product designed as a durable and impermeable under-slab “moisture barrier” such as Stego Wrap should be used for moisture protection.

Protection of slabs and floor coverings from moisture can be further improved by installing a course of open-graded gravel (OGG) such as *Permeable Ballast* (*WSDOT 9-03.9(2)*) at least 6 inches thick below the slab to break the capillary potential of water in the pore space of soils and aggregates. The combination of a durable, impermeable membrane and OGG provides the best means of slab moisture control, in our opinion. We recommend designing the OGG for slab moisture protection to also serve as a drainage layer. Building code requires radon protection, which can be incorporated into the OGG layer.

Backfill adjacent to footings and underlying utility excavations in accordance with the recommendations described in *Earthwork* to provide uniform slab support.

Earth Pressures and Lateral Resistance

The recommended equivalent fluid pressures for wall design are 35 pounds per square foot per foot of height (pcf). For the at rest case, use 55 pcf and 400 pcf for the passive case. The recommended earth to concrete friction factor is 0.42.

These values are based on properly compacted backfill and will be substantially reduced when unit weights are less than those recommended in Earthwork. Values anticipate horizontal surfaces above and below shoring walls and drained conditions. Apply appropriate safety factors in design, as values provided are un-factored.

Flexible Pavement

ADT information was provided by the Client. If traffic information is updated, we should be contacted to re-evaluate pavement sections.

Factors considered in the recommended pavement section include the following:

- Maximum ADT equals 123.
- 8 percent of ADT as trucks is added to account for truck traffic (delivery trucks, moving vans, garbage trucks, etc.).

Based upon the above considerations, the recommended section for drive isles (DI) is 3 inches hot mix asphalt (HMA) over 6 inches CSTC over subgrade compacted to 95 percent of maximum dry unit weight at a minimum depth of 8 inches at as summarized in *Table 2*. For parking areas (PA), the recommended section is 2.5 inches HMA over 6 inches CSTC over 8 inches compacted subgrade.

Table 2: Pavement Thickness Summary – non FDR/C

Thickness	Material	Compaction
DI: 3 inches PA: 2.5 inches	HMA	92% TM
6 inches	CSTC	95% MP
	Native Subgrade top 8 inches	95% MP

TM = Theoretical Maximum Unit Weight
MP = Modified Proctor *(AASHTO T-180)*

Recommended pavement materials are summarized in Table 3, below.

Table 3: Recommended Pavement Materials

Material	Specification
HMA	*Washington State Department of Transportation (WSDOT) Standard Specifications Section 9-03.8(6).*
CSTC	*WSDOT Standard Specifications Section 9-03.9(3)*
Subgrade	Native soils or embankment fill, improved by compaction

Stormwater Drainage

Gradation analysis was used to estimate permeability based on the fines percentages from representative samples in accordance with the SRSM, *Appendix 4A – Spokane 200 Method*. The results are summarized in the table below.

Table 4. Drywell Design Outflow Rate Analysis

Test Pit 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
						Single Depth H=6	Double Depth H=10	
B-1	14-15.5	5.4	38	0.069	1.5	0.28	0.46	yes
B-2	9-11	5.3	40	0.072	1.5	0.29	0.48	yes
B-2	19-20.5	2.2	206	0.30	1.3	1.4	2.3	yes
TP-4	8-9	17	4.4	0.011	NA[5]	NA	NA	no
TP-5	5-6	8.7	16	0.032	2.3	0.080	0.14	limited
TP-7	2-3	5.1	42	0.076	1.5	0.30	0.51	yes

1. in/hr - inches per hour ($in^3/in^2/hr$)
2. cfs/ft - cubic feet per second per foot
3. Safety Factors from SRSM Table 4A-1
4. cfs - cubic feet per second
5. NA – not suitable for drywell disposal per SRSM design criteria

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

We recommend sizing single and double-depth drywells at maximum design outflow rates of 0.2 and 0.4 cfs, respectively. Should higher infiltration rates become desirable, we recommend full-scale permeability testing of newly constructed drywells 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 Item 2 of the 5-phase endeavor. 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, GIT, and supervised by geotechnical engineer John Finnegan, PE, on September 10 through 12, 2019. The field activities generally consisted of the following:

- Reconnaissance of the site and surrounding area;
- Logging subsurface conditions for 2 test borings and 5 test pits;
- Performing DCP testing; and
- Obtaining bulk and split-spoon samples of the soils.

Results are presented in *Figures*.

Test Borings

Explorations included use of air rotary overburden drilling with integrated ring and pilot bit, and split-spoon sampling.

Air rotary drilling. Borings were drilled with a track-mounted Geoprobe 7822DT by the air rotary method utilizing 4.5-inch outside diameter casing. The air rotary method involves circulating air through a specially designed pilot bit that engages with a casing bit during drilling but disengages upon reversal of rotation to allow retrieval of the drill stem at desired sampling depths.

Test Pits

Test pits were excavated by Vietzke utilizing a CAT 305E track-mounted excavator with a 24-inch-wide bucket. Criteria governing the depth to which test pits were excavated included confirmation of favorable soils.

Soil Samples

Driven split-spoon samples were obtained at various intervals through the air rotary casing at the proposed depths during test boring operations.

Samples collected during test pit excavations were obtained by capturing representative material from the bucket of the excavator or directly from within the excavation while less than 4 feet below grade.

DCP Testing

DCP Testing – ASTM D6951. Soil strength was estimated with a series of DCP tests. The DCP results can be correlated to N-values for estimating relative soil strength for bearing capacity. A Trigg's Wildcat DCP system was used, which consists of a 35-pound slide hammer and rods with 4-inch graduations. The results of DCP penetration per 4-inch intervals are provided in *Figures*.

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 a preliminary plan provided by the client and is based on measured offsets from existing site features at the time of exploration.

Elevations presented on the *Test Boring* and *Test Pit Logs* were correlated from 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

pH – **AASHTO T-289**. Measurement of the pH of soils are made with a potentiometer using a pH sensitive electrode system. The pH of the soil is a useful variable in determining the solubility of soil minerals and the mobility of ions in the soil and assessing the viability of the soil-plant environment.

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

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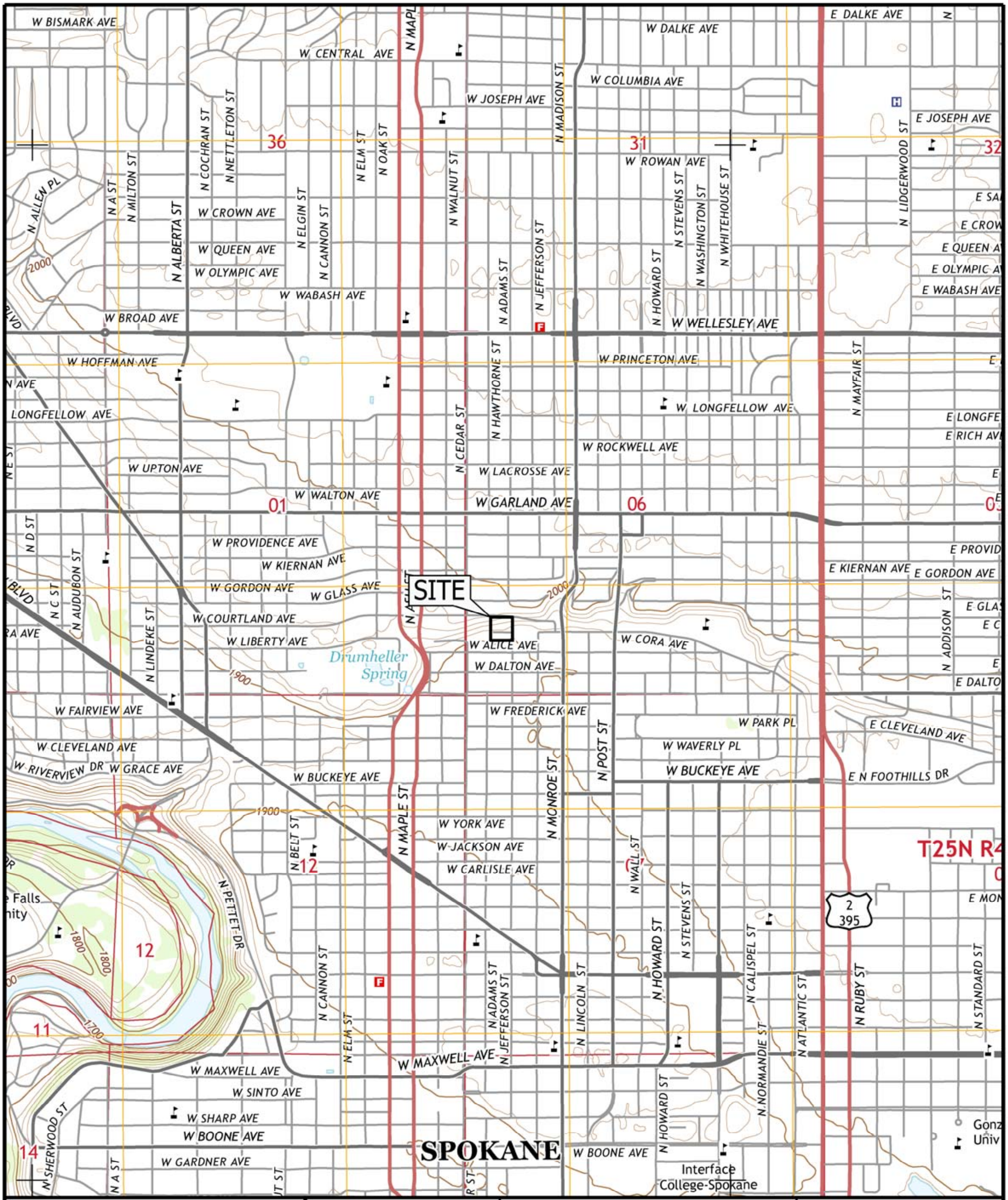


SCALE: 1"=2000'
0 1000 2000

SECTION 6
T25N R43E
SPOKANE NW, WA
USGS 2014

Budinger
& Associates

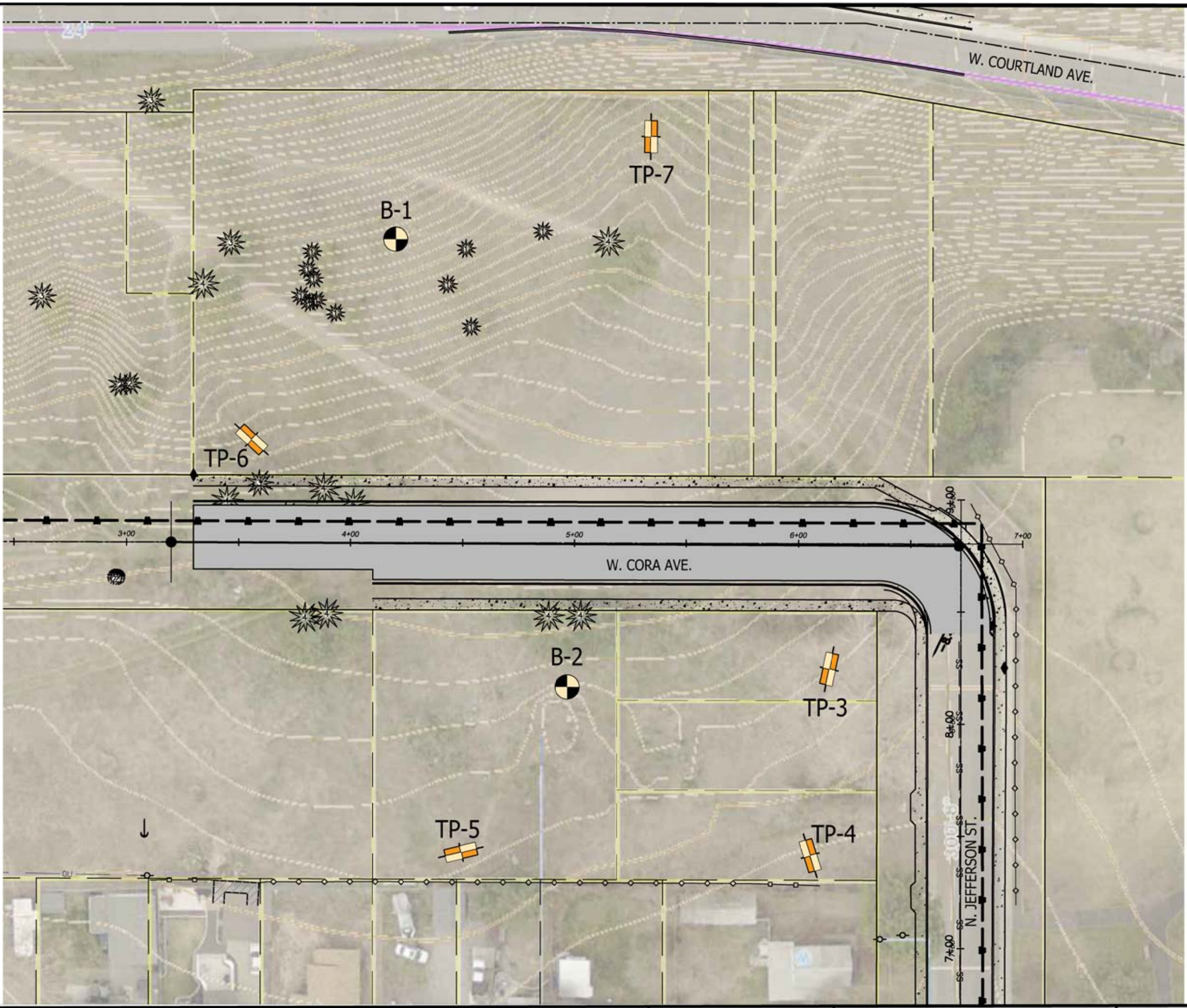
VICINITY MAP

EMERSON COTTAGES
SPOKANE, WASHINGTON

FIGURE 1

PROJECT NUMBER S19202

DATE: 9/2019



◑ TEST BORING LOCATION (B-1)

▮ TEST PIT LOCATION (TP-1)

N

SCALE: 1"=60'

0 30 60

Budinger
& Associates

SITE PLAN

EMERSON COTTAGES
SPOKANE, WASHINGTON

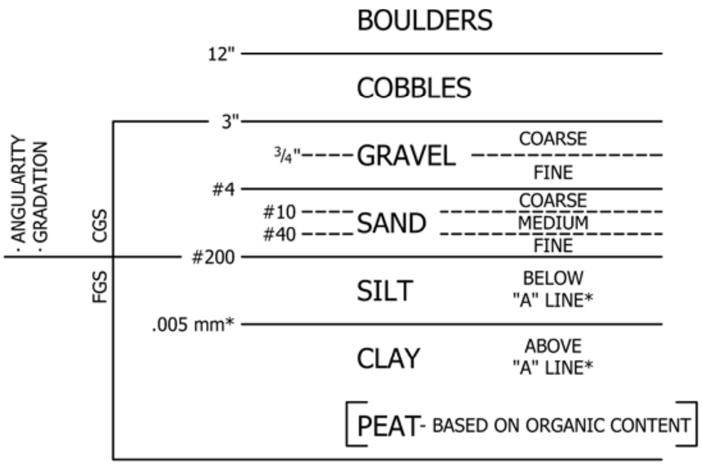
FIGURE 2

PROJECT NUMBER S19202

DATE: 10/2019

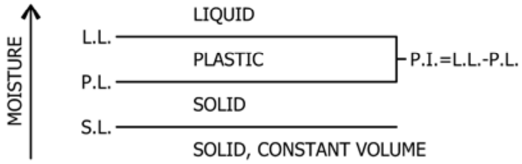
GUIDE TO SOIL & ROCK DESCRIPTIONS

SOIL CLASSIFICATION

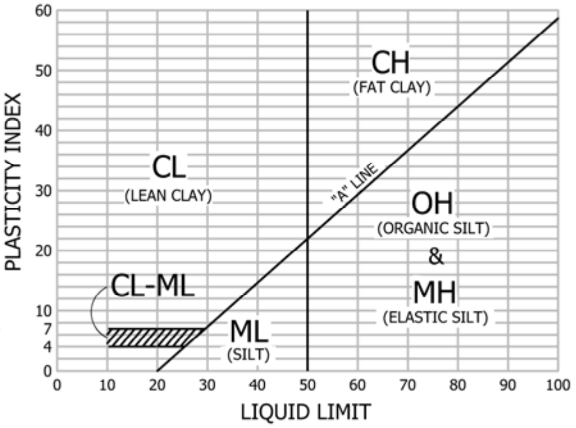


* SEE PLASTICITY CHART
CGS - COARSE GRAINED SOIL - MORE THAN 50% RETAINED ON A #200 SIEVE
FGS - FINE GRAINED SOIL - 50% MORE PASSES, #200 SIEVE
FINES - PORTION FINER THAN #200 SIEVE

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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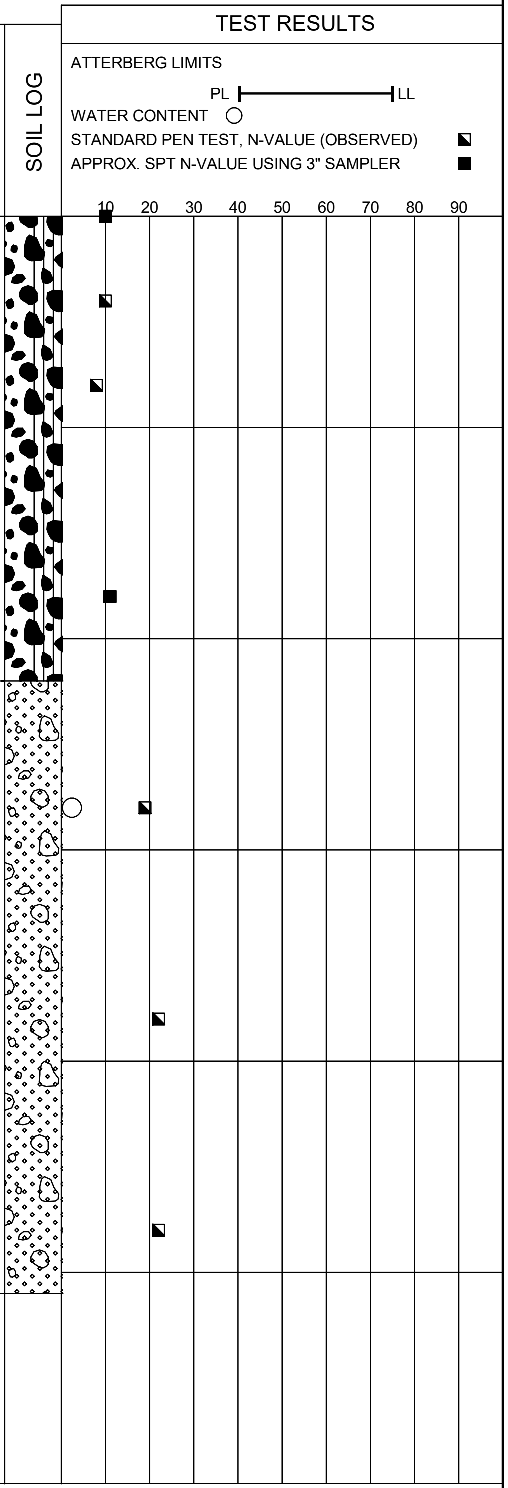
FIGURE 3

TEST BORING 1

Date of Boring: 9-10-19
Driller: Budinger & Assoc., Inc.
Type of Drill: Geoprobe 7822DT Drill, Automatic SPT Hammer
Location: North-central portion of Parcel #35063.2601
Surface: grass and weeds

Elevation: 1946 ft
Logged by: J. Pritzl
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, SPT N (% RECOVERY) (Blows per 6")	MOISTURE, COLOR, CONDITION	DESCRIPTION
0	10 (71%) *(5-10-11-14)*	dry, light brown, loose	GRAVEL with Silt, Sand, Cobbles and Boulders, sugangular to subrounded, occasionally interbedded with zones of Sand, colluvium
	10 *(6-5-5)* (67%)		
5	8 *(4-4-4)* (33%)		
10	11 (46%) *(9-13-13-11)*		decreasing fines content after 10 feet
		dry, brownish gray, medium dense	SAND with Gravel, coarse, subangular to subrounded, occasionally interbedded with zones of Gravel
15	19 *(5-8-11)* (61%)		
20	22 (0%) *(4-10-12-14)*		
25	22 *(8-10-12)* (67%)		
		no free groundwater observed	End of Boring @ 25.5 ft
30			



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BORING LOGS

FIGURE 4-1

Project: Emerson Cottages
Location: Spokane, WA
Number: S19202

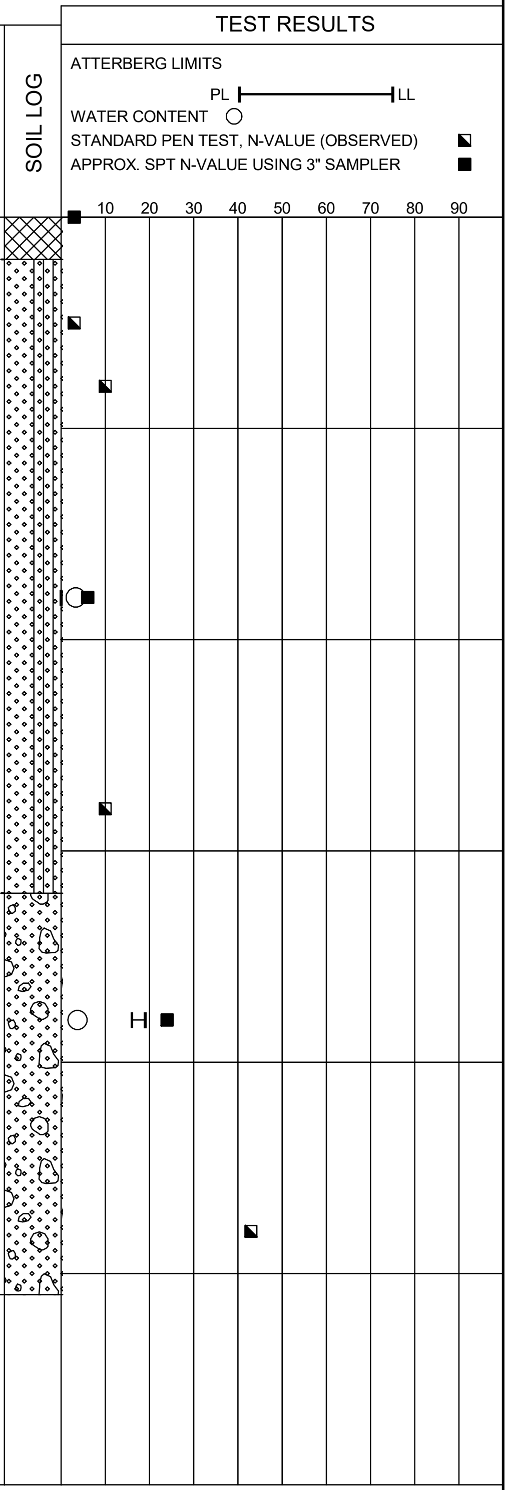
LOGS WITHOUT WELL WITH TESTS S19202.GPJ BUDINGER.GDT 9/26/19

TEST BORING 2

Date of Boring: 9-10-19
Driller: Budinger & Assoc., Inc.
Type of Drill: Geoprobe 7822DT Drill, Automatic SPT Hammer
Location: Northeast corner of Parcel #35063.2816
Surface: grass and weeds

Elevation: 1905 ft
Logged by: J. Pritzl
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, SPT N (% RECOVERY) (Blows per 6")	MOISTURE, COLOR, CONDITION	DESCRIPTION
0	3 (67%) (1-2-3-4)	dry, dark brown, very loose	SILTY SAND with Gravel (FILL)
		dry, medium brown, very loose	SAND with Silt and Gravel, coarse to medium, subangular to subrounded, occasionally interbedded with zones of Gravel
	3 (1-1-2) (39%)		
5	10 (4-6-4) (33%)	loose	
10	6 (50%) (5-6-7-7)		(seepage test performed at 9 feet; boring exfiltrated at approximately 15 gpm)
			decreasing Gravel content, becoming medium to fine grained
15	10 (3-4-6) (67%)		
		dry, brownish gray, medium dense to dense	SAND with Gravel, coarse, subangular to subrounded
20	24 (18-25-28) (83%)		
25	43 (7-20-23) (72%)		
		no free groundwater observed	End of Boring @ 25.5 ft
30			



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BORING LOGS

FIGURE 4-2

Project: Emerson Cottages
Location: Spokane, WA
Number: S19202

TEST PIT 3

Date: 9-12-19
Excavator: Budinger & Assoc., Inc.
Equipment: CAT 305E with 24" bucket
Location: East end of Parcel #35063.2823
Surface: grass and weeds

Elevation: 1904 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		dry, dark brown, loose	SILTY SAND with Gravel, decaying organics, wood debris (FILL)	☒
	▨	dry, brownish gray, loose to medium dense	SAND with Silt, Gravel and occasional Cobbles, coarse, subangular to subrounded, caliche accumulation on underside of coarse particles	⁘
5				
		no free groundwater observed	End of Excavation @ 8 ft	
10				
15				
20				
25				
30				

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TEST PIT LOGS

FIGURE 4-3

Project: Emerson Cottages
Location: Spokane, WA
Number: S19202

TEST PIT 4

Date: 9-12-19
Excavator: Budinger & Assoc., Inc.
Equipment: CAT 305E with 24" bucket
Location: East end of Parcel #35063.2817
Surface: grass and weeds

Elevation: 1898 ft
Logged by: J. Pritzl
Size of hole: 3 X 8 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS ATTERBERG LIMITS PL ├──┤ LL WATER CONTENT ○ 10 20 30 40 50 60 70 80 90
0		dry, dark brown, loose	SILTY SAND with Gravel, decaying organics, wood, brick and metal debris (FILL)	▩	
		dry, grayish brown, loose to medium dense	SILTY SAND with Gravel and occasional Cobbles, subangular to subrounded, stratified with clean Sand zones, caliche accumulation on underside of coarse particles	▒	
5				▒	
	▨			▒	○ H
		no free groundwater observed	End of Excavation @ 9 ft		
10					
15					
20					
25					
30					

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TEST PIT LOGS

FIGURE 4-4

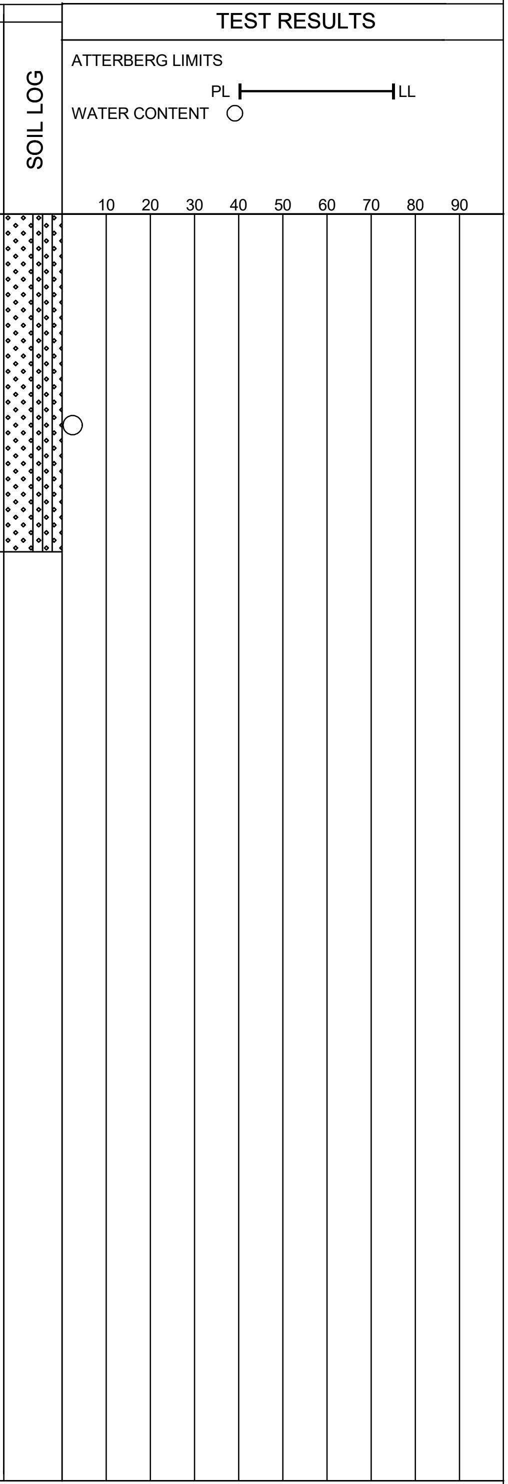
Project: Emerson Cottages
Location: Spokane, WA
Number: S19202

TEST PIT 5

Date: 9-12-19
Excavator: Budinger & Assoc., Inc.
Equipment: CAT 305E with 24" bucket
Location: Southwest corner of Parcel #35063.2816
Surface: grass and weeds

Elevation: 1903 ft
Logged by: J. Pritzl
Size of hole: 3 X 8 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION
0		dry, brownish gray, loose to medium dense	SAND with Silt, Gravel and occasional Cobbles, coarse, subangular to subrounded, caliche accumulation on underside of coarse particles
5	▨		
8		no free groundwater observed	End of Excavation @ 8 ft
10			
15			
20			
25			
30			



TEST PIT LOGS

FIGURE 4-5

Project: Emerson Cottages
Location: Spokane, WA
Number: S19202

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TEST PIT 6

Date: 9-12-19
Excavator: Budinger & Assoc., Inc.
Equipment: CAT 305E with 24" bucket
Location: Southwest corner of Parcel #35063.2601
Surface: grass and weeds

Elevation: 1920 ft
Logged by: J. Pritzl
Size of hole: 3 X 8 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS ATTERBERG LIMITS PL ├──┤ LL WATER CONTENT ○ 10 20 30 40 50 60 70 80 90
0 5	▨	dry, brownish gray, loose to medium dense	SAND with Silt, Gravel and occasional Cobbles, coarse, subangular to subrounded, caliche accumulation on underside of coarse particles		
10 15 20 25 30		no free groundwater observed	End of Excavation @ 8 ft		

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TEST PIT LOGS

FIGURE 4-6

Project: Emerson Cottages
Location: Spokane, WA
Number: S19202

TEST PIT 7

Date: 9-12-19
Excavator: Budinger & Assoc., Inc.
Equipment: CAT 305E with 24" bucket
Location: Northeast corner of Parcel #35063.2601
Surface: grass and weeds

Elevation: 1939 ft
Logged by: J. Pritzl
Size of hole: 3 X 8 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS ATTERBERG LIMITS PL ├─┤ LL WATER CONTENT ○ 10 20 30 40 50 60 70 80 90
0	▨	dry, brownish gray, medium dense to dense	GRAVEL with Silt, Sand, Cobbles and Boulders, subangular to subrounded, colluvium	▨	○
5		dry, brownish gray, loose to medium dense	SAND with Gravel and occasional Cobbles, coarse, subangular to subrounded, caliche accumulation on underside of coarse particles	▨	
		no free groundwater observed	End of Excavation @ 8 ft		
10					
15					
20					
25					
30					

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TEST PIT LOGS **FIGURE 4-7**

Project: Emerson Cottages

Location: Spokane, WA

Number: S19202

WILDCAT DYNAMIC CONE LOG

PROJECT NUMBER: S19202
DATE STARTED: 09-17-2019
DATE COMPLETED: 09-17-2019

HOLE #: DCPT-1 @ TP-3
CREW: C. Andrews
PROJECT: Emerson Cottages
ADDRESS: 1230 W. Cora Ave.
LOCATION: Spokane, WA

SURFACE ELEVATION: 1904
WATER ON COMPLETION:
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

	BLOWS	RESISTANCE	GRAPH OF CONE RESISTANCE		TESTED CONSISTENCY	
DEPTH	PER 10 cm	Kg/cm^2	0 50 100 150	N'	NON-COHESIVE	COHESIVE
-	5	22.2	••••••	6	LOOSE	MEDIUM STIFF
-	5	22.2	••••••	6	LOOSE	MEDIUM STIFF
- 1 ft	6	26.6	•••••••	7	LOOSE	MEDIUM STIFF
-	5	22.2	••••••	6	LOOSE	MEDIUM STIFF
-	12	53.3	•••••••••••••••	15	MEDIUM DENSE	STIFF
- 2 ft	10	44.4	••••••••••••	12	MEDIUM DENSE	STIFF
-	8	35.5	••••••••••	10	LOOSE	STIFF
-	8	35.5	••••••••••	10	LOOSE	STIFF
- 3 ft	7	31.1	•••••••••	8	LOOSE	MEDIUM STIFF
- 1 m	8	35.5	••••••••••	10	LOOSE	STIFF
-	7	27.0	•••••••	7	LOOSE	MEDIUM STIFF
- 4 ft	9	34.7	••••••••••	9	LOOSE	STIFF
-	10	38.6	•••••••••••	11	MEDIUM DENSE	STIFF
-	14	54.0	•••••••••••••••	15	MEDIUM DENSE	STIFF
- 5 ft	22	84.9	••••••••••••••••••••••••	24	MEDIUM DENSE	VERY STIFF
-	20	77.2	••••••••••••••••••••••	22	MEDIUM DENSE	VERY STIFF
-	17	65.6	•••••••••••••••••••	18	MEDIUM DENSE	VERY STIFF
- 6 ft	16	61.8	•••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
-	17	65.6	•••••••••••••••••••	18	MEDIUM DENSE	VERY STIFF
- 2 m	16	61.8	•••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
- 7 ft	18	61.6	•••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
-	14	47.9	•••••••••••••	13	MEDIUM DENSE	STIFF
-	20	68.4	•••••••••••••••••••	19	MEDIUM DENSE	VERY STIFF
- 8 ft	17	58.1	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
-	17	58.1	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
-	19	65.0	••••••••••••••••••	18	MEDIUM DENSE	VERY STIFF
- 9 ft	14	47.9	•••••••••••••	13	MEDIUM DENSE	STIFF
-	15	51.3	••••••••••••••	14	MEDIUM DENSE	STIFF
-	17	58.1	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
- 3 m 10 ft	19	65.0	••••••••••••••••••	18	MEDIUM DENSE	VERY STIFF
-	18	55.1	•••••••••••••••	15	MEDIUM DENSE	STIFF
-	22	67.3	•••••••••••••••••••	19	MEDIUM DENSE	VERY STIFF
-	20	61.2	•••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
- 11 ft	23	70.4	••••••••••••••••••••	20	MEDIUM DENSE	VERY STIFF
-	20	61.2	•••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
-	21	64.3	••••••••••••••••••	18	MEDIUM DENSE	VERY STIFF
- 12 ft	24	73.4	•••••••••••••••••••••	20	MEDIUM DENSE	VERY STIFF
-	26	79.6	•••••••••••••••••••••••	22	MEDIUM DENSE	VERY STIFF
-	33	101.0	•••••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
- 4 m 13 ft	50	153.0	•••	25+	DENSE	HARD

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Construction Materials Testing & Special Inspection

Figure 5-1

WILDCAT DYNAMIC CONE LOG

Page 1 of 1

PROJECT NUMBER: S19202
DATE STARTED: 09-17-2019
DATE COMPLETED: 09-17-2019

HOLE #: DCPT-2 @ TP-4
CREW: C. Andrews
PROJECT: Emerson Cottages
ADDRESS: 1230 W. Cora Ave.
LOCATION: Spokane, WA

SURFACE ELEVATION: 1898
WATER ON COMPLETION:
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

	BLOWS	RESISTANCE	GRAPH OF CONE RESISTANCE		TESTED CONSISTENCY	
DEPTH	PER 10 cm	Kg/cm^2	0 50 100 150	N'	NON-COHESIVE	COHESIVE
-	8	35.5	••••••••••	10	LOOSE	STIFF
-	9	40.0	•••••••••••	11	MEDIUM DENSE	STIFF
- 1 ft	14	62.2	••••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
-	24	106.6	••••••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
-	21	93.2	•••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
- 2 ft	23	102.1	•••••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
-	17	75.5	•••••••••••••••••••••	21	MEDIUM DENSE	VERY STIFF
-	14	62.2	••••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
- 3 ft	11	48.8	••••••••••••••	13	MEDIUM DENSE	STIFF
- 1 m	12	53.3	•••••••••••••••	15	MEDIUM DENSE	STIFF
-	8	30.9	••••••••	8	LOOSE	MEDIUM STIFF
- 4 ft	7	27.0	•••••••	7	LOOSE	MEDIUM STIFF
-	4	15.4	••••	4	VERY LOOSE	SOFT
-	6	23.2	••••••	6	LOOSE	MEDIUM STIFF
- 5 ft	10	38.6	•••••••••••	11	MEDIUM DENSE	STIFF
-	13	50.2	••••••••••••••	14	MEDIUM DENSE	STIFF
-	12	46.3	•••••••••••••	13	MEDIUM DENSE	STIFF
- 6 ft	12	46.3	•••••••••••••	13	MEDIUM DENSE	STIFF
-	15	57.9	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
- 2 m	24	92.6	••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
- 7 ft	23	78.7	••••••••••••••••••••••	22	MEDIUM DENSE	VERY STIFF
-	23	78.7	••••••••••••••••••••••	22	MEDIUM DENSE	VERY STIFF
-	33	112.9	••••••••••••••••••••••••••••••••	25+	DENSE	HARD
- 8 ft	50	171.0	•••	25+	DENSE	HARD
-						
-						
- 9 ft						
-						
-						
- 3 m 10 ft						
-						
-						
-						
- 11 ft						
-						
-						
- 12 ft						
-						
-						
- 4 m 13 ft						

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Construction Materials Testing & Special Inspection

Figure 5-2

WILDCAT DYNAMIC CONE LOG

Page 1 of 1

PROJECT NUMBER: S19202
DATE STARTED: 09-17-2019
DATE COMPLETED: 09-17-2019

HOLE #: DCPT-3 @ TP-5
CREW: C. Andrews
PROJECT: Emerson Cottages
ADDRESS: 1230 W. Cora Ave.
LOCATION: Spokane, WA

SURFACE ELEVATION: 1903
WATER ON COMPLETION:
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

	BLOWS	RESISTANCE	GRAPH OF CONE RESISTANCE		TESTED CONSISTENCY	
DEPTH	PER 10 cm	Kg/cm²	0 50 100 150	N'	NON-COHESIVE	COHESIVE
-	6	26.6	•••••••	7	LOOSE	MEDIUM STIFF
-	7	31.1	•••••••••	8	LOOSE	MEDIUM STIFF
- 1 ft	11	48.8	••••••••••••••	13	MEDIUM DENSE	STIFF
-	18	79.9	•••••••••••••••••••••••	22	MEDIUM DENSE	VERY STIFF
-	19	84.4	••••••••••••••••••••••••	24	MEDIUM DENSE	VERY STIFF
- 2 ft	19	84.4	••••••••••••••••••••••••	24	MEDIUM DENSE	VERY STIFF
-	20	88.8	•••••••••••••••••••••••••	25	MEDIUM DENSE	VERY STIFF
-	24	106.6	••••••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
- 3 ft	22	97.7	••••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
- 1 m	14	62.2	••••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
-	13	50.2	••••••••••••••	14	MEDIUM DENSE	STIFF
- 4 ft	10	38.6	•••••••••••	11	MEDIUM DENSE	STIFF
-	11	42.5	••••••••••••	12	MEDIUM DENSE	STIFF
-	11	42.5	••••••••••••	12	MEDIUM DENSE	STIFF
- 5 ft	13	50.2	••••••••••••••	14	MEDIUM DENSE	STIFF
-	15	57.9	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
-	15	57.9	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
- 6 ft	19	73.3	•••••••••••••••••••••	20	MEDIUM DENSE	VERY STIFF
-	18	69.5	••••••••••••••••••••	19	MEDIUM DENSE	VERY STIFF
- 2 m	19	73.3	•••••••••••••••••••••	20	MEDIUM DENSE	VERY STIFF
- 7 ft	21	71.8	••••••••••••••••••••	20	MEDIUM DENSE	VERY STIFF
-	23	78.7	••••••••••••••••••••••	22	MEDIUM DENSE	VERY STIFF
-	24	82.1	•••••••••••••••••••••••	23	MEDIUM DENSE	VERY STIFF
- 8 ft	24	82.1	•••••••••••••••••••••••	23	MEDIUM DENSE	VERY STIFF
-	30	102.6	•••••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
-	34	116.3	•••••••••••••••••••••••••••••••••	25+	DENSE	HARD
- 9 ft	50	171.0	•••	25+	DENSE	HARD
-						
-						
- 3 m 10 ft						
-						
-						
-						
- 11 ft						
-						
-						
- 12 ft						
-						
-						
- 4 m 13 ft						

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Geotechnical & Environmental Engineers
Construction Materials Testing & Special Inspection

Figure 5-3

WILDCAT DYNAMIC CONE LOG

PROJECT NUMBER: S19202
DATE STARTED: 09-17-2019
DATE COMPLETED: 09-17-2019

HOLE #: DCPT-4 @ TP-6
CREW: C. Andrews
PROJECT: Emerson Cottages
ADDRESS: 1230 W. Cora Ave.
LOCATION: Spokane, WA

SURFACE ELEVATION: 1920
WATER ON COMPLETION:
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

	BLOWS	RESISTANCE	GRAPH OF CONE RESISTANCE		TESTED CONSISTENCY	
DEPTH	PER 10 cm	Kg/cm^2	0 50 100 150	N'	NON-COHESIVE	COHESIVE
-	4	17.8	•••••	5	LOOSE	MEDIUM STIFF
-	4	17.8	•••••	5	LOOSE	MEDIUM STIFF
- 1 ft	7	31.1	•••••••••	8	LOOSE	MEDIUM STIFF
-	10	44.4	••••••••••••	12	MEDIUM DENSE	STIFF
-	11	48.8	••••••••••••••	13	MEDIUM DENSE	STIFF
- 2 ft	14	62.2	••••••••••••••••••	17	MEDIUM DENSE	VERY STIFF
-	20	88.8	•••••••••••••••••••••••••	25	MEDIUM DENSE	VERY STIFF
-	17	75.5	•••••••••••••••••••••	21	MEDIUM DENSE	VERY STIFF
- 3 ft	18	79.9	•••••••••••••••••••••••	22	MEDIUM DENSE	VERY STIFF
- 1 m	12	53.3	•••••••••••••••	15	MEDIUM DENSE	STIFF
-	11	42.5	••••••••••••	12	MEDIUM DENSE	STIFF
- 4 ft	14	54.0	•••••••••••••••	15	MEDIUM DENSE	STIFF
-	18	69.5	••••••••••••••••••••	19	MEDIUM DENSE	VERY STIFF
-	11	42.5	••••••••••••	12	MEDIUM DENSE	STIFF
- 5 ft	4	15.4	••••	4	VERY LOOSE	SOFT
-	6	23.2	••••••	6	LOOSE	MEDIUM STIFF
-	20	77.2	••••••••••••••••••••••	22	MEDIUM DENSE	VERY STIFF
- 6 ft	27	104.2	••••••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
-	26	100.4	•••••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
- 2 m	40	154.4	•••	25+	DENSE	HARD
- 7 ft	47	160.7	•••	25+	DENSE	HARD
-	50	171.0	•••	25+	DENSE	HARD
-						
- 8 ft						
-						
-						
- 9 ft						
-						
-						
- 3 m 10 ft						
-						
-						
-						
- 11 ft						
-						
-						
- 12 ft						
-						
-						
- 4 m 13 ft						

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Figure 5-4

WILDCAT DYNAMIC CONE LOG

PROJECT NUMBER: S19202
DATE STARTED: 09-17-2019
DATE COMPLETED: 09-17-2019

HOLE #: DCPT-5 @ TP-7
CREW: C. Andrews
PROJECT: Emerson Cottages
ADDRESS: 1230 W. Cora Ave.
LOCATION: Spokane, WA

SURFACE ELEVATION: 1939
WATER ON COMPLETION:
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

DEPTH	BLOWS PER 10 cm	RESISTANCE Kg/cm²	GRAPH OF CONE RESISTANCE 0 50 100 150	N'	TESTED CONSISTENCY NON-COHESIVE	TESTED CONSISTENCY COHESIVE
-	7	31.1	•••••••••	8	LOOSE	MEDIUM STIFF
-	13	57.7	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
- 1 ft	12	53.3	•••••••••••••••	15	MEDIUM DENSE	STIFF
-	20	88.8	•••••••••••••••••••••••••	25	MEDIUM DENSE	VERY STIFF
-	26	115.4	•••••••••••••••••••••••••••••••••	25+	DENSE	HARD
- 2 ft	50	222.0	•••	25+	VERY DENSE	HARD
-						
-						
- 3 ft						
- 1 m						
-						
- 4 ft						
-						
-						
- 5 ft						
-						
-						
- 6 ft						
-						
- 2 m						
- 7 ft						
-						
-						
- 8 ft						
-						
-						
- 9 ft						
-						
-						
- 3 m 10 ft						
-						
-						
-						
- 11 ft						
-						
-						
- 12 ft						
-						
-						
- 4 m 13 ft						

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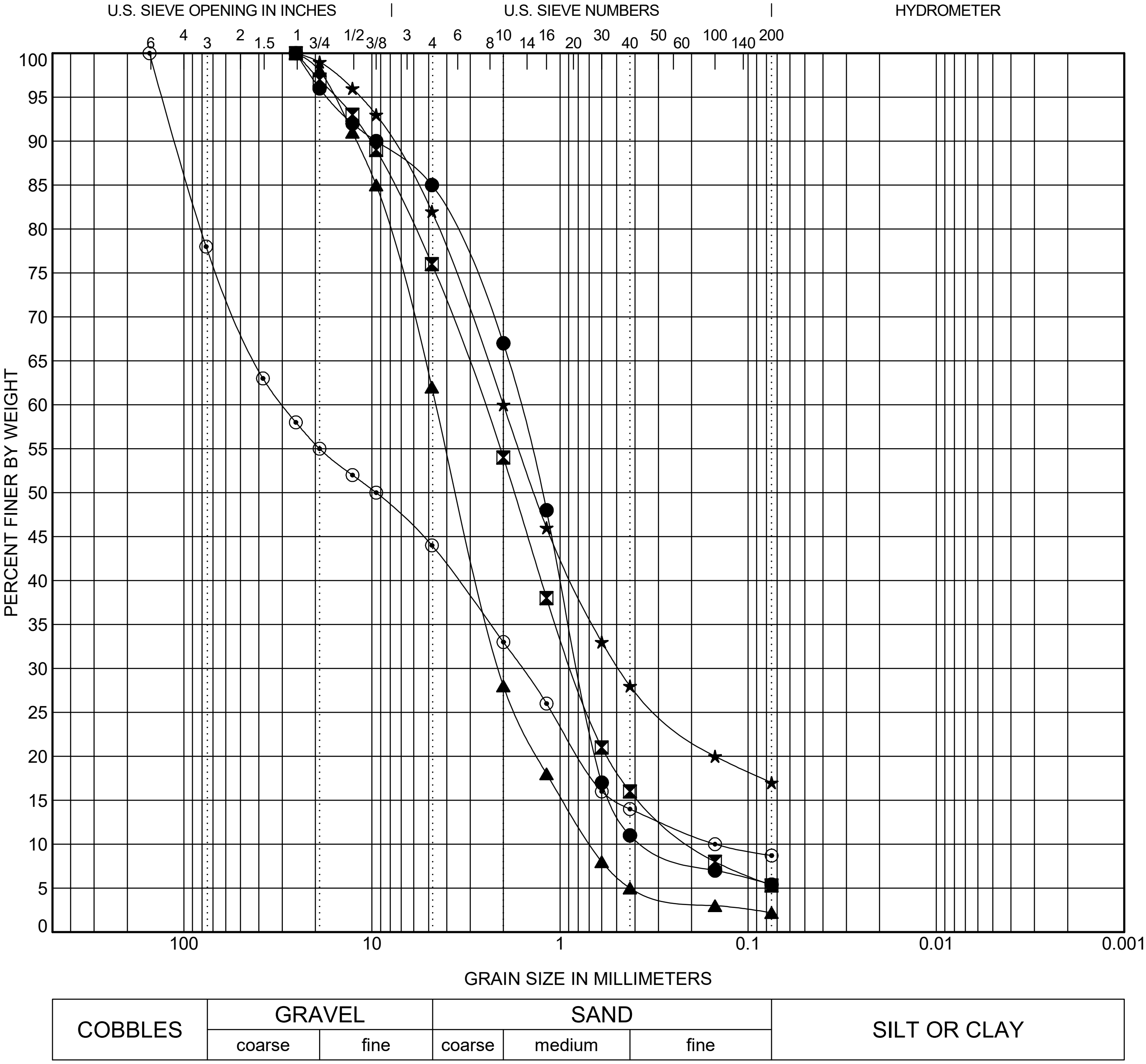
Figure 5-5

SOIL MECHANICS
LABORATORY SUMMARY

		Units	Test Methods						
LABORATORY NUMBER				19-5430	19-5431	19-5432	19-5433	19-5434	19-5435
BORING/TEST PIT NUMBER				B-1	B-2	B-2	TP-4	TP-5	TP-7
DEPTH	TOP	feet		14	9	19	8	5	2
	BOTTOM	feet		15 1/2	11	20 1/2	9	6	3
MOISTURE CONTENT		%	ASTM D2216	2.4	3.3	3.7	4.3	2.4	2.1
pH			AASHTO T289	8.2	8.4		6.8		
LIQUID LIMIT		%	ASTM D4318			19	20		
PLASTIC LIMIT		%				16	18		
PLASTICITY INDEX		%			NP*	3	2		
UNIFIED CLASSIFICATION			ASTM D2487		SW-SM	SW	SM		
SIEVE ANALYSIS									
	6"/3"		ASTM D6913					100/78	100
	1 1/2"							63	95
S	1"	%		100	100	100	100	58	91
I	3/4"			96	97	98	99	55	87
E	1/2"	P		92	93	91	96	52	84
V	3/8"	A		90	89	85	93	50	81
E	#4	S		85	76	62	82	44	73
	#10	S		67	54	28	60	33	57
S	#16	I		48	38	18	46	26	39
I	#30	N		17	21	8	33	16	17
Z	#40	G		11	16	5	28	14	13
E	#100			7	8	3	20	10	6
	#200			5.4	5.3	2.2	17	8.7	5.1

NP* = non-plastic

Figure 6



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	1	14.0					1.18	5.03
⧗	2	9.0	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	NP	NP	NP	1.49	13.05
▲	2	19.0	WELL-GRADED SAND with GRAVEL(SW)	19	16	3	1.42	6.64
★	4	8.0	SILTY SAND with GRAVEL(SM)	20	18	2		
⊙	5	5.0					0.57	198.94

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	1	14.0	25.4	1.647	0.797	0.328	15.2	79.4	5.4	
⧗	2	9.0	25.4	2.539	0.858	0.195	24.3	70.4	5.3	
▲	2	19.0	25.4	4.559	2.106	0.687	38.4	59.4	2.2	
★	4	8.0	25.4	2	0.488		18.3	64.7	17.0	
⊙	5	5.0	152.4	29.841	1.595	0.15	33.8	35.2	8.7	

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Spokane Valley, WA 99212

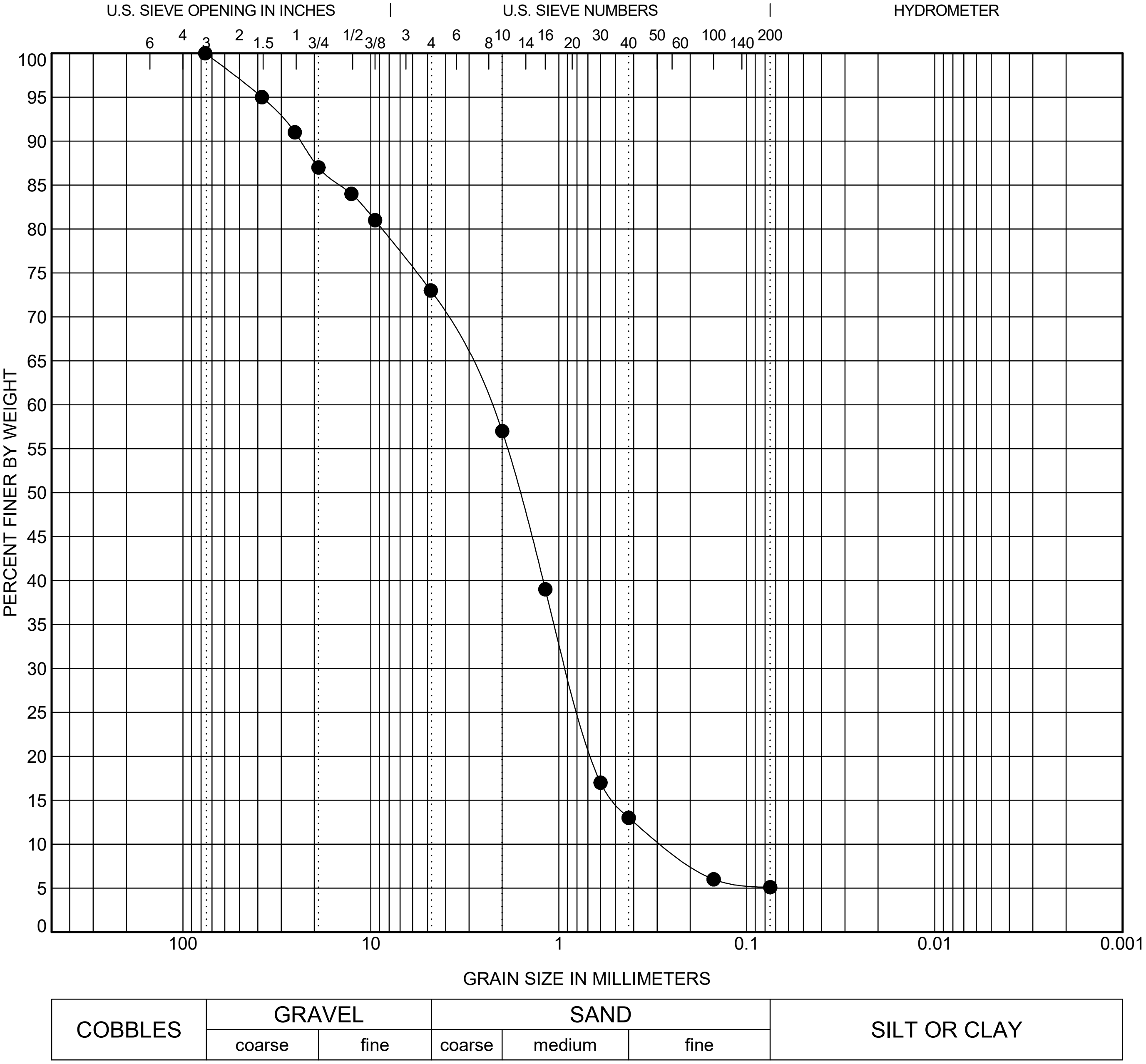
GRAIN SIZE DISTRIBUTION

Project: Emerson Cottages

Location: Spokane, WA

Number: S19202

Figure 7-1



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**7**	**2.0**					**1.25**	**8.67**

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**7**	**2.0**	**76.2**	**2.357**	**0.895**	**0.272**	**27.1**	**67.7**	**5.1**	

Budinger
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Spokane Valley, WA 99212

GRAIN SIZE DISTRIBUTION

Project: Emerson Cottages

Location: Spokane, WA

Number: S19202

Figure 7-2

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
of the Geoprofessional Business Association

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