Notes from Foundation Engineering, Inc Preliminary Geotechnical Investigation
Stamped report dated July 23rd, final draft received 8/2/2021

The boring extended to a depth of ±66.5 feet. Samples were retained at 2½-foot intervals to a depth of ±20 feet and typically at 5-foot intervals thereafter. Soil samples were obtained in conjunction with Standard Penetration Testing (SPT). The SPT provides an indication of the relative stiffness, or density, of the foundation soils. The number of blows required to drive the sampler the final 12 inches of an 18-inch long drive is recorded and represents the standard penetration resistance, or N-value, in blows per foot (bpf).

The subsurface conditions are relatively consistent to a depth of ±66.5 feet, the maximum depth of our exploration. The soils consist of predominantly light brown, fine sand with trace to some silt (Quaternary dune sand). This soil unit is consistent with the locally mapped geology, which suggests the area is underlain by sand to a depth of ±127 feet followed by sedimentary bedrock (Schlicker et al., 1972).

The recorded SPT N-values included on the appended log show a trend of increasing soil density with depth.

Mud-rotary drilling methods precluded an accurate groundwater measurement in BH-1 at the time of drilling. However, we noted the retained samples were damp to moist to a depth of 60 feet and moist to wet thereafter. This information suggests groundwater was likely present at a depth between ±51.5 and 60 feet at the time of our investigation.

Fault Rupture
We reviewed local geologic maps and the USGS Interactive Fault Map to identify potentially active crustal faults at and surrounding the project area. The available data indicates no known potentially active crustal faults or mapped faults extend beneath the project site (Schlicker et al., 1972; Niem and Niem, 1985; USGS, 2006). The nearest mapped potentially active crustal faults (Class A) are the Cascadia Fold and Fault Belt and unnamed offshore faults scattered within ±5 miles west of the site (USGS, 2006).

Liquefaction
Liquefaction is typically observed in saturated deposits of loose sand and non-plastic or low plasticity silt (i.e., a PI of less than 8) subjected to intense ground shaking. The soils underlying the site include loose sand to ±12.5 feet, followed by medium dense sand to ±50 feet, and dense to very dense sand at greater depths. The static groundwater is anticipated to be below a depth of ±50 feet. Therefore, the loose sandy soils are well above the anticipated groundwater level and these soils are not expected to become saturated enough to exhibit liquefaction.
We completed a preliminary liquefaction analysis based on the soil profile encountered in BH-1. We assumed a groundwater level at a depth of ±50 feet. The analysis suggests the dense to very dense sand encountered below ±50 feet is not susceptible to liquefaction.

Lateral Spread

Lateral spread is a liquefaction-induced hazard, which occurs when soil or blocks of soil are displaced down slope or toward a free face along a liquefied layer. The liquefaction hazard at the site is considered low. Therefore, the lateral spread hazard at the site should also be considered low.

Settlement of Unsaturated Soils

Settlement of unsaturated granular soils can occur under seismic loading due to soil densification. SPT N-values in the sand above the assumed static groundwater level (i.e., the upper ±50 feet of the soil profile) ranged from ±5 to 29 bpf indicating a loose to medium dense consistency. This material may be susceptible to settlement or densification under seismic loading. Additional drilling during the Phase 2 work will confirm the thickness and density of the sand above the groundwater level.

Landslides and Earthquake-Induced Landslides (Slope Stability)

The existing topography at the site is relatively flat with a gentle slope to the west and a steep slope to the east. No landslide or slope instability features were observed on site during our reconnaissance. DOGAMI's references, including LiDAR, also indicate no historic landslide inventory or mapped landslides at the site with a mostly low landslide susceptibility with isolated moderate susceptibility (DOGAMI, 2016, 2017, 2018).

We completed a preliminary evaluation of the slope stability of the east slope under static and seismic loads using limit equilibrium analysis with pseudo-static loading. The analysis was completed using the program SLIDE by Rocscience. Limits to the minimum Factor of Safety (FS) search were established to preclude the selection of shallow failure surfaces. The limits were set requiring the top of the failure surface to be set back from the crest of the slope and lower portion of the failure surface to pass through the toe of the slope.

The results suggest relatively high FS for static slope stability. However, a shallow slope failure in the loose sand stratum may occur under seismic loading. Additional explorations should be completed during the Phase 2 work to refine the thickness of the loose sand and evaluate the required slope setback distance for the proposed facilities.

Subsidence

Seismic-ground subsidence is a regional phenomenon resulting from a large magnitude earthquake generated from a subduction source, such as the CSZ. It occurs because the subduction of the oceanic crust beneath the continental crust compresses the continental crust and pushes it upward. Prior to the earthquake, the continental crust is held in this position by friction at the interface. The frictional bond breaks when the earthquake occurs, allowing the continental crust to drop.

The hazard map included in the Oregon Resilience Plan indicates ground subsidence in the project area could range from ±4 to 6 feet for a Mw 9 earthquake (OSSPAC, 2013). Ground subsidence cannot be mitigated. Therefore, it should be assumed the ground surface in the project area may drop up to 6 feet during a large CSZ interface earthquake.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

Based on the preliminary geotechnical investigation described above, we have concluded the following:

1. Our preliminary investigation suggests there are several geologic or geotechnical hazards associated with building on the Oregon Coast, however, these hazards do not necessarily preclude building at the proposed site. Potential geologic hazards include ground motion amplification, settlement of non-liquefiable soil, slope stability, subsidence, and tsunami inundation. Full mitigation of these hazards is not practical. Therefore, risks from these hazards will need to be accepted for the construction of the proposed facilities. A more detailed analysis of the geologic and seismic hazards should be completed as part of a site-specific hazard study during the design-phase work, once the location, type and size of the facility is known. Additional explorations will be necessary to refine our preliminary analyses and provide detailed mitigation recommendations.

2. The site can be used for the planned development. However, densification of the upper loose sand is recommended to improve the bearing resistance of the soil and reduce potential settlement due to both static foundation loads and seismic ground shaking.
For planning and budgeting purposes, assume mitigation of loose sand will be required beneath building foundations and any settlement-sensitive hardscapes. The mitigation should be relatively straightforward and consist of excavating the sand to a depth of ±10 feet, moisture-conditioning the sand, and placing it back into the excavation and mechanically compacting it in lifts.

3. Conventional shallow foundations (i.e., spread footings and continuous wall footings) should be suitable to support the proposed facilities after the recompaction of the loose soil is completed.

4. Groundwater is not expected to be a critical geotechnical issue.

5. Additional exploratory drilling is recommended to evaluate the limits of overexcavation for the proposed facilities and provide detailed site grading and foundation design and construction recommendations.

Foundation Engineering, Inc.
Professional Geotechnical Services

Memorandum

Date: July 23, 2021

To: Chad Sweet, City Administrator
City of Gearhart

From: Mallory L. McAdams, E.I.T.
Brooke Running, R.G., C.E.G.
James K. Maitland, P.E., G.E.

Subject: Preliminary Geotechnical Investigation

Project: The Cottages Emergency Operations Police/Fire Station
Project No.: 2211058

This memorandum summarizes our findings from a preliminary geotechnical investigation for the above-referenced project. Details of our work, a description of subsurface conditions, and a discussion of geologic and geotechnical hazards are provided below. Preliminary conclusions regarding the suitability of the site for the proposed facilities and recommendations for future design-phase work are also provided.

BACKGROUND

Preliminary planning is underway for a new emergency operations police/fire station in Clatsop County, near Gearhart, Oregon. The proposed location is on an undeveloped parcel located south of Highlands Lane and west of Highway 101. The project location is shown on Figure 1A (Appendix A). A topographic map of the project area, prepared by CKI, Inc. is shown on Figure 2A (Appendix A).

The City of Gearhart is the project owner. The City retained Foundation Engineering, Inc. as the geotechnical consultant. The focus of our work was to identify potential geotechnical concerns that would impact the construction of the proposed facilities. Our scope of work was outlined in a proposal dated June 21, 2021, and subsequently authorized by a signed agreement.

There are numerous values in geotechnical investigations that are approximate, including calculated values, measured lengths, soil layer depths and elevations, and strength measurements. For brevity, the symbol "±" is used throughout this memorandum to represent the words approximate or approximately.

PURPOSE

This preliminary geotechnical investigation is part of the due-diligence process and focuses on site conditions that may preclude the construction of the planned development. It is assumed additional geotechnical work will be completed at a later date to provide more detailed geotechnical recommendations after the actual size, location, and layout of the facility are established.

FIELD EXPLORATION AND RECONNAISSANCE

We drilled one exploratory boring (BH-1) at the proposed site of the new police/fire station on June 28, 2021. The approximate boring location is shown on Figure 2A.

The boring was completed using a CME-850 track-mounted drill rig with mud-rotary drilling techniques. The boring extended to a depth of ±66.5 feet. Samples were retained at 2½-foot intervals to a depth of ±20 feet and typically at 5-foot intervals thereafter. Soil samples were obtained in conjunction with Standard Penetration Testing (SPT). The SPT provides an indication of the relative stiffness, or density, of the foundation soils. The number of blows required to drive the sampler the final 12 inches of an 18-inch long drive is recorded and represents the standard penetration resistance, or N-value, in blows per foot (bpf).

Upon completion of drilling, the borehole was backfilled in accordance with Oregon Water Resources Department (OWRD) guidelines.

The borehole was continually logged during drilling. The final log (Appendix B) was prepared based on a review of the field log and laboratory test results, and an examination of the soil samples in our office.

A site reconnaissance was conducted by Brooke Running, R.G., C.E.G. concurrently with the field exploration. We traversed the property to observe site conditions and surface features including vegetation, drainage areas, seeps or springs, slopes, and other surface features. We also took photos of the site. Our site observations are discussed in subsequent sections of this memorandum.

LOCAL GEOLOGY

The project site is located within the Clatsop Plains of the northern Oregon Coast Range. At the western margin of Oregon is the Cascadia Subduction Zone (CSZ). The CSZ is a converging, oblique plate boundary where the Juan de Fuca oceanic plate is being subducted beneath the western edge of the North American continental plate (Geomatrix Consultants, 1995). The CSZ extends from central Vancouver Island, in British Columbia, Canada, through Washington and Oregon to Northern California in the United States (Atwater, 1970). The movement of the subduction zone has resulted in earthquakes, accretion, folding, faulting, and uplift of oceanic and other sediments on the western margin of the North American plate. The project site is ±75 miles east of the surface expression of the CSZ.

The Clatsop Plains are a series of sand dunes and beach sand extending north of Tillamook Head and the mouth of the Necanicum River to the Clatsop Spit at the mouth of the Columbia River. Due to the proximity of the Columbia River and a significant source of sand, this section of shoreline prograded westward forming a series of parallel sand dune ridges (Reckendorf, 1998). Local geologic maps indicate the dune sand (Quaternary dune sand) is underlain by massive, tuffaceous mudstone with minor amounts of siltstone, claystone, and sandstone of the Cannon Beach Member of the Astoria Formation (Schlicker et al., 1972; Niem and Niem, 1985).

The soil profile encountered in the exploration consists of loose to very dense sand with trace to some silt. The subsurface conditions encountered in our exploration are consistent with the mapped local geology. Details are provided in the Subsurface Conditions section below and on the exploration log in Appendix B.

SITE CONDITIONS

Surface Conditions

The proposed project site is a 2.14-acre lot on a dune west of Highway 101 and south of Highlands Lane. Survey information provided by CKI indicates the crest of the dune lies at ±El. 70 feet and is offset along the eastern portion of the parcel.

The ground surface is predominately covered in grass, blackberries, scotch broom, and ferns. Pine trees are scattered across the site. Several large fir trees (up to ±3- to 4-foot diameter) and scattered deciduous trees are along the eastern lot line. Fir trees and deciduous bushes are along the western lot line.

The ground surface is uneven across the site and there is a depression southwest of the boring location as shown on the topographic map. The terrain slopes down more abruptly to the east with ±1.75:1 (H:V) to ±2:1 (H:V) slopes that extend beyond the parcel limits. The ground surface west of the site slopes down more gently to the west beyond the parcel limits.

Subsurface Conditions

A general discussion of the subsurface profile encountered in the boring is provided below. Detailed descriptions of the conditions encountered in the boring are summarized on the appended boring log.

The subsurface conditions are relatively consistent to a depth of ±66.5 feet, the maximum depth of our exploration. The soils consist of predominantly light brown, fine sand with trace to some silt (Quaternary dune sand). This soil unit is consistent with the locally mapped geology, which suggests the area is underlain by sand to a depth of ±127 feet followed by sedimentary bedrock (Schlicker et al., 1972).

The recorded SPT N-values included on the appended log show a trend of increasing soil density with depth. The N-values indicate the sand is loose to a depth of ±12.5 feet, medium dense between ±12.5 to 50 feet, dense from ±50 to 65 feet, and very dense to ±66.5 feet, the maximum depth of the exploration.

Groundwater

We reviewed local water well logs in the project vicinity including two well logs (CLAT 52056 and CLAT 52448, Appendix B) on properties immediately south of the project site. Those logs suggest a static groundwater level ranging from ±50 to 53 feet below the ground surface. Mud-rotary drilling methods precluded an accurate groundwater measurement in BH-1 at the time of drilling. However, we noted the retained samples were damp to moist to a depth of 60 feet and moist to wet thereafter. This information suggests groundwater was likely present at a depth between ±51.5 and 60 feet at the time of our investigation.

No standing water, seeps, or springs were observed while on site. At the base of the east slope, skunk cabbage was observed suggesting wetland conditions. No drainages or significant erosion was observed.

LABORATORY TESTING

The laboratory testing included moisture content and percent fines tests to help classify the soils according to the Unified Classification System (USCS) and estimate their overall engineering properties. The test results are summarized in Table 1C (Appendix C). Non-tested samples were visually classified in accordance with ASTM D 2487 and ASTM D 2488. USCS symbols shown on the boring log for untested samples should be considered approximations.

PRELIMINARY DISCUSSION OF GEOLOGIC AND SEISMIC HAZARDS

We reviewed potential geologic and seismic site hazards including seismic fault sources and amplification, fault rupture, liquefaction, lateral spread, settlement of non-liquefiable soils, slope stability, subsidence, flooding, and tsunami inundation. Discussions of the seismic hazards and our preliminary seismic analyses are provided in the following sections.

Seismic Sources and Ground Motion Amplification

The potential seismic sources, design bedrock accelerations, and earthquake magnitudes were selected based on the current 2014 U.S. Geological Survey (USGS) seismic maps (USGS, 2014a and USGS, 2014b). Each seismic source can be identified on the basis of its magnitude (M) and the source-to-site distance (R). The sources having the greatest contribution to the overall uniform seismic hazard are highlighted in a process termed deaggregation. Specific earthquake scenarios are evaluated based on the results of the deaggregation. The interactive deaggregation tool on the USGS website (USGS, 2014b) indicates the probabilistic seismic risk at the site is dominated by Cascadia Subduction Zone (CSZ) interface earthquakes with a moment magnitude (M_w) between 8.5 and 9.3.

Ground motion amplification is the influence of a soil deposit on the earthquake motion. As seismic energy propagates up through the soil strata, the ground motion is typically increased (i.e., amplified) or decreased (i.e., attenuated) to some extent. Based on the density of the underlying sand and anticipated depth to bedrock, we anticipate the ground motion amplification at the site will be consistent with an Oregon Structural Specialty Code (OSSC) Site Class D. The site is expected to experience severe ground shaking during a CSZ earthquake due to its proximity to the CSZ (DOGAMI, 2018).

Fault Rupture

We reviewed local geologic maps and the USGS Interactive Fault Map to identify potentially active crustal faults at and surrounding the project area. The available data indicates no known potentially active crustal faults or mapped faults extend beneath the project site (Schlicker et al., 1972; Niem and Niem, 1985; USGS, 2006). The nearest mapped potentially active crustal faults (Class A) are the Cascadia Fold and Fault Belt and unnamed offshore faults scattered within ±5 miles west of the site (USGS, 2006).

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Liquefaction is typically observed in saturated deposits of loose sand and non-plastic or low plasticity silt (i.e., a PI of less than 8) subjected to intense ground shaking. The soils underlying the site include loose sand to ±12.5 feet, followed by medium dense sand to ±50 feet, and dense to very dense sand at greater depths. The static groundwater is anticipated to be below a depth of ±50 feet. Therefore, the loose sandy soils are well above the anticipated groundwater level and these soils are not expected to become saturated enough to exhibit liquefaction.

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Lateral spread is a liquefaction-induced hazard, which occurs when soil or blocks of soil are displaced down slope or toward a free face along a liquefied layer. The liquefaction hazard at the site is considered low. Therefore, the lateral spread hazard at the site should also be considered low.

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or densification under seismic loading. Additional drilling during the Phase 2 work will confirm the thickness and density of the sand above the groundwater level.

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The existing topography at the site is relatively flat with a gentle slope to the west and a steep slope to the east. No landslide or slope instability features were observed on site during our reconnaissance. DOGAMI's references, including LiDAR, also indicate no historic landslide inventory or mapped landslides at the site with a mostly low landslide susceptibility with isolated moderate susceptibility (DOGAMI, 2016, 2017, 2018).

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The results suggest relatively high FS for static slope stability. However, a shallow slope failure in the loose sand stratum may occur under seismic loading. Additional explorations should be completed during the Phase 2 work to refine the thickness of the loose sand and evaluate the required slope setback distance for the proposed facilities.

Subsidence

Seismic-ground subsidence is a regional phenomenon resulting from a large magnitude earthquake generated from a subduction source, such as the CSZ. It occurs because the subduction of the oceanic crust beneath the continental crust compresses the continental crust and pushes it upward. Prior to the earthquake, the continental crust is held in this position by friction at the interface. The frictional bond breaks when the earthquake occurs, allowing the continental crust to drop.

The hazard map included in the Oregon Resilience Plan indicates ground subsidence in the project area could range from ±4 to 6 feet for a M_w 9 earthquake (OSSPAC, 2013). Ground subsidence cannot be mitigated. Therefore, it should be assumed the ground surface in the project area may drop up to 6 feet during a large CSZ interface earthquake.

Flooding

According to the Oregon Department of Geology and Mineral Industries (DOGAMI) HazVu (2018), no flood hazards are mapped at the site. Therefore, there is no flooding risk at the proposed operations center site. A 100-year floodplain hazard associated with Neacoxie Creek is mapped ±770 feet west of the site.

Tsunami Inundation

Tsunami are waves created by a large-scale displacement of the seafloor due to earthquakes, landslides, or volcanic eruptions (Priest, 1995). Gearhart is located on the Oregon Coast and is close to the CSZ and other distal seismogenic sources. Therefore, there is a potential for tsunami impacting the low-lying coastal areas, including Gearhart and the adjacent coastline.

DOGAMI has prepared tsunami inundation maps (TIM) for the entire Oregon Coast. The inundation maps include distinctions between tsunami caused by a local CSZ source earthquake and a distant Alaskan source earthquake (Alaskan-Aleutian subduction zone). The local source includes scenarios ranging from small (S) to extra extra large (XXL) that are based on the tide when the tsunami wave occurs and with variable slip, frequency of occurrence, subsidence, and earthquake magnitude. The distant source includes two scenarios including the impact of an Alaskan M_w 9.2 earthquake (replicating the 1964 event) and a hypothetical Alaskan maximum source tsunami (worse-case event, including uniform slip on one subfault) at high tide.

The ground surface elevations at the project site range from ±El. 60 to ±El. 70. The tsunami maps indicate the site is located above the earthquake tsunami scenario zones for all CSZ earthquake scenarios except the XL and XXL scenarios (DOGAMI, 2013). The estimated CSZ inundation scenarios of XL and XXL also extend east of Highway 101 to the western foothills of the Coast Range between ±El. 50 and ±El. 75. The site is well outside the area that will be impacted by Alaskan-Aleutian subduction zone earthquakes, which the inundation impacts only the beach in the project vicinity (DOGAMI, 2013).

The current tsunami evacuation map for Seaside and Gearhart shows run-up for a tsunami caused by a local Cascadia earthquake source ranging from ±El. 61 to ±El. 75 in the project vicinity (DOGAMI, 2021). However, the map shows the project site as an "optional tsunami assembly area" indicating the site is anticipated to be "dry" for 95% of the analyzed tsunami scenarios.

The City of Gearhart has adopted a Tsunami Hazard Overlay Zone (THO) as part of the work to increase the resiliency and establish community land use standards. Section 3.1450 of the THO prohibits land use for several facilities, including police and fire stations, within the mapped zone for a L magnitude tsunami zone. The local source TIM suggests the proposed project site is mapped outside of the L tsunami scenario (DOGAMI, 2013). Therefore, the THO allows for a use exception.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

Based on the preliminary geotechnical investigation described above, we have concluded the following:

1. Our preliminary investigation suggests there are several geologic or geotechnical hazards associated with building on the Oregon Coast, however, these hazards do not necessarily preclude building at the proposed site. Potential geologic hazards include ground motion amplification, settlement of non-liquefiable soil, slope stability, subsidence, and tsunami inundation. Full mitigation of these hazards is not practical. Therefore, risks from these hazards will need to be accepted for the construction of the proposed facilities.

   A more detailed analysis of the geologic and seismic hazards should be completed as part of a site-specific hazard study during the design-phase work, once the location, type and size of the facility is known. Additional explorations will be necessary to refine our preliminary analyses and provide detailed mitigation recommendations.

2. The site can be used for the planned development. However, densification of the upper loose sand is recommended to improve the bearing resistance of the soil and reduce potential settlement due to both static foundation loads and seismic ground shaking.

   For planning and budgeting purposes, assume mitigation of loose sand will be required beneath building foundations and any settlement-sensitive hardscapes. The mitigation should be relatively straightforward and consist of excavating the sand to a depth of ±10 feet, moisture-conditioning the sand, and placing it back into the excavation and mechanically compacting it in lifts.

3. Conventional shallow foundations (i.e., spread footings and continuous wall footings) should be suitable to support the proposed facilities after the recompaction of the loose soil is completed.

4. Groundwater is not expected to be a critical geotechnical issue.

5. Additional exploratory drilling is recommended to evaluate the limits of overexcavation for the proposed facilities and provide detailed site grading and foundation design and construction recommendations.

RECOMMENDATIONS FOR PHASE 2 INVESTIGATION

Based on the results of our Phase 1 investigation, we have concluded there are no apparent adverse soil conditions that would preclude the proposed development. We anticipate, with proper site development and design, the new facilities could be supported using conventional shallow foundations (i.e., spread footing and continuous wall footings).

If the City of Gearhart decides to purchase the property, we recommend we be retained to complete a Phase 2 (design-level) investigation. We anticipate the Phase 2 work would include the following items:

- Additional field explorations (possibly a combination of exploratory borings and CPT probes) to better define the limits of the loose sand layer. Installation of a piezometer would provide data to confirm groundwater levels for liquefaction analysis.

- A site-specific seismic hazard study to develop seismic design parameters and assess geologic, seismic, and geotechnical hazards in more detail.

- Engineering analyses include liquefaction, slope stability, bearing capacity, settlement, and pavement design.

- Preparation of detailed recommendations for soil mitigation, site grading, foundation design and construction, and pavements.

At your request, we will prepare a formal proposal for you outlining the scope of work and estimated costs for the Phase 2 investigation.

VARIATION OF SUBSURFACE CONDITIONS, USE OF THIS REPORT AND WARRANTY

The analysis, conclusions, and recommendations contained herein assume the subsurface profile encountered in BH-1 is representative of the site conditions. No changes in the enclosed recommendations should be made without our approval. We will assume no responsibility or liability for any engineering judgment, inspection, or testing performed by others.

This report was prepared for the exclusive use of the City of Gearhart and their design consultants for the proposed Cottages Emergency Operations Police/Fire Station project in Clatsop County, Oregon. Information contained herein should not be used for other sites or for unanticipated construction without our written consent. This report is intended for preliminary planning purposes only. It is assumed a more detailed geotechnical investigation will be completed prior to final design and construction. Contractors using this information to estimate construction quantities, production rates, or costs do so at their own risk.

Our services do not include any survey or assessment of potential surface contamination or contamination of the soil or ground water by hazardous or toxic materials. We assume those services, if needed, have been completed by others. Our work was done in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

We hope this above information meets your current needs and look forward to assisting you further. Please do not hesitate to call with any questions.

Attachments

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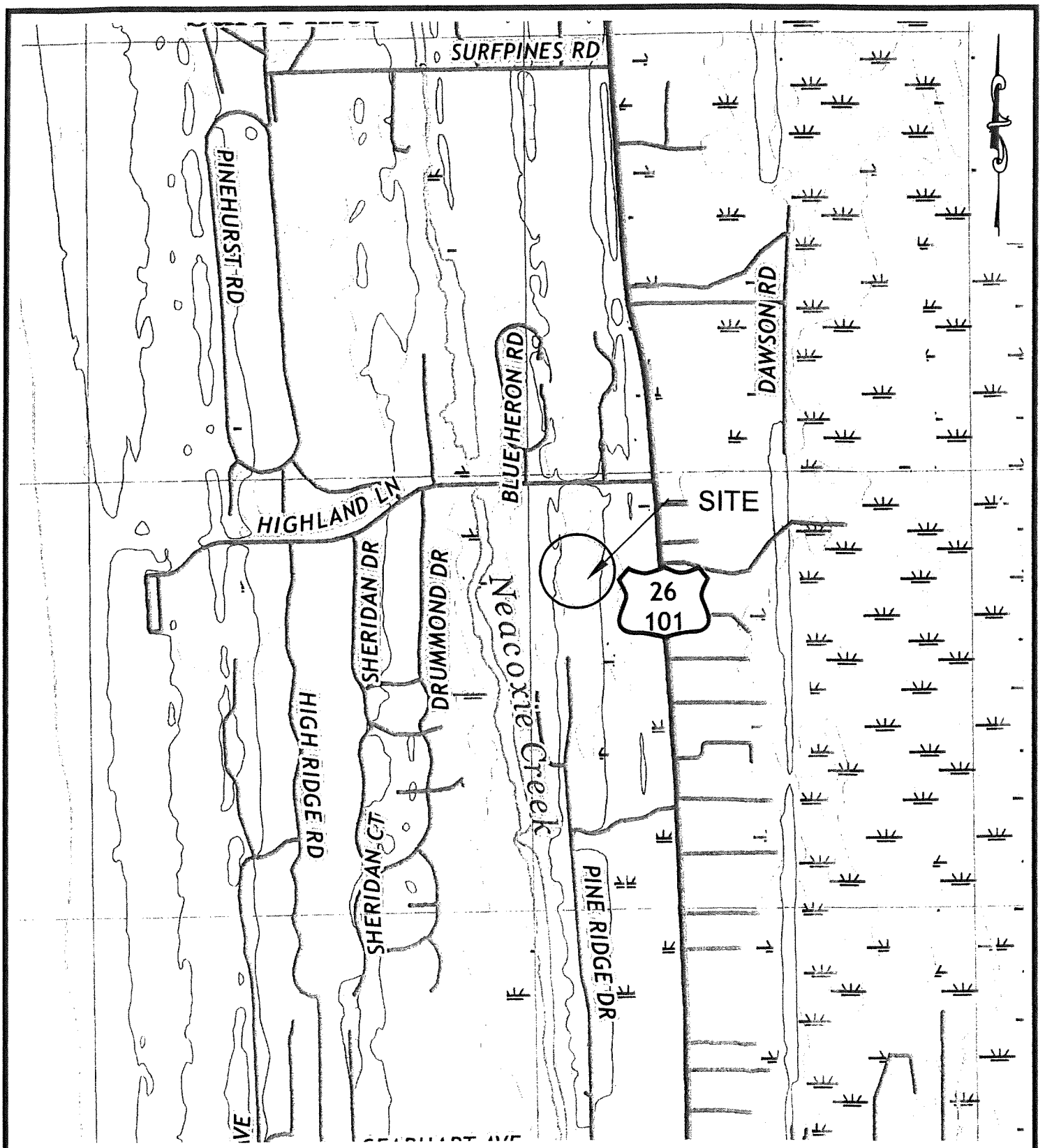
Appendix A

Figures



NOTE:
MAP OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY WEBSITE (*WWW.USGS.GOV*).

SCALE IN FEET

0 500 1,000 2,000

Foundation Engineering, Inc.
Professional Geotechnical Services

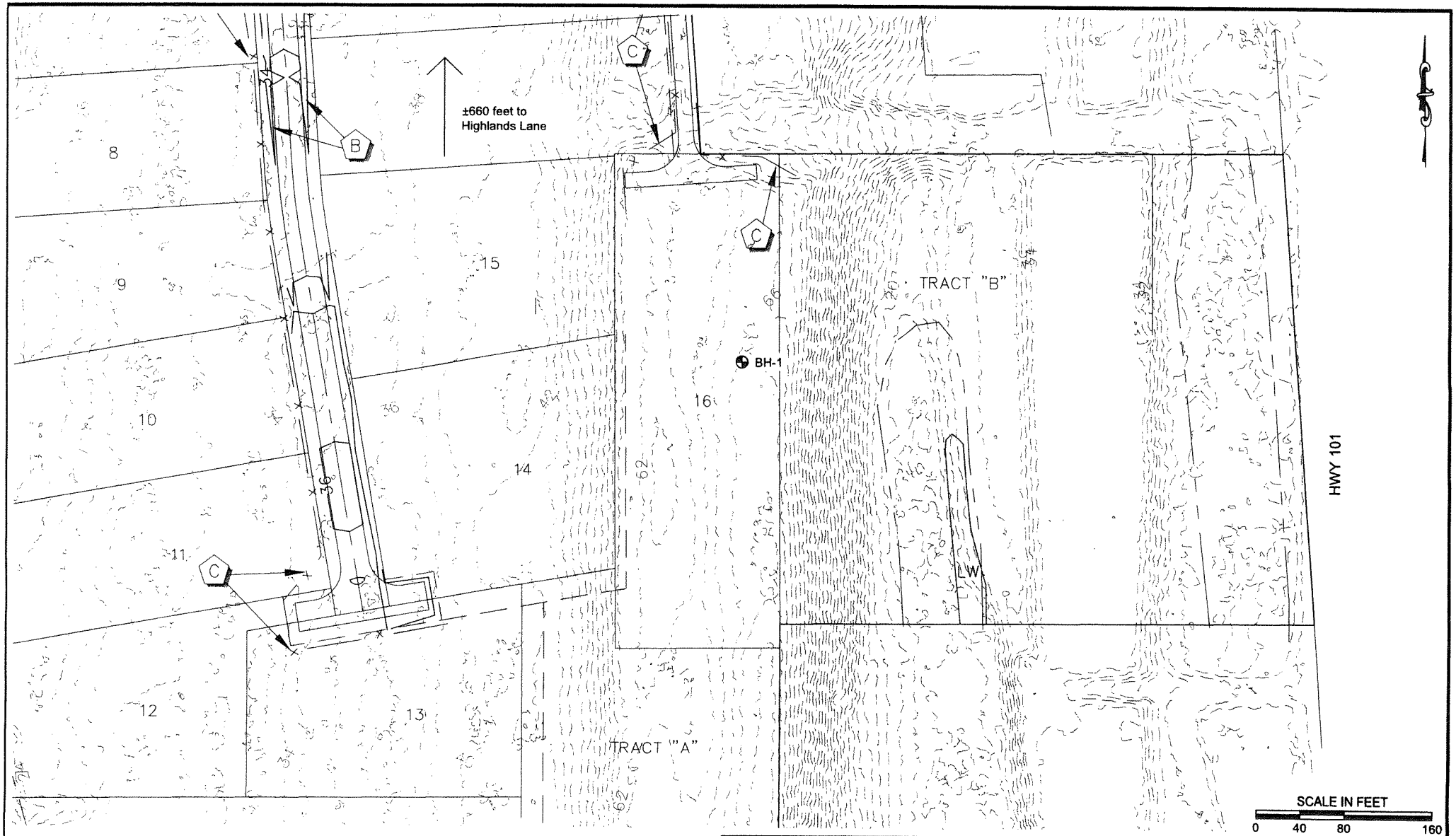
PROJECT NO.	DATE:	DRAWN BY:
2211058	JUN 2021	MLM

VICINITY MAP

THE COTTAGES EMERGENCY OPERATIONS
POLICE/FIRE STATION
CLATSOP COUNTY, OREGON

FIGURE NO.

1A



NOTES:
1. BORING LOCATION WAS ESTABLISHED REFERENCING EXISTING LANDMARKS AND IS APPROXIMATE.
2. SEE REPORT FOR A DISCUSSION OF THE SUBSURFACE CONDITIONS.
3. BASE MAP PROVIDED BY CKI, INC.

Foundation Engineering, Inc.
Professional Geotechnical Services

PROJECT NO.	DATE:	DRAWN BY:
2201058	JUL 2021	MLM

SITE LAYOUT AND BORING LOCATION

THE COTTAGES EMERGENCY OPERATIONS
POLICE/FIRE STATION
CLATSOP COUNTY, OREGON

FIGURE NO.
2A

Appendix B

Boring Log

Foundation Engineering, Inc.
Professional Geotechnical Services

DISTINCTION BETWEEN FIELD LOGS AND FINAL LOGS

A field log is prepared for each boring or test pit by our field representative. The log contains information concerning sampling depths and the presence of various materials such as gravel, cobbles, and fill, and observations of ground water. It also contains our interpretation of the soil conditions between samples. The final logs presented in this report represent our interpretation of the contents of the field logs and the results of the sample examinations and laboratory test results. Our recommendations are based on the contents of the final logs and the information contained therein and not on the field logs.

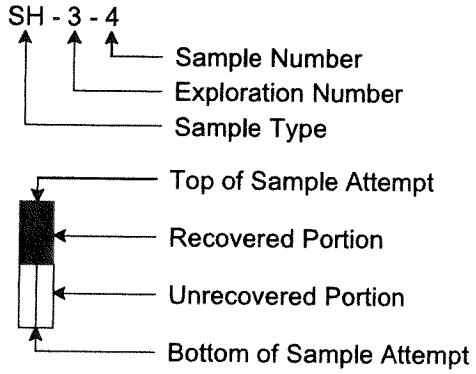
VARIATION IN SOILS BETWEEN TEST PITS AND BORINGS

The final log and related information depict subsurface conditions only at the specific location and on the date indicated. Those using the information contained herein should be aware that soil conditions at other locations or on other dates may differ. Actual foundation or subgrade conditions should be confirmed by us during construction.

TRANSITION BETWEEN SOIL OR ROCK TYPES

The lines designating the interface between soil, fill or rock on the final logs and on subsurface profiles presented in the report are determined by interpolation and are therefore approximate. The transition between the materials may be abrupt or gradual. Only at boring or test pit locations should profiles be considered as reasonably accurate and then only to the degree implied by the notes thereon.

SAMPLE OR TEST SYMBOLS



C - Pavement Core Sample
CS - Rock Core Sample
OS - Oversize Sample (3-inch O.D. split-spoon)
S - Grab Sample
SH - Thin-walled Shelby Tube Sample
SS - Standard Penetration Test Sample (2-inch O.D. split-spoon)

▲ Standard Penetration Test Resistance equals the number of blows a 140 lb. weight falling 30 in. is required to drive a standard split-spoon sampler 1 ft. Practical refusal is equal to 50 or more blows per 6 in. of sampler penetration.

● Water Content (%)

FIELD SHEAR STRENGTH TEST

Shear strength measurements on test pit side walls, blocks of soil or Shelby tube samples are typically made with Torvane or Field Vane shear devices.

WATER TABLE

▼ Water Table Location

(1/31/16) Date of Measurement

TYPICAL SOIL/ROCK SYMBOLS

Concrete	Silt	Basalt
Organics	Sand	Sandstone
Clay	Gravel	Siltstone

UNIFIED SOIL CLASSIFICATION SYMBOLS

G - Gravel	W - Well Graded
S - Sand	P - Poorly Graded
M - Silt	L - Low Plasticity
C - Clay	H - High Plasticity
Pt - Peat	O - Organic

Foundation Engineering, Inc.
Professional Geotechnical Services

SYMBOL KEY

EXPLORATION LOGS

Explanation of Common Terms Used in Soil Descriptions

Field Identification	Cohesive Soils			Granular Soils	
	SPT*	S_u** (tsf)	Term	SPT*	Term
Easily penetrated several inches by fist.	0 - 2	< 0.125	Very Soft	0 - 4	Very Loose
Easily penetrated several inches by thumb.	2 - 4	0.125 - 0.25	Soft	4 - 10	Loose
Can be penetrated several inches by thumb with moderate effort.	4 - 8	0.25 - 0.50	Medium Stiff	10 - 30	Medium Dense
Readily indented by thumb but penetrated only with great effort.	8 - 15	0.50 - 1.0	Stiff	30 - 50	Dense
Readily indented by thumbnail.	15 - 30	1.0 - 2.0	Very Stiff	> 50	Very Dense
Indented with difficulty by thumbnail.	> 30	> 2.0	Hard		

* SPT N-value in blows per foot (bpf)
** Undrained shear strength

Term	Soil Moisture Field Description
Dry	Absence of moisture. Dusty. Dry to the touch.
Damp	Soil has moisture. Cohesive soils are below plastic limit and usually moldable.
Moist	Grains appear darkened, but no visible water. Silt/clay will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grain surfaces. Sand and cohesionless silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is wetter than the optimum moisture content and above the plastic limit.

Term	PI	Plasticity Field Test
Non-plastic	0 - 3	Cannot be rolled into a thread at any moisture.
Low Plasticity	3 - 15	Can be rolled into a thread with some difficulty.
Medium Plasticity	15 - 30	Easily rolled into thread.
High Plasticity	> 30	Easily rolled and re-rolled into thread.

Term	Soil Structure Criteria
Stratified	Alternating layers at least ¼ inch thick.
Laminated	Alternating layers less than ¼ inch thick.
Fissured	Contains shears and partings along planes of weakness.
Slickensided	Partings appear glossy or striated.
Blocky	Breaks into small lumps that resist further breakdown.
Lensed	Contains pockets of different soils.

Term	Soil Cementation Criteria
Weak	Breaks under light finger pressure.
Moderate	Breaks under hard finger pressure.
Strong	Will not break with finger pressure.

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth 68	Samples	SPT, N-Value / Recovery / Moisture, % / RQD., % (0 – 50 – 100)	Backfill/ Installations/ Water Table
1	Loose SAND, trace silt (SP); light brown, damp, fine sand, (Quarternary dune sand).		0.0	SS-1-1	5	Capped with cuttings
2						
3						Backfilled with bentonite chips (±0.5 to 5 feet)
4						
5				SS-1-2	6	
6						
7						Bentonite grout (±5 to 66.5 feet)
8				SS-1-3	9	
9	Dark brown at ±8.2 feet.					
10				SS-1-4	10	
11						
12						
13	Medium dense below ±12.5 feet.			SS-1-5	11	
14						
15				SS-1-6	11	
16						
17						
18				SS-1-7	13	
19						
20				SS-1-8	14	
21						
22						
23						
24						
25				SS-1-9	19	
26						
27						
28						
29						
30			38.0			
31	Medium dense SAND, some silt (SP-SM); light brown, damp to moist, fine sand, (Quarternary dune sand).		30.0	SS-1-10	23	
32						
33						
34						
35				SS-1-11	22	
36						
37						
38						
39						

Project No.: 2211058

Surface Elevation: 68.0 feet (Approx.)

Date of Boring: June 28, 2021

Boring Log: BH-1

The Cottages Emergency Operations Police/Fire Station

Clatsop County, Oregon

Foundation Engineering, Inc.

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth	Samples	SPT, N-Value / Recovery / Moisture, % / RQD., %	Backfill/ Installations/ Water Table
			28		0 — 50 — 100	
41				SS-1-12	25	
42						
43						
44						
45				SS-1-13	29	
46						
47						
48	Dense from ±50 to 65 feet.					
49						
50	Grey-brown below ±50.5 feet.			SS-1-14	32	
51						
52						
53						
54						
55						
56						
57						
58						
59						
60	Moist to wet below ±60 feet.			SS-1-15	46	
61						
62						
63						
64						
65	Very dense below ±65 feet.			SS-1-16	70	
66			1.5			
	BOTTOM OF BORING		66.5			

Project No.: 2211058

Surface Elevation: 68.0 feet (Approx.)

Date of Boring: June 28, 2021

Boring Log: BH-1

The Cottages Emergency Operations Police/Fire Station

Clatsop County, Oregon

Foundation Engineering, Inc.

CLAT 52050

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

WELL I.D. # L 71761
START CARD # 166623

Instructions for completing this report are on the last page of this form.

(1) LAND OWNER Well Number _____
Name DON WICKERSHAM
Address 3097 PINE RIDGE RD/P.O. BOX 2601
City GEARHART State OR Zip 97138

(2) TYPE OF WORK
☒ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☐ Rotary Air ☒ Rotary Mud ☐ Cable ☐ Auger
☐ Other _____

(4) PROPOSED USE:
☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other _____

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☒ No Depth of Completed Well 95 ft.
Explosives used ☐ Yes ☒ No Type _____ Amount _____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
10	0	95	Cement	0	50	15 Sacks

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☐ Other _____
Backfill placed from _____ ft. to _____ ft. Material _____
Gravel placed from 50 ft. to 95 ft. Size of gravel 1C Sand

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	+1	70	SDR21	☐	☒	☒	☐
	6	90	95	SDR21	☐	☒	☒	☐
	8	+18"	5	.250	☒	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Drive Shoe used ☐ Inside ☐ Outside ☒ None
Final location of shoe(s) _____

(7) PERFORATIONS/SCREENS:
☐ Perforations Method _____
☒ Screens Type Slotted Material PVC

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
70	90	.020		6	Pipe	☒	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☒ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
24	17		1 hr.

Temperature of water 56°F Depth Artesian Flow Found _____
Was a water analysis done? ☐ Yes By whom _____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other _____
Depth of strata: _____

(9) LOCATION OF WELL by legal description:
County Clatsop Latitude _____ Longitude _____
Township 7N N or S Range 10W E or W. WM.
Section 34 NW 1/4 SW 1/4
Tax Lot 200 Lot _____ Block _____ Subdivision _____
Street Address of Well (or nearest address) 3097 PINE RIDGE RD.

(10) STATIC WATER LEVEL:
53 ft. below land surface. Date 6-18-04
Artesian pressure _____ lb. per square inch Date _____

(11) WATER BEARING ZONES:
Depth at which water was first found 70

From	To	Estimated Flow Rate	SWL
70	90	24 gpm	53

(12) WELL LOG:
Ground Elevation _____

Material	From	To	SWL
Fine Brn sand	0	72	53
Fine gry-brn sand	72	90	
Fine to med blk sand w/shell & wood.	90	95	53

RECEIVED
JUN 25 2004
WATER RESOURCES DEPT
SALEM, OREGON

Date started 6-16-04 Completed 6-18-04

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
WWC Number _____
Signed _____ Date _____

(bonded) Water 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 water supply well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 1266
Signed _____ Date 06/21/04

ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER

CLAT 52448

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

WELL I.D. # L 81110

START CARD # 181843

Instructions for completing this report are on the last page of this form.

(1) LAND OWNER Well Number _____
Name Joy R. Merkley
Address PO Box 2699
City Gearhart State OR Zip 97138

(2) TYPE OF WORK ☑ New Well
☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment ☐ Conversion

(3) DRILL METHOD
☐ Rotary Air ☑ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud
☐ Other _____

(4) PROPOSED USE
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other _____

(5) BORE HOLE CONSTRUCTION Special Construction: ☐ Yes ☑ No
Depth of Completed Well 93 ft.
Explosives used: ☐ Yes ☑ No Type _____ Amount _____

BORE HOLE Diameter	From	To	SEAL Material	From	To	Sacks or Pounds
10"	0	93	Bentonite	0	5	4 sacks
			Cement	5	50	12 sacks

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☑ Other Poured into annular
Backfill placed from _____ ft. to _____ ft. Material _____
Gravel placed from 50 ft. to 93 ft. Size of gravel 1C Sand

(6) CASING/LINER

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6"	+1	70	SDR21	☐	☑	☑	☐
	6"	90	93	SDR21	☐	☑	☑	☐
	8"	+18"	5	.250	☑	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Drive Shoe used ☐ Inside ☐ Outside ☑ None
Final location of shoe(s) _____

(7) PERFORATIONS/SCREENS
☐ Perforations Method _____
☑ Screens Type Slotted Material PVC

From	To	Slot Size	Number	Diameter	Tele/pipe size	Casing	Liner
70	90	.020		6"	pipe	☑	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☑ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
24	10		1 hour

Temperature of water 56° F Depth Artesian Flow Found _____
Was a water analysis done? ☐ Yes By whom _____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other _____
Depth of strata: _____

(9) LOCATION OF WELL (legal description)
County Clatsop
Tax Lot 300 Lot _____
Township 7N N or S Range 10W E or W WM
Section 34 NW 1/4 SW 1/4
Lat ____ ° ____ ' ____ " or _____ (degrees or decimal)
Long ____ ° ____ ' ____ " or _____ (degrees or decimal)
Street Address of Well (or nearest address) 3050 Pine Ridge Dr. Gearhart, OR

(10) STATIC WATER LEVEL
50 ft. below land surface. Date 12/09/2005
_____ ft. below land surface. Date _____
Artesian pressure _____ lb. per square inch Date _____

(11) WATER BEARING ZONES
Depth at which water was first found 70

From	To	Estimated Flow Rate	SWL
70	90	24 gpm	50'

(12) WELL LOG Ground Elevation _____

Material	From	To	SWL
Fine brown sand	0	70	
Fine gray sand	70	93	50'

RECEIVED
DEC 15 2005
WATER RESOURCES DEPT
SALEM, OREGON

Date Started 12/07/2005 Completed 12/09/2005

(unbonded) Water Well Constructor Certification
I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

WWC Number _____ Date _____

Signed _____

(bonded) Water Well Constructor Certification
I accept responsibility for the construction, deepening, 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 water supply well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 1266 Date 12/12/2005

Signed _____

ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER 06/16/2004

Appendix C

Laboratory Testing

Foundation Engineering, Inc.
Professional Geotechnical Services

Table 1C. Moisture Contents (ASTM D 2216) and Percent Fines (ASTM D 1140)

Sample Number	Sample Depth (ft)	Moisture Content (%)	Fines (%)
SS-1-1	2.5 - 4.0	28.0	
SS-1-2	5.0 - 6.5	22.3	1.5
SS-1-3	7.5 - 9.0	22.4	
SS-1-4	10.0 - 11.5	22.3	
SS-1-5	12.5 - 14.0	20.2	
SS-1-6	15.0 - 16.5	24.2	4.8
SS-1-7	17.5 - 19.0	23.1	
SS-1-8	20.0 - 21.5	22.0	
SS-1-9	25.0 – 26.5	20.5	
SS-1-10	30.0 - 31.5	23.6	6.9
SS-1-11	35.0 - 36.5	22.5	
SS-1-12	40.0 - 41.5	21.3	6.4
SS-1-13	45.0 - 46.5	24.8	
SS-1-14	50.0 - 51.5	21.7	
SS-1-15	60.0 – 61.5	26.8	
SS-1-16	65.0 - 66.5	23.9	10.3