Earth Engineers, Inc.

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April 27, 2020
Revised April 28, 2020

Innovative Housing, Inc.
219 Northwest 2nd Avenue
Portland, Oregon 97209
Attention: Julie Garver

Phone: (503) 226-4368, ext.3
E-mail: jgarver@innovativehousinginc.com

Subject: **Geotechnical Investigation Report**
Proposed Apartment Complex
Lincoln County Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00
Accessed by Northeast 25th Street
Lincoln City, Lincoln County, Oregon
EEI Report No. 20-047-1

Dear Ms. Garver:

Earth Engineers, Inc. (EEI) is pleased to transmit our Geotechnical Investigation Report for the above referenced project. The attached report includes the results of field and laboratory testing, an evaluation of geotechnical factors that may influence the proposed development, and geotechnical recommendations for the proposed structures and general site development. ***We revised the report on April 28, 2020 to include an updated conceptual site plan that incorporated our recommended setbacks. Revisions are bold and italicized.***

We appreciate the opportunity to perform this geotechnical study and look forward to continued participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
Earth Engineers, Inc.

Ken Andrieu, R.G.
Senior Geologist

Troy Hull, P.E., G.E.
Principal Geotechnical Engineer

Attachment: Geotechnical Investigation Report

Distribution (electronic copy only): Addressee

GEOTECHNICAL INVESTIGATION REPORT

for the

Proposed Northeast 25th Street Apartment Complex
Lincoln County Tax Lots:
07-11-11-BB-04302-00 and 07-11-11-BB-04300-00
Lincoln City, Lincoln County, Oregon

Prepared for

IHI
INNOVATIVE HOUSING, INC.
CREATING SOLUTIONS TO UNMET HOUSING NEEDS

219 Northwest 2nd Avenue
Portland, Oregon 97209

Prepared by

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EEI Report No. 20-047-1

April 27, 2020
Revised April 28, 2020

Earth Engineers, Inc.

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TABLE OF CONTENTS

1.0 PROJECT INFORMATION

1.1 Project Authorization

Earth Engineers, Inc. (EEI) has completed a Geotechnical Investigation Report for the proposed apartment complex to be located on Lincoln County Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, accessed via Northeast 25th Street in Lincoln City, Oregon. Our services were performed in general accordance with EEI Proposal No. 20-P032 dated February 11, 2020 and authorized by Julie Garver on February 19, 2020.

1.2 Project Description

Our current understanding of the project is based on the information provided in an e-mail to EEI Principal Geotechnical Engineer Troy Hull from Julie Garver with Innovative Housing, Inc. on January 31, 2020. Briefly, we understand the plan is to develop a low-rise, garden-style apartment complex on the currently undeveloped 4-acre property.

We were provided the following documents:

- Undated aerial photo outlining the property
- March 14, 2018 proposed site plan indicating there will be 6 buildings; with a total of 89 housing units and 127 parking spaces, as well as a driveway circling through the project. See Figure 1 below.
- An undated topographic property plan.
- Topographic survey prepared by Emerio Design, dated April 10, 2020.
- ***Preliminary site plan prepared by LRS Architects, received April 27, 2020. This site plan incorporates the slope and cliff setback recommendations in this report.***

Figure 1: Preliminary site plan prepared by LRS Architects.

Since the project is still in the preliminary design stages, we have not been provided detailed construction drawings, foundation loading, or grading plans for the proposed apartment complex construction. For the purposes of this report, we are assuming typical residential foundation loads of 4 kips per linear foot for wall footings, 50 kips per column footing, and 150 psf for floor slabs. We have assumed that the apartment buildings will be constructed in accordance with the 2019 Oregon Structural Specialty Code (OSSC) and ASCE 7-16. We have assumed that maximum cuts and fills may be on the order of about 3 feet.

1.3 Purpose and Scope of Services

The purpose of our services was to perform a geotechnical investigation of the property in order to provide geotechnical recommendations for the proposed apartment complex. Our site investigation consisted of advancing 10 test pits using a Zaxis 40U excavator subcontracted from Dan J Fischer Excavating, Inc. of Forest Grove, Oregon. Grab samples from the test pit excavations were collected at the discretion of the Senior Geologist conducting the subsurface investigation.

Each soil sample collected in the test pits was screened for possible environmental contamination using a Photoionization detector (PID). The PID detects a broad range of volatile organic compounds (VOCs) such as formaldehyde, methane, benzene, as well as hydrocarbons that typically occur in oil and gas. The PID readings are included on our exploration logs. We consider a positive reading for VOCs to be greater than about 5 ppm. Our testing should be considered an initial site screening tool and does not replace a study by a qualified environmental professional.

The soil samples were tested in our laboratory to determine the material properties for our evaluation. Laboratory testing was accomplished in general accordance with ASTM procedures.

This report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions, and presents recommendations regarding the following:

- A discussion of subsurface conditions encountered including pertinent soil and groundwater conditions.
- Geotechnical related recommendations for foundation recommendations, including allowable bearing pressure; depth to bearing; minimum widths, estimated total and differential settlements.
- Seismic design parameters in accordance with ASCE 7-16.
- Structural fill recommendations, including an evaluation of whether the existing site soils can be used as structural fill.
- General retaining wall recommendations, including earth pressures and coefficient of friction soil parameters, as well as retaining wall backfill recommendations.

- General floor slab support recommendations.
- General discussion on site grading and drainage.
- Pavement section thickness recommendations based on as assumed CBR value and assumed traffic loading conditions.
- Results of the in-situ soil percolation testing.
- Results of the PID soil sample testing.
- Discussions on geotechnical issues that may impact the project.

Other than the PID testing of the soil samples obtained in our explorations, our scope of services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the exploration logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. Prior to development of the site, an environmental assessment is typically advisable.

2.0 SITE AND SUBSURFACE CONDITIONS

2.1 Site Location and Description

The subject property is located on Lincoln County tax lots 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00 off of Northeast 25th Street in Lincoln City, Oregon. The property is elongate and irregularly rectangular with inverted corners at the northwest and northeast corners of the property. The property is surrounded by vacant lots to the north, east and west; a residential subdivision to the northeast; commercial properties to the northwest and southwest; and a church and baseball fields to the south. See Figure 2 below.

Figure 2: Lincoln County tax map with the project property outlined in blue.

The site is vacant with remnants of past site development in the form of concrete retaining walls and rockery walls. There are also buried in-situ concrete slabs, asphalt pavement and gravel surfacing. The site is densely vegetated with a mix of coniferous and deciduous trees, shrubs, and grasses. The exposed features are noted on the Topographic Survey prepared by Emerio Design (see Figure 3).

The site was originally developed as an estate by Charles Walker who built and operated the Dorchester House located on the west side of Highway 101 a short distance north of the property. In 1950's the property was briefly converted into a hospital, and then into a retirement home. A series of aerial photos illustrates the development of the property from 1939 until it became overgrown with vegetation in 1984 (see Figures 3 to 8 below).

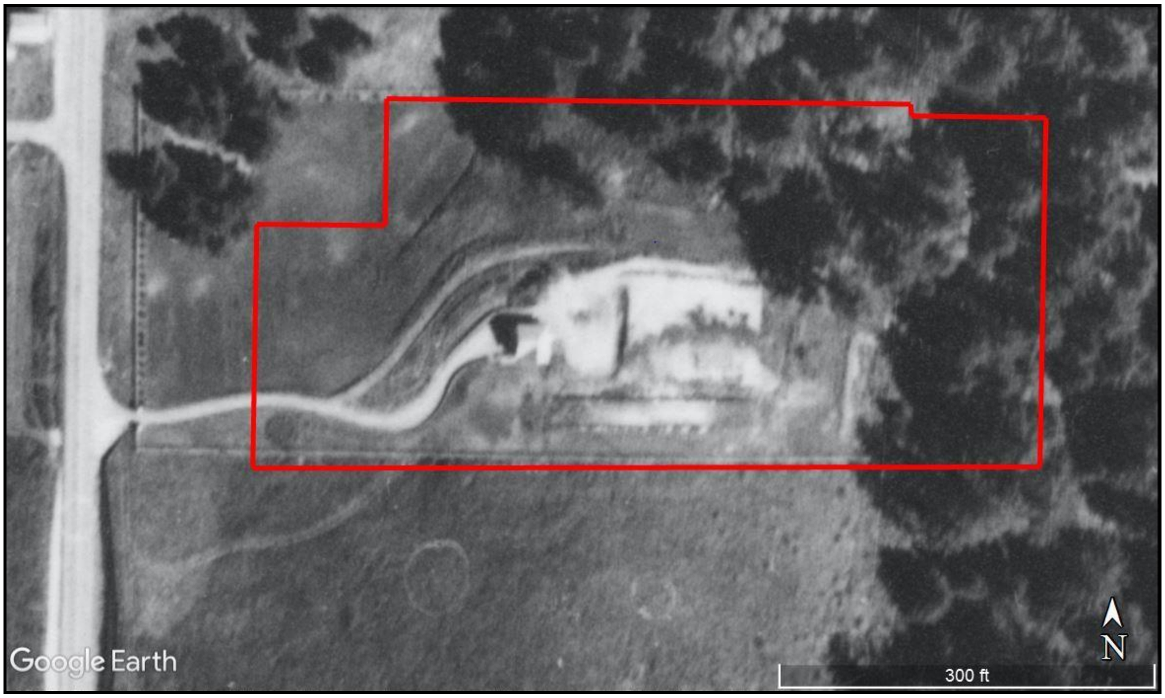

Figure 3: 1939 – The Estate appears to still be under construction. The main house and retaining walls are visible, but no buildings have been constructed in the area east of the main house which appears to be graded.

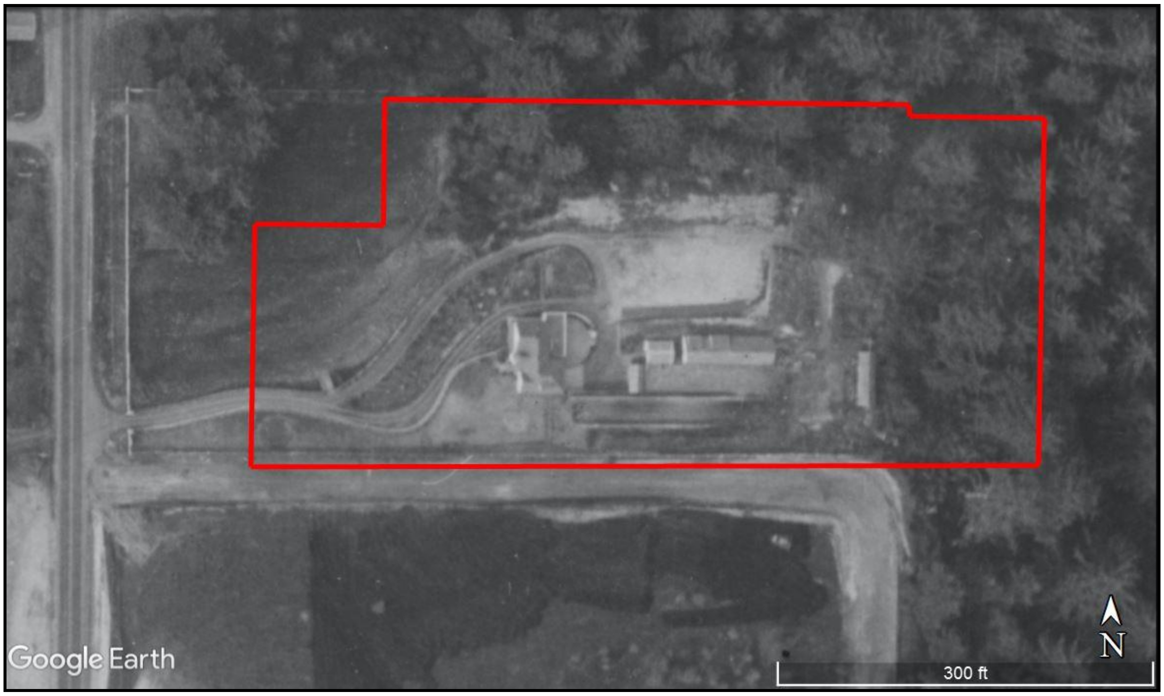

Figure 4: 1945 – The landscaping and outbuildings are more developed. We observed a concrete slab with floor tile in the area of the long building during our site investigation.

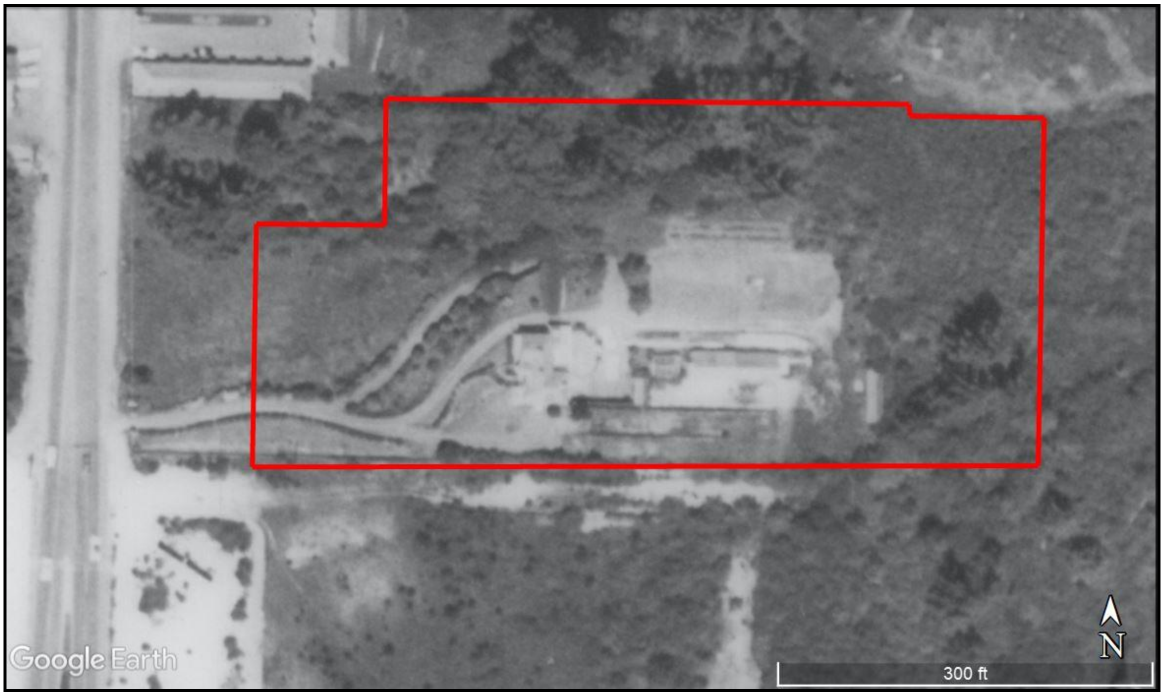

Figure 5: 1958 – The trees are more mature and the large open area/parking lot has been expanded. At this time the property would have been a retirement home.

Figure 6: 1969 – A gas station has been built to the west of the property, truncating the driveway. The lower driveway has been removed. The parking lot has been reduced in size. Mature vegetation is encroaching around the developed areas.

Figure 7: 1979 **–** The buildings appear to have been removed. Some retaining walls and open spaces are still visible through the vegetation.

Figure 8: 1984 – The property is completely overgrown with vegetation.

The above historical aerial photos were obtained from the University of Oregon map library.

Figure 9: Postcard of the Walker estate viewed from Highway 101.

The property generally slopes down to the north from an elevation of 172 feet MSL at the southern property line to an elevation of 89 feet MSL at the northern property line. The maximum topographic relief on the property is about 83 feet. The central portion of the property, above an elevation of 150 feet, is mostly level with terraces rising to the south property line, separated by retaining walls. This upper area also has many hard surface areas (concrete, asphalt and gravel) buried under a shallow veneer of soil (less than 2 inches) and shallow-rooted vegetation. The slopes to the north and east are irregular, mostly sloping at 15 to 50 percent grades. Along the north property line there is a roughly 100-foot long cliff that drops about 35 feet from approximate elevations of 125 to 90 feet MSL. The slope to the west is crossed with the remains of the driveways and retaining walls, many of which are showing signs of severe distress and failure. The fir trees on the property are mostly straight trunked; however, there are some leaning or toppled trees due to close proximity to the top of the cliff and shallow root systems. See topographic map below in Figure 10.

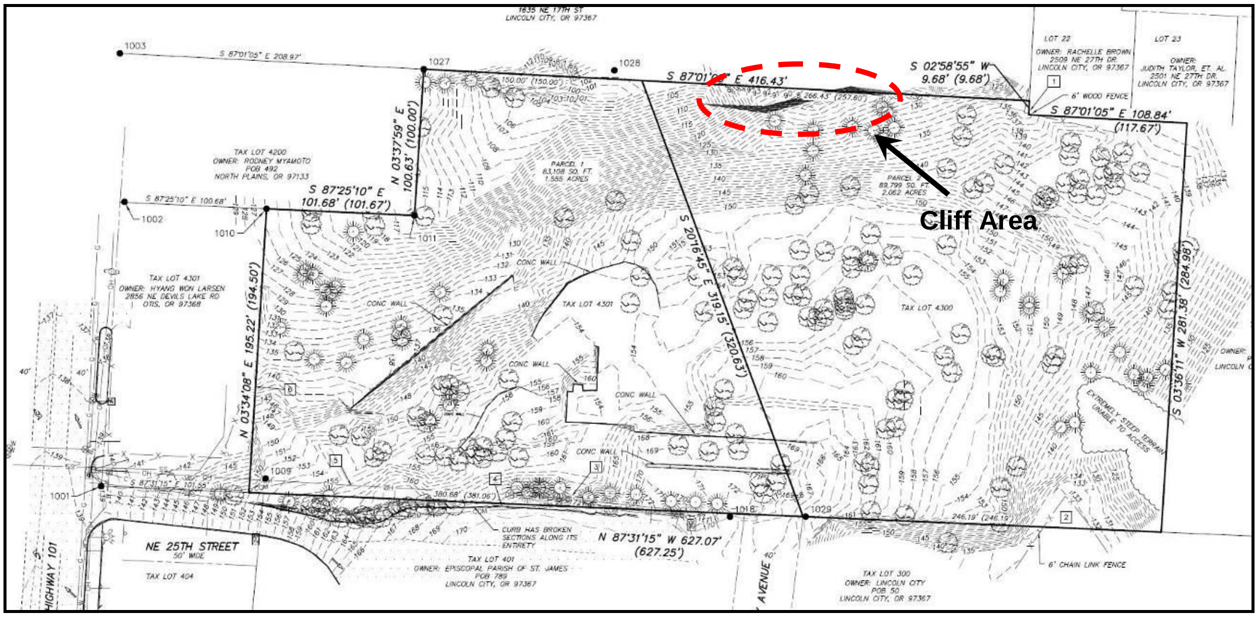

Figure 10: Topographic survey prepared by Emerio Design, dated April 10, 2020.

Photo 1: Upper area, terraced with retaining walls (near TP-5).

Photo 2: Looking west along slope above the cliff.

Photo 3: Looking west along the top of the cliff.

Photo 4: Level area in the central area of the property (near TP-7).

Photo 5: The top of the driveway coming onto the level area. Probe rod is touching asphalt.

Photo 6: Retaining wall with a large drain pipe near where old residence had been.

Photo 7: Looking southeast at failed retaining wall near where driveway had entered property from the west.

Photo 8: Lower driveway area with buttressed retaining wall covered in vegetation.

Photo 9: Siltstone exposed in upper cliff face.

Photo 10: Upper slope on eastern portion of site (near TP-1).

Photo 11: Tiled floor buried under veneer of soil.

2.2 Mapped Soils and Geology

The United States Department of Agriculture (USDA) Soil Survey provides geographical information of the soils in Lincoln County as well as summarizing various properties of the soils. The USDA shows the native soils on the site mapped as Winema-Fendall silt loams on 3 to 15 percent slopes. This soil unit is well drained and occurs on hillslopes with a parent material of colluvium derived from sedimentary rock[1].

The project area was mapped by Snavely, Macleod and Wagner (1972) of the U.S. Geological Survey as the Yamhill Formation[2]. The Yamhill Formation is described as a massive to thinly-bedded concretionary siltstone with interbeds of arkosic sandstone.

As a part of our due diligence, we reviewed the Oregon Department of Geology and Mineral Industries (DOGAMI) Statewide Geohazards Information Database for Oregon (HazVu) website (https://gis.dogami.oregon.gov/hazvu/). This database maps the property to have a severe Cascadia earthquake shaking hazard, a very strong earthquake shaking hazard, a low liquefaction hazard, and a high landslide hazard although no landslide deposits are mapped on the property.

The USGS U.S. Quaternary Faults Interactive Map (https://usgs.maps.arcgis.com) database indicates there are no mapped Quaternary faults in the immediate vicinity of the property, but maps the Cascadia Fold and Thrust Belt lays 6.5 miles northwest of the site, and the Siletz Bay faults 4.0 miles south of the site.

2.3 Subsurface Materials

As stated earlier, the site was explored with 10 test pit excavations (TP-1 through TP-10). For the approximate exploration locations, see the "Exploration Location Plan" in Appendix B.

The test pit excavations were advanced to depths ranging from 4 to 10 feet. Excavation equipment consisted of a Zaxis 40U excavator equipped with a 2-foot wide toothed bucket. Grab samples were obtained at the discretion of the Senior Geologist for laboratory testing. The soil samples were tested for indication of potential environmental contamination with a PID meter and the results ranged from x to x ppm. We consider a positive reading for VOCs to be greater than about 5 ppm.

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[1] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/ accessed February 11, 2020.

[2] Snavely, P.D., MacLeod, N.S., and Wagner, H.C., 1972, Preliminary bedrock geologic map of the Cape Foulweather and Euchre Mountain quadrangles, Oregon: U.S. Geological Survey, Open-File Report OF-72-350, scale 1:48,000

Photo 12: Excavating TP-4.

Photo 13: TP-4 Excavation.

Select soil samples were tested in the laboratory to determine material properties for our evaluation. Laboratory testing was accomplished in general accordance with ASTM procedures. The testing performed included moisture content tests (ASTM D2216), the amount of material in the soils finer than the #200 sieve (ASTM D1140) and Atterberg limits (ASTM D4318). The test results have been included in the Exploration Logs in Appendix C.

The same general subsurface strata were encountered in each of our explorations, which generally consisted of topsoil overlying fill, clayey silt, and a terminal layer of siltstone.

Topsoil: The surficial layer consisted of a dark brown silty clay with some siltstone fragments and organics. Where present, the stratum thickness ranged from 18 inches to 2 feet across the site. Other surficial layers encountered included fill soils in TP-6 and TP-8, as well as 2-inches of asphalt over 4-inches of gravel in TP-9.

Fill: Fill soils were encountered in TP-5, TP-6, TP-8, and TP-9 and generally consisted of organic topsoil mixed with brown clayey silt and weathered siltstone. Stratum thickness ranged from 1 foot to the terminal depth of 8.5 feet in TP-8. The measured moisture contents in this stratum ranged from 52 to 70 percent, indicating the soil is wet.

Elastic Silt with Sand (MH): Underlying the topsoil in TP-1, TP-2, TP-3, TP-4, and TP-10, and underlying the fill in TP-7 and TP-9 was a dark brown elastic silt with siltstone fragments. This stratum ranged in thickness from 1.5 to 9.5 feet across the site. Measured moisture contents in this stratum ranged from 46 to 71 percent, indicating it is wet. The measured fines contents (passing the #200 sieve) in this stratum ranged from 79 to 94 percent. Two Atterberg limits tests were run, and both resulted in a liquid limit of 80 and a plastic limit of 56, indicating the soil has high plasticity and is potentially expansive. Based on pocket penetrometer readings ranging from 1.5 to 2.0, this stratum is stiff

Siltstone: Beneath the above strata we encountered siltstone in test pits TP-1 through TP-6; this was the terminal stratum in each of aforementioned test pits. This siltstone is described as tan with rust staining, friable, moderately fractured, and highly weathered. The siltstone is excavatable with a toothed bucket. The measured moisture contents in this stratum ranged from 59 to 78 percent.

The classifications noted above were made in accordance with the Unified Soil Classification System (USCS) as shown in Appendix D. The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The exploration logs included in Appendix C should be reviewed for specific information at specific locations. These records include soil descriptions, stratifications, and locations of the samples. The stratifications shown on the logs represent the conditions only at the actual exploration locations. As described, we encountered fill/debris/topsoil in our explorations. It should be noted that the explorations performed are not adequate to accurately identify the full extent of existing fill across the site. Consequently, the actual fill extent may be much greater than that shown on the exploration logs and discussed herein. Variations may occur and should be expected between locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during field operations is also shown on these logs. The samples that were not altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded.

2.4 Groundwater Information

Groundwater was not encountered in any of the explorations. Based on well logs from neighboring property at 2510 Highway 101, groundwater was first encountered at depths of 23 feet below the ground surface. This is the vacant lot (former gas station) to the west of the subject property, which is at an average elevation of about 140 feet msl. It should be noted that the groundwater elevation can fluctuate seasonally and annually, especially during periods of extended wet or dry weather or from changes in land use. The historic water well logs discussed are attached in Appendix E.

2.5 Seismicity

In accordance with the 2019 OSSC and ASCE 7-16, we recommend a Site Class D (stiff soil profile) for this site when considering the average of the upper 100 feet of bearing material beneath the foundations. This recommendation is based on the results of our subsurface investigation as well as our understanding of the local geology.

Inputting our recommended Site Class as well as the site latitude and longitude into the Seismic Design Maps (SEAOC/OSHPD) website (http://seismicmaps.org), we obtained the seismic design parameters shown in Table 1 below. The return interval for these ground motions is 2 percent probability of exceedance in 50 years.

Table 1: Seismic Design Parameter Recommendations (ASCE 7-16)

PARAMETER	RECOMMENDATION
S_s	1.320g
S_1	0.684g
F_a	1
F_v	Null – See ASCE 7-16 Section 11.4.8
S_{MS} ($=S_s \times F_a$)	1.320g
S_{M1} ($=S_1 \times F_v$)	Null – See ASCE 7-16 Section 11.4.8
S_{DS} ($=2/3 \times S_s \times F_a$)	0.880g
Design PGA ($=S_{DS}/2.5$)	0.352g
MCE_G PGA	0.654g
F_{PGA}	1.100
PGA_M= (MCE_G PGA x F_{PGA})	0.719g

Note: Site latitude = 44.983689, longitude = -124.005885

Per Section 11.4.8 of ASCE 7-16 a site-specific seismic site response analysis (i.e. SHAKE software or equivalent) is required for structures on Site Class D and E sites with S_1 greater than or equal to 0.2g. The S_1 value for this site is greater than 0.2g as shown in Table 1 above. Therefore a site response analysis is required as part of the design phase. However, Section 11.4.8 does provide an exception for not requiring a site response analysis (reference Sections 11.4.8.1, 11.4.8.2 and 11.4.8.3). The project Structural Engineer should determine if the proposed buildings will meet any of the exceptions – if the buildings do not meet the exception requirements then EEI should be retained to perform a site-specific site response analysis.

We understand a Supplement 1 dated December 12, 2018 has been issued for ASCE 7-16 to correct some issues in the original publication. One of the corrections in the Supplement pertains to Table 11.4-2 (see table below) for determining the value of the Long-Period Site Coefficient, F_V, which is then used to calculate the value of T_S. The T_S value is needed for one of the exceptions in Section 11.4.8. Without the correction in Supplement 1, it would not be possible to determine F_V and calculate T_s. Based on Supplement 1, the F_V value may be determined from the following corrected table.

Table 2: Long-Period Site Coefficient, F_V (corrected Table 11.4-2 in ASCE 7-16).

	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at 1-s Period					
Site Class	S_1<=0.1	S_1<=0.2	S_1<=0.3	S_1<=0.4	S_1<=0.5	S_1<=0.6
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.8	0.8	0.8	0.8	0.8	0.8
C	1.5	1.5	1.5	1.5	1.5	1.4
D	2.4	**2.2**[a]	**2.0**[a]	**1.9**[a]	**1.8**[a]	**1.7**[a]
E	4.2	**3.3**[a]	**2.8**[a]	**2.4**[a]	**2.2**[a]	**2.0**[a]
F	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8

Note: use linear interpolation for intermediate values of S_1.

[a] **See requirements for site-specific ground motions in Section 11.4.8. These values of F_V shall be used only for calculation of T_S.**

2.6 Infiltration Testing Results

The infiltration testing was conducted in general accordance with the 1980 EPA single ring falling head test method. One test (consisting of 3 trial holes) was conducted for the proposed apartment complex. The location of the infiltration test can be seen in Appendix B.

Each of the 3 trials consisted of placing one 6-inch diameter PVC pipe and seating it at least 6-inches into the bottom of an excavated trench. Soil samples were taken from the bottom of the trial locations and returned to our laboratory for testing which included grain size and fines content analysis. After seating the pipes, approximately 2 to 3-inches of clean gravel was placed in the bottom of the pipes to prevent scouring. Twelve inches of water was then placed into the pipe and allowed to drain. Since the water did not drain completely in the first 10-minutes, the holes required a 4-hour minimum presoak period.

After the 4-hour pre-soak, 12-inches of clean water was placed in each of the pipes and the fall of water was timed until consistent results were observed. The results of our infiltration test are shown below in Table 3. **The results should be considered ultimate values and do not include a factory of safety.**

Table 3: Infiltration Test Data

Test #	Depth (feet)	% Fines	% Moisture	Soil Description	Infiltration Rate (inches/hour)[1]
IT-1a	3	85	51	Elastic Silt with Sand	2 1/2
IT-1b	3	84	54	Elastic Silt with Sand	1 5/8
IT-1c	3	79	54	Elastic Silt with Sand	4 1/4

Note 1: No safety factors have been applied to the test rates above.

Based on the low infiltration rates and moisture sensitive soils, we do not recommend infiltration within 25 feet of grades steeper than 2H:1V.

Photo 12: Infiltration Test

3.0 EVALUATION AND FOUNDATION RECOMMENDATIONS

3.1 Geotechnical Discussion

Based on our subsurface investigation, it is our professional opinion that the primary factors impacting the proposed development include the following:

1. **Previous development on the property.** The property has been extensively developed in the past with buildings, retaining walls and driveways. It was also likely regraded, which probably included cuts and fills. Our report does not document the full extent of previous development and it should be assumed that some surprises (i.e. remnants of old construction) may be encountered during construction that need to be dealt with.

2. **Presence of fill soils.** Fill soils were encountered within some of the test pits. Whenever old fill has been placed without the knowledge that it was tested and inspected by a Geotechnical professional, there is some risk that the fill may not have been placed properly. The presence of such materials could result in excess settlements and unsatisfactory foundation performance for the new construction project. Therefore, we do not recommend supporting the proposed apartment buildings on the apparent fill soils. If fills are encountered within the building footprints, we recommend removing the fill and replacing it with structural fill. The extent of the removal and backfill should extend laterally 6 inches from the footing in all directions for every foot that the excavation extends below the bottom of the footing. Alternately, the footings could be extended through the fill to bear directly on the firm native subgrade.

   In general, the fill in our explorations was only up to about 2 feet deep. However, in TP-8 it extended to the maximum depth of our test pit (8.5 feet). That is pretty significant and could impact the construction costs, if it turns out that there is deep fill prevalent in some areas of the project. It may be prudent to perform supplemental explorations to better define the fill extent and thicknesses, once the building pad locations are finalized and the site has been cleared somewhat to provide better access for excavation equipment (especially in the area of TP-8).

3. **Presence of fine-grained, moisture sensitive soils.** As stated above we encountered a high plasticity elastic silt in our explorations. This soil should be considered sensitive to changes in moisture content and prone to disturbance/softening when wet. In our experience, the siltstone may also become soft when exposed to prolonged periods of moisture. Therefore, care should be taken to not allow water to pond on prepared subgrades. If the proposed construction takes place during the wet winter months, we recommend the placement of a compacted granular crushed rock pad to protect the subgrade from soil disturbance and/or softening. We recommend a depth of 4 to 6 inches of crushed rock in foot traffic areas, and a depth of 12 to 18 inches in heavy construction areas.

4. **Presence of potentially expansive soils.** There are potentially expansive, elastic silt soils beneath the proposed apartment building footprints. As such, there is a higher risk of differential movement due to these expansive soils which are highly moisture sensitive. Expansive soils can cause cracks in the foundations when these soils either shrink or swell based on changes in moisture content. We recommend all foundations bear on a minimum of 12 inches of "dirty" crushed rock (i.e. screenings or reject rock with at least 15 percent passing the #200 sieve) placed and compacted atop the stiff clayey silt subgrade, with the bottom of the "dirty" crushed rock at least 30 inches below the ground surface. It is our professional opinion that the floor slabs can be grade supported on a minimum of 1 foot of "dirty" crushed rock placed and compacted atop of the stiff elastic silt subgrade. Additionally, the potentially expansive elastic silt should be removed from within 4 feet of the back of any retaining walls and replaced with structural wall backfill as described in sections 3.3 and 3.7. This combination will mitigate the potentially expansive soils which could cause excessive settlement and/or expansion/shrinkage based on changes in moisture content. This settlement and/or expansion/shrinkage could result in excessive stresses on the foundation elements leading to cracking and shifting of the foundations and/or slab is not mitigated. Alternatively, the foundations could bear directly on the siltstone without the need for the 12 inches of over excavation and "dirty" crushed rock backfill.

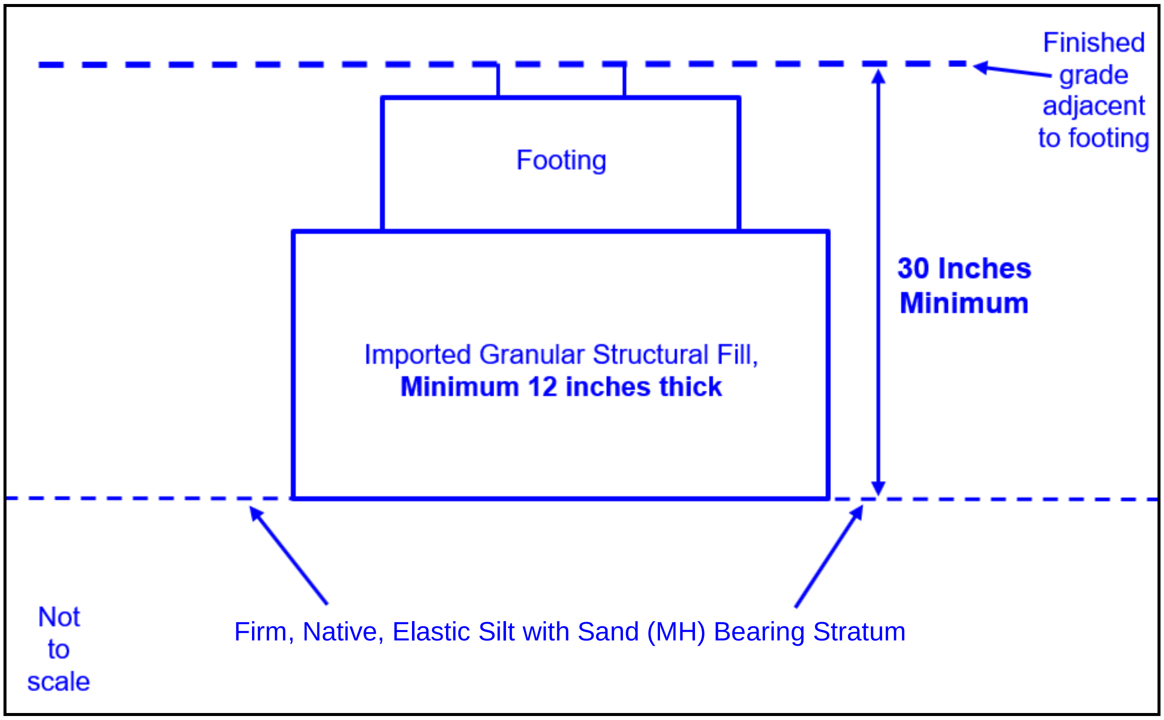

Figure 11: Footing sketch showing minimum structural fill thickness of 12 inches and minimum 30-inch embedment depth recommendation for proposed footings.

5. **Low infiltration rates and sloping site.** Due to the steep site grades and low infiltration rate coupled with moisture sensitive soils, we do not recommend using infiltration within 25 feet of slopes steeper than 2H:1V. Additionally, infiltration should not be used anywhere immediately up-slope of the cliff.

6. **Close proximity of the building foundation to slopes.** As stated above, the property is sloping with a 35-foot tall cliff along the north property line. We recommend that all structures and driveways be set back 30 feet horizontally from the face of the cliff. Additionally, the foundation should be embedded such that the downhill face of the footings are a minimum of 10 feet horizontally away from the undisturbed slope face in order to provide sufficient passive earth pressure.

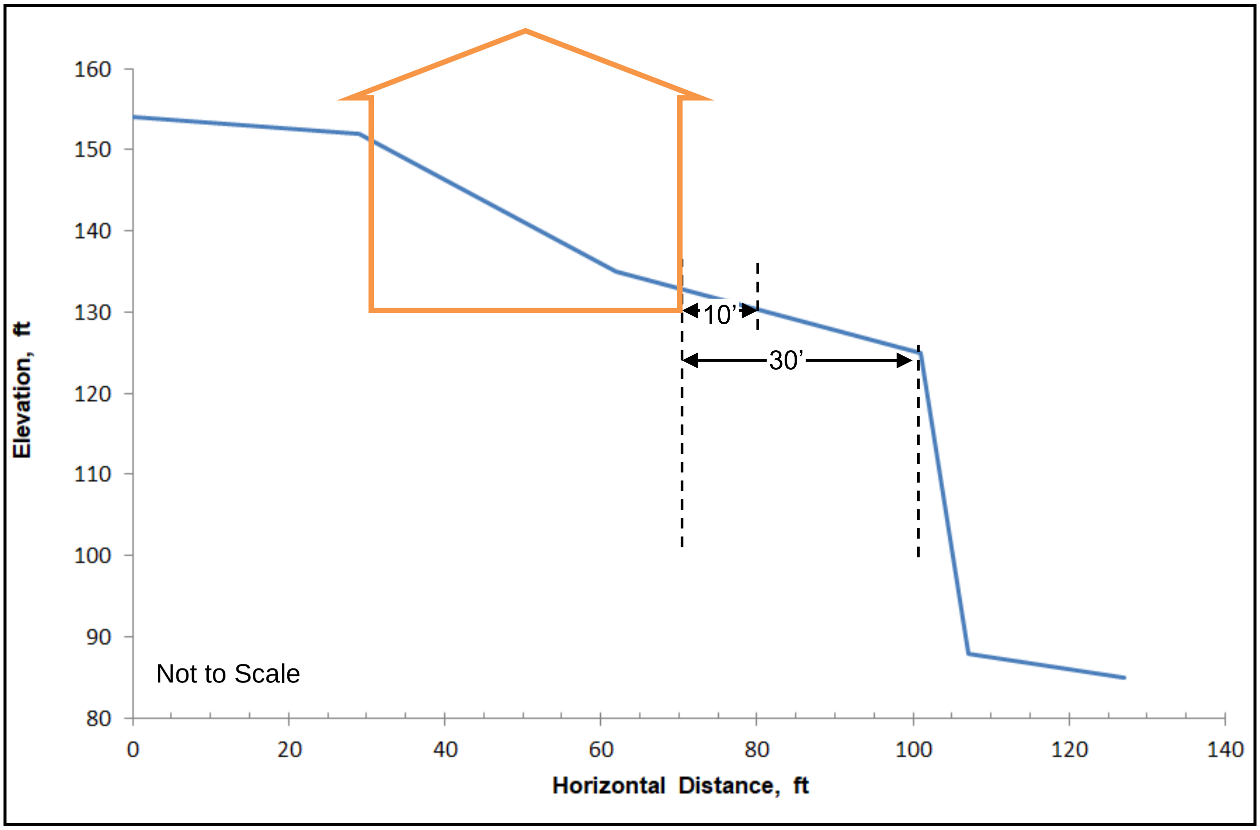

Figure 12: Slope Profile with setbacks

In summary, assuming that the moderate risks outlined above are acceptable to the property owner, this site appears to be developable provided our recommendations in this report are followed.

3.2 Site Preparation

Prior to starting construction, the contractor should locate the test pits conducted for this study, excavate to the depths shown on the test pit logs, and backfill each excavation with properly compacted granular structural fill under the observation of a representative of the Geotechnical Engineer.

We envision that the vegetation, roots, topsoil, organic laden soils, and any fill soils or deleterious soils will need to be stripped from beneath the proposed construction areas to expose the underlying stiff clayey silt. The topsoil and fill thicknesses ranged from approximately 1.5 to 2 feet within our explorations with the exception of TP-8 where fill soils were found to the terminal depth of 8.5 feet. Topsoil and fill thickness may vary from these depths across the site. A representative of the Geotechnical Engineer should be present to determine the depth of removal of the various soils during construction as well as to check the temporary excavations and fill benching as required.

After stripping and excavating to the proposed subgrade level, as required, the building and pavement areas should be proofrolled with a heavily loaded tandem axle dump truck or similar rubber-tired vehicle where feasible. Soils that are observed to rut or deflect excessively under the moving load, or are otherwise judged to be unsuitable should be undercut and replaced with properly compacted structural fill. The proofrolling and undercutting activities should be witnessed by a representative of the Geotechnical Engineer, and should be performed during a period of dry weather.

Where the expansive elastic silt soils are exposed during earthwork operations, they should not be allowed to dry out. In general, the contractor should plan to conduct a cut and cover operation where the elastic silt soils are covered the same day they are exposed. This is especially important during the dry summer months when the exposed soils are more likely to dry.

Any existing utilities present beneath the proposed construction will need to be located and rerouted as necessary and any abandoned pipes or utility conduits should be removed to inhibit the potential for subsurface erosion. Because the property has been previously developed, we do expect that there will be old utility pipes to remove and the contractor should budget accordingly. Utility trench excavations should be backfilled with properly compacted structural fill in accordance with Section 4.3.

3.3 Structural Fill

Structural fill should be free of organics or other deleterious materials, have a maximum particle size less than 3 inches, be relatively well graded, and have a liquid limit less than 45 and plasticity index less than 25. Since the native soils have a liquid limit in excess of 45, we do not recommend that they be used for structural fill. This includes the native siltstone. As such, we recommend a “dirty” crushed rock (i.e. screenings with at least 15 percent passing the #200 sieve) to be used for the bulk of the structural fill.

We recommend all structural fill be moisture conditioned to within 3 percentage points below and 2 percentage points above optimum moisture as determined by ASTM D1557 (Modified Proctor). If water must be added, it should be uniformly applied and thoroughly mixed into the soil by disking or scarifying.

Fill should be placed in relatively uniform horizontal lifts on the prepared subgrade which has been stripped of deleterious materials (i.e. topsoil and fill) and approved by the Geotechnical Engineer or his representative. Each loose lift should be about 1-foot thick. The type of compaction equipment used will ultimately determine the maximum lift thickness. Structural fill should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557. Each lift of compacted engineered fill should be tested by a representative of the Geotechnical Engineer prior to placement of subsequent lifts.

3.4 Foundation Recommendations

Once the site has been properly prepared as discussed above, the proposed structures can be supported on a conventional shallow foundation system. Again, all foundations should bear on a minimum of 12 inches of compacted structural fill (i.e. “dirty” crushed rock) placed atop the stiff clayey silt subgrade or directly upon the deeper siltstone. The expansive soils should be covered the same day they are exposed so that they do not dry out.

The base of the dirty rock should be at least 30 inches below adjacent design site grades. Furthermore, as also recommend above, foundations on slopes should be spaced at least 10 feet horizontally away from the undisturbed slope face, and set back at least 30 feet horizontally from the top of the cliff.

Spread footings for isolated columns and continuous bearing walls can be designed for an allowable soil bearing pressure of up to 2,000 psf when bearing on the granular structural fill placed upon the native stiff clayey silt stratum typically encountered in our subsurface explorations between 1.5 and 2.5 feet bgs. Foundations bearing directly on the siltstone first encountered at a depth of 1.5 to 4.5 feet bgs can be designed for an allowable soil bearing pressure of up to 4,000 psf. Our recommended allowable bearing capacities are based on dead load plus design live load, and can be increased by one-third when including short-term wind or seismic loads. Building footing dimensions should meet the minimum requirements of the 2019 OSSC.

Lateral frictional resistance between the base of footings and the subgrade can be expressed as the applied vertical load multiplied by a coefficient of friction of 0.36 for concrete foundations bearing granular crushed rock structural fill placed atop native clayey silt and/or directly on siltstone. In addition, lateral loads may be resisted by passive earth pressures based on an equivalent fluid pressure of 250 pounds per cubic foot (pcf) for footings poured “neat” against the native soils, or properly backfilled structural fill. For footings adjacent to slopes, in order to mobilize the full passive earth pressure noted above, the bottom front corner of the footing needs to be a minimum 10 feet laterally from the face of the slope. These are ultimate values—we recommend a factor of safety of 1.5 be applied to the equivalent fluid pressure, which is appropriate due to the amount of movement required to develop full passive resistance. To be clear, no safety factor has been applied to the values discussed above.

Exterior footings and foundations in unheated areas should be located at a depth of at least 12 inches below the final exterior grade to provide adequate frost protection. If the construction is to take place during the winter months or if the foundation soils will likely be subjected to freezing temperatures after foundation construction, then the foundation soils should be adequately protected from freezing. Otherwise, interior foundations can be located at nominal depths compatible with architectural and structural considerations.

Again, variable conditions (i.e. fill soils, etc.) are anticipated to be present during construction. The foundation excavations should be observed by a representative of the Geotechnical Engineer prior to placement of structural fill, steel, or concrete to assess that the foundation materials are capable of supporting the design loads and are consistent with the materials discussed in this report. Unsuitable soil zones encountered at the bottom of the foundation excavations should be removed to the level of suitable soils or properly compacted structural fill as directed by the Geotechnical Engineer.

After opening, foundation excavations should be observed and structural fill placed as quickly as possible to avoid exposure of the excavation bottoms to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. If possible, the structural fill should be placed during the same day the excavation is made. If the soils will be exposed for more than 2 days, consideration should be given to leaving the upper 1 foot of soil above design grade in place to protect the final subgrade from the elements.

Based on the known subsurface conditions we anticipate that properly designed and constructed foundations supported on the recommended materials (as noted above) could experience maximum total and differential settlements on the order of 1-inch and ½-inch, respectively.

The foundation excavations should be observed by a representative of the Geotechnical Engineer prior to steel or concrete placement to assess that the foundation materials are capable of supporting the design loads and are consistent with the materials discussed in this report. Unsuitable soil zones encountered at the bottom of the foundation excavations should be removed to the level of suitable soils or properly compacted structural fill as directed by the Geotechnical Engineer. Cavities formed as a result of excavation of unsuitable soil zones should be backfilled and compacted with structural fill in accordance with Section 3.3 above.

3.5 Slab on Grade Recommendations

For the purposes of this report, we have assumed that maximum floor slab loads will not exceed 150 psf. Based on the existing soil conditions, the design of slabs-on-grade can be based on a subgrade modulus (k) of 150 pci. This subgrade modulus value represents an anticipated value which would be obtained in a standard in-situ plate test with a 1-foot square plate. Use of this subgrade modulus for design or other on-grade structural elements should include appropriate modification based on dimensions as necessary.

The floor slabs should not be supported on either the existing fill soils or the expansive, elastic silt soils. We recommend they be supported on at least 12 inches of properly compacted “dirty” crushed rock gravel structural fill overlying firm native soils. The expansive soils should be covered the same day they are exposed so that they do not dry out.

The floor slabs should have an adequate number of joints to reduce cracking resulting from any differential movement and shrinkage.

Prior to placing the structural fill, the exposed subgrade surface should be prepared as discussed in Section 3.2. The subgrade will need to be visually evaluated by a representative of the Geotechnical Engineer by means of proof rolling with a fully loaded tandem axle dump truck or a fully loaded water truck. In areas not accessible to a proof roll the subgrade shall be evaluated by means of a ½-inch diameter steel probe rod or by means of density testing with a nuclear density gag. If fill is required, the structural fill should be placed on the prepared subgrade after it has been approved by the Geotechnical Engineer.

We recommend the floor slab areas be topped with 4 inches of cleaner crushed rock gravel (i.e. base course material with no more than 5 percent fines) to provide a capillary break and limit migration of moisture through the slab. If additional protection against moisture vapor is desired, a moisture vapor retarding membrane may also be incorporated into the design. Factors such as cost, special considerations for construction, and the floor coverings suggest that decisions on the use of vapor retarding membranes be made by the project design team, the contractor and the owner.

3.6 Pavement Recommendations

The following pavement section thickness recommendations are presented as preliminary for your consideration. This design is based on assumed apartment complex traffic loading. The Civil Engineer for the project may have more specific traffic and project design data available than is presently known and may wish to modify or refine our pavement section thickness recommendations. We are available, upon request, to provide a more detailed pavement design once more definitive traffic plans are available. Additionally, this design is based off of an assumed California Bearing Ratio (CBR) value of a representative mix of the upper site soils.

The thickness recommendations presented below are considered typical and minimum for the assumed parameters. We understand that budgetary considerations sometimes warrant thinner pavement sections than those presented. However, the client, the owner, and the project principals should be aware that thinner pavement sections might result in increased maintenance costs and lower than anticipated pavement life.

If the local jurisdiction requires a thicker pavement section (i.e. if any public right-of-way work will occur), then the roadway should be constructed to meet their section. We expect that your project Civil Engineer will be able to provide comment on this.

Prior to placing the base or leveling course, paving surfaces should be prepared as discussed in Section 3.2 of this report. Areas found to be soft by the Geotechnical Engineer's representative during the proof-rolling activities (i.e. deflecting/rutting more than about 1-inch under the weight of the fully loaded, rubber tire dump truck or water truck) should be overexcavated to expose firm and unyielding soils and replaced with structural fill as defined by Section 4.3 of this report.

Asphalt pavement base course material should consist of a well-graded, 1½-inch or ¾-inch-minus, crushed rock, having less than 5 percent material passing the No. 200 sieve. The base course and asphaltic concrete materials should conform to the requirements set forth in the latest edition of the State of Oregon's Standard Specifications for Highway Construction. Base course material should be moisture conditioned to within ± 2 percent of optimum moisture content, and compacted to a minimum of 95 percent of the material's maximum dry density as determined in accordance with ASTM D1557 (Modified Proctor). Fill materials should be placed in layers that, when compacted, do not exceed about 8 inches. Asphaltic concrete material should be compacted to at least 91 percent of the material's theoretical maximum density as determined in accordance ASTM D2041 (Rice Specific Gravity).

We have assumed the subgrade soils will be prepared to a California Bearing Ratio (CBR) of at least 8. We have also assumed a pavement life of 20 years, a terminal serviceability of 2.0 (poor condition), and traffic loading of 5 and 25 daily Equivalent 18-kip Single Axle Loads (ESALS) for parking and drive lanes, respectively. The project Civil Engineer should review our traffic loading assumptions and notify us if they need to be revised. Making these assumptions, it is possible to use a locally typical "standard" pavement section consisting of the following:

Table 4: Asphalt Pavement Section Thickness Recommendations for Roadways

	Thickness Recommendations (inches)	
Pavement Materials	Parking	Drive Lanes
Asphalt Surface Course	2.5	3
Crushed Stone Base	8	10

The design pavement section noted above may be placed after the prepared (i.e. compacted) subgrade has been proofrolled and approved. The work should be done in accordance with Oregon Department of Transportation guidelines.

Where the pavement base rock will be placed on silt soils, we recommend consideration of a geotextile fabric (i.e. Mirafi 500X or equivalent) to extend the pavement life. The intent of the geotextile is to reduce the risk of base rock contamination by the underlying fine-grained soils and also to provide additional section strength to resist the effects of the expansive soils. To be clear, the geotextile is optional and not a requirement. Ultimately, the project budget constraints will likely dictate whether the geotextile can be included.

Water should not be allowed to pond behind curbs and saturate the base materials. If the base material consists of granular fill, it should extend through the section and underneath the curb to allow any water entering the base stone a path to exit. Again, as stated above, if water is allowed to sheet flow off of the edge of the pavement; the pavement edges shall be armored to prevent erosion at the edge of the pavement.

3.7 Retaining Wall Recommendations

At this time, we are not aware of specific retaining wall plans. As such, we are providing preliminary retaining wall recommendations. Once specific retaining wall plans are known, we should be provided that information so that we can review our retaining wall recommendations and update/revise them as necessary. Preliminarily, we anticipate tall building stem walls may need to be designed as retaining walls on some of the sloping areas. In addition, there may be landscape retaining walls to terrace portions of the development.

Retaining wall footings should be designed in general accordance with the recommendations contained in Section 3.4 above and the slope setback recommendations in Section 4.1. Lateral earth pressures on walls, which are not restrained at the top, may be calculated on the basis of an “active” equivalent fluid pressure of 35 pcf for level backfill, and 60 pcf for sloping backfill with a maximum 2H:1V slope. Lateral earth pressures on walls that are restrained from yielding at the top (i.e. stem walls) may be calculated on the basis of an “at-rest” equivalent fluid pressure of 55 pcf for level backfill, and 90 pcf for sloping backfill with a maximum 2H:1V slope. The stated equivalent fluid pressures do not include surcharge loads, such as foundation, vehicle, equipment, etc., adjacent to walls, hydrostatic pressure buildup, or earthquake loading. Surcharge loads on walls should be calculated based on the attached calculations/formulas shown in Appendix H.

For seismic loading on retaining walls with level backfill, new research indicates that the seismic load is to be applied at 1/3 H of the wall instead of 2/3 H, where H is the height of the wall[3]. We recommend that a Mononobe-Okabe earthquake thrust per linear foot of 9.1 psf* H^2 be applied at 1/3 H for level backfill.

Backfill for retaining walls should be select granular material, such as sand or crushed rock with a maximum particle size between ¾ and 1 ½ inches, having less than 5 percent material passing the No. 200 sieve. Because of their fines content, the native soils do not meet this requirement, and it will be necessary to import material to the project for structure backfill. As stated previously, the native elastic silt should be removed from within 4 feet of the back of retaining walls to reduce stresses from potentially expansive soils. **It’s possible that we may be able to reduce the 4-foot recommendation during construction if it turns out certain retaining walls are supporting the siltstone stratum instead of the expansive elastic silt soils. This will have to be determined by our geotechnical inspector during construction when the soils behind the new walls are exposed.**

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[3] Lew, M., et al (2010). “Seismic Earth Pressures on Deep Building Basements,” SEAOC 2010 Convention Proceedings, Indian Wells, CA.

Silty soils can be used for the last 18 to 24 inches of backfill, thus acting as a seal to the granular backfill. All backfill behind retaining walls should be moisture conditioned to within ± 2 percent of optimum moisture content, and compacted to a minimum of 90 percent of the material's maximum dry density as determined in accordance with ASTM D 1557. Fill materials should be placed in layers that, when compacted, do not exceed about 8 inches. Care in the placement and compaction of fill behind retaining walls must be taken in order to ensure that undue lateral loads are not placed on the walls.

An adequate subsurface drain system will need to be designed and installed behind retaining walls to prevent hydrostatic buildup. A waterproofing system should be designed for any basement walls where moisture intrusion is not desirable.

4.0 CONSTRUCTION CONSIDERATIONS

EEI should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. EEI cannot accept any responsibility for any conditions that deviate from those described in this report, nor for the performance of the foundations if not engaged to also provide construction observation for this project.

4.1 Moisture Sensitive Soils/Weather Related Concerns

The upper soils encountered at this site are expected to be sensitive to disturbances caused by construction traffic and to changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

Exposed fine grained soils can be extremely sensitive to moisture and should be protected with a layer granular fill (at least 2 inches thick) if the excavations are to be left open during periods of wet weather.

4.2 Drainage, Groundwater, and Stormwater Considerations

Water should not be allowed to collect in the foundation excavations or on prepared subgrades for the floor slab during construction. Positive site drainage should be maintained throughout construction activities. Undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater, or surface runoff.

The site grading plan should be developed to provide rapid drainage of surface water away from the building areas and to inhibit infiltration of surface water around the perimeter of the buildings, floor slabs, and pavement. As stated previously, we do not recommend using infiltration within 25 feet of slopes 2H:1V or steeper, nor anywhere up-slope of the cliff. The grades should be sloped away from the building areas. We anticipate stormwater runoff will be routed to a detention facility, treated, and then discharged to the seasonal drainage in the northwest corner of the property via a solid pipe. The outlet should be adequately armored to prevent erosion. In no case should stormwater be allowed to point discharge directly onto site slopes. Alternatively, runoff from the building roofs could be discharged upon a paved surface adjacent to the buildings and allowed to sheet flow away from the building. Provided the water stays in a sheet flow condition (and does not require treatment) it may also be allowed to sheet flow off of the pavement, as long as it is not directed toward slopes steeper than 2H:1V or the cliff area. Adequate armoring of the edge of pavement is advised to prevent erosion at the pavement edges.

4.3 Excavations

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". This document and subsequent updates were issued to better ensure the safety of workmen entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavations or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

We are providing this information solely as a service to our client. EEI does not assume responsibility for construction site safety or the contractor's compliance with local, state, and federal safety or other regulations.

4.4 Supplemental Geotechnical Services to be Performed during the Design and Construction Phases

We recommend the following geotechnical-related items be performed:

A. During the design phase, review the final design documents. Issue a supplemental geotechnical report stating whether the design complies with our geotechnical recommendations.
B. During construction, verify topsoil stripping has been performed under all structures (i.e. roadways, buildings, retaining walls) and that the test pits conducted during our subsurface investigation have been properly backfilled with structural fill.
C. During construction, inspect all excavated native subgrade for structures (i.e. buildings and pavement).
D. During construction, inspection and test all structural fill.
E. During construction, approve all footing subgrade bearing surfaces just prior to the placement of concrete.
F. During construction, inspect all retaining wall backfill and drainage.

5.0 REPORT LIMITATIONS

As is standard practice in the geotechnical industry, the conclusions contained in our report are considered preliminary because they are based on assumptions made about the soil, rock, and groundwater conditions exposed at the site during our subsurface investigation. A more complete extent of the actual subsurface conditions can only be identified when they are exposed during construction. Therefore, EEI should be retained as your consultant during construction to observe the actual conditions and to provide our final conclusions. If a different geotechnical consultant is retained to perform geotechnical inspection during construction then they should be relied upon to provide final design conclusions and recommendations, and should assume the role of geotechnical engineer of record, as is the typical procedure required by the governing jurisdiction.

The geotechnical recommendations presented in this report are based on the available project information, and the subsurface materials described in this report. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, EEI should be notified immediately to determine if changes in the foundation recommendations are required. If EEI is not retained to review these changes, we will not be responsible for the impact of those conditions on the project.

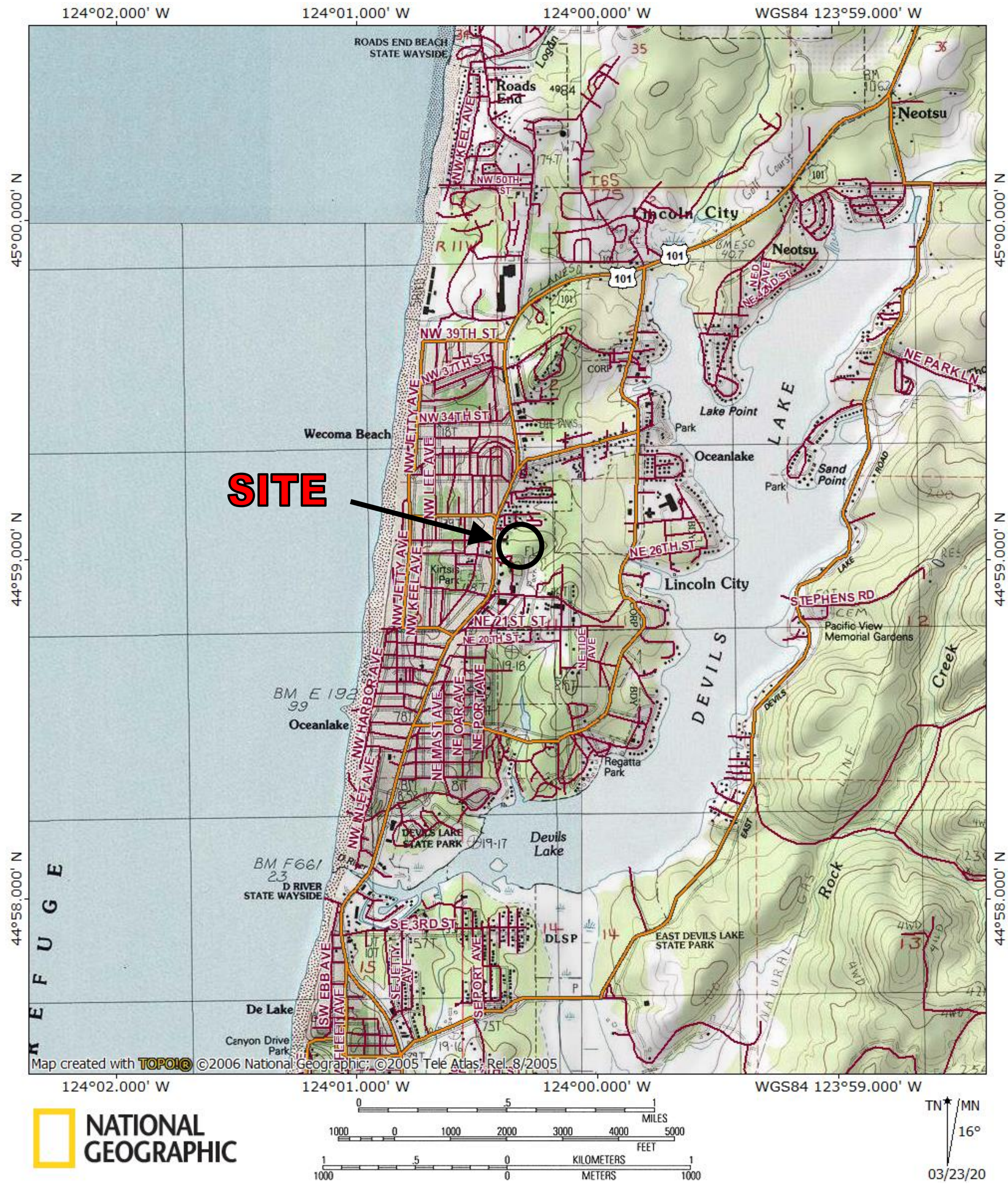
The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the Geotechnical Engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents.

This report has been prepared for the exclusive use of Innovating Housing, Inc. for the specific application to the proposed apartment complex to be located on Lincoln County tax lots 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00 accessed by 25th Street in Lincoln City, Lincoln County, Oregon. EEI does not authorize the use of the advice herein nor the reliance upon the report by third parties without prior written authorization by EEI.

APPENDICES

APPENDIX A – SITE LOCATION PLAN



Source: National Geographic TOPO! Software

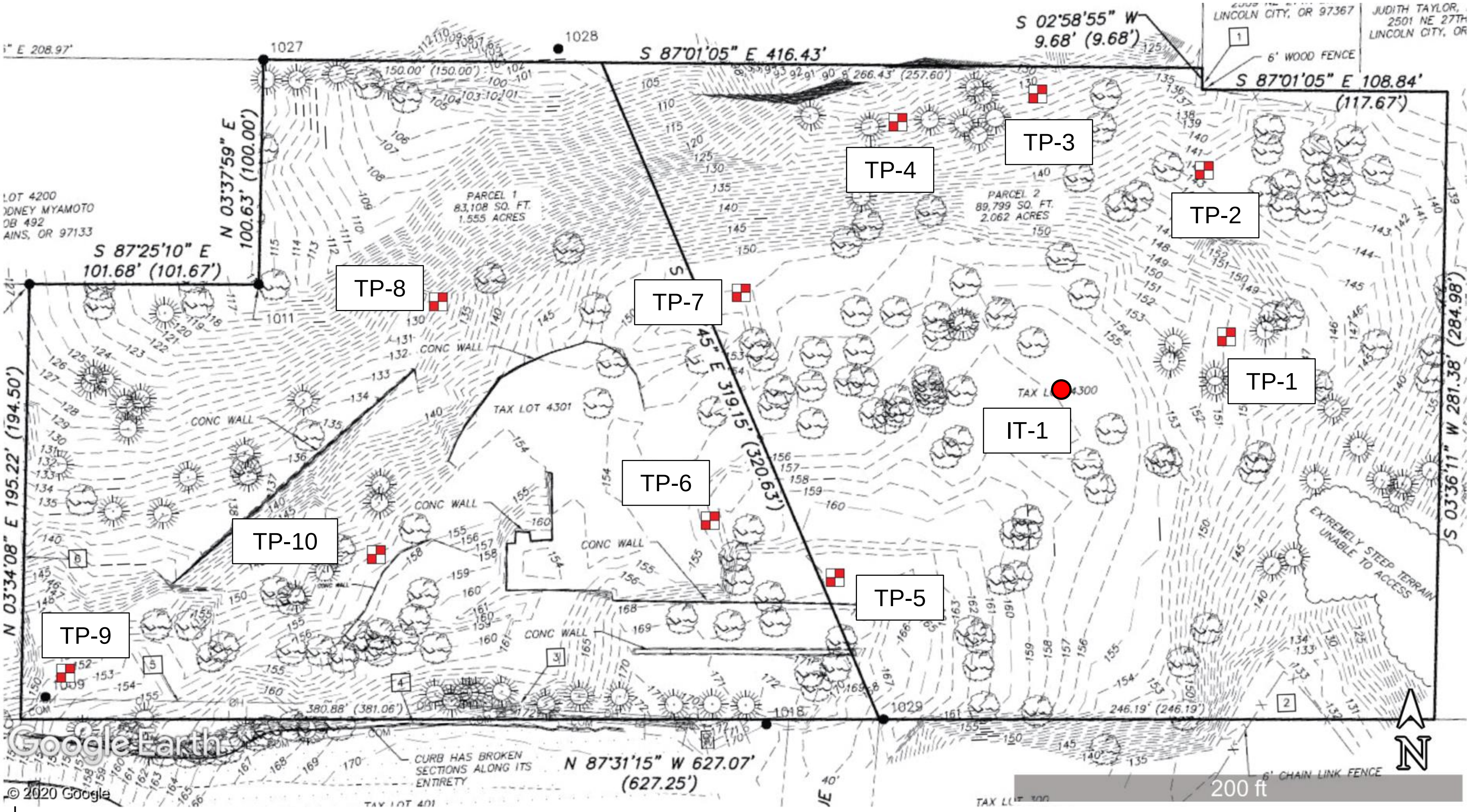
Earth Engineers, Inc.

Proposed Apartment Complex
Northeast 25th Street
Lincoln City, Lincoln County, Oregon

Report No. 20-047-1

April 28, 2020

APPENDIX B – EXPLORATION LOCATION PLAN



▨ = Approximate Test Pit Location

Base map source: Topographic Survey prepared by Emerio Design, dated 4/10/2020

● = Approximate Infiltration Test Location

Earth Engineers, Inc.	**Proposed Apartment Complex** **Northeast 25th Street** **Lincoln City, Lincoln County, Oregon**	**Report No. 20-047-1**	**April 28, 2020**

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Appendix C: Test Pit TP-1

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 151'

		Lithology		Sampling Data							
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0			TOPSOIL - dark brown silty clay, moist with some siltstone fragments and organics (2 feet thick).								
1											
2			ELASTIC SILT with Sand (MH) - dark brown, clayey silt with siltstone fragments, moist.	GRAB-1				66	1.50		PID Reading: 0.0
3			SILTSTONE - tan with rust staining siltstone, friable, moderately fractured, highly weathered.								
4				GRAB-2				78			PID Reading: 0.0
5											
6											
7											
8											
9											
10											

Notes : Test pit terminated at a depth of approximately 7 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

Earth Engineers, Inc.

Appendix C: Test Pit TP-2

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 142'

Depth (ft)	Water Level	Lithology		Sampling Data							
		Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0		▒	TOPSOIL - dark brown silty clay, moist with some siltstone fragments and organics (18 inches thick).								
1		▒									
		▥	ELASTIC SILT with Sand (MH) - dark brown to brown, clayey silt with siltstone fragments, moist.								
2		▥									
		▥		GRAB-1				71	1.50		PID Reading: 0.0
3		▥									
4		▤	SILTSTONE - tan with rust staining siltstone, friable, moderately fractured, highly weathered.								
5											
6											
7											
8											
9											
10											

Notes : Test pit terminated at a depth of approximately 5 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

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Appendix C: Test Pit TP-3

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 131'

		Lithology		Sampling Data							
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0			TOPSOIL - dark brown silty clay, moist with some siltstone fragments and organics (2 feet thick).								
1											
2			ELASTIC SILT with Sand (MH) - dark brown to brown, clayey silt with siltstone fragments, moist.								
3											
			SILTSTONE - tan with rust staining siltstone, friable, moderately fractured, highly weathered.								
4											
5											
6											
7											
8											
9											
10											

Notes : Test pit terminated at a depth of approximately 4.5 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

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Appendix C: Test Pit TP-4

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 128'

Depth (ft)	Water Level	Lithology		Sampling Data							
		Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0			TOPSOIL - dark brown silty clay, moist with some siltstone fragments and organics (18 inches thick).								
1											
			ELASTIC SILT with Sand (MH) - medium brown to dark brown, clayey silt with siltstone fragments, moist.								
2											
3				GRAB-1				64	2.00		PID Reading: 0.0
4											
			SILTSTONE - tan with rust staining siltstone, friable, moderately fractured, highly weathered.								
5											
6				GRAB-2				59			PID Reading: 0.0
7											
8											
9											
10											

Notes : Test pit terminated at a depth of approximately 7 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

Earth Engineers, Inc.

Appendix C: Test Pit TP-5

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 163'

		Lithology		Sampling Data							
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0			TOPSOIL - dark brown silty clay, moist with some siltstone fragments and organics (8 inches thick).								
			FILL - topsoil mixed with brown clayey silt and weatherd siltstone.								
1				GRAB-1				52	1.50		PID Reading: 0.0
			SILTSTONE - tan with rust staining siltstone, friable, moderately fractured, highly weathered.								
2											
3											
			Siltstone becomes hard								
4											
5											
6											
7											
8											
9											
10											

Notes : Test pit terminated at a depth of approximately 4 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

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Appendix C: Test Pit TP-6

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 157'

		Lithology		Sampling Data							
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0		▨	FILL - topsoil mixed with brown clayey silt.								
1		▨									
2		▤	SILTSTONE - tan with rust staining siltstone, friable, moderately fractured, highly weathered.								
3		▤									
4											
5											
6											
7											
8											
9											
10											

Notes : Test pit terminated at a depth of approximately 4 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

Earth
Engineers,
Inc.

Appendix C: Test Pit TP-7

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and
07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 152'

		Lithology		Sampling Data							
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0			TOPSOIL - dark brown, wet, silt with sand, roots and decomposed organics (18 inches thick).								
1											
2				GRAB-1				68	0.75		PID Reading: 0.0
			ELASTIC SILT with Sand (MH) - brown, clayey silt, moist.								
3				GRAB-2	94	80	56	64			PID Reading: 0.0
4											
5											
6											
7											
8											
9				GRAB-3				61	2.00		PID Reading: 0.0
10											

Notes : Test pit terminated at a depth of approximately 9.5 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

Earth Engineers, Inc.

Appendix C: Test Pit TP-8

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 131'

		Lithology		Sampling Data							
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0		▨	FILL - topsoil mixed with brown clayey silt and tan siltstone.								
1											
2											
3											
4											
5											
6											
				GRAB-1				70			PID Reading: 0.0
7											
8											
9											
10											

Notes : Test pit terminated at a depth of approximately 8.5 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

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Engineers,
Inc.

Appendix C: Test Pit TP-9

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 152'

Depth (ft)	Water Level	Lithology		Sampling Data							
		Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0		▨	ASPHALT - 2 inches of asphalt over 4 inches of gravel.								
		▨	Fill - mixed of dark brown silt and brown silty clay								
1		▨									
2		▥	ELASTIC SILT with Sand (MH) - brown, clayey silt with siltstone fragments, moist.								
		▥		GRAB-1				42	1.50		PID Reading: 0.0
3		▥									
4		▥									
5		▥									
6		▥	Becomes gray with rust mottling								
		▥		GRAB-2	91	80	56	53			PID Reading: 0.0
7											
8											
9											
10											

Notes : Test pit terminated at a depth of approximately 7 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

Earth Engineers, Inc.

Appendix C: Test Pit TP-10

Sheet 1 of 1

Client: Innovative Housing, Inc.
Project: 25th Street Apartments
Site Address: Tax Lots: 07-11-11-BB-04302-00 and 07-11-11-BB-04300-00, Lincoln Ciry, Lincoln County, Oregon
Location of Test Pit: See Appendix B
Date Excavated: 3/20/2020
Logged By: Ken Andrieu, R.G.

Report Number: 20-047-1
Excavation Contractor: Dan Fisher
Excavation Method: Excavator with 2-foot toothed bucket
Excavation Equipment: ZAXIS 40U
Approximate Elevation (ft msl): 154'

Depth (ft)	Water Level	Lithology		Sampling Data							
		Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Moisture Content (%)	Pocket Pen (tsf)	Torvane Shear (tsf)	Remarks
0		▨	TOPSOIL - dark brown, wet, silt with sand, roots and decomposed organics (6 inches thick).								
		▥	ELASTIC SILT with Sand (MH) - dark brown to brown, clayey silt with siltstone fragments, moist.								
1				GRAB-1				65	2.00		PID Reading: 0.0
2											
3				GRAB-2				46	2.00		PID Reading: 0.0
4											
5											
6											
7											
8											
9											
10											

Notes : Test pit terminated at a depth of approximately 10 feet bgs. Groundwater was not encountered at the time of our exploration. Test pit loosely backfilled with excavated soil on 3/20/2020. Elevations based on the topographic survey prepared by Emerio Design, Dated 4/10/2020.

APPENDIX E:
HISTORICAL WELL LOGS

16

LINC 1781

JAN 19 1993
WATER RESOURCES DEPT.
SALEM, OREGON

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)

7S/ 11W / 11 bc

Start Card # 44225

(1) OWNER/PROJECT:

WELL NO. MW #9

Name Unocal

Address P.O. Box 76

City Seattle State WA Zip 98111

(2) TYPE OF WORK:

☑ New construction ☐ Repair ☐ Recondition
☐ Conversion ☐ Deepening ☐ Abandonment

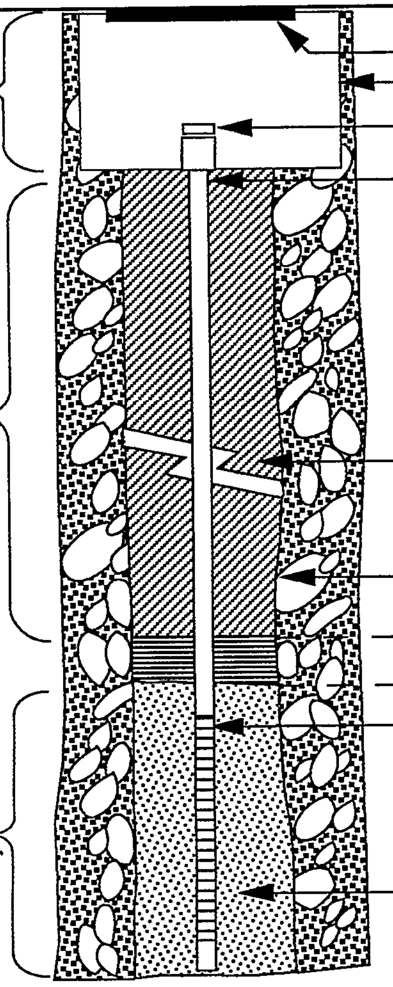
(3) DRILLING METHOD

☐ Rotary Air ☐ Rotary Mud ☐ Cable
☑ Hollow Stem Auger ☐ Other

(4) BORE HOLE CONSTRUCTION

Special Standards Yes ☐ No ☒

Depth of completed well 25 ft.



Vault 0 ft. TO 1 ft.

Seal 1 ft. TO 4 ft.

Filter pack 4 ft. TO 25 ft.

Casing diameter 2" in.
material P.V.C.
Welded ☐ Threaded ☑ Glued ☐

Liner diameter N/A in.
material
Welded ☐ Threaded ☐ Glued ☐

Well seal:
Material Bentonite
Amount 5 50LB SACKS

Borehole diameter 8" in.

Screen material P.V.C.
interval(s):
From 5 To 25
From To
Slot size .020 in.

Filter pack:
Material Silica Sand
Size 8-12 in.

(5) WELL TEST:

☐ Pump ☒ Bailer ☐ Air ☐ Flowing Artesian

Permeability Yield GPM

Conductivity PH

Temperature of water 14°C F/C Depth artesian flow found ft.

Was water analysis done? ☒ Yes ☐ No

By whom? Geo. Engineers

Depth of strata to be analyzed. From 23 ft. to 25 ft.

Remarks:

Name of supervising Geologist/Engineer Nancy EAST

(6) LOCATION OF WELL By legal description

Well Location: County Lincoln

Township 7S (N or [✓ S]) Range 11 W (E or [✓ W]) Section 11

1. SW 1/4 of NW 1/4 of above section.

2. Street address of well location 2510 U.S. Hwy 101 Lincoln City, OR

3. Tax lot number of well location 220430100

4. ATTACH MAP WITH LOCATION IDENTIFIED.

(7) STATIC WATER LEVEL:

23' Ft. below land surface. Date 12-28-92

Artesian Pressure lb/sq. in. Date

(8) WATER BEARING ZONES:

Depth at which water was first found 23'

From	To	Est. Flow Rate	SWL
23'	25'	?	23'

(9) WELL LOG:

Ground elevation

Material	From	To	SWL
MEDIUM CRUSHED	0"	7'	
GRAVEL, Loose, MOIST			
Dark Brown silt w/trace	7'	14'	
organics, medium stiff moist			
Mottled tan and	14'	22'	
orange fractured			
siltstone, hard, moist			
weathered bedrock			
Gray siltstone, hard,	22'	25'	23'
moist to wet			

Date started 12-28-92 Completed 12-28-92

(unbonded) Monitor Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to the best knowledge and belief.

MWC Number

Signed Date

(bonded) Monitor Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

MWC Number 10013

Signed Randy L. Crisman Date 1-14-93

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

16

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)

LINC 1782

JAN 19 1993
WATER RESOURCES DEPT
SALEM, OREGON

7S/11W/11bc

Start Card # 44226

(1) OWNER/PROJECT:
WELL NO. MW#10

Name Unocal

Address P.O. Box 76

City Seattle State WA Zip 98111

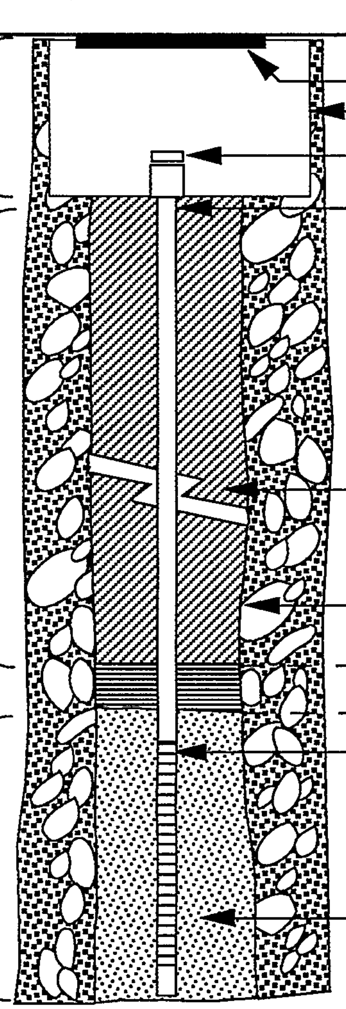
(2) TYPE OF WORK:
☑ New construction ☐ Repair ☐ Recondition

☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD
☐ Rotary Air ☐ Rotary Mud ☐ Cable

☑ Hollow Stem Auger ☐ Other

(4) BORE HOLE CONSTRUCTION
Special Standards Yes ☐ No ☒ Depth of completed well 35 ft.



Vault 0 ft. TO 1 ft.

Seal 1 ft. TO 4 ft.

Filter pack 4 ft. TO 35 ft.

Casing diameter 2" in. material P.V.C.

Welded ☐ Threaded ☒ Glued ☐

Liner diameter N/A in. material

Welded ☐ Threaded ☐ Glued ☐

Well seal: Material Bentonite Amount 5

Borehole diameter 8 in.

Screen material Bentonite interval(s): From 0 To

From 18 To 35

Slot size .020 in.

Filter pack: Material Silica Sand Size 8/12 in.

(5) WELL TEST:
☐ Pump ☒ Bailer ☐ Air ☐ Flowing Artesian

Permeability Yield GPM

Conductivity PH

Temperature of water 14°C F/C Depth artesian flow found ft.

Was water analysis done? ☒ Yes ☐ No

By whom? Geo. Engineers

Depth of strata to be analyzed. From 23 ft. to 35 ft.

Remarks:

Name of supervising Geologist/Engineer Nancy EAST

(6) LOCATION OF WELL By legal description
Well Location: County Lincoln

Township 7S (N or [✓ S]) Range 11W (E or [✓ W]) Section 11

1. SW 1/4 of NW 1/4 of above section.

2. Street address of well location 2510 U.S. Hwy 101 Lincoln City, OR

3. Tax lot number of well location 2204 30100

4. ATTACH MAP WITH LOCATION IDENTIFIED.

(7) STATIC WATER LEVEL:
23' Ft. below land surface. Date 12-28-92

Artesian Pressure lb/sq. in. Date

(8) WATER BEARING ZONES:
Depth at which water was first found 23'

From	To	Est. Flow Rate	SWL
23'	30'	?	23'

(9) WELL LOG:
Ground elevation

Material	From	To	SWL
Asphalt pavement	0"	6"	
Crushed medium to	6"	3'	
large angular gravel			
dense, moist			
Dark Brown silt w/	3'	8'	
trace organics, very			
stiff, moist			23'
Mottled tan & orange	8'	26'	
fractured siltstone			
very stiff to hard, moist			
weathered bedrock			
Gray Siltstone	26'	30'	
hard, wet			

Date started 12-28-92 Completed 12-28-92

(unbonded) Monitor Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to the best knowledge and belief.

MWC Number

Signed Date

(bonded) Monitor Well Constructor Certification:

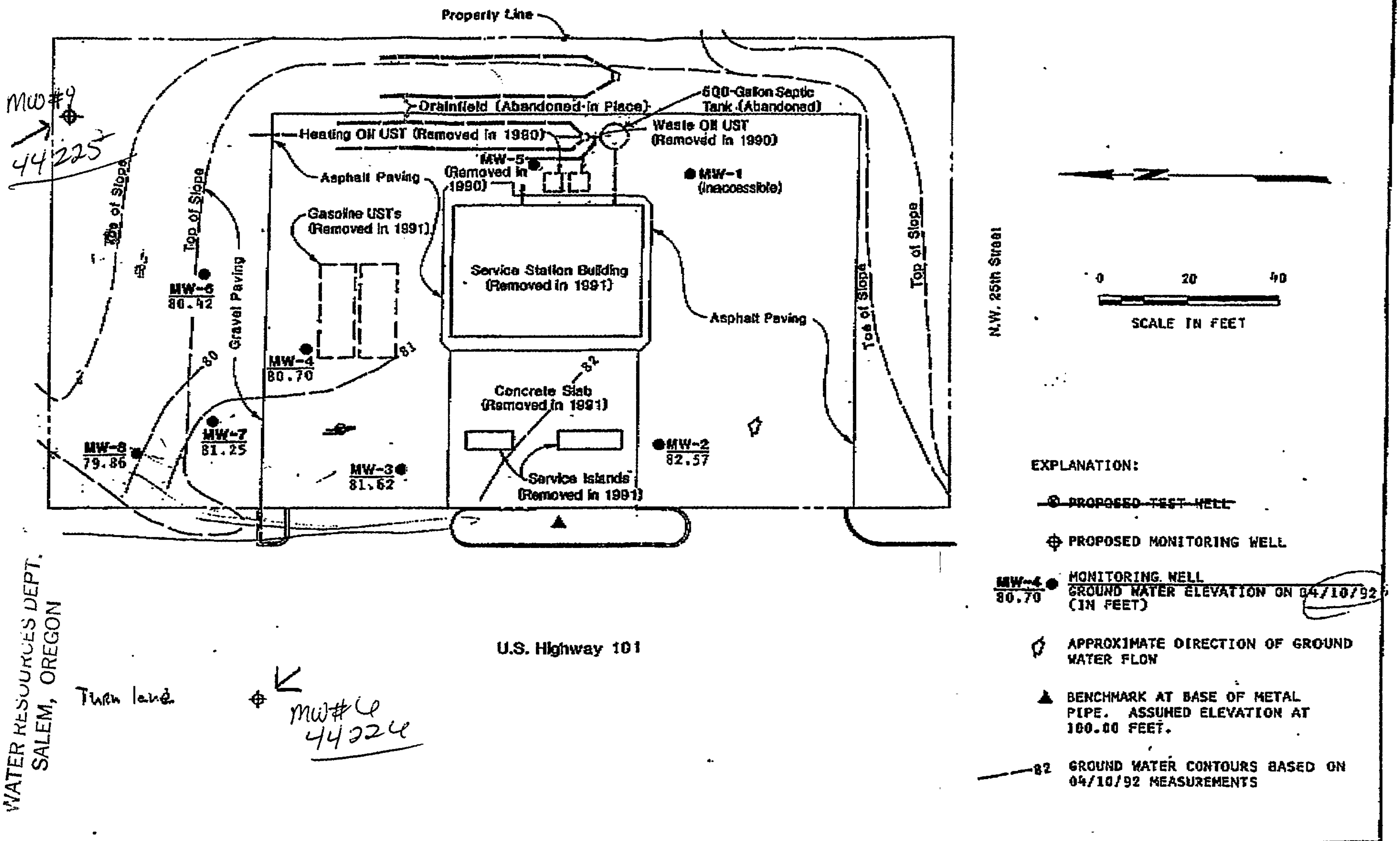
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

MWC Number 10013

Signed Randy J. Ouman Date 1-14-93

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

RECEIVED
JAN 19 1993
WATER RESOURCES DEPT.
SALEM, OREGON



REFERENCE: DRAWING ENTITLED "GENERAL ARRANGEMENT, SERVICE STATION 4946, HWY 101 & SCENIC STREET, LINCOLN CITY, ORE.," DATED 7/2/62, BY UNOCAL.

GeoEngineers

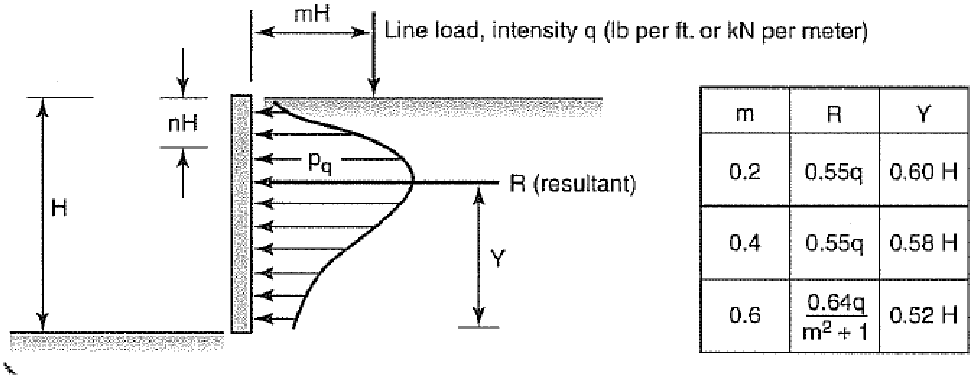
SITE PLAN

FIGURE 2

APPENDIX F:
LATERAL EARTH PRESSURES FOR WALL DESIGN

APPENDIX F: SURCHARGE-INDUCED LATERAL EARTH PRESSURES FOR WALL DESIGN

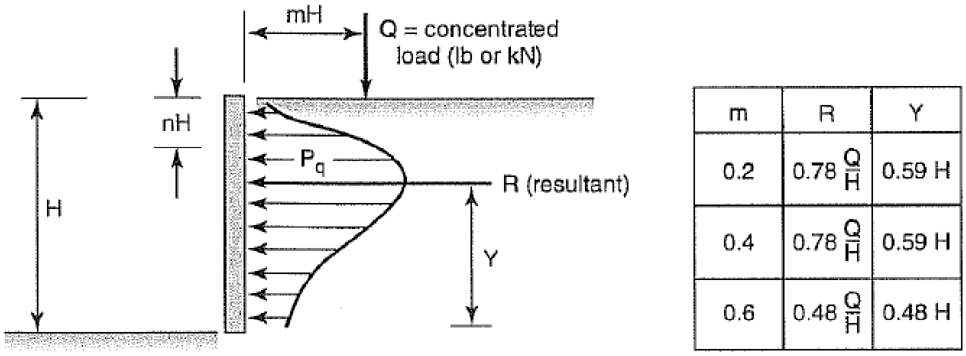
LINE LOAD (applicable for retaining walls not exceeding 20 feet in height):



m	R	Y
0.2	0.55q	0.60 H
0.4	0.55q	0.58 H
0.6	$\frac{0.64q}{m^2+1}$	0.52 H

Figure 16-28 Pressure distribution against vertical wall resulting from line load of intensity *q*.

CONCENTRATED POINT LOAD (applicable for retaining walls not exceeding 20 feet in height):



m	R	Y
0.2	$0.78\frac{Q}{H}$	0.59 H
0.4	$0.78\frac{Q}{H}$	0.59 H
0.6	$0.48\frac{Q}{H}$	0.48 H

Figure 16-27 Pressure distribution against vertical wall resulting from point load, *Q*.

AREAL LOAD:

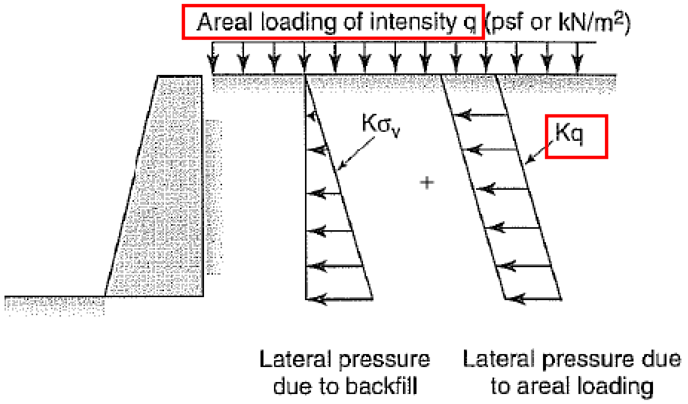
Figure 16-26 Influence of areal loading on wall pressures.

use K=0.4 for active condition (i.e. top of wall allowed to deflect laterally)

use K=0.9 for at-rest condition (i.e. top of wall not allowed to deflect laterally)

Resultant, R = K * q * H

Where H = wall height (feet)



Source of Figures: McCarthy, D.F., 1998, "Essentials of Soil Mechanics and foundations, Basic Geotechnics, Fifth Edition."

Earth Engineers, Inc.

Proposed Apartment Complex
Northeast 25th Street
Lincoln City, Lincoln County, Oregon

EEI Report No. 20-047-1

April 28, 2020