Holly Schlentz
Geotechnical Engineering Evaluation

Holley Park Subdivision – Phase 2
La Center, Washington 98629

True North Project No. 22-0411-1
February 2023

February 8, 2023

Dunning & Associates
10710 NW Lakeshore Ave, #105
Vancouver, WA 98685

Attn: Ms. Holly Schlentz

Subject: Geotechnical Engineering Evaluation
Holley Park Subdivision – Phase 2
Ivy Ave & 2nd Way
La Center, WA 98601
Clark County Parcel No. 986044822
True North Project # 22-0411-1

Dear Ms. Schlentz:

At your request, True North Geotechnical Services (True North) is providing you with this report summarizing our geotechnical services for the proposed new phase 2 of the Holley Park Subdivision development to be located at the above-mentioned tax lot in La Center, Washington (site). The purpose of our services was to provide a geotechnical evaluation of the site as it pertains to the proposed new development.

We have endeavored to prepare this report in accordance with generally accepted geotechnical engineering practices at the time we prepared it, for the exclusive use of Holley Schlentz, the owner, and their agents, for specific application to this project. Use or reliance upon this report by a third party is at their own risk. True North does not make any representation or warranty, express or implied, to such other parties as to the accuracy or completeness of this report or the suitability of its use by such other parties for any purpose whatever, known or unknown, to True North.

Based on the results of our study, development of the site with the proposed buildings and associated parking and utilities is feasible provided the recommendations in this report are included in the project design and implemented during construction. The chief geotechnical concerns of note associated with the project are maintaining proper slope setbacks from the steeper slopes and geologic hazards on site, ensuring foundations are bearing on firm native soil, and designing a stormwater system that meets the needs of the site.

The attached report includes a summary of our project understanding, geologic site reconnaissance, subsurface explorations, and our conclusions regarding the expected effect that the proposed lot development will have on the site.

PURPOSE AND SCOPE OF WORK

The purpose of our services was to provide a geotechnical evaluation of the site as it pertains to the proposed new development. This report includes a summary of our project understanding, geologic site reconnaissance, subsurface exploration, our conclusions regarding the effects of the proposed lot development on the site, and recommendations for design and construction.
The following describes our specific scope of work that was completed:

- **Geologic Map and Literature Review**: We reviewed published geologic and geologic hazard mapping for the site.
- **Test Pit Excavations:** We completed five (5) test pit excavations on the property. The test pit excavations extended to depths of about 13 feet below the ground surface (bgs).
- **Infiltration Testing:** Infiltration testing was completed at TP-5 at a depth of about 4 feet bgs.
- **Laboratory Testing:** Samples collected from the borings were returned to our office for further examination including classification in general accordance with the Unified Soil Classification, Visual-Manual Procedure. Select samples were subjected to laboratory testing, including natural moisture content analysis, and fines content analysis.
- **Analysis:** Data collected during the literature research, subsurface explorations, and laboratory testing were used to develop site-specific geotechnical design parameters and construction recommendations.
- **Report Preparation:** This Geotechnical Engineering Evaluation summarizes the results of our explorations and analyses, including information relating to the following:
    - Exploration logs and site plan with exploration locations
    - Laboratory test results
    - Summary of interpreted surface and subsurface conditions
    - Shallow foundation design recommendations
        - Minimum embedment and allowable bearing pressure
        - Estimated settlement
        - Sliding coefficient and passive earth pressure
    - Subsurface drainage requirements
    - Earthwork recommendations
        - Temporary and permanent slope inclinations
        - Structural fill materials and preparation
        - Suitability of native and on-site soils for reuse as structural fill
        - Wet weather/conditions consideration
    - Foundation, slab and pavement subgrade preparation recommendations
    - Flexible and rigid pavement design recommendations
    - Utility trench excavation and backfill recommendations for associated utilities
    - Seismic design criteria and design considerations

PROJECT UNDERSTANDING

True North understands that you are planning to subdivide an existing Clark County Tax Parcel, No. 986044822, comprising approximately 4.87 acres, into fourteen (14) buildable lots, four (4) stormwater tracts, and a roadway connected to the west end of 2nd Way.

Our understanding of the proposed development is based on a review of a "Conceptual Layout for Parcel 986044822" for the project, prepared by AKS Engineering and Forestry, LLC, dated February 14, 2020. We understand that the proposed project consists of the subdivision of the existing lot into fourteen new lots, two access tracts, a stormwater tract, and a critical area tract. The new lots will range in size from approximately 0.14 to 0.29 acres and will each accommodate one single-family home. In general, we understand that utilities are planned below the new roadways. The location of our explorations with respect to existing site conditions and boundaries is shown on the attached Figure 2, Site and Exploration Plan.

We anticipate the future homes at all lots will have relatively short driveways to the proposed roadway which connects NE Ivy Ave with E 2nd Way and will be supported by conventional concrete spread footings. We anticipate that the stormwater management plan directs runoff to facilities located within the proposed stormwater tract. Based on our understanding of proposed development, we anticipate cuts and fills of less than 4 feet across the site. The purpose of our explorations was to evaluate subsurface conditions and provide geotechnical recommendations for design and construction, including site preparation and support of the proposed new development.

SITE CONDITIONS

Geologic Setting

The site is located in the western margin of the Vancouver Basin, a structural basin with basalt bedrock overlain by sediment associated with repeated glacial outburst flooding of the Columbia River and its tributaries. The last of these outburst flooding events, known as the Missoula Floods, occurred about 10,000 years ago. The flood deposits include layers of clay, silt, sand, and gravel. Some layers may include boulders up to 8 feet in diameter.

In the immediate vicinity of the site, the near surface soils are mapped as Pleistocene-age fluvial sediments (Qf), consisting of unconsolidated sandy gravel with interbedded silt lenses deposited along the Snake River by the draining of glacial Lake Bonneville, underlain at depth by silt, sand, and boulder deposits from the draining of Lake Missoula (Qfs).

Surface Conditions

The site consists of the above-mentioned parcel, which comprises approximately 4.87 acres located near the intersection of Ivy Ave and 2nd Way. The parcels to the east and northeast of the site are developed into subdivisions, the parcel to the north houses La Center Elementary School, and the parcel to the west is owned and maintained by the county as the La Center Bottoms Greenway, a tract of land protected as part of the Legacy Lands program.

The site is currently undeveloped and is relatively level. Over the majority of the site, the ground surface slopes gently towards the southwest at a gradient of approximately 0 to 5 percent. The west and south property boundaries of the site include steep wooded slopes exceeding 40 percent gradient. The site ranges in elevation from about 122 feet above mean sea level (AMSL) at the northeast corner of the site to about 106 feet AMSL at the western property boundary. The site is currently lightly wooded, consisting of tall grasses, undergrowth, shrubs, some fruit and ornamental trees, and tall evergreen trees.

Subsurface Conditions

On November 4th, 2022, we visited the site to excavate five test pits (see attached Site Plan, Figure 2). The test pit explorations, designated TP-1 through TP-5, were excavated to maximum depths of about 13 feet bgs. The approximate test pit locations are shown on Figure 2. Descriptions of field and laboratory procedures and the interpreted exploration logs are included in Attachment A. The following is a generalized description of the subsurface units encountered in our explorations:

Sandy SILT: Light brown Sandy Silt (ML) was observed below the topsoil in all the test pits, extending to depths of about 5 and 8 feet below the ground surface. Fine orange and gray material were encountered at varying depths across this layer in every test pit. Trace gray clay was observed in TP-3 and TP-4 starting at about 6 feet bgs and extending to the bottom of the layer, 8 and 7 feet bgs, respectively. Generally, the relative density of this layer was medium stiff, increasing slightly with depth. The moisture content of seven samples tested from this layer ranged from about 22 to 31 percent. The fines content of three samples from this layer in TP-4 and TP-5, ranged from about 50 to 62 percent, increasing with depth. The soils from this near-surface layer can generally be classified as AASHTO A-6 type soil.

Sandy CLAY: Gray Sandy Clay (CL) with orange mottling was encountered beneath the silt layer in all test pits, extending to depths of about 10 to 11.5 feet bgs, except Dark nodules and red mottling were observed in this layer in TP-4 and TP-5. The consistency of this layer was medium stiff to stiff with medium to high plasticity. The moisture content of seven samples tested from this layer ranged from 32 to 40 percent. The fines content of one sample from this layer in TP-2 was about 83 percent.

CLAY: Gray Clay (SM) with orange mottling and varying trace amounts of fine sand was encountered beneath the clay layer in all test pits extending to the termination depth of each, about 13 feet bgs. In general, the consistency of this layer was stiff. Black nodules were observed in this layer in TP-1 only.

The moisture content of five samples tested from this layer ranged from about 31 to 43 percent.

Groundwater

Groundwater was not encountered during the test pit explorations. Generally, we expect the depth to groundwater to increase as one moves northeast and to higher elevations within the property. Based on a review of nearby well logs as well as Clark County data, the static groundwater level at the property is mapped at about 100 feet bgs. Zones of isolated restrictive layers may occur, resulting in seasonally higher perched water levels at times.

Infiltration Testing

Infiltration testing was completed in TP-5 at a depth of about 4.0 feet bgs. The infiltration test was conducted within a 6-inch outside diameter PVC pipe embedded into the underlying soils using the single-ring falling head method, in general accordance with the 2021 Clark County Stormwater Manual (CCSM). Water was placed into the pipe to achieve a minimum 6-inch-high column of water (head). After a period of saturation, the height of the water column in the pipe was measured initially and at regular timed intervals to determine the rate of water infiltration into the soil. Results of the field infiltration testing are presented in Table 1.

Table 1. Infiltration Testing Results

Location	Depth of Test (feet bgs)	Coefficient of Permeability, k (inches/hour)	Fines Content (percent)	Soil Classifiction[2]
TP-5	4.0	3.92	49.5	Light brown/orange Sandy SILT with trace clay, low plasticity, wet to moist

[1] Average rate after saturation. [2] Based on visual-manual classification and limited lab testing

The recommended coefficients of permeability, k, presented in Table 1 have been determined using the guidelines presented in the 2021 CCSM. It is recommended that the designer also include correction factors to account for the level of maintenance, type of system, vegetation, siltation, etc., as necessary.

Applicability of Infiltration Rates: Based on the results of our explorations and our understanding of the site topography, it is our opinion that the soils tested in TP-5 are representative of the sandy silt soils in the near surface across the site. Our opinion is that additional tests would yield similar results, and the rates provided in Table 1 are appropriate for use in the described soils at the listed depths across the portions of the site where development is proposed, provided appropriate safety/correction factors are applied by the site stormwater designer.

Field verification of the design infiltration rate should be conducted during construction for facilities using the rate measured in TP-5.

Hydrologic Soil Properties

According to the USDA Web Soil Survey, three near-surface soils at the site are identified: Gee Silt Loam, Hillsboro Silt Loam, and Odne Silt Loam, which generally consist of soils classified as silt loam and silty clay loam at the approximate test depths and are assigned the hydrologic soil groups C, B, and D, respectively, based on drainage and other properties, indicating the soils have a varying capacity to transmit water, from very low to very high. Approximately 2/3 of the site is mapped as Gee Silt Loam.

For the purposes of the stormwater system design using the Western Washington Hydrologic Model (WWHM), it is our opinion, based on the results of our explorations, infiltration testing, and laboratory testing, that the native near-surface soil conditions observed in our explorations can generally be classified as Soil Group 4 (SG4).

Geologic Hazards

The following provides a geologic hazard review for the subject site. The geologic hazard review as based on our site reconnaissance and explorations, as well as a review of publicly available published literature and maps.

Slope Hazards:

As discussed previously, the majority of the site is relatively level, with a very slight decline (0 to 5 percent) to the southwest across the site. However, the parcel is surrounded on three sides by deeply incised slopes resulting from the flows of the East Fork Lewis River and its smaller tributary drainages. The lots near the northwest, west and southeast corners of the site are adjacent to these steep slopes with approximately 25 to 45 percent gradient. During our reconnaissance, we assessed the condition of native surficial soil. We saw no evidence of localized slumps, bulges, seeps, or springs that would indicate the possibility of unstable slopes on the property. Regardless, we recommend the inclusion of geotechnical slope setbacks from the slope breaks of these steeper slopes, as shown in Figure 2 – Site Plan. Further clarification regarding development near and within these setback areas is included in the Recommendations section of this report. Given these proper setbacks are maintained between buildings and the steep slopes in the northwest and southeast corners, it is our opinion that slope hazards are not considered a concern at the property.

Landslide Hazards:

Clark County Maps Online and the Washington Natural Hazards Map on the Geologic Information Portal shows an “Area of Older Landslide Debris” located approximately 300 feet southeast of the southeast corner of the site. Upon review of the most currently available lidar overlay from the Washington Geologic Information Portal, it is our opinion that this landslide feature is located much closer to the site, and the mapped location would seem to be a poorly defined relic of the geologic map from which the landslide overlay was derived. The steep slopes at the southwest corner of the site, which comprise the western end of a bowl-shaped depression, would appear to represent the possible scarp of this slide.

Based on our site reconnaissance, a review of historic aerials, and a review of the available lidar data, we suspect that this landslide is prehistoric and dormant. Nonetheless, given the proximity to proposed new lots, we recommend maintaining a setback of at least 30 feet from the southeast slope break. Further clarification regarding development near and within this setback area also is included in the Recommendations section of this report.

Erosion:
Sections of lots 7, 8, 9, and 11 lie within a mapped severe erosion hazard area. However, given the relatively level nature of these lots and the soil properties encountered during our explorations, proper implementation of standard erosion and sediment control BMPs within the project area should adequately mitigate erosion risk on site.

Hydric Soils:
Based on a review of Clark County Maps Online, the middle eastern section of the site, about 1.3 acres, is mapped as having hydric soils, however this area showed no signs of groundwater at the surface during our site reconnaissance. This area of mapped hydric soils extends eastward and underlies many homes of the neighbouring subdivision, and as a result, hydric soils are not a concern at the property.

Seismic Hazards:
The following seismic hazards have been considered as part of our geologic hazards review for the project site:

<u>Ground Motion Amplification:</u> Based on a review of Clark County Maps Online, the site is designated as seismic Site Class “D”. Based on the presence of medium stiff silty soil at shallow depths in our explorations, it is our opinion that Site Class “D” is indeed appropriate for use at the site. The seismic design parameters, in accordance with the 2018 IBC (with Washington State amendments), are summarized in Table 2.

Table 2. 2018 IBC Seismic Design Parameters

Location	Short Period	1-Second
Maximum Credible Earthquake Spectral Acceleration	S_s = 0.89 g	S_1 = 0.397 g
Site Class	D	
Site Coefficient	F_a = 1.144	F_v = 1.606*
Adjusted Spectral Acceleration	S_{MS} = 1.018 g	S_{M1} = 0.638 g*
Design Spectral Response Acceleration Parameters	S_{DS} = 0.679 g	S_{D1} = 0.425 g*

g – acceleration due to gravity *see note below

Due to the Site Class "D" designation and the long period MCES (S_1) value exceeding 0.2 g, the structural engineer must apply the site-specific ground motion increases outlined in Section 11.4.8 of ASCE 7-16, including an increase of 50 percent to the seismic base shear coefficient, C_s. As an alternative to applying these conservative increases to the ground motions, a site-specific ground motion hazard analysis may be performed, however such an analysis was not included in the scope of this study.

Liquefaction: Based on the deep groundwater and relative density and grain size of the soils encountered in our explorations, we consider the potential for liquefaction settlement within the site boundaries to be low to negligible. Indeed, site is mapped as having a "very low to low" liquefaction susceptibility based on the Liquefaction Susceptibility Map of Clark County.

CONCLUSIONS AND RECOMMENDATIONS

Geotechnical Design and Construction Considerations

Based on the results of our site reconnaissance, subsurface explorations, and geologic map review, it is our opinion that the planned single-family residential developments within the proposed new lots and the associated utilities, access roads and driveways are feasible provided the recommendations in this report are included in the project design and implemented during construction. The chief geotechnical concerns of note associated with the project are maintaining proper slope setbacks, ensuring foundations bear on firm native soil, and designing a stormwater system that meets the needs of the site. Our opinion is based on field observations and subsurface explorations completed by True North and review of the following documents and information sources: County soils and groundwater mapping, a published geologic map, and our understanding of the proposed development plans.

Site Preparation

After any surface and near surface water sources have been controlled, the construction areas should be cleared and stripped of organic matter, and other deleterious materials. Silt fences, hay bales, buffer zones of natural growth, sedimentation ponds, and granular haul roads should be used as required to reduce sediment transport during construction to acceptable levels.

Where present, existing topsoil, buried structures, and other disturbed surface materials should be stripped and removed from proposed development locations and for a five-foot-margin around such areas. Based on our explorations, the depth of stripping may range from 6 to up to 12 inches, although greater stripping depths may be required if loose or soft materials are encountered, abandoned utilities or other embedded structures, or where mature trees and their associated roots are removed. Deleterious materials encountered during site preparation should be removed from the subgrade soils and hauled off site for disposal. Stripped material should be transported off site for disposal or stockpiled for use in landscaped areas. If stripping operations occur during wet weather, a generally greater stripping depth might be required in order to remove disturbed moisture sensitive soils; therefore, stripping is best performed during a period of dry weather.

Subgrade Verification

Following site preparation, including removal of all topsoil/till zone and compaction of the exposed subgrade and prior to placing aggregate base for the foundations, building pad, or pavement section, the exposed subgrade should be evaluated. The subgrades should be evaluated by qualified True North personnel using a steel foundation probe, proofroll, or other acceptable method. Unsuitable areas identified during the field evaluation should be re-compacted to or be excavated to firm ground and replaced with structural fill.

Wet/Freezing-Weather/Wet-Soil Conditions

Due to the presence of fine-grained silt and clay in the near-surface materials at the site, construction equipment may have difficulty operating on the near-surface soils when the moisture content of the surface soil is more than a few percentage points above the optimum moisture required for compaction. Soils that have been disturbed during site preparation activities, or unsuitable areas identified during proofrolling or probing, should be removed and replaced with compacted structural fill.

Site earthwork and subgrade preparation should not be completed during freezing conditions.

Protection of the subgrade is the responsibility of the contractor. Construction of granular haul roads may help reduce further damage to the pavement and disturbance of site soils. The thickness of the granular material for haul roads and staging areas will depend on the amount and type of construction traffic. The actual thickness of haul roads and staging areas should be based on the contractors' approach to site development, and the amount and type of construction traffic. The imported granular material should be placed in one lift over the prepared, undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. A geotextile fabric should be used to separate the subgrade from the imported granular material in areas of repeated construction traffic.

Excavations

Where required, temporary soil cuts associated with site excavations or regrading activities should be adequately sloped back to prevent sloughing and collapse, unless a shoring box or other suitable excavation side wall bracing is provided. It is the responsibility of the contractor to ensure that excavations are properly sloped or braced for worker safety protection, in accordance with OSHA safety guidelines.

Structural Fill

Structural fill includes any fill materials placed under footings, pavements, or driveways and backfill over the embedded mat foundation. Typical materials used for structural fill include: clean, well-graded sand and gravel; clean sand; crushed rock; controlled-density fill (CDF); and various soil mixtures of silt, sand, and gravel. Use of on-site soils as structural fill may be feasible, provided they are properly moisture conditioned prior to placement and compaction.

Imported granular structural fill should consist of angular pit or quarry run rock, crushed rock, or crushed gravel and sand that is fairly well graded between coarse and fine particle sizes. The fill should contain no organic matter or other deleterious materials, have a maximum particle size of one inch, and have less than 5 percent passing the U.S. No. 200 Sieve. In deep excavations, or where subgrade soils require stabilization, the particle size may be increased to four inches. The percentage of fines can be increased to 12 percent of the material passing the U.S. No. 200 Sieve if placed during dry weather and provided the fill material is moisture-conditioned, as necessary, for proper compaction. The material should be placed in lifts with a maximum uncompacted thickness of 12 inches and be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D 1557. During the wet season or when wet subgrade conditions exist, the initial lift thickness may be increased to 24 inches and should be compacted by rolling with a smooth-drum, nonvibratory roller.

Geotechnical Slope Setback

To reduce the risk of slope instability at the site, we recommend that residential structures be set back from steeper slopes (slopes that exceed 40 percent gradient), such as those along the northwest corner, west side and southwest corner of the site at the ratio of H/3, where H is equal to the total height of the slope. Without individual lot-specific evaluations, these setbacks would be on the order of about 15 feet in the slopes in the northwest corner, 20 feet from the slopes along the west of the property line and 15 feet from the slopes at the southeast corner. Because of the suspected landslide scarp topography at the southeast corner, we suggest doubling the setback to 30 feet at this location only. The limitation recommendation is intended to reduce potential for slope instability by limiting the dynamic and static loading resulting from construction and permanent structures.

The setback is based on the horizontal distance of the outside base of footings from the adjacent slope. With increased embedment of the footings, structures may be founded closer to the adjacent top of slope, providing the horizontal distance from the slope surface is maintained. Reduction of the setback from the top of the slope may also be achieved with embedded “daylight” basement style foundations, which may allow for structures placed up to and even extending into the steeper slope areas, depending on a site-specific evaluation prior to finalizing the home design.

To reduce the risk of slope instability, clearing, grading, soil stockpiling, utility installation and other major construction activities should not be permitted within the limitation area or along the slopes themselves. The probability for slope instability increases with disturbance or alteration of existing slope vegetation. The setback zone is not intended to be an undisturbed conservation area, and small disturbances such as minor landscaping or construction of decks or fences are acceptable. The recommendations provided are intended to address the geotechnical aspects of construction within the recommended limitation zones.

Actual slope limits and associated setbacks should be determined after completion of a site-specific topographic survey. We have included a typical slope setback figure for guidance as Figure 4 of this report.

Foundations

Continuous-wall and isolated-spread footings should be at least 12 and 24 inches wide, respectively. For frost protection, the footings should be founded at least 12 inches below the lowest adjacent grades or deeper if required by local building code. The footings should be founded below an imaginary line project at a 1H:1V slope from the base of any adjacent, parallel utility trenches.

Footings should bear on the near-surface silt or gravelly clay or structural fill placed in accordance with our recommendations. Footings should be sized for an allowable bearing capacity of 1,500 psf. We estimate post construction settlements will be less than one inch for our recommended allowable bearing capacity. We estimate that the differential settlement will be approximately half of the total settlement. Our recommended bearing capacity is based on limiting settlements and includes a minimum factor of safety of 3 against ultimate bearing failure.

Lateral loads acting on the foundations can be resisted by passive earth pressures on the sides of the foundation and by friction along the soil-rock-concrete interface at the base of the foundation. We recommend using an allowable passive earth pressure of 250 pounds per cubic foot (pcf) for foundations confined by the near-surface silty sand or structural fill placed in accordance with our recommendations. We recommend an allowable coefficient of friction of 0.35 for foundations. In order to develop these capacities, concrete must be poured neat in excavations, the adjacent grade must be level, and the static ground water level must remain below the base of the footing throughout the year. The passive pressure within the upper foot of embedment should be neglected. These allowable lateral resistance values include a factor of safety of 1.5.

Slab-on-grade Floors

Satisfactory subgrade support for lightly-loaded building floor slabs can be obtained on the undisturbed native soil or on engineered structural fill. A subgrade modulus of 125 pounds per cubic inch may be used to design floor slabs.

A minimum 6-inch-thick layer of drain rock should be placed and compacted over the prepared subgrade to assist as a capillary break and blanket drain. The drain rock may include a capping layer of clean ¾ inch minus crushed rock that contains no more than 5% fines. The drain rock and capping rock should be placed in one lift and compacted until well-keyed, about 90% of the maximum dry density as determined by ASTM D698.

A vapor retarder manufactured for use beneath floor slabs should be installed according to the manufacturer's recommendations. Careful attention should be made during construction to prevent perforating the retarder, and to seal edges and utility penetrations. We recommend following ACI 302.1, Chapter 3 with regard to installing a vapor retarder.

Pavement Design

The City of La Center has set standards for the minimum pavement sections for each design level category of public roadways, depending on the AASHTO classification of the expected subgrade conditions. The minimum section for both Local Access and Neighborhood Access streets with the anticipated AASHTO Class A-5 on-site soils is 4 inches of asphaltic concrete (AC) over 11 inches of crushed rock base (CRB). In our opinion, based on anticipated traffic volume and subgrade conditions, the minimum sections will provide a minimum 20-year service life with terminal serviceability within the AASHTO recommended range.

These recommended pavement sections are based on the assumption that the subgrade consists of firm structural fill or compacted native subgrade and that the pavement will be constructed during the dry summer months. Proofrolling should be used to evaluate pavement subgrade. Any soft areas disclosed by proofrolling will likely need to be reworked. Some contingency should be provided for the repair of any soft areas. If pavement construction is scheduled for the wet season, it will be necessary to increase the above-recommended base course sections.

AC and CRB materials should conform to WSDOT specifications. All CRB should be compacted to at least 95 percent of the modified proctor ASTM D-1557 laboratory test standard.

Permanent, properly installed drainage is also an essential aspect of pavement design and construction. All paved areas should have positive drainage to prevent ponding of surface water and saturation of the base course. This is particularly important in cut sections or at low points within the paved areas, such as around stormwater catch basins.

Drainage

The Contractor should be made responsible for temporary drainage of surface water and groundwater as necessary during construction to prevent standing water and/or erosion at the site.

As a matter of good construction practice, we recommend that perimeter drains be installed for all buildings. Perimeter drains should consist of perforated drainpipe embedded in a zone of free draining fill that is wrapped in a non-woven geotextile filter. The pipe should be connected to a tightline drainpipe leading to storm drain facilities. Foundation and crawl space drainage should be sloped to drain to a sump or low point drain outlet. Water should not be allowed to pond within crawl spaces. Roof drains should be connected to a tightline drainpipe leading to storm drain outlet facilities.

Water should not be allowed to "pond" or collect anywhere on the site. The ground surface around structures should be sloped to drain away from building foundations for a distance of at least 5 feet. Surface water should be directed away from all buildings into drainage swales or other approved drainage areas. "Trapped" planting areas should not be created next to any buildings without providing means for drainage.

Soil Erosion

Site-specific erosion control measures should be implemented to address the maintenance of slopes or exposed areas. This may include silt fence, bio-filter bags, straw wattles, or other suitable methods. During construction, all exposed areas should be well compacted and protected from erosion. Temporary slopes or expose areas may be covered with straw, crushed aggregate, or rip in localized areas to minimize erosion.

Finished slopes should be vegetated as soon as possible with erosion-resistant native grasses and plants. Once established, slope vegetation should be properly maintained. Concentrated water should be prevented from flowing over slope faces.

CONSTRUCTION OBSERVATIONS

Satisfactory earthwork performance depends on the quality of construction. Sufficient monitoring of the contractor's activities is a key part in ensuring that work is completed in accordance with the construction drawings and specifications. We recommend that True North observe that the subsurface conditions observed during our site investigation are consistent with those encountered during construction, and that foundation subgrades are suitable for placement of structural fill, rebar, or concrete for the new structures.

The City of La Center and/or Clark County may require a final letter of geotechnical compliance before they will finalize a permit. If such a letter is required, a representative from True North MUST observe foundation subgrades PRIOR to concrete being poured for the foundation. If True North does not perform this observation, we cannot provide a final letter of geotechnical compliance, and a permit will not be eligible for final sign-off. It is the owner's responsibility to ensure that True North be notified in a timely manner (i.e., at least 48 hours prior to the required site observation) of the need for our services on site during construction.

LIMITATIONS

We have prepared this report for use by the owner/developer and other members of the design and construction team for phase 2 of the proposed Holley Park Subdivision. The opinions and recommendations contained within this report are not intended to be construed as a warranty of subsurface conditions but are forwarded to assist in the planning and design process. The conclusions and recommendations contained in this report are based on our understanding of the currently proposed project, as derived from written and verbal information supplied to us by you.

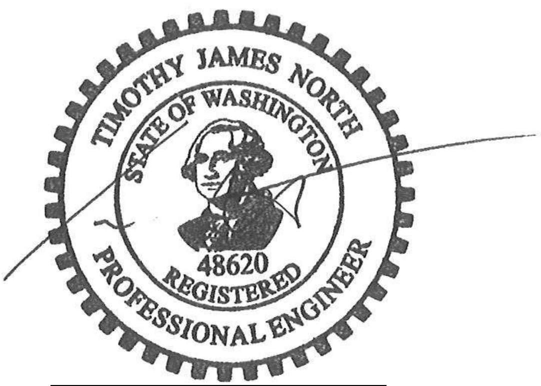
The conclusions and recommendations contained in this report are based on our understanding of the currently proposed project and potential future development, as derived from written and verbal information supplied to us by you. When the design has been finalized, we recommend that we review the design and specifications to see that our recommendations have been interpreted and implemented as intended. If design changes are made, we request that we be retained to review our conclusions and recommendations and to provide a written modification or verification.

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

CLOSING

We appreciate the opportunity to be of service to you. If you have any questions, or if we can be of further assistance to you, please contact us at (360) 984-6584.

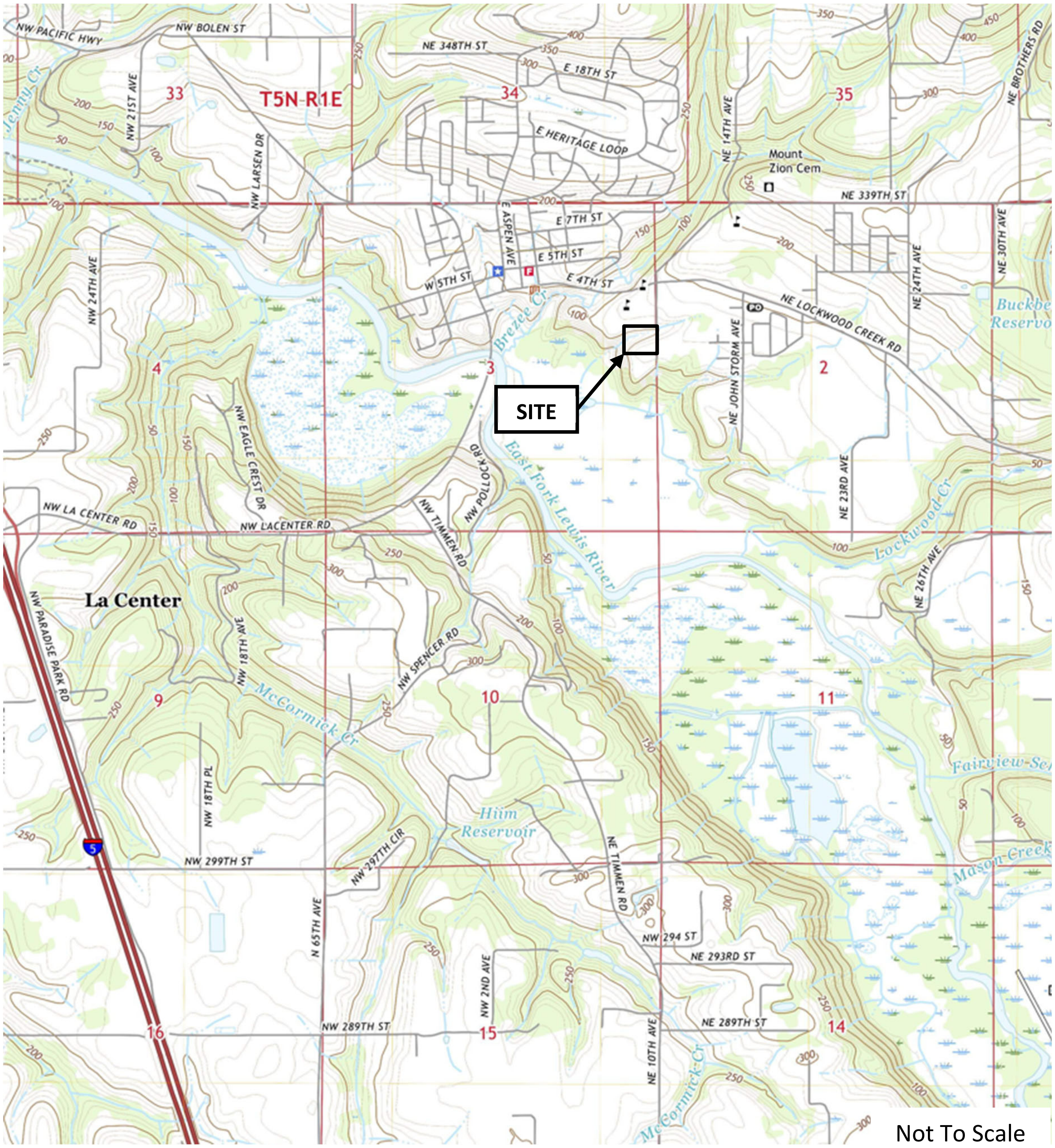
Respectfully Submitted,



Timothy J. North, P.E.
Geotechnical Engineer

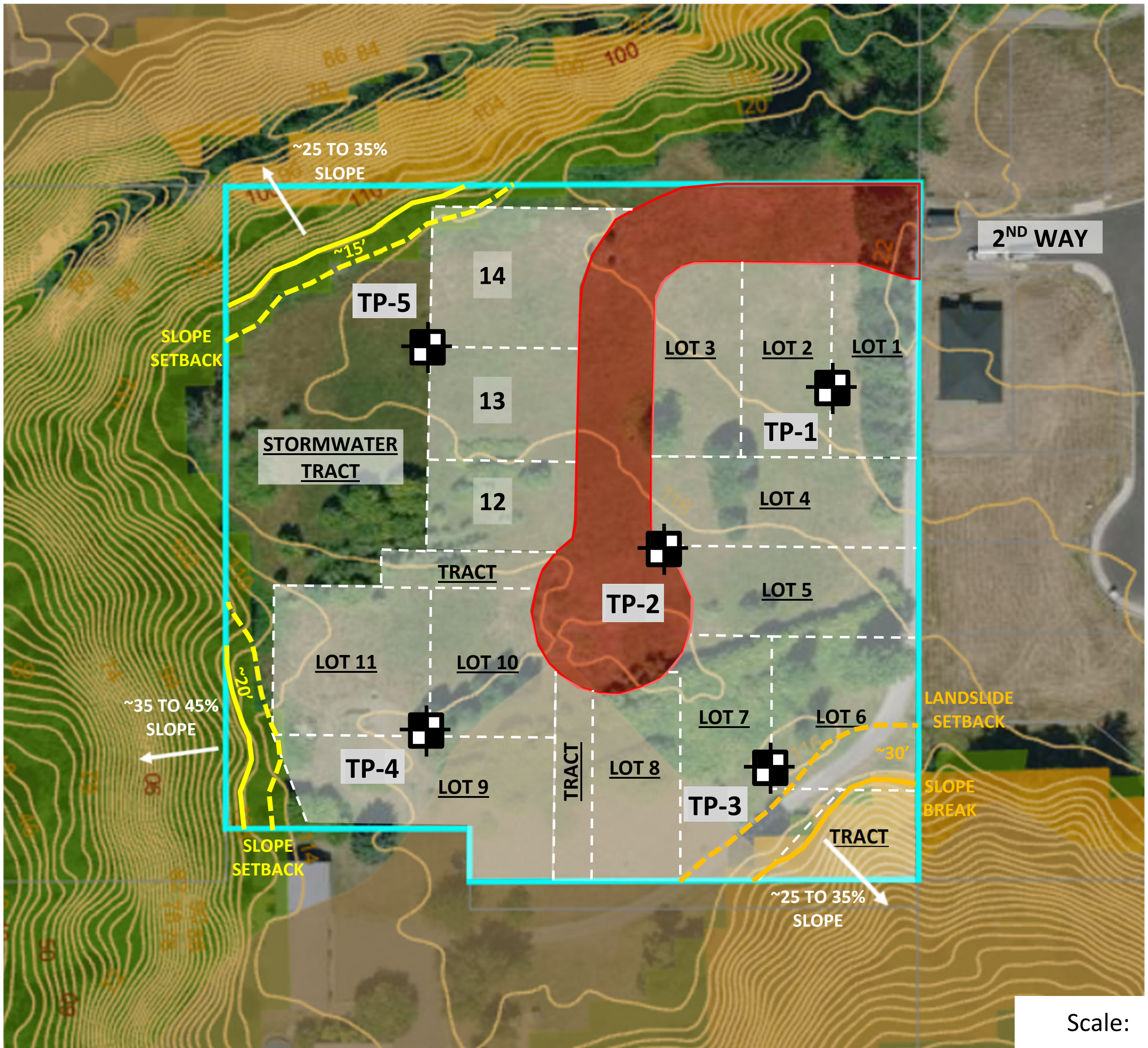
Attachment: Figure 1 – Vicinity Map
Figure 2 – Site & Exploration Plan
Figure 3 – Site Photographs
Figure 4 – Typical Slope Setback
Appendix A – Field and Laboratory Procedures
Test Pit Logs TP-1 through TP-5

FIGURES



Source: “Topographic Map of the Ridgefield Quadrangle, 7.5 minute series” 2020, United States Geological Survey (USGS).

TRUE NORTH GEOTECHNICAL	Holley Park Phase 2 La Center, WA	Project # 22-0411-1
219 West 4th Street Vancouver, WA 98660 360-984-6584	February 2023	Figure 1 – Site Vicinity



Scale:
1" ≈ 120'

TP-1 Approximate Exploratory Test Pit Locations, November 4, 2022.

Note: Green shading indicates mapped slope gradients exceeding 15 percent.
Brown shading indicates mapped severe erosion hazard area.
Orange shading indicates mapped areas of potential instability.

Source: Aerial & Topo – Clark County MapsOnline, accessed October 21, 2022.

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TRUE NORTH GEOTECHNICAL	Holley Park Phase 2 La Center, WA	Project # 22-0411-1
219 West 4th Place Vancouver, WA 98660 360-984-6584	February 2023	Figure 2 –Site & Exploration Plan

Photo 1. Area of potential instability in southeast corner of site, looking southwest

Photo 2. Area of potential instability in southeast corner of site, looking southeast.

TRUE NORTH GEOTECHNICAL	Holley Park Phase 2 La Center, WA	Project # 22-0411-1
219 West 4th Street Vancouver, WA 98660 360-984-6584	February 2023	Figure 2A (Sheet 1 of 2) – Site Photographs

Photo 3. Location of TP-2, looking northwest. These conditions represent most of the site.

Photo 4. Conditions of mapped severe erosion hazard area, looking south.

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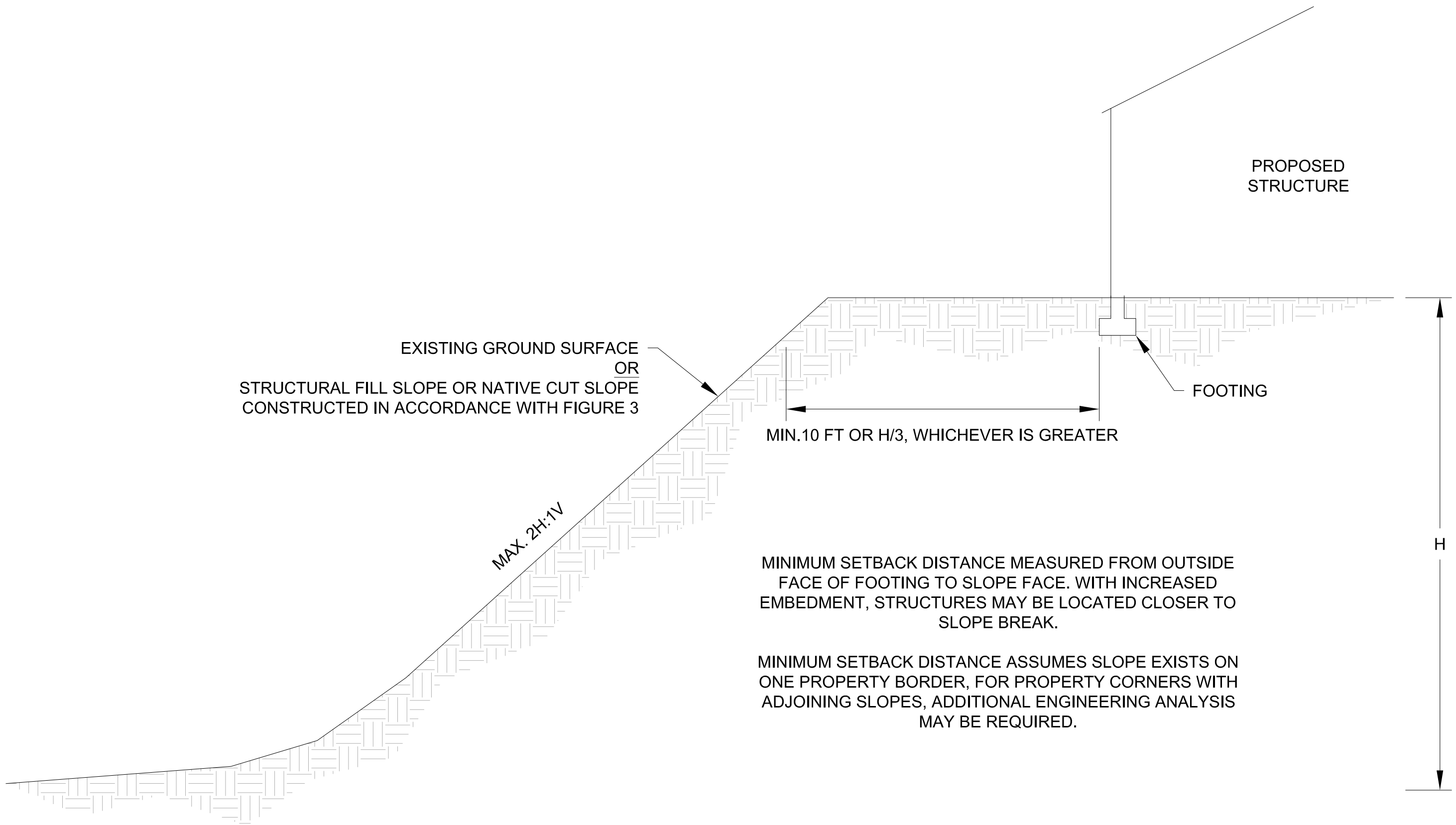

NOTES:

1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE
3. DRAWING REPRESENTS TYPICAL SLOPE SECTION, AND IS NOT SITE SPECIFIC.

TRUE NORTH GEOTECHNICAL	Holley Park Phase 2 La Center, WA	Project # 22-0411-1
219 West 4th Street Vancouver, WA 98660 360-984-6584	February 2023	Figure 4 – Typical Slope Setback Detail

APPENDIX A

Field Exploration Procedures
Laboratory Testing Procedures
Exploration Test Pit Logs

FIELD EXPLORATION PROCEDURES

General

We explored subsurface conditions at the site by excavating five test pits, designated TP-1 through TP-5, to depths of about 13 feet bgs. The test pit explorations were excavated on November 4, 2022, with a Deere 75G Mini Excavator, owned and operated by Dan Tapani Excavating. Upon completion, the test pits were backfilled with excavated soils and tamped into place as best possible.

Soil Sampling

A True North representative observed subsurface explorations to record the soil, rock, and groundwater conditions encountered, and to obtain soil samples. Disturbed soil samples were obtained from the sidewalls of the excavation and the excavator bucket at selected depths throughout the explorations. Soil samples were sealed to retain moisture and returned to our laboratory for additional examination and testing.

Field Classification

The observed soils were classified initially on site in general accordance with ASTM D 2488 Description and Identification of Soils (Visual-Manual Procedure). Consistency, color, relative moisture, degree of plasticity, peculiar odors, and other distinguishing characteristics of the soil samples were noted. The terminology used is described in the key and glossary that follow.

Summary Exploration Logs

Results from the test pits are shown in the summary exploration logs. The left-hand portion of a log provides our interpretation of the soil encountered, sample depths, and groundwater information. The right-hand portion of a log shows the results of field and laboratory testing. Soil descriptions and interfaces between soil types shown in summary logs are interpretive, and actual transitions may be gradual.

LABORATORY TESTING PROCEDURES

Soil samples obtained during field explorations are examined in a laboratory, and representative samples may be selected for further testing. The testing program included visual-manual classification and natural moisture content testing.

Visual Manual Classification

Soil samples are classified in general accordance with guidelines presented in ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). The physical characteristics of the samples are noted, and the field classifications are modified, where necessary, in accordance with ASTM terminology, though certain terminology that incorporates current local engineering practice may be used. The term which best described the major portion of the sample is used to describe the soil type.

Natural Moisture Content

Natural moisture content is determined in general accordance with guidelines presented in ASTM D2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. The natural moisture content is the ratio, expressed as a percentage, of the weight of water in a given amount of soil to the weight of solid particles.

Fines Content

Fines content testing is performed in general accordance with guidelines presented in ASTM D1140, *Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No.200) Sieve in Soils by Washing*. The fines content is the fraction of soil that passes the U.S. Standard Number 200 Sieve. This sieve differentiates fines (silt and clay) from sand and gravel. Soil material that remains on the Number 200 sieve is sand and gravel. Material that passes the sieve is fines. The test is used to refine soil type.

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TABLE A1
Key to Test Pit and Boring Terminology and Symbols

MAJOR DIVISIONS			SYMBOLS: LETTER	TYPICAL DESCRIPTION
Coarse Grained Soils More Than 50% Material Retained on No. 200 Sieve	Gravel and Gravelly Soils More Than 50% Coarse Fraction Retained on No. 4 Sieve	Clean Gravels (Little or No Fines)	GW	Well-graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly-graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		Gravels with Fines (Significant Percentage of FInes)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand and Sandy Soils More Than 50% Coarse Fraction Passing No. 4 Sieve	Clean Sands (Little or No Fines)	SW	Well-graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly-graded Sands, Gravelly Sands, Little or No Fines
		Sands with Fines (Significant Percentage of FInes)	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils More Than 50% Material Passing No. 200 Sieve	Silts and Clays	Liquid Limit Less than 50 percent	ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands, Clayey Silts
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays
			OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays	Liquid Limit Greater than 50 percent	MH	Inorganic Silts Micaceous or Diatomaceous Fine Sand or Silty Soils
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Clays of Medium to High Plasticity, Organic Silts
			PT	Peat, Humus, Swamp Soils
Topsoil				Humus and Duff Layer
Fill				Highly Variable Constituents

Relative Density of Coarse-Grained Soils	
Relative Density	**N - Blows per Foot**
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50+

Consistency of Fine-Grained Soils	
Relative Density	**N - Blows per Foot**
Very Soft	0 - 2
Soft	2 - 4
Medium Stiff	4 -8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	30 - 50
Very Hard	50+

Key to Sampler Type Symbols

G Grab

SPT

Shelby Tube

Dames & Moore

Rock Core

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TEST PIT LOG TP-1

Project Name	Holley Park Phase 2
Project Location	Ivy Ave and 2nd Way, La Center, WA 98629
Project No.	22-0411-1
Operator	Dan Tapani Excavating
Equipment	Deere 75G Midi Excavator
Date Started	11/04/22
Logged By	EP
Checked By	TJN
Date Completed	11/04/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0–1					Soft, dark brown TOPSOIL with trace sand; wet.			
1–6				ML	Medium stiff, light brown Sandy SILT; low plasticity; fine sand; wet to moist.		PP= 1.0 PP= 2.5 PP= 4.0 PP= 3.0	
3	G	S-1				22		
4					fine orange material encountered at 4 feet			
6–10				CL	Medium stiff to stiff, gray Sandy CLAY; medium plasticity; fine sand; trace orange mottling; moist.			
6	G	S-2				35		
9	G	S-3				32		
10–13				CH	Stiff, gray CLAY with orange mottling; high plasticity; trace black nodules; moist.			
11	G	S-4				41		
13					Test Pit excavation terminated at 13.0 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			

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TEST PIT LOG TP-2

Project Name: Holley Park Phase 2		
Project Location: Ivy Ave and 2nd Way, La Center, WA 98629		Project No.: 22-0411-1
Operator: Dan Tapani Excavating	Equipment: Deere 75G Midi Excavator	Date Started: 11/04/22
Logged By: EP	Checked By: TJN	Date Completed: 11/04/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0–1					Soft, dark brown TOPSOIL with trace sand; wet.			
1–5				ML	Medium stiff, light brown Sandy SILT; low plasticity; fine sand; increasing sand content with depth; wet to moist.		PP= 1.0	
2	G	S-1			fine orange material encountered at 2 feet	29	PP= 2.5	
3					fine gray ashy material encountered at 3 feet		PP= 4.0	
4							PP= 3.0	
5–11.5	G	S-2		CL	Medium stiff to stiff, gray Sandy CLAY; medium to high plasticity; fine sand; orange mottling; moist.	36		Fines content = 83%
9	G	S-3				37		
11.5–13	G	S-4		CH	Stiff, gray CLAY with trace sand; fine sand; high plasticity; orange mottling; moist.	40		
13					Test Pit excavation terminated at 13.0 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			

TRUE NORTH GEOTECHNICAL 202 E Evergreen Blvd Suite B, Vancouver, WA 360-984-6584 - www.tnorthgeo.com	Project Name: Holley Park Phase 2		TEST PIT LOG TP-3
	Project Location: Ivy Ave and 2nd Way, La Center, WA 98629		Project No.: 22-0411-1
	Operator: Dan Tapani Excavating	Equipment: Deere 75G Midi Excavator	Date Started: 11/04/22
	Logged By: EP	Checked By: TJN	Date Completed: 11/04/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0					Soft, dark brown TOPSOIL with trace sand; wet.			
1					Medium stiff, light brown Sandy SILT; low plasticity; fine sand; increasing sand content with depth; wet to moist.		PP= 0.5	
2					fine orange/gray material encountered at 2 feet		PP= 0.5	
3	G	S-1				24	PP= 3.0	
4				ML			PP= 4.0	
5					fine red/orange material encountered at 5 feet			
6	G	S-2			trace gray clay encountered from 6 to 8 feet	26		
7					Medium stiff to stiff, gray Sandy CLAY; medium to high plasticity; fine sand; orange mottling; moist.			
8				CL				
9	G	S-3				33		
10					Stiff, gray CLAY with trace sand; fine sand; high plasticity; orange mottling; moist.			
11				CH				
12	G	S-4				43		
13					Test Pit excavation terminated at 13.0 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
14								
15								

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TEST PIT LOG TP-4

Project Name: Holley Park Phase 2			
Project Location: Ivy Ave and 2nd Way, La Center, WA 98629		Project No.: 22-0411-1	
Operator: Dan Tapani Excavating	Equipment: Deere 75G Midi Excavator	Date Started: 11/04/22	
Logged By: EP	Checked By: TJN	Date Completed: 11/04/22	

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0–1					Soft, dark brown TOPSOIL with trace sand; wet.		PP= 0.5	
1–7				ML	Medium stiff, light brown/orange Sandy SILT; low plasticity; fine sand; increasing sand content with depth; wet to moist.		PP= 1.5	
3	G	S-1			fine gray material encountered at 3 feet	24	PP= 4.0 PP= 3.5	
6	G	S-2			trace gray clay encountered at 6 feet	29		Fines content = 62%
7–10				CL	Medium stiff to stiff, gray/brown Sandy CLAY; medium to high plasticity; fine sand; orange/red mottling and dark nodules; moist.			
9	G	S-3				37		
10–13				CH	Stiff, gray CLAY with trace sand; fine sand; high plasticity; orange mottling; moist.			
11	G	S-4				39		
13					Test Pit excavation terminated at 13.0 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

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TEST PIT LOG TP-5

Project Name	Holley Park Phase 2		
Project Location	Ivy Ave and 2nd Way, La Center, WA 98629	Project No.	22-0411-1
Operator	Dan Tapani Excavating	Equipment	Deere 75G Midi Excavator
Date Started	11/04/22		
Logged By	EP	Checked By	TJN
Date Completed	11/04/22		

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0–1					Soft, dark brown TOPSOIL with trace sand; wet.		PP= 0.5	
1–8				ML	Medium stiff, light brown/orange Sandy SILT; low plasticity; fine sand; increasing sand content with depth; wet to moist.		PP= 3.0 PP= 4.0 PP= 3.0	
3					trace brown/gray clay encountered at 3 feet			
4	G	S-1				25		Fines content = 50% Permeability = 3.92 in/hr
5					fine gray material encountered at 5 feet			
7	G	S-2				31		Fines content = 56%
8–10				CL	Medium stiff to stiff, gray/brown Sandy CLAY; medium to high plasticity; fine sand; orange/red mottling and dark nodules; moist.			
9	G	S-3				40		
10–13				CH	Stiff, gray CLAY with trace sand; fine sand; high plasticity; orange mottling; moist.			
11					increasing sand content with depth			
12.5	G	S-4				31		
13					Test Pit excavation terminated at 13.0 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			