NELSON GEOTECHNICAL
ASSOCIATES, INC.

105 Palouse Street
Wenatchee, WA 98801
(509) 665-7696
www.nelsongeotech.com

September 22, 2023

Gary Fowler
VIA E-mail: gmf350@gmail.com

Geotechnical Engineering Evaluation
Fowler Residence Development
68 Adel Lane
Chelan County, Washington
NGA File No. 1466123

Dear Gary:

We are pleased to submit the attached report titled ***"Geotechnical Engineering Evaluation – Fowler Residence Development – 68 Adel Lane – Chelan County, Washington."*** This report summarizes our explorations of the surface and subsurface conditions at the site and provides recommendations for the proposed site development. Our services were completed in general accordance with our proposal dated August 3, 2023, and signed by you on August 7, 2023.

The property is a vacant, irregularly-shaped 1.5-acre lot in a residential area in the Sunnyslope area of Chelan County, Washington. The building site consists of a cut-and-fill building pad on moderately steep slopes below Adel Lane. The ground is primarily covered with semi-arid grass, brush, and weeds.

We explored the subsurface soil and groundwater conditions at the site on August 21, 2023, with six geotechnical test pits ranging from 4.5 to 12.5 feet in depth below existing ground surface, and three geotechnical hand auger holes ranging from 1.0 to 5.0 feet in depth below existing ground surface. The test pits encountered up to 8.0 feet of undocumented fill in the pre-existing building pad. The fill consisted of light brown silt with trace sand in a stiff to very stiff condition. The fill overlies native sandy silt in a very stiff condition derived from loess overlying sandstone bedrock. We did not encounter groundwater or seepage in any of the geotechnical explorations.

It is our opinion, from a geotechnical standpoint, that the development of a new residence is feasible provided that our recommendations are incorporated into project plans. Due to the existence of the steep slope and fill, and the nature of the native soils, we recommend all residence foundations extend through the fill and bear directly on the underlying native soils or on 2-inch railroad ballast placed on the native soils. This will result in foundation trench excavations of up to 8 feet, depending on final building location. Alternatively, the residence should be placed on driven pin piles. These options are discussed in more detail in the attached report. We also recommend that the downhill foundation line be setback 25 feet from the face of the steep slope.

The attached report includes recommendations for site preparation and grading, structural fill, foundation support, retaining walls, building setbacks, temporary and permanent slopes, erosion control, and site drainage.

We appreciate the opportunity to provide service to you on this project. Please contact us if you have any questions regarding this report or require further information.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Khaled M. Shawish, PE
Principal Engineer

TABLE OF CONTENTS

LIST OF FIGURES

Geotechnical Engineering Evaluation
Fowler Residence Development
68 Adel Lane
Chelan County, Washington

INTRODUCTION

This report presents the results of our geotechnical engineering investigation and evaluation of the property located at 68 Adel Lane in the Sunnyslope area of Chelan County, Washington. The property is a vacant, irregularly shaped 1.5-acre lot surrounded by single-family residences. The Chelan County parcel number is 232008542255.

It is our understanding that a single-family residence with a pool is planned for the northwestern portion of the property. To aid in our evaluation of the site, we have been provided with an untitled and undated site plan. This site plan depicts the approximate residence location and lot corners. The location of the site is shown on the Vicinity Map in Figure 1 and Site Plan in Figure 2.

SCOPE

The purpose of this study is to explore and characterize the site surface and subsurface conditions and provide general recommendations for site development.

Specifically, our scope of services included the following:

1. Review available soil and geologic maps of the area as well as other relevant geotechnical information and historical documents.
2. Explore the subsurface soil and groundwater conditions within the planned residence development area with several trackhoe-excavated test pits and hand auger explorations. Trackhoe and operator were subcontracted by NGA.
3. Perform dynamic penetrometer testing within selected test pit excavations.
4. Measure site slopes and construct subsurface cross sections of slopes within the area.
5. Perform shallow hand-tool explorations to aid in geologic analyses.
6. Perform classification and laboratory analysis on selected soil samples obtained from the explorations, including sieve analyses and Atterberg Limits.
7. Provide geologic hazard assessment per Chelan County Code.
8. Provide general recommendations for stabilization, including shoring and piling.
9. Provide recommendations for earthwork, including cuts and structural fills.
10. Provide recommendations for conventional retaining walls, including lateral earth pressures.

11. Provide recommendations for foundations and slabs on grade, including soil pressures.
12. Provide recommendations for temporary and permanent slopes.
13. Provide general recommendations for site drainage and erosion control.
14. Document the results of our findings, conclusions, and recommendations in a written geotechnical engineering report.

SITE CONDITIONS

Surface Conditions

We visited the site and made our observations and explorations on August 21, 2023. The lot is bordered by Adel Lane to the northwest, undeveloped residential lots to the south and east, and single-family residences to the southeast. The area to be developed is on a southeastern facing slope measuring about 15 to 20 degrees (27 to 36 percent). A pre-existing cut-and-fill building pad lies directly below Adel Lane. The existing ground surface is shown on Cross-Sections A-A' and B-B', as presented in Figures 3 and 4. The slopes are covered with sparse native grasses and brush.

Subsurface Conditions

Geology: The geologic units for this site are shown on the Geologic Map of the Wenatchee 1:100,000 Quadrangle, Central Washington, by R. W. Tabor, et al., (USGS, 1982). The project site is mapped as Chumstick Formation (Tc) bedrock. Tc is described as white, locally gray, medium- to coarse-grained micaceous sandstone, interbedded with shale. We observed exposures around and near the site which appear to consist of tan sand and silt, derived from weathered soil and Chumstick Formation rock.

Explorations: The subsurface conditions within the site were explored on August 21, 2023, with six geotechnical test pits ranging from 4.5 to 12.5 feet below existing ground surface and three geotechnical hand auger holes ranging from 1.0 to 5.0 feet below existing ground surface. The approximate locations of our explorations are shown on the Site Plan in Figure 2. A Geologist from Nelson Geotechnical Associates, Inc. (NGA) was present during the test pit explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the explorations. During the excavation process, we measured the relative soil consistency using a dynamic, mini-cone penetrometer. The mini-cone uses a slide hammer to drive a conical tip into the soil. The number of hammer blows required to drive the cone 1¾-inch increments is roughly equivalent to a Standard Penetration Test (SPT) blow count. The blows per increment provide an indication of the relative soil density. The blow counts are recorded on the exploration logs.

The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 5. The exploration logs are presented in Figures 6 through 8. We present a brief summary of the subsurface conditions in the following paragraph. For a detailed description of the subsurface conditions, the exploration logs should be reviewed.

The test pits encountered up to 8.0 feet of undocumented fill in the pre-existing building pad. The fill consisted of light brown silt with trace sand in a stiff to very stiff condition. The fill overlies sandy silt in a very stiff condition derived from loess overlying sandstone bedrock. We did not encounter bedrock in the test pits.

Hydrogeologic Conditions

We did not encounter groundwater seepage during our explorations. During wet weather, a perched water condition may develop on this site. Perched water occurs when surface water infiltrates through less dense, more permeable soils and accumulates on top of underlying, less permeable soils. Perched water does not represent a regional groundwater "table" within the upper soil horizons. Perched water tends to vary spatially and is dependent upon the amount of rainfall or irrigation schedule. We would expect the amount of perched water to decrease during drier times of the year and increase during wetter periods.

GEOLOGIC HAZARD EVALUATION

Seismic Hazard

Hazards associated with seismic activity include liquefaction and amplification of ground motion by soft deposits. Liquefaction is caused by a rise in pore pressures in a loose, fine sand deposit beneath the groundwater table.

We reviewed the Washington State Department of Natural Resources (WSDNR) *Site Class Map of Chelan County, Washington* (Palmer, et. al., Sept 2004) for seismic site classification for this project. Site conditions best fit the description for Site Class B.

We reviewed the WSDNR *Liquefaction Susceptibility Map of Chelan County, Washington* (Palmer, et. al., Sept 2004) for the liquefaction susceptibility for this project. Based on the absence of groundwater expected at the site and our review of the WSDNR map, it is our opinion that the on-site soils have a low potential for liquefaction.

The slopes around the site have the potential to experience shallow failures during seismic events. Such failures should not impact the residence when the foundation and structure setback recommendations provided in this report are implemented. Should seismic movement of the slopes occur, the geotechnical consultant should be notified to provide additional input for potential stabilization and/or repair methods.

Erosion Hazard

The criteria used to determine erosion hazard include soil type, slope gradient, vegetation cover, and groundwater conditions. The erosion sensitivity is related to the vegetative cover and the specific surface soil types, which are related to the underlying geologic soil units. The Soil Survey, Chelan County Area, Washington, by the Soil Conservation Service (SCS) was reviewed to determine the erosion hazard of the on-site soils. The site soils were classified as Cowiche silt loam, 15 to 25 percent slopes (CwD) and Cowiche silt loam, 25 to 45 percent slopes (CwE). CwD is described as residuum weathered from metamorphic and sedimentary rock with loess formed on hillsides. This soil is well drained with a medium runoff hazard and a moderate hazard of water erosion. If irrigated, runoff is very rapid, and the hazard of water erosion is very high. CwE is similar to CwD; however, the hazard of water erosion is high and if irrigated, runoff is very rapid, and the hazard of water erosion is high. These soils should have a low hazard for erosion if not disturbed and the vegetation cover is not removed.

LANDSLIDE HAZARD/SLOPE STABILITY

The criteria used for evaluation of landslide hazards include soil type, slope gradient, and groundwater conditions. We measured native slope inclinations above and below the planned residence area at about 15 to 20 degrees (27 to 36 percent). Due to the lack of large-scale slide scarps, it is our opinion that the potential of deep-seated landsliding is low under current site conditions. It should be noted that small-scale surface slides and sloughing are natural processes on slopes and should be expected to occur at times in the steeper portions around the site. If the area at the top of the slope is significantly disturbed during construction, slope movement may increase and may require stabilization. Spoils from the excavation of the residence should not be placed near the tops of slopes or be cast down the slope.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion, from a geotechnical standpoint, that the proposed new development is feasible, provided that the geotechnical recommendations presented in this report are incorporated into project plans and followed during construction. We should be retained to review final development plans, including grading, foundation, and drainage plans prior to construction. We should also be retained to evaluate foundation subgrades prior to placing concrete forms.

We recommend that all residence foundations extend through any fill and any loose soil and rest on competent native soils, or on railroad ballast extending to the competent native soils. This could require excavations up to 8.0 feet deep depending on the final residence location. Alternatively, the residence could be supported on pin piles driven through the fill to terminate in the underlying native soils. Details regarding structural fill are presented in the **Structural Fill** subsection of this report. Downhill footing lines should also be deep enough to maintain a 25-foot horizontal setback from the face of the slope below. We should review the proposed foundation plans prior to construction.

To restore the stability of the steep slope area below the residence after the residence has been constructed, we recommend that slope areas that are disturbed during construction be covered with heavy-duty erosion control matting staked to the slope and vegetated with deep-rooting native vegetation. Detailed recommendations for slope stabilization measures are described in the **Slope Improvements** subsection of this report.

The new construction may require both cuts and fill. Cut slopes are recommended to be constructed to stable slopes and protected from erosion. Fill slopes are recommended to be benched and compacted to engineering standards. Recommendations for the cuts and fills within this site are presented in the sections below.

The on-site surface soils consist of materials that are highly sensitive to moisture and will disturb when wet. We recommend that construction take place during the drier months, if possible. If construction takes place during the wet season, additional expenses and delays should be expected if exposed soils become saturated. Additional expenses could include the need to export on-site soil, import clean, granular soil for fill, and place a blanket of rock spalls or crushed rock in the construction traffic areas and exposed subgrades prior to placing structural fill or structural elements.

Erosion Control and Slope Protection Measures

The erosion hazard for the on-site soils is considered slight but actual erosion potential will be dependent on how the site is graded and how water is allowed to concentrate. Best Management Practices (BMPs) should be used to control erosion. Erosion control measures may include diverting surface water away from the stripped or disturbed areas. Silt fences and/or straw bales could be erected to prevent muddy water from leaving the site. Disturbed areas should be planted and/or paved as soon as practical and the vegetation should be maintained until it is established. The erosion control systems should be maintained until fully established. Irrigation systems should be avoided near the steep slopes.

Site Preparation and Grading

After erosion control measures are implemented, site preparation should consist of stripping any topsoil, undocumented fill, and loose soils from the areas to be developed to expose medium dense or better native soils. Where structural elements area to be supported on pin piles, the fill soils could remain in place. The stripped soil should be removed from the site or stockpiled for later use as landscaping fill. Our explorations encountered medium dense native soils underlying the undocumented fill in the building pad and the loose silt loess elsewhere. After excavating through the undocumented fill and the silt loess, if the exposed subgrade appears to be loose, it should be compacted to a non-yielding condition. Areas observed to pump or weave during compaction should be reworked to structural fill specifications or over-excavated and replaced with properly compacted structural fill or rock spalls. If significant surface water flow is encountered during construction, this flow should be diverted around areas to be developed and the exposed subgrade maintained in a semi-dry condition.

Subgrade preparation within slab-on-grade or pavement areas should consist of a minimum of 24-inch of overexcavation and replacement with railroad ballast after the exposed subgrade is compacted to a firm unyielding state.

Temporary and Permanent Slopes

Temporary cut slope stability is a function of many factors, including the type and consistency of soils, depth of the cut, surcharge loads adjacent to the excavation, length of time a cut remains open, and the presence of surface water or groundwater. It is exceedingly difficult under these variable conditions to estimate a stable, temporary, cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations since they are continuously at the job site, able to observe the soil and groundwater conditions encountered and able to monitor the nature and condition of the cut slopes.

The following information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Nelson Geotechnical Associates, Inc. assumes responsibility for job site safety. Job site safety is the sole responsibility of the project contractor.

For planning purposes, we recommend that temporary cuts in the on-site soils be no steeper than 1.5 horizontal to 1.0 vertical (1.5H:1.0V). If significant groundwater seepage or surface water flow are encountered, we would expect that flatter inclinations would be necessary. We recommend that cut slopes be protected from erosion. The slope protection measures may include covering cut slopes with plastic sheeting and diverting surface runoff away from the top of cut slopes. We do not recommend vertical slopes for cuts deeper than four feet, if worker access is necessary. We recommend that cut slope heights and inclinations conform to appropriate OSHA/WISHA regulations.

Permanent cut and fill slopes should be no steeper than 2.0H:1.0V. However, flatter inclinations may be required in areas where loose soils are encountered. If permanent slopes steeper than 2.0H:1.0V are created, we would anticipate such slope(s) to require on-going maintenance. Permanent slopes should be planted, and the vegetative cover should be maintained until it is established.

Slope Setbacks

We recommend that foundations be setback a minimum distance from the tops of steep slopes. For the purposes of this report, steep slopes are defined as slopes with an inclination greater than 19 degrees (35 percent). For conventional shallow spread foundations designed and constructed as recommended in the **Foundation Support** subsection of this report, the foundations should be constructed with a minimum effective setback of 25 feet from the face of the slope to bottom of foundation. The recommended setback is an effective setback, meaning that the setback distance is intended to be measured from the base of the foundation along a horizontal plane to the face of the slope. This horizontal plane will likely be below the existing ground surface. In any case, all foundation lines along slopes, including, exterior retaining walls, should be keyed into the underlying competent native soils. This should be confirmed by NGA prior to pouring concrete.

Foundation Support

The following foundation support recommendations are intended to improve foundation performance and reduce the potential for total and differential settlements across the building area. Within the proposed residence foundation area, we encountered very stiff native sandy silt between 3.0 and 8.0 feet below existing ground surface. We recommend that the proposed residence and pool be founded directly on medium dense or better native soils or on railroad ballast extending down to medium dense or better native soils. If footings are supported on structural fill, the fill zone should extend outside the edges of the footing a distance equal to one half of the depth of the over-excavation below the bottom of the footing. Alternatively, the residence and pool could be supported on driven pin piles. We could provide further recommendations for pin piles if this option becomes viable during final design.

As described in the **Slope Setback** subsection of this report, we recommend foundations be embedded into native soils to maintain a minimum setback of 25 feet from the face of steep slopes. If a 25-foot setback is not achievable at the existing top of the steep slope, an effective setback should be maintained by embedding the foundation deep enough to provide a minimum distance of 25 feet from the face of the foundation to the face of the steep slope at that depth. We recommend that the downhill, southeastern foundation lines be embedded into the native medium dense or better competent soils a minimum of 4 feet. We should be retained to review the project plans prior to construction. We should also be retained during construction to observe the foundation excavations and verify minimum setbacks from steep slopes are achieved.

All footings should extend at least 24 inches below the lowest adjacent finished ground surface for frost protection and bearing capacity considerations. Foundations should be designed in accordance with the current IBC. Footing widths should be based on the anticipated loads and allowable soil bearing pressure. Water should not be allowed to accumulate in footing trenches. All loose or disturbed soil should be removed from the foundation excavation prior to placing concrete.

For foundations constructed as outlined above, we recommend an allowable design bearing pressure of not more than 2,000 pounds per square foot (psf) be used for the design of footings founded on the medium dense or better native soils or railroad ballast extending to the competent native material. The foundation bearing soil should be evaluated by a representative of NGA. We should be consulted if higher bearing pressures are needed. Current IBC guidelines should be used when considering increased allowable bearing pressure for short-term transitory wind or seismic loads. Potential foundation settlement using the recommended allowable bearing pressure is estimated to be less than one-inch total and ½-inch differential between adjacent footings or across a distance of about 20 feet, based on our experience with similar projects.

Lateral loads may be resisted by friction on the base of the footing and passive resistance against the subsurface portions of the foundation. A coefficient of friction of 0.35 may be used to calculate the base friction and should be applied to the vertical dead load only. Passive resistance may be calculated as a triangular equivalent fluid pressure distribution. An equivalent fluid density of 150 pounds per cubic foot (pcf) should be used for passive resistance design for a level ground surface adjacent to the footing. This level surface should extend a distance equal to at least three times the footing depth. These recommended values incorporate safety factors of 1.5 and 2.0 applied to the estimated ultimate values for frictional and passive resistance, respectively. To achieve this value of passive resistance, the foundations should be poured "neat" against the native medium dense soils or compacted fill should be used as backfill against the front of the footing. We recommend that the upper one foot of soil be neglected when calculating the passive resistance.

Slab-on-Grade

Slabs-on-grade, including all exterior hard surfaces and pool aprons, should be supported on subgrade soils prepared as described in the **Site Preparation and Grading** subsection of this report, with a minimum of 24 inches of ballast underlying the slabs. The exposed subgrade should be compacted to a firm condition and evaluated by NGA. This is intended to reduce the effects of potential settlement of the underlying soils but will not fully eliminate it. We recommend that all floor slabs be underlain by at least six inches of free-draining gravel with less than three percent by weight of the material passing the U.S. No. 200 sieve for use as a capillary break. A suitable vapor barrier, such as heavy plastic sheeting (6-mil minimum), should be placed over the capillary break material. An additional 2-inch thick moist sand layer may be used to cover the vapor barrier. This sand layer is optional and is intended to protect the vapor barrier membrane during construction.

Slope Improvements

If the slopes are disturbed during construction, we recommend that the resulting slope surface be compacted to an unyielding state. Generally, the exposed soils should be compacted to a firm, unyielding state and then be covered with heavy-duty erosion control matting such as Tensar C350 Turf Reinforcement Mat or equivalent. The matting should be staked to the slope using 2- to 3-foot long metal rebar stakes that have metal “T’s” welded to the end. The matting should be staked to the competent soil every three to five feet. After the matting has been placed, we recommended that deep-rooted vegetation be planted on the slope. We should be retained to review and comment on final slope improvement plans and observe the slope repairs. The actual improvement methods for these areas will be highly dependent on the conditions encountered during and after construction. We should work with your contractor to determine the best course of action at the time of construction.

Structural Fill

General: Fill placed beneath foundations, slabs, pavement, or other settlement-sensitive structures should be placed as structural fill. Structural fill, by definition, is placed in accordance with prescribed methods and standards, and is monitored by an experienced geotechnical professional or soils technician. Field monitoring procedures would include the performance of a representative number of in-place density tests to document the attainment of the desired degree of relative compaction. The area to receive the fill should be suitably prepared as described in the **Site Preparation and Grading** subsection prior to fill placement. Sloping areas to receive fill should be benched to key the fill into the slope. The benches should be level and have a minimum width of six feet.

Materials: Structural fill should consist of good quality, granular soil, free of organics and other deleterious material, and be well graded to a maximum size of about three inches. If fill will be placed during wet weather, the fill materials should contain no more than five percent fines (soil finer than U.S. No. 200 sieve, based on that fraction passing the U.S. 3/4-inch sieve). We do not recommend use of the on-site soils as structural fill. All fill to be placed below foundation lines, slabs-on-grade, or other hard surfaces should consist of railroad ballast. We should be retained to evaluate proposed structural fill material prior to placement.

Fill Placement: Following subgrade preparation, placement of structural fill may proceed. All fill placements should be accomplished in uniform lifts up to eight inches thick. Each lift should be spread evenly and be thoroughly compacted prior to placement of subsequent lifts.

All structural fill underlying building areas and pavement subgrade should be compacted to a minimum of 95 percent of its maximum dry density. Maximum dry density, in this report, refers to that density as determined by the ASTM D-1557 Compaction Test procedure. The moisture content of the fill soils to be compacted should be within about two percent of optimum so that a readily compactable condition exists. It may be necessary to over-excavate and remove wet soils in cases where drying to a compactable condition is not feasible. It may be necessary to add moisture to condition dry soils for use as structural fill. All compaction should be accomplished by equipment of a type and size sufficient to attain the desired degree of compaction.

Retaining Walls

The lateral pressure acting on subsurface retaining walls is dependent on the nature and density of the soil behind the wall, the amount of lateral wall movement which can occur as backfill is placed, wall drainage conditions, the inclination of the backfill, and other possible surcharge loads. For walls that are free to yield at the top at least one thousandth of the height of the wall (active condition), soil pressures will be less than if movement is limited by such factors as wall stiffness or bracing (at-rest condition). We recommend that walls supporting horizontal backfill and not subjected to hydrostatic forces be designed using a triangular earth pressure distribution equivalent to that exerted by a fluid with a density of 45 pcf for yielding (active condition) walls, and 65 pcf for non-yielding (at-rest condition) walls.

These recommended lateral earth pressures are for a drained backfill and are based on the assumption of a horizontal ground surface behind the wall for a distance of at least the subsurface height of the wall, and do not account for surcharge loads. Additional lateral earth pressures should be considered for surcharge loads acting adjacent to subsurface walls and within a distance equal to the subsurface height of the wall. This would include the effects of surcharges such as traffic loads, foundation loads, floor slab loads, backslopes, or other surface loads. We could consult with you and your structural engineer regarding additional loads on retaining walls during final design, if needed.

The lateral pressures on walls may be resisted by friction between the foundation and subgrade soil, and by passive resistance acting on the below-grade portion of the foundation. Recommendations for frictional and passive resistance to lateral loads are presented in the **Foundation Support** subsection of this report.

All wall backfill should be well compacted as outlined in the **Structural Fill** subsection of this report. Care should be taken to prevent the buildup of excess lateral soil pressures due to over-compaction of the wall backfill. This can be accomplished by placing wall backfill in eight-inch loose lifts and compacting it with small, hand-operated compactors within a distance behind the wall equal to at least one-half the height of the wall. The thickness of the loose lifts should be lessened to accommodate the lower compactive energy of the hand-operated equipment. The recommended level of compaction should still be maintained.

Permanent drainage systems should be installed for retaining walls. Recommendations for these systems are found in the **Subsurface Drainage** subsection of this report. We recommend that we be retained to evaluate the proposed wall drain backfill material and drainage systems prior to construction.

Site Drainage

Surface Drainage: Water should not be allowed to collect in any areas where footings are to be constructed. Final site grades should allow for drainage away from the structures. We suggest that the finished ground be sloped at a gradient of three percent minimum for a distance of at least 10 feet away from the structures and site slopes. Surface drains should be maintained separately and not be interconnected with foundation or wall drains. Water should not be allowed to flow uncontrollably over the slopes, as this will lead to severe erosion on the slope.

Subsurface Drainage: If groundwater seepage is encountered or if excessive rainfall or snowmelt occurs during construction, we recommend that the contractor slope the bottom of the excavations and direct the water to ditches and small sump pits. The collected water can then be pumped to a suitable discharge point. We generally recommend the use of footing drains around structures and behind retaining walls. Footing drains should be installed at least one foot below planned finished floor elevation. If used, the drains should consist of a minimum four-inch-diameter, rigid, slotted or perforated, PVC pipe surrounded by free-draining material wrapped in a filter fabric. We recommend that the free-draining material consist of an 18-inch-wide zone of clean (less than three-percent fines), granular material placed along the back of walls. Washed rock is an acceptable drain material, or drainage composite may be used instead. The free-draining material should extend up the wall to one foot below the finished surface.

The top foot of soil should consist of low permeability soil placed over plastic sheeting or building paper to minimize the migration of surface water or silt into the footing drain. Footing drains should discharge into tightlines leading to an appropriate collection and discharge point with convenient cleanouts to prolong the useful life of the drains. Roof drains should not be connected to wall or footing drains.

USE OF THIS REPORT

NGA has prepared this report for Gary Fowler, and his agents, for use in the planning and design of the project planned on this site only. The scope of our work does not include services related to construction safety precautions and our recommendations are not intended to direct the contractors' methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. There are possible variations in subsurface conditions between the explorations and with time. Our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions. A contingency for unanticipated conditions should be included in the budget and schedule.

We recommend that NGA be retained to review project plans and consult with the design team during final design. We also recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications. We should be contacted a minimum of one week prior to construction activities and could attend pre-construction meetings if requested.

All people who own or occupy homes on or near hillsides should realize that landslide movements are always a possibility. The landowner should periodically inspect the slope, especially after a winter storm. If distress is evident, a geotechnical engineer should be contacted for advice on remedial/preventative measures as soon as possible. The probability that landsliding will occur is substantially reduced by the proper maintenance of drainage control measures at the site (the runoff from the impervious surfaces should be led to an approved discharge point). Therefore, the homeowner should take responsibility for performing such maintenance.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this report was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

o-o-o

We appreciate the opportunity to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Chris Ward-Guthrie
Project Geologist

9/22/2023

Khaled M. Shawish, PE
Principal Engineer

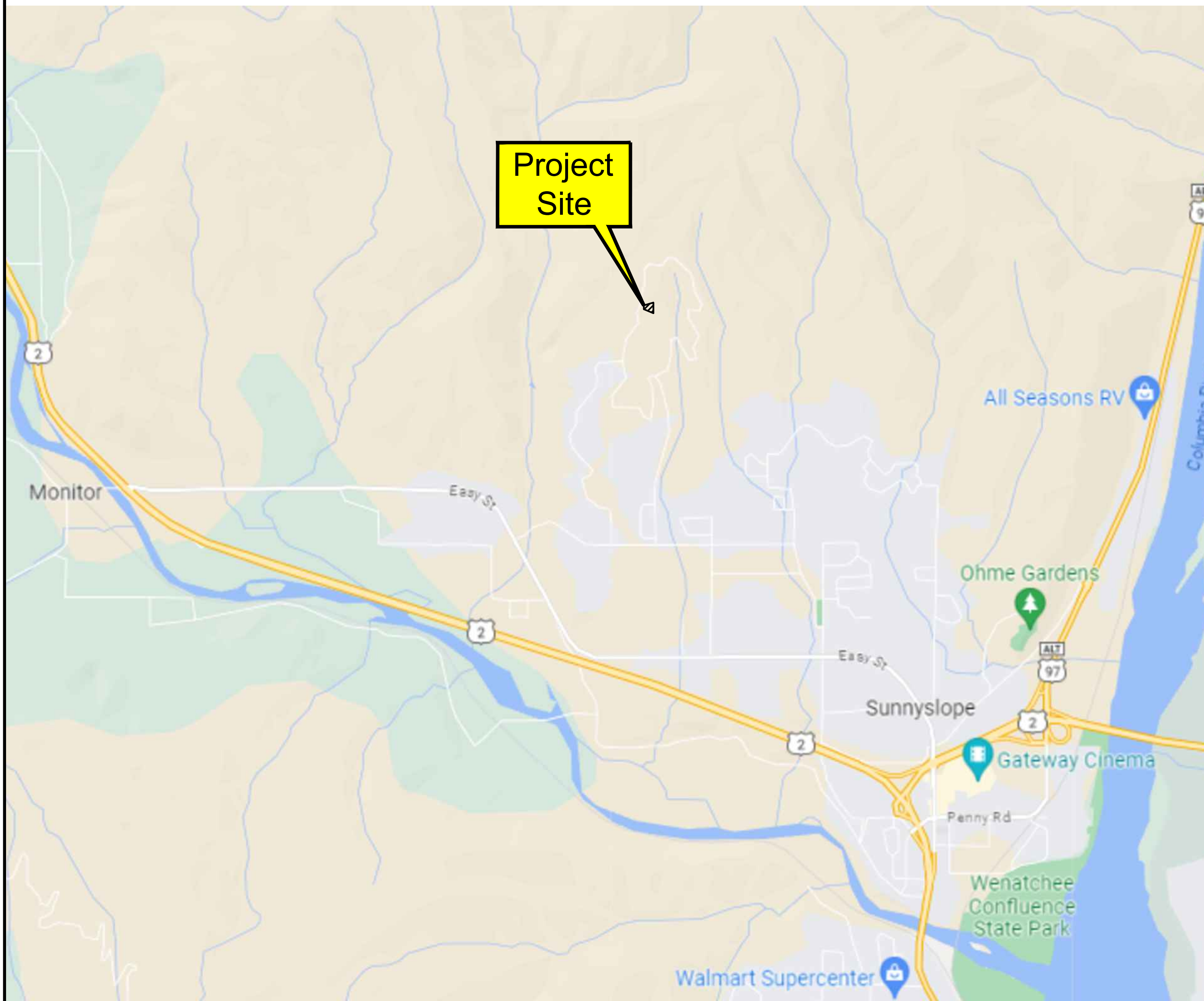
CWG:KMS:sg

Eight Figures Attached

VICINITY MAP

Not to Scale

N

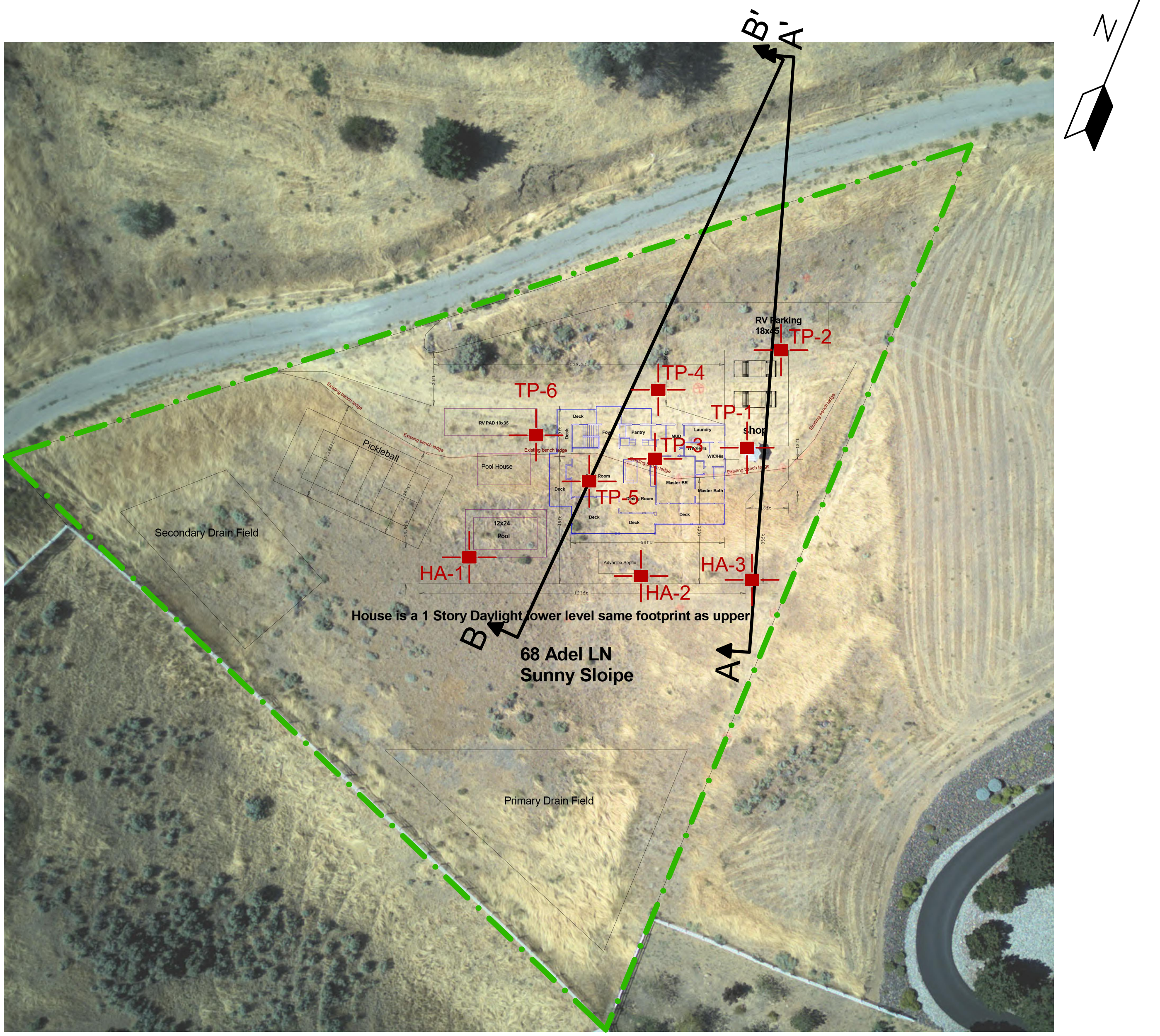


Chelan County, WA

Project Number 1466123	Fowler Residence Development Vicinity Map	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
Figure 1		Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510; Wenatchee Office 105 Palouse St. Wenatchee, WA 98801 (509) 665-7696 / Fax: 665-7692; www.nelsongeotech.com	1	9/14/23	Original	ABT	CWG

C:\Users\Alexander(Alex)Baucc\OneDrive - Nelson Geotechnical Associates, Inc\2023 NGA Project\2023 NGA East\14661-23 Fowler Res and Pool Geotech Eagle Rock\Drafting\VM.dwg

Site Plan



LEGEND

Property line

TP-1
Number and approximate location of test pit

HA-1
Number and approximate location of hand auger

A A'
Approximate location of cross-section

0 60 120

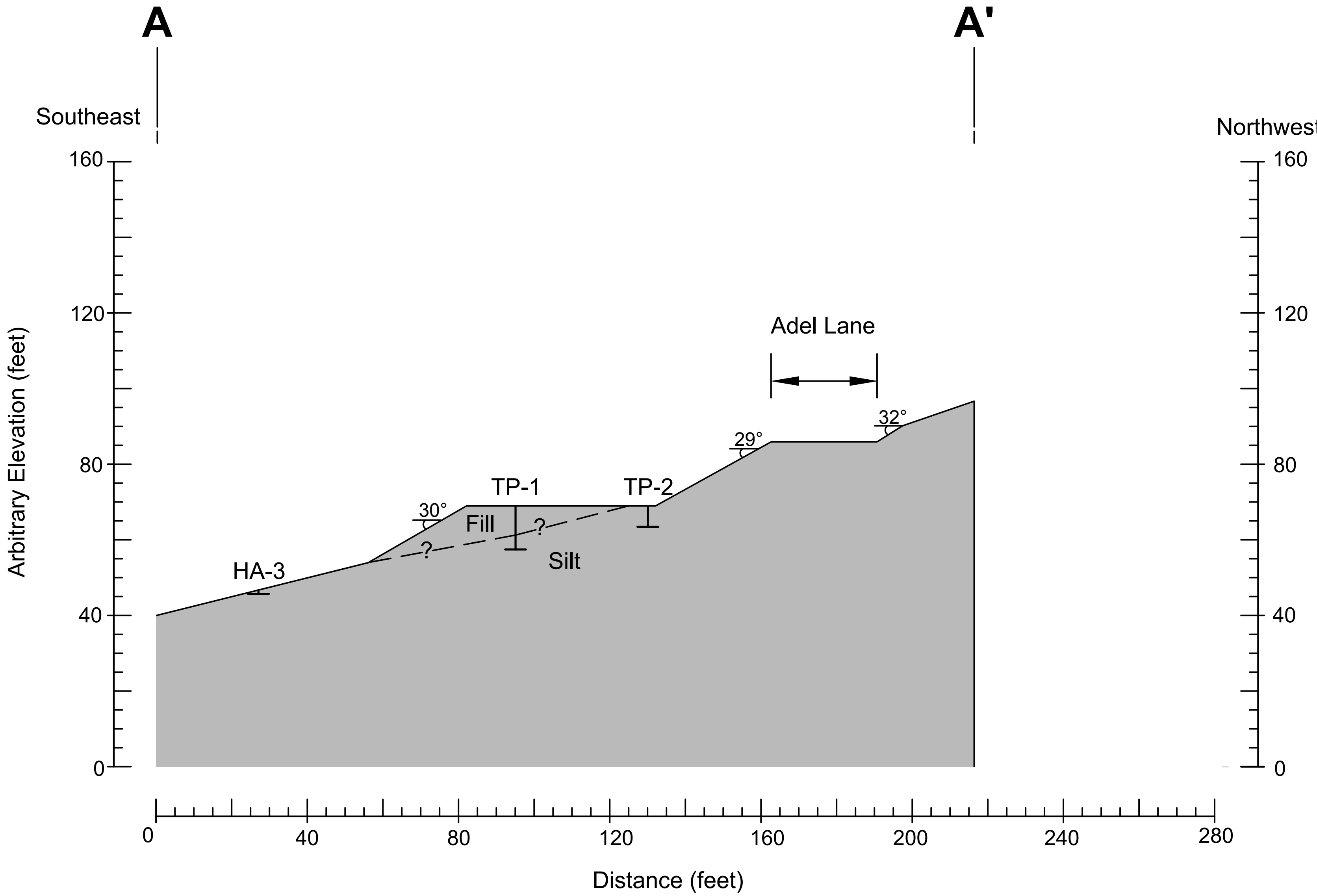
Approximate Scale: 1 inch = 60 feet

Reference: Site Plan based on field measurements, observations, and aerial parcel map review.

Project Number 1466123	Fowler Residential Development Site Plan	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
Figure 2			1	9/14/23	Original	ABT	CWG

www.nelsongeotech.com
Woodinville Office
17311-135th Ave. NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax: 481-2510
Wenatchee Office
105 Palouse St.
Wenatchee, WA 98801
(509) 665-7696 / Fax: 665-7692

C:\Users\Alexander(Alex)Baucc\OneDrive - Nelson Geotechnical Associates, Inc\2023 NGA Project\2023 NGA East\14661-23 Fowler Res and Pool Geotech Eagle Rock\Drafting\SP.dwg



Exploration

Test Pit/Hand Auger Designation → TP-1/HA-1

Groundwater Level During Exploration →

Geologic Contact (approximate) → ? — — ?

NOTES:
1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are arbitrary.

Reference: Cross Section is based on field measurements using a hand-held clinometer and 100-ft tape measure.

C:\Users\ChrisWard-Guthrie\Downloads\CS (5).dwg

No.	Date	Revision	By	CK
1	9/14/23	Original	ABT	CWG

NELSON GEOTECHNICAL ASSOCIATES, INC

Woodinville Office
17311-135th Ave. NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax: 481-2510

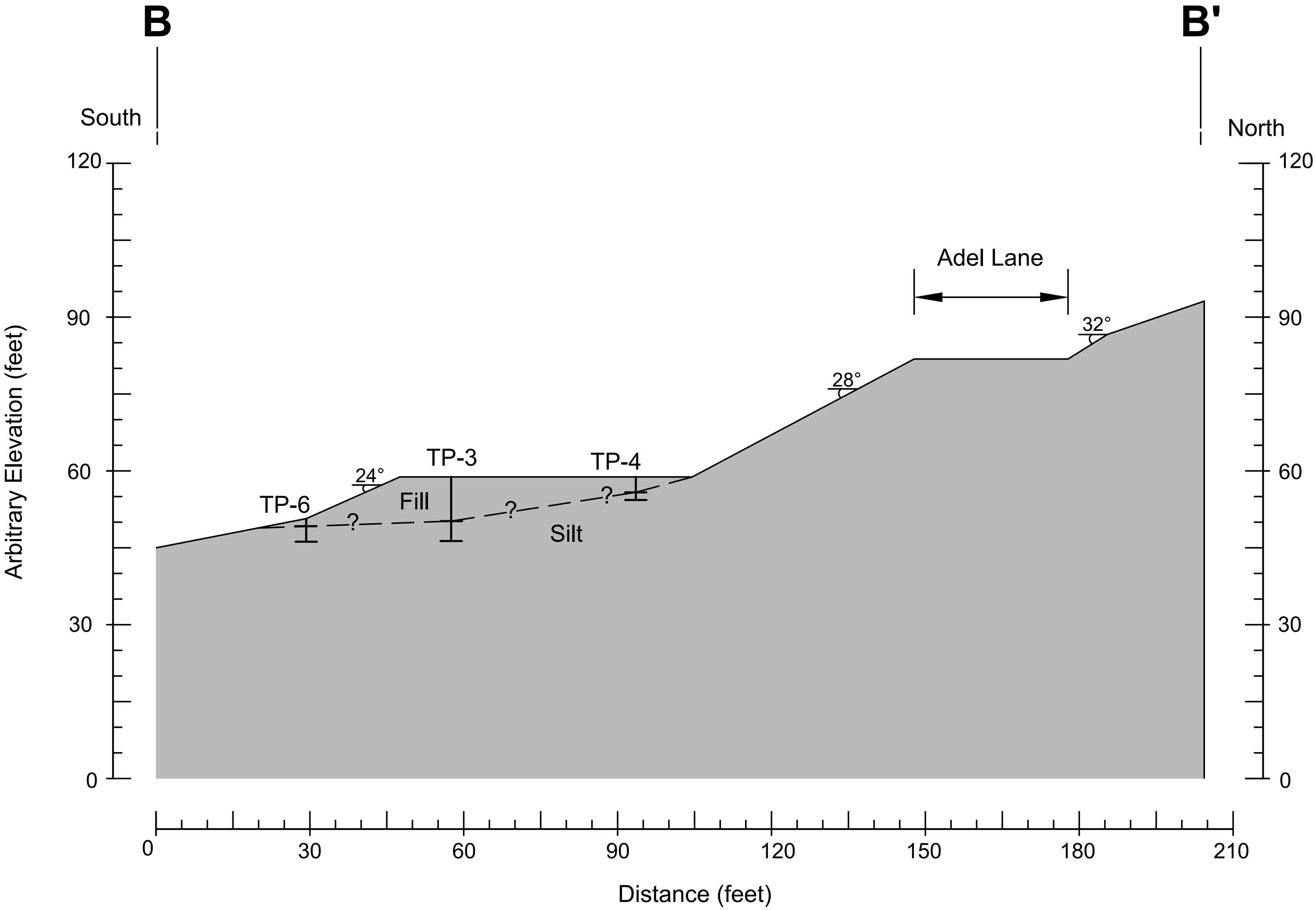
Wenatchee Office
105 Palouse St.
Wenatchee, WA 98801
(509) 665-7696 / Fax: 665-7692

www.nelsongeotech.com

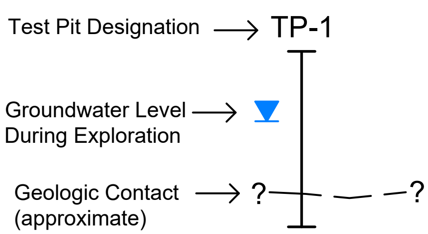
Fowler Residential Development
Cross-Section A-A'

Project Number
1466123

Figure 3



Exploration



NOTES:
1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are arbitrary.

Reference: Cross Section is based on field measurements using a hand-held clinometer and 100-ft tape measure.

C:\Users\ChrisWard-Guthrie\Downloads\CS (5).dwg

No.	Date	Revision	By	CK
1	9/14/23	Original	ABT	CWG

NELSON GEOTECHNICAL ASSOCIATES, INC

Woodinville Office
17311-135th Ave. NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax: 481-2510

Wenatchee Office
105 Palouse St.
Wenatchee, WA 98801
(509) 665-7696 / Fax: 665-7692

www.nelsongeotech.com

Fowler Residential Development
Cross-Section B-B'

Project Number
1466123

Figure 4

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE - GRAINED SOILS MORE THAN 50 % RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE - GRAINED SOILS MORE THAN 50 % PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50 %	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 % OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-93.

2) Soil classification using laboratory tests is based on ASTM D 2488-93.

3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water.

Wet - Visible free water or saturated, usually soil is obtained from below water table

Project Number	Fowler Residential Development Soil Classification Chart	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
1466123			1	9/14/23	Original	ABT	CWG
Figure 5							

Woodinville Office
17311-135th Ave. NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax: 481-2510

Wenatchee Office
105 Palouse St.
Wenatchee, WA 98801
(509) 665-7696 / Fax: 665-7692

www.nelsongeotech.com

LOG OF EXPLORATION

DEPTH (FEET)	USCS	BLOW COUNTS ASTM STP 399	SOIL DESCRIPTION
TEST PIT TP-1			
0.0 – 3.7		15/11/12 at 2.0 ft	Light brown, SILT, with trace sand (**FILL**)
3.7 – 7.7		12/33/42 at 4.0 ft 9/11/13 at 6.0 ft	Light brown, SILT, with hard layers and white mineralization (**FILL**)
7.7 – 11.5	ML		Light brown to orange, SILT, with white mineralization (hard, moist)
			Sample was collected at 10.0 feet No groundwater seepage was encountered No caving was encountered Test pit completed at 11.5 feet on 8/21/023
TEST PIT TP-2			
0.0 – 5.5	ML	23/23/21 at 2.0 ft	Light brown to orange, SILT, with white mineralization (very stiff, moist)
			No samples were collected No groundwater seepage was encountered No caving was encountered Test pit completed at 5.5 feet on 8/21/2023
TEST PIT TP-3			
0.0 – 8.0		7/15/22 at 2.5 ft 7/13/20 at 4.5 ft 11/23/29 at 7.5 ft	Light brown, SILT, with trace sand and organics (**FILL**)
8.0 – 12.5	ML		Dark brown, sandy SILT (hard, moist)
			Samples were collected at 2.5, 4.5, 7.5 and 12.5 feet No groundwater seepage was encountered No caving was encountered Test pit completed at 12.5 feet on 8/21/2023

LOG OF EXPLORATION

DEPTH (FEET)	USCS	BLOW COUNTS ASTM STP 399	SOIL DESCRIPTION
TEST PIT TP-4			
0.0 – 3.0			Light brown, SILT with trace sand, organics, white mineralization (**FILL**)
3.0 – 4.5		50 for ¾” at 4.0 ft	Dark brown, sandy SILT (hard, moist)
			No samples were collected No groundwater seepage was encountered No caving was encountered Test pit completed at 4.5 feet on 8/21/2023
TEST PIT TP-5			
0.0 – 0.6			Grey, GRAVEL (**FILL**)
0.6 – 4.0		16/16/25 at 2.0 ft	Light brown, sandy, SILT with sandstone blocks (**FILL**)
4.0 – 4.5		20/28/26 at 4.5 ft	Light brown, SILT with trace sand (**FILL**)
4.5 – 12.0	ML		Dark brown, sandy SILT (hard, moist)
			No samples were collected No groundwater seepage was encountered No caving was encountered Test pit completed at 12.5 feet on 8/21/2023
TEST PIT TP-6			
0.0 – 1.5			Light brown, SILT with trace sand (**FILL**)
1.5 – 4.5	ML		Light brown, sandy SILT (very stiff to hard, moist)
			No samples were collected No groundwater seepage was encountered No caving was encountered Test pit completed at 4.5 feet on 8/21/2023

LOG OF EXPLORATION

DEPTH (FEET)	USCS	BLOW COUNTS ASTM STP 399	SOIL DESCRIPTION
HAND AUGER HA - 1			
0.0 – 1.0	ML		Brown, SILT with some sand (very stiff, dry to moist)
1.0 – 5.0	ML		Light brown, sandy, SILT with white mineralization (very stiff, dry)
			Sample was collected at 5.0 feet No groundwater seepage was encountered No caving was encountered Hand auger completed at 5.0 feet on 8/21/2023
HAND AUGER HA - 2			
0.0 – 2.0	ML		Light brown, sandy SILT (very stiff, dry to moist)
			Sample was collected at 2.0 feet No groundwater seepage was encountered No caving was encountered Hand auger completed at 2.0 feet on 8/21/2023
HAND AUGER HA - 3			
0.0 – 1.0	ML		Brown, SILT with some sand (very stiff, dry to moist)
			Sample was collected at 1.0 feet No groundwater seepage was encountered No caving was encountered Hand auger completed at 1.0 feet on 8/21/2023