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May 14, 2025

JN 25110

Shelter Resources, Inc.
2223 – 112th Avenue Northeast, Suite 102
Bellevue, Washington 98004

Attention: Jeremy Wilkening
via email: jeremyw@shelterresourcesinc.com

Subject: **Transmittal Letter – Geotechnical Engineering Study**
Proposed Affordable Housing Project
~1200 Southwest Swantown Avenue
Oak Harbor, Washington

Greetings:

Attached to this transmittal letter is our geotechnical engineering report for the affordable housing project to be constructed in Oak Harbor, Washington. The scope of our services consisted of exploring site surface and subsurface conditions, and then developing this report to provide geotechnical engineering conclusions and recommendations for the project. This work was authorized by your acceptance of our proposal, P-11838, dated March 3, 2025.

The attached report contains a discussion of the study and our recommendations. Please contact us if there are any questions regarding this report, or for further assistance during the design and construction phases of this project.

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

D. Robert Ward, P.E.
Principal

cc: **Ufilya Davis**
via email: ufilyad@shelterresourcesinc.com

DRW:kg

GEOTECHNICAL ENGINEERING STUDY
Affordable Housing Project
~1200 Southwest Swantown Avenue
Oak Harbor, Washington

This report presents the findings and recommendations of our geotechnical engineering study for the site of the proposed affordable housing project to be located in Oak Harbor.

We were provided with architectural plans of the project and a topographic map. Dahlin developed these plans, which are dated September 10, 2024. The topography map was prepared by Jepson and Assoc's dated September 13, 2024. Based on this information, we understand that six buildings are proposed throughout the site, along with paved driveways/parking areas and a fair amount of open space. Five of the buildings will be two-story apartment buildings and one community building whose lower floor levels will be near the existing ground level, and the driveway/parking areas will also be near the existing grade. We also understand that the infiltration of stormwater at the southern end of the site is being considered.

If the scope of the project changes from what we have described above, we should be provided with revised plans in order to determine if modifications to the recommendations and conclusions of this report are warranted.

SITE CONDITIONS

SURFACE

The Vicinity Map, Plate 1, illustrates the general location of the site in Oak Harbor. The very odd-shaped site is bordered on its northeastern side by Southwest Swantown Avenue; the site has approximately 700 feet of frontage along this street. The site is relatively flat, with only about 10 feet of grade change over a distance of greater than 600 feet. However, there is an approximate 4- to 7-foot-tall steep slope that rises up at the northeastern edge of the site up to Swantown Avenue, with the tallest portion to the north. The site generally has two portions, one to the northwest and the other to the southwest. The northwestern portion of the site is larger than the southwestern portion. It is very apparent, based on our observations and the provided topography map, that the site was once a mobile home park, although no development is currently on the site. Numerous trailer pads exist throughout the site, along with paved driveways, concrete foundations and walls of structures and old utility remnants.

The site is bordered to the northeast by Swantown Avenue and to the southeast by Southwest Fort Nugent Road. Much of the remaining bordering properties contain residential structures. In addition to the rise in elevation up to the northeast near Swantown Avenue, there is also a rise in the ground to the southwest. It appears the site is part of a geologic swale feature that extends in the northwest to southeast direction.

SUBSURFACE

The subsurface conditions were explored by excavating 12 test pits at the approximate locations shown on the Site Exploration Plan, Plate 2. Our exploration program was based on the proposed

construction, anticipated subsurface conditions and those encountered during exploration, and the scope of work outlined in our proposal.

The test pits were excavated on April 21, 2025 with a small, tracked excavator. A geotechnical engineer from our staff observed the excavation process, logged the test pits, and obtained representative samples of the soil encountered. "Grab" samples of selected subsurface soil were collected from the backhoe bucket. The Test Pit Logs are attached to this report as Plates 3 through 8.

Soil Conditions

No obstructions were revealed by our explorations. However, debris, buried utilities, and old foundation and slab elements are commonly encountered on sites that have had previous development.

Groundwater Conditions

No groundwater seepage was observed in the test pits with the exception of some perched groundwater at a depth of about 8 feet in a test pit located at the southeastern corner of the site. It should be noted that groundwater levels vary seasonally with rainfall and other factors. However, we did not observe indications of any near-surface groundwater in the test pits.

The stratification lines on the logs represent the approximate boundaries between soil types at the exploration locations. The actual transition between soil types may be gradual, and subsurface conditions can vary between exploration locations. The logs provide specific subsurface information only at the locations tested. The relative densities and moisture descriptions indicated on the test pit logs are interpretive descriptions based on the conditions observed during excavation.

The compaction of test pit backfill was not in the scope of our services. The test pits were backfilled with excavated soil that was lightly tamped into place. Loose soil will therefore be found in the area of the test pits. If this presents a problem, the backfill will need to be removed and replaced with structural fill during construction. We attempted to locate the test pits outside of proposed building footprints as much as possible to hopefully avoid the removal/replacement of soil within building footprints.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

THIS SECTION CONTAINS A SUMMARY OF OUR STUDY AND FINDINGS FOR THE PURPOSES OF A GENERAL OVERVIEW ONLY. MORE SPECIFIC RECOMMENDATIONS AND CONCLUSIONS ARE CONTAINED IN THE REMAINDER OF THIS REPORT. ANY PARTY RELYING ON THIS REPORT SHOULD READ THE ENTIRE DOCUMENT.

The test pits conducted for this study encountered native sand soils with varying grain sizes and varying amounts of gravel and silt; the silt content was generally quite low. Below a relatively thin layer of loose topsoil and fill soil, sand soils were in a loose to medium-dense condition to a depth of approximately 2 to 5 feet, although the depth was generally about 3 feet. The sand soils then became medium-dense and somewhat denser that extended to the maximum explored depth of

approximately 9 feet. The medium-dense or denser sand is very suitable to provide support for the proposed buildings that are founded on conventional footings. However, we believe that if the excavations for the footings are made to a depth of approximately 2 feet into just the loose to medium-dense sand soil, which is just above the medium-dense or dense sand, and the sand subgrade at the 2-foot depth is compacted with vibratory equipment, the footings can be placed on the compacted subgrade or structural fill placed above the compacted subgrade. The vibratory equipment needs to be larger than a small plate compactor.

As noted earlier, we understand that the infiltration of stormwater is being considered at the lower, southeastern corner of the site. Sandy soils and no near-surface groundwater were revealed in that portion of the site; these conditions are conducive for the infiltration of stormwater. To provide a formal infiltration rate for the sand soils in the southeastern portion of the site, we will need to perform an infiltration test in that portion. However, preliminarily we believe that using a design infiltration rate of approximately 5 inches/hour is suitable provided the base of an infiltration facility.

The erosion control measures needed during the site development will depend heavily on the weather conditions that are encountered. We anticipate that a silt fence will be needed around the downslope sides of any cleared areas. Existing pavements, ground cover, and landscaping should be left in place wherever possible to minimize the amount of exposed soil. Rocked staging areas and construction access roads should be provided to reduce the amount of soil or mud carried off the property by trucks and equipment. Wherever possible, the access roads should follow the alignment of planned pavements. Trucks should not be allowed to drive off of the rock-covered areas. Cut slopes and soil stockpiles should be covered with plastic during wet weather. Following clearing or rough grading, it may be necessary to mulch or hydroseed bare areas that will not be immediately covered with landscaping or an impervious surface. On most construction projects, it is necessary to periodically maintain or modify temporary erosion control measures to address specific site and weather conditions.

The drainage and/or waterproofing recommendations presented in this report are intended only to prevent active seepage from flowing through concrete walls or slabs. Even in the absence of active seepage into and beneath structures, water vapor can migrate through walls, slabs, and floors from the surrounding soil, and can even be transmitted from slabs and foundation walls due to the concrete curing process. Water vapor also results from occupant uses, such as cooking, cleaning, and bathing. Excessive water vapor trapped within structures can result in a variety of undesirable conditions, including, but not limited to, moisture problems with flooring systems, excessively moist air within occupied areas, and the growth of molds, fungi, and other biological organisms that may be harmful to the health of the occupants. The designer or architect must consider the potential vapor sources and likely occupant uses, and provide sufficient ventilation, either passive or mechanical, to prevent a build up of excessive water vapor within the planned structure.

Geotech Consultants, Inc. should be allowed to review the final development plans to verify that the recommendations presented in this report are adequately addressed in the design. Such a plan review would be additional work beyond the current scope of work for this study, and it may include revisions to our recommendations to accommodate site, development, and geotechnical constraints that become more evident during the review process.

We recommend including this report, in its entirety, in the project contract documents. This report should also be provided to any future property owners so they will be aware of our findings and recommendations.

SEISMIC CONSIDERATIONS

In accordance with the International Building Code (IBC), the site class within 100 feet of the ground surface is best represented by Site Class Type D (Stiff Soil). As noted in the ASCE 7 Hazard Tool website, the mapped spectral acceleration value for a 0.2 second (S_s) and 1.0 second period (S_1) equals 1.36g and 0.49g, respectively.

The IBC and ASCE 7 require that the potential for liquefaction (soil strength loss) during an earthquake be evaluated for the peak ground acceleration of the Maximum Considered Earthquake (MCE), which has a probability of occurring once in 2,475 years (2 percent probability of occurring in a 50-year period). The MCE peak ground acceleration adjusted for site class effects (F_{PGA}) equals 0.65g. The soils beneath the site are not susceptible to seismic liquefaction under the ground motions of the MCE because of their dense nature and/or the absence of near-surface groundwater.

Sections 1803.5 of the IBC and 11.8 of ASCE 7 require that other seismic-related geotechnical design parameters (seismic surcharge for retaining wall design and slope stability) include the potential effects of the Design Earthquake. The peak ground acceleration for the Design Earthquake is defined in Section 11.2 of ASCE 7 as two-thirds (2/3) of the MCE peak ground acceleration, or 0.43g.

CONVENTIONAL FOUNDATIONS

The proposed structure can be supported on conventional continuous and spread footings bearing on compacted native soil at two feet below the ground surface, or on structural fill placed above the compacted native soil. See the section entitled ***General Earthwork and Structural Fill*** for recommendations regarding the placement and compaction of structural fill beneath structures. Adequate compaction of structural fill should be verified with frequent density testing during fill placement. Prior to placing structural fill beneath foundations, the excavation should be observed by the geotechnical engineer to document that adequate bearing soils have been exposed.

We recommend that continuous and individual spread footings have minimum widths of 16 and 24, respectively. Exterior footings should also be bottomed at least 18 inches below the lowest adjacent finish ground surface for protection against frost and erosion. The local building codes should be reviewed to determine if different footing widths or embedment depths are required. Footing subgrades must be cleaned of loose or disturbed soil prior to pouring concrete. Depending upon site and equipment constraints, this may require removing the disturbed soil by hand.

An allowable bearing pressure of 2,500 pounds per square foot (psf) is appropriate for footings supported on competent native soil. A one-third increase in this design bearing pressure may be used when considering short-term wind or seismic loads. For the above design criteria, it is anticipated that the total post-construction settlement of footings founded on competent native soil, or on structural fill up to 2 feet in thickness, will be about 3/4-inch, with differential settlements on the order of 1/2-inch in a distance of 40 feet along a continuous footing with a uniform load.

Lateral loads due to wind or seismic forces may be resisted by friction between the foundation and the bearing soil, or by passive earth pressure acting on the vertical, embedded portions of the foundation. For the latter condition, the foundation must be either poured directly against relatively level, undisturbed soil or be surrounded by level, well-compacted fill.

We recommend using the following ultimate values for the foundation's resistance to lateral loading:

PARAMETER	ULTIMATE VALUE
Coefficient of Friction	0.50
Passive Earth Pressure	300 pcf

Where: pcf is Pounds per Cubic Foot, and Passive Earth Pressure is computed using the Equivalent Fluid Density.

If the ground in front of a foundation is loose or sloping, the passive earth pressure given above will not be appropriate. The above ultimate values for passive earth pressure and coefficient of friction do not include a safety factor.

Thickened slabs are often used to support interior walls in multifamily and commercial structures. It is important to remember that thickened slab areas support building loads, just like conventional footings do. For this reason, the subgrade below thickened slabs must be prepared in the same way as for conventional footings. All unsuitable soils have to be removed and any structural fill compacted in accordance with the recommendations of this report. We recommend against the use of thickened slabs for most projects, particularly single-family residential, as it is difficult to ensure that the subgrades have been appropriately prepared. Also, the compacted slab fill has to be protected from disturbance by the earthwork, foundation, and utility contractors.

FOUNDATION AND RETAINING WALLS

Retaining walls backfilled on only one side should be designed to resist the lateral earth pressures imposed by the soil they retain. The following recommended parameters are for walls that restrain level backfill:

PARAMETER	VALUE
Lateral Earth Pressure *	35 pcf
Passive Earth Pressure	300 pcf
Coefficient of Friction	0.40
Soil Unit Weight	XX0 pcf

Where: pcf is Pounds per Cubic Foot, and Lateral and Passive Earth Pressures are computed using the Equivalent Fluid Pressures.

*** For a restrained wall that cannot deflect at least 0.002 times its height, a uniform lateral pressure equal to 10 psf times the height of the wall should be added to the above lateral equivalent fluid pressure. This applies only to walls with level backfill.**

The design values given above do not include the effects of any hydrostatic pressures behind the walls and assume that no surcharges, such as those caused by slopes, vehicles, or adjacent foundations will be exerted on the walls. If these conditions exist, those pressures should be added to the above lateral soil pressures. Where sloping backfill is desired behind the walls, we will need to be given the wall dimensions and the slope of the backfill in order to provide the appropriate design earth pressures. A surcharge due to traffic loads behind a wall can typically be accounted

for by adding a uniform pressure equal to 2 feet multiplied by the above lateral fluid density. Heavy construction equipment should not be operated behind retaining and foundation walls within a distance equal to the height of a wall, unless the walls are designed for the additional lateral pressures resulting from the equipment.

The values given above are to be used to design only permanent foundation and retaining walls that are to be backfilled, such as conventional walls constructed of reinforced concrete or masonry. It is not appropriate to use the above earth pressures and soil unit weight to back-calculate soil strength parameters for design of other types of retaining walls, such as soldier pile, reinforced earth, modular or soil nail walls. We can assist with the design of these types of walls, if desired.

The passive pressure given is appropriate only for a shear key poured directly against undisturbed native soil, or for the depth of level, well-compacted fill placed in front of a retaining or foundation wall. The values for friction and passive resistance are ultimate values and do not include a safety factor. Restrained wall soil parameters should be utilized for the wall and reinforcing design for a distance of 1.5 times the wall's height from corners or bends in the walls, or from other points of restraint. This is intended to reduce the amount of cracking that can occur where a wall is restrained by a corner.

Wall Pressures Due to Seismic Forces

Per IBC Section 1803.5.12, a seismic surcharge load need only be considered in the design of walls over 6 feet in height. A seismic surcharge load would be imposed by adding a uniform lateral pressure to the above-recommended lateral pressure. The recommended seismic surcharge pressure for this project is 8**H** pounds per square foot (psf), where **H** is the design retention height of the wall. Using this increased pressure, the safety factor against sliding and overturning can be reduced to 1.2 for the seismic analysis.

Retaining Wall Backfill and Waterproofing

Backfill placed behind retaining or foundation walls should be coarse, free-draining structural fill containing no organics. This backfill should contain no more than 5 percent silt or clay particles and have no gravel greater than 4 inches in diameter. The percentage of particles passing the No. 4 sieve should be between 25 and 70 percent. The later section entitled ***Drainage Considerations*** should also be reviewed for recommendations related to subsurface drainage behind foundation and retaining walls.

The purpose of these backfill requirements is to ensure that the design criteria for a retaining wall are not exceeded because of a build-up of hydrostatic pressure behind the wall. Also, subsurface drainage systems are not intended to handle large volumes of water from surface runoff. The top 12 to 18 inches of the backfill should consist of a compacted, relatively impermeable soil or topsoil, or the surface should be paved. The ground surface must also slope away from backfilled walls at one to 2 percent to reduce the potential for surface water to percolate into the backfill.

Water percolating through pervious surfaces (pavers, gravel, permeable pavement, etc.) must also be prevented from flowing toward walls or into the backfill zone. Foundation drainage and waterproofing systems are not intended to handle large volumes of infiltrated water. The compacted subgrade below pervious surfaces and any associated drainage layer should therefore be sloped away. Alternatively, a membrane and subsurface collection system could be provided below a pervious surface.

Wall backfill should be placed in lifts and be properly compacted, in order for the above-recommended design earth pressures to be appropriate. The recommended wall design criteria assume that the backfill will be well-compacted in lifts no thicker than 12 inches. The compaction of backfill near the walls should be accomplished with hand-operated equipment to prevent the walls from being overloaded by the higher soil forces that occur during compaction. The section entitled ***General Earthwork and Structural Fill*** contains additional recommendations regarding the placement and compaction of structural fill behind retaining and foundation walls.

The above recommendations are not intended to waterproof below-grade walls, or to prevent the formation of mold, mildew or fungi in interior spaces. Over time, the performance of subsurface drainage systems can degrade, subsurface groundwater flow patterns can change, and utilities can break or develop leaks. Therefore, waterproofing should be provided where future seepage through the walls is not acceptable. This typically includes limiting cold-joints and wall penetrations, and using bentonite panels or membranes on the outside of the walls. There are a variety of different waterproofing materials and systems, which should be installed by an experienced contractor familiar with the anticipated construction and subsurface conditions. Applying a thin coat of asphalt emulsion to the outside face of a wall is not considered waterproofing, and will only help to reduce moisture generated from water vapor or capillary action from seeping through the concrete. As with any project, adequate ventilation of basement and crawl space areas is important to prevent a buildup of water vapor that is commonly transmitted through concrete walls from the surrounding soil, even when seepage is not present. This is appropriate even when waterproofing is applied to the outside of foundation and retaining walls. We recommend that you contact an experienced envelope consultant if detailed recommendations or specifications related to waterproofing design, or minimizing the potential for infestations of mold and mildew are desired.

The ***General***, ***Slabs-On-Grade***, and ***Drainage Considerations*** sections should be reviewed for additional recommendations related to the control of groundwater and excess water vapor for the anticipated construction.

SLABS-ON-GRADE

The building floors can be constructed as slabs-on-grade atop non-organic soils or on structural fill. The subgrade soil must be in a firm, non-yielding condition at the time of slab construction or underslab fill placement. Any soft areas encountered should be excavated and replaced with select, imported structural fill.

Even where the exposed soils appear dry, water vapor will tend to naturally migrate upward through the soil to the newly constructed space above it. This can affect moisture-sensitive flooring, cause imperfections or damage to the slab, or simply allow excessive water vapor into the space above the slab. All interior slabs-on-grade should be underlain by a capillary break drainage layer consisting of a minimum 4-inch thickness of clean gravel or crushed rock that has a fines content (percent passing the No. 200 sieve) of less than 3 percent and a sand content (percent passing the No. 4 sieve) of no more than 10 percent. Pea gravel or crushed rock are typically used for this layer.

As noted by the American Concrete Institute (ACI) in the *Guides for Concrete Floor and Slab Structures*, proper moisture protection is desirable immediately below any on-grade slab that will be covered by tile, wood, carpet, impermeable floor coverings, or any moisture-sensitive equipment or

products. ACI recommends a minimum 10-mil thickness vapor retarder for better durability and long term performance than is provided by 6-mil plastic sheeting that has historically been used. A vapor retarder is defined as a material with a permeance of less than 0.3 perms, as determined by ASTM E 96. It is possible that concrete admixtures may meet this specification, although the manufacturers of the admixtures should be consulted. Where vapor retarders are used under slabs, their edges should overlap by at least 6 inches and be sealed with adhesive tape. The sheeting should extend to the foundation walls for maximum vapor protection.

If no potential for vapor passage through the slab is desired, a vapor *barrier* should be used. A vapor barrier, as defined by ACI, is a product with a water transmission rate of 0.01 perms when tested in accordance with ASTM E 96. Reinforced membranes having sealed overlaps can meet this requirement.

We recommend that the contractor, the project materials engineer, and the owner discuss these issues and review recent ACI literature and ASTM E-1643 for installation guidelines and guidance on the use of the protection/blotter material.

The ***General***, ***Permanent Foundation and Retaining Walls***, and ***Drainage Considerations*** sections should be reviewed for additional recommendations related to the control of groundwater and excess water vapor for the anticipated construction.

EXCAVATIONS AND SLOPES

Temporary excavation slopes should not exceed the limits specified in local, state, and national government safety regulations. Also, temporary cuts should be planned to provide a minimum of 2 to 3 feet of space for construction of foundations, walls, and drainage. Temporary cuts to a maximum overall depth of about 4 feet may be attempted vertically in unsaturated soil, if there are no indications of slope instability. However, vertical cuts should not be made near property boundaries, or existing utilities and structures. Based upon Washington Administrative Code (WAC) 296, Part N, the soil at the subject site would generally be classified as Type B. Therefore, temporary cut slopes greater than 4 feet in height should not be excavated at an inclination steeper than 1:1 (Horizontal:Vertical), extending continuously between the top and the bottom of a cut.

The above-recommended temporary slope inclination is based on the conditions exposed in our explorations, and on what has been successful at other sites with similar soil conditions. It is possible that variations in soil and groundwater conditions will require modifications to the inclination at which temporary slopes can stand. Temporary cuts are those that will remain unsupported for a relatively short duration to allow for the construction of foundations, retaining walls, or utilities. Temporary cut slopes should be protected with plastic sheeting during wet weather. It is also important that surface runoff be directed away from the top of temporary slope cuts. Cut slopes should also be backfilled or retained as soon as possible to reduce the potential for instability. Please note that sand or loose soil can cave suddenly and without warning. Excavation, foundation, and utility contractors should be made especially aware of this potential danger. These recommendations may need to be modified if the area near the potential cuts has been disturbed in the past by utility installation, or if settlement-sensitive utilities are located nearby.

All permanent slopes for the project should have an inclination no greater than 2:1 (H:V). If fill soils are used to construct a slope, the fill must be compacted to the face of these slopes to reduce the potential for shallow sloughing. This can be accomplished by overbuilding the compacted fill and then trimming it back to its final inclination. Adequate compaction of the slope face is important for

long-term stability and is necessary to prevent excessive settlement of patios, slabs, foundations, or other improvements that may be placed near the edge of the slope.

Water should not be allowed to flow uncontrolled over the top of any temporary or permanent slope. All permanently exposed slopes should be seeded with an appropriate species of vegetation to reduce erosion and improve the stability of the surficial layer of soil.

DRAINAGE CONSIDERATIONS

Footing drains are only needed for buildings and retaining walls of the project where: (1) crawl spaces or basements will be below a structure; (2) a slab is below the outside grade; or, (3) the outside grade does not slope downward from a building. Drains should also be placed at the base of all earth-retaining walls. These drains should be surrounded by at least 6 inches of 1-inch-minus, washed rock that is encircled with non-woven, geotextile filter fabric (Mirafi 140N, Supac 4NP, or similar material). At its highest point, a perforated pipe invert should be at least 6 inches below the bottom of a slab floor or the level of a crawl space. The discharge pipe for subsurface drains should be sloped for flow to the outlet point. Roof and surface water drains must not discharge into the foundation drain system. For the best long-term performance, perforated PVC pipe is recommended for all subsurface drains. Clean-outs should be provided for potential future flushing or cleaning of footing drains.

As a minimum, a vapor retarder, as defined in the ***Slabs-On-Grade*** section, should be provided in any crawl space area to limit the transmission of water vapor from the underlying soils. Crawl space grades are sometimes left near the elevation of the bottom of the footings. As a result, an outlet drain is recommended for all crawl spaces to prevent an accumulation of any water that may bypass the footing drains. Providing a few inches of free draining gravel underneath the vapor retarder is also prudent to limit the potential for seepage to build up on top of the vapor retarder.

If seepage is encountered in an excavation, it should be drained from the site by directing it through drainage ditches, perforated pipe, or French drains, or by pumping it from sumps interconnected by shallow connector trenches at the bottom of the excavation.

The excavation and site should be graded so that surface water is directed off the site and away from the tops of slopes. Water should not be allowed to stand in any area where foundations, slabs, or pavements are to be constructed. Final site grading in areas adjacent to the buildings should slope away at least one to 2 percent, except where the area is paved. Surface drains should be provided where necessary to prevent ponding of water behind foundation or retaining walls. A discussion of grading and drainage related to pervious surfaces near walls and structures is contained in the ***Foundation and Retaining Walls*** section.

PAVEMENT AREAS

The pavement section may be supported on firm, non-organic soil on structural fill compacted to a 95 percent density. The pavement subgrade must be in a stable, non-yielding condition at the time of paving. Granular structural fill or geotextile fabric may be needed to stabilize soft, wet, or unstable areas. To evaluate pavement subgrade strength, we recommend that a proof roll be completed with a loaded dump truck immediately before paving. In most instances where unstable subgrade conditions are encountered, an additional 12 inches of granular structural fill will stabilize the subgrade, except for very soft areas where additional fill could be required. The subgrade

should be evaluated by Geotech Consultants, Inc., after the site is stripped and cut to grade. Recommendations for the compaction of structural fill beneath pavements are given in the section entitled ***General Earthwork and Structural Fill***. The performance of site pavements is directly related to the strength and stability of the underlying subgrade.

The pavement for lightly loaded traffic and parking areas should consist of 2 inches of asphalt concrete (AC) over 4 inches of crushed rock base (CRB) or 3 inches of asphalt-treated base (ATB). We recommend providing heavily loaded areas with 3 inches of AC over 6 inches of CRB or 4 inches of ATB. Heavily loaded areas are typically main driveways, dumpster sites, or areas with truck traffic. Increased maintenance and more frequent repairs should be expected if thinner pavement sections are used.

Water from planter areas and other sources should not be allowed to infiltrate into the pavement subgrade. The pavement section recommendations and guidelines presented in this report are based on our experience in the area and on what has been successful in similar situations. As with any pavements, some maintenance and repair of limited areas can be expected as the pavement ages. Cracks in the pavement should be sealed as soon as possible after they become evident, in order to reduce the potential for degradation of the subgrade from infiltration of surface water. For the same reason, it is also prudent to seal the surface of the pavement after it has been in use for several years. To provide a design without the need for any maintenance or repair would be uneconomical.

GENERAL EARTHWORK AND STRUCTURAL FILL

All building and pavement areas should be stripped of surface vegetation, topsoil, organic soil, and other deleterious material. The stripped or removed materials should not be mixed with any materials to be used as structural fill, but they could be used in non-structural areas, such as landscape beds.

Structural fill is defined as any fill, including utility backfill, placed under, or close to, a building, or in other areas where the underlying soil needs to support loads. All structural fill should be placed in horizontal lifts with a moisture content at, or near, the optimum moisture content. The optimum moisture content is that moisture content that results in the greatest compacted dry density. The moisture content of fill is very important and must be closely controlled during the filling and compaction process.

The allowable thickness of the fill lift will depend on the material type selected, the compaction equipment used, and the number of passes made to compact the lift. The loose lift thickness should not exceed 12 inches, but should be thinner if small, hand-operated compactors are used. We recommend testing structural fill as it is placed. If the fill is not sufficiently compacted, it should be recompacted before another lift is placed. This eliminates the need to remove the fill to achieve the required compaction.

The following table presents recommended levels of relative compaction for compacted fill:

LOCATION OF FILL PLACEMENT	MINIMUM RELATIVE COMPACTION
Beneath footings, slabs or walkways	95%
Filled slopes and behind retaining walls	90%
Beneath pavements	95% for upper 12 inches of subgrade; 90% below that level

Where: Minimum Relative Compaction is the ratio, expressed in percentages, of the compacted dry density to the maximum dry density, as determined in accordance with ASTM Test Designation D 1557-91 (Modified Proctor).

Use of Onsite Soil

The onsite sand soils underlying the topsoil could be used as structural fill, provided the sand soils do not contain excessive roots and/or organics. During dry weather, it may be necessary to add water to the sand in order for it to be near its optimum moisture content.

LIMITATIONS

The conclusions and recommendations contained in this report are based on site conditions as they existed at the time of our exploration and assume that the soil and groundwater conditions encountered in the test pits are representative of subsurface conditions on the site. If the subsurface conditions encountered during construction are significantly different from those observed in our explorations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. Unanticipated conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking samples in test pits. Subsurface conditions can also vary between exploration locations. Such unexpected conditions frequently require making additional expenditures to attain a properly constructed project. It is recommended that the owner consider providing a contingency fund to accommodate such potential extra costs and risks. This is a standard recommendation for all projects.

This report has been prepared for the exclusive use of Shelter Resources, Inc. and their representatives for specific application to this project and site. Our conclusions and recommendations are professional opinions derived in accordance with our understanding of current local standards of practice, and within the scope of our services. No warranty is expressed or implied. The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. Our services also do not include assessing or minimizing the potential for biological hazards, such as mold, bacteria, mildew and fungi in either the existing or proposed site development.

ADDITIONAL SERVICES

Geotech Consultants, Inc. should be retained to provide geotechnical consultation, testing, and observation services during construction. This is to confirm that subsurface conditions are consistent with those indicated by our exploration, to evaluate whether earthwork and foundation construction activities comply with the general intent of the recommendations presented in this report, and to provide suggestions for design changes in the event subsurface conditions differ from those anticipated prior to the start of construction. However, our work would not include the supervision or direction of the actual work of the contractor and its employees or agents. Also, job and site safety, and dimensional measurements, will be the responsibility of the contractor.

During the construction phase, we will provide geotechnical observation and testing services when requested by you or your representatives. Please be aware that we can only document site work we actually observe. It is still the responsibility of your contractor or onsite construction team to verify that our recommendations are being followed, whether we are present at the site or not.

The following plates are attached to complete this report:

Plate 1	Vicinity Map
Plate 2	Site Exploration Plan
Plates 3 - 8	Test Pit Logs

We appreciate the opportunity to be of service on this project. Please contact us if you have any questions, or if we can be of further assistance.

Respectfully submitted,

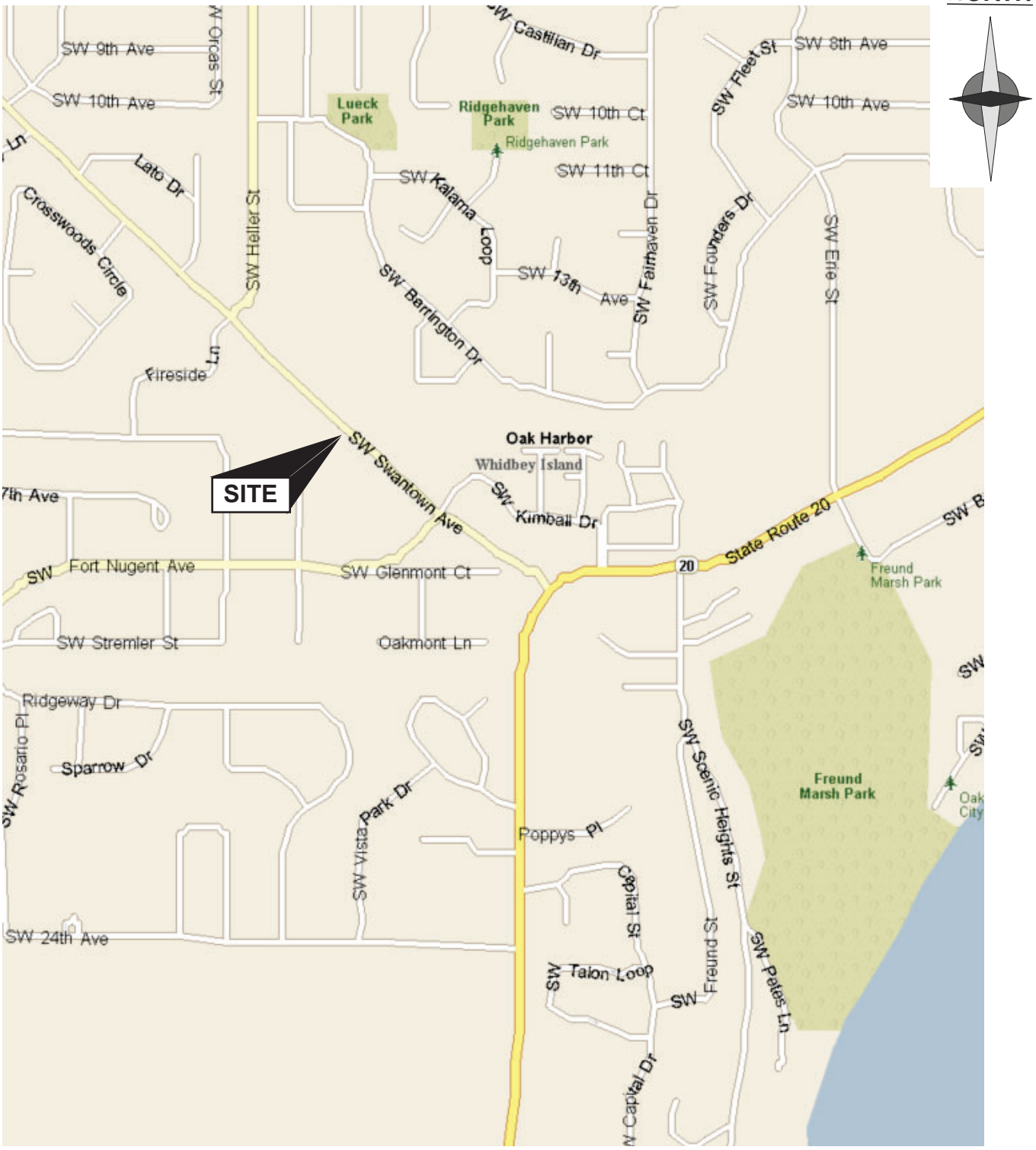
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5/14/2025

D. Robert Ward, P.E.
Principal

DRW:kg



(Source: King County iMap)

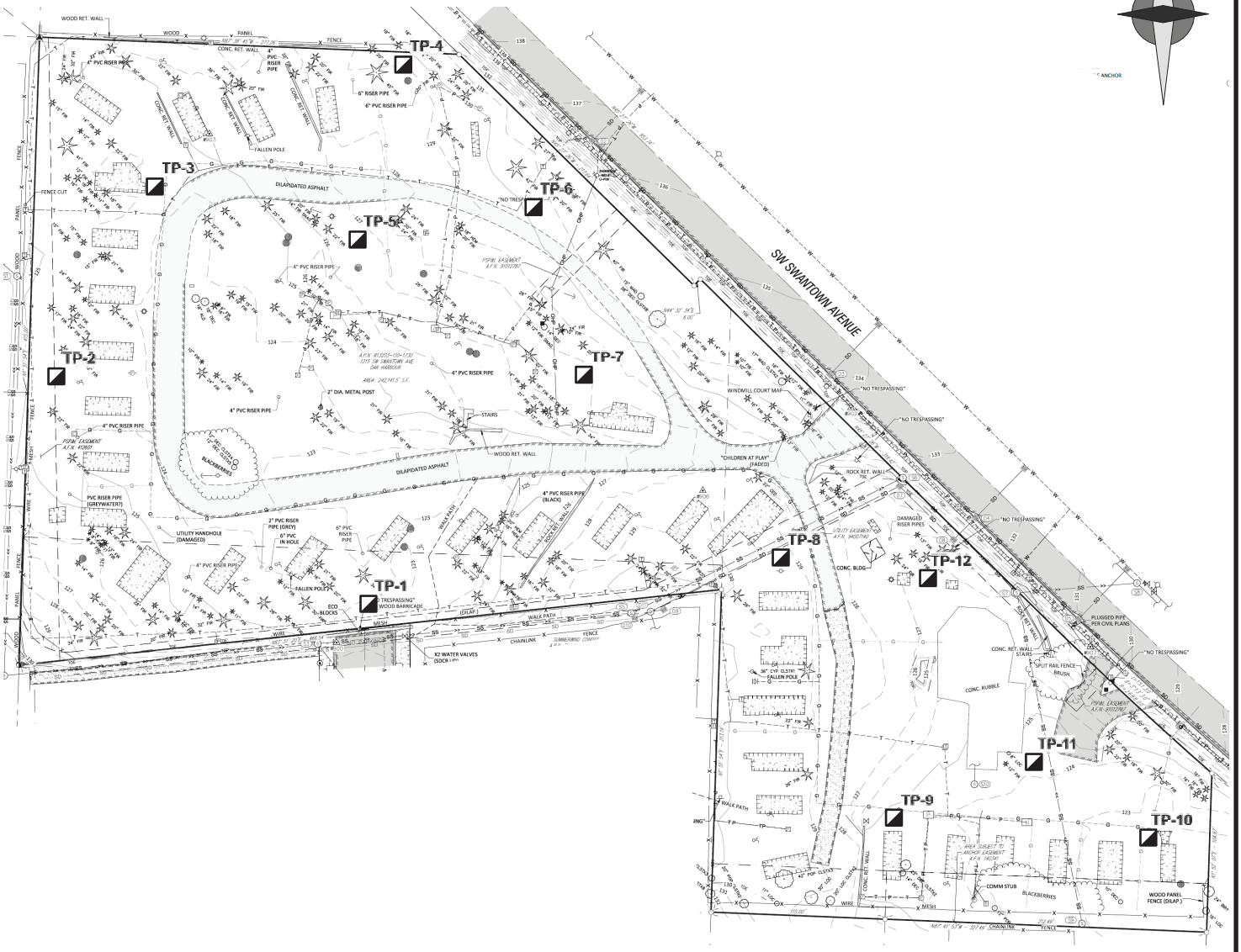
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VICINITY MAP

~1200 Southwest Swantown Avenue
Oak Harbor, Washington

Job	Date:		Plate:
25110	May 2025		1

NORTH



Legend:

- Test Pit Location

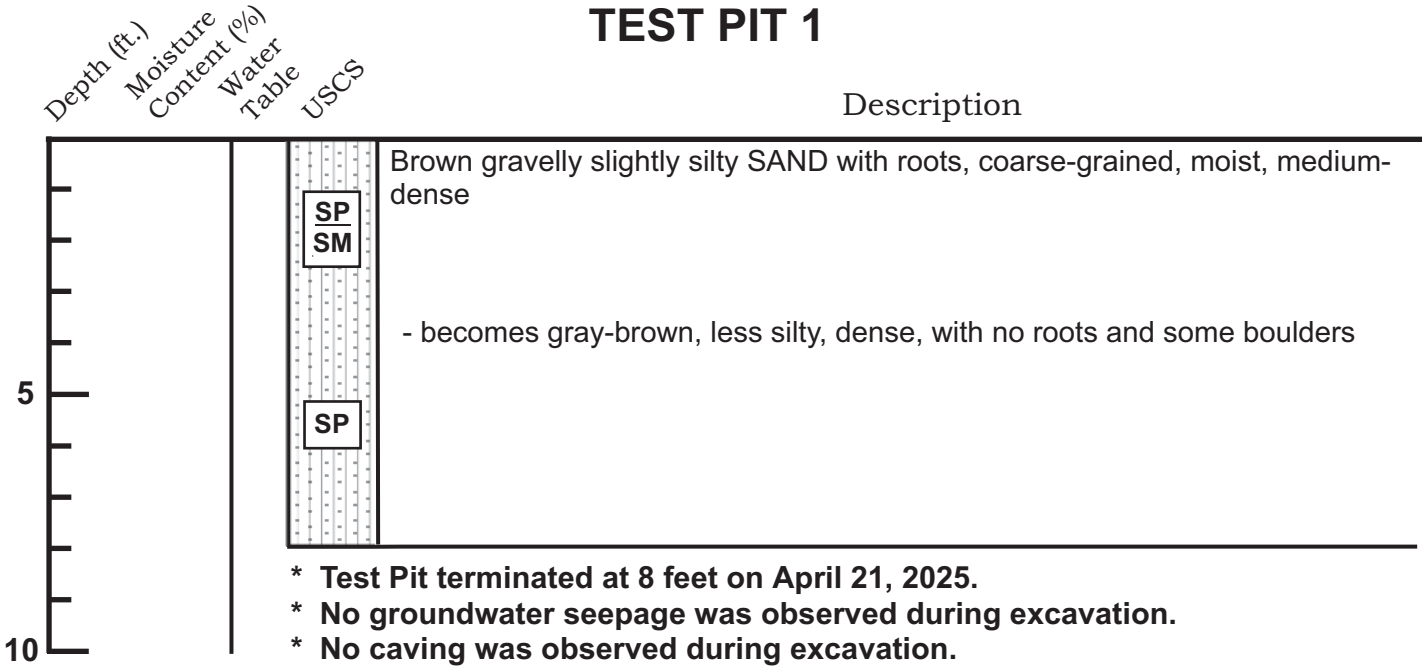
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SITE EXPLORATION PLAN

~1200 Southwest Swantown Avenue
Oak Harbor, Washington

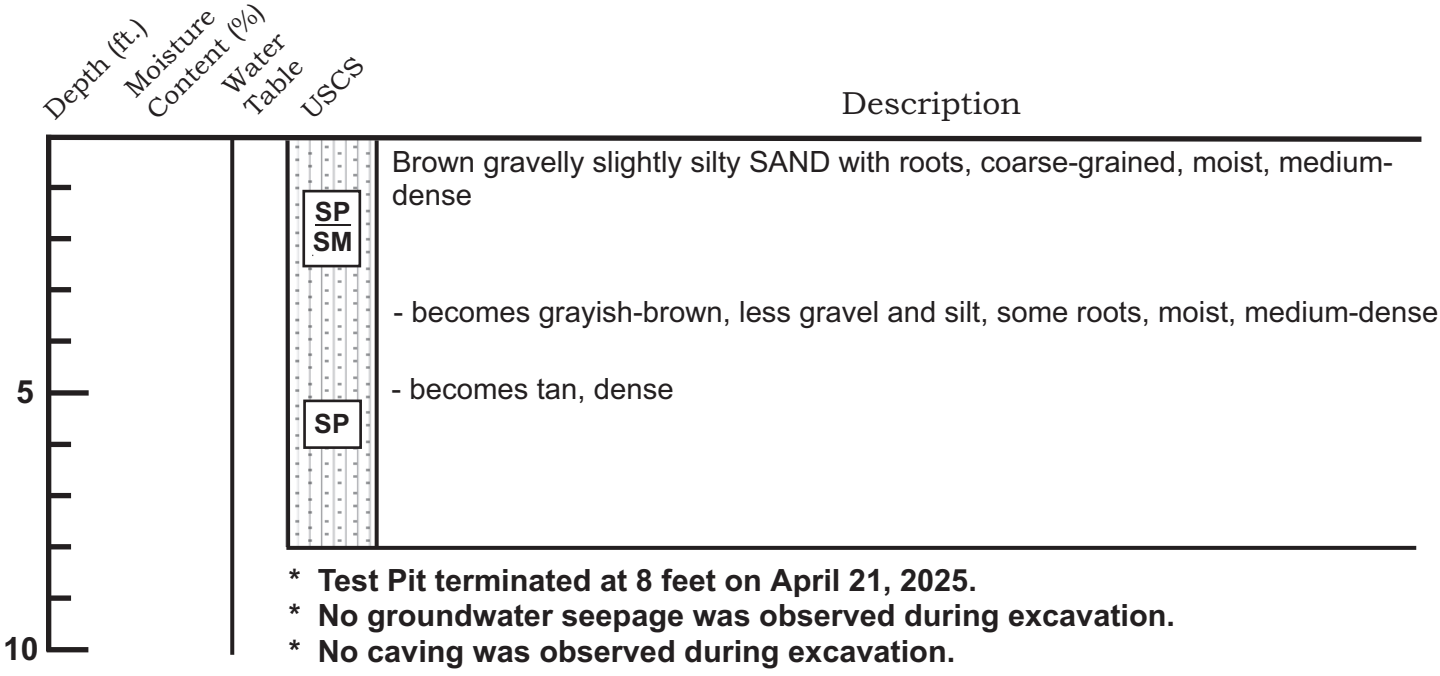
Job	Date:		Plate:
25110	May 2025	No Scale	2

TEST PIT 1



* **Test Pit terminated at 8 feet on April 21, 2025.**
* **No groundwater seepage was observed during excavation.**
* **No caving was observed during excavation.**

TEST PIT 2



* **Test Pit terminated at 8 feet on April 21, 2025.**
* **No groundwater seepage was observed during excavation.**
* **No caving was observed during excavation.**

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TEST PIT LOG

~1200 Southwest Swantown Avenue
Oak Harbor, Washington

Job	Date:	Logged by:	Plate:
25110	May 2025	DRW	3

TEST PIT 3

Depth (ft.)	Moisture Content (%)	Water Table	USCS	Description
				Old TOPSOIL
			SM	Reddish-brown slightly silty SAND with roots, fine-grained, moist, loose to medium-dense
5			SP/SM	Grayish-brown slightly silty SAND with gravel and some roots, medium-grained, moist, medium-dense - no roots
10				

* **Test Pit terminated at 7 feet on April 21, 2025.**
* **No groundwater seepage was observed during excavation.**
* **No caving was observed during excavation.**

TEST PIT 4

Depth (ft.)	Moisture Content (%)	Water Table	USCS	Description
			SM	Reddish-brown slightly silty SAND with roots, fine-grained, moist, loose to medium-dense
5			SP/GP	Brownish-gray gravelly SAND, coarse-grained, moist, medium-dense - becomes reddish-gray, less gravelly
10				

* **Test Pit terminated at 8 feet on April 21, 2025.**
* **No groundwater seepage was observed during excavation.**
* **No caving was observed during excavation.**

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TEST PIT LOG

~1200 Southwest Swantown Avenue
Oak Harbor, Washington

Job	Date:	Logged by:	Plate:
25110	May 2025	DRW	4

TEST PIT 5

Depth (ft.)	Moisture Content (%)	Water Table	USCS	Description
				TOPSOIL
			SM	Reddish-brown slightly silty SAND with roots, fine-grained, moist, loose to medium-dense
5			SP GP	Brownish-gray gravelly SAND, coarse-grained, moist, medium-dense
			SP SM	Reddish gray, slightly silty SAND with gravel, medium-grained, moist, medium-dense
10				

*** Test Pit terminated at 8 feet on April 21, 2025.**
*** No groundwater seepage was observed during excavation.**
*** No caving was observed during excavation.**

TEST PIT 6

Depth (ft.)	Moisture Content (%)	Water Table	USCS	Description
				TOPSOIL
			SM	Reddish-brown slightly silty SAND with roots, fine-grained, moist, loose to medium-dense
			SP GP	Brownish-gray gravelly SAND, coarse-grained, moist, medium-dense
5			SP SM	Grayish-brown slightly silty SAND with gravel and some roots, medium-grained, moist, medium-dense - no roots
10				

*** Test Pit terminated at 8.5 feet on April 21, 2025.**
*** No groundwater seepage was observed during excavation.**
*** No caving was observed during excavation.**

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TEST PIT LOG

~1200 Southwest Swantown Avenue
Oak Harbor, Washington

Job	Date:	Logged by:	Plate:
25110	May 2025	DRW	5

TEST PIT 7

Depth (ft.)	Moisture Content (%)	Water Table	USCS	Description
				TOPSOIL
			SM	Reddish-brown slightly silty SAND with roots, fine-grained, moist, loose to medium-dense
5			SP/GP	Brownish-gray gravelly SAND, coarse-grained, moist, medium-dense
10				

* **Test Pit terminated at 7 feet on April 21, 2025.**
* **No groundwater seepage was observed during excavation.**
* **Slight caving was observed at 3 feet during excavation.**

TEST PIT 8

Depth (ft.)	Moisture Content (%)	Water Table	USCS	Description
				TOPSOIL
			SM	Reddish-brown slightly silty SAND with roots, fine-grained, moist, loose to medium-dense
5			SP	Gray SAND with small gravel, very coarse-grained, moist, medium-dense
10				

* **Test Pit terminated at 7 feet on April 21, 2025.**
* **No groundwater seepage was observed during excavation.**
* **Some caving was observed below 2 feet during excavation.**

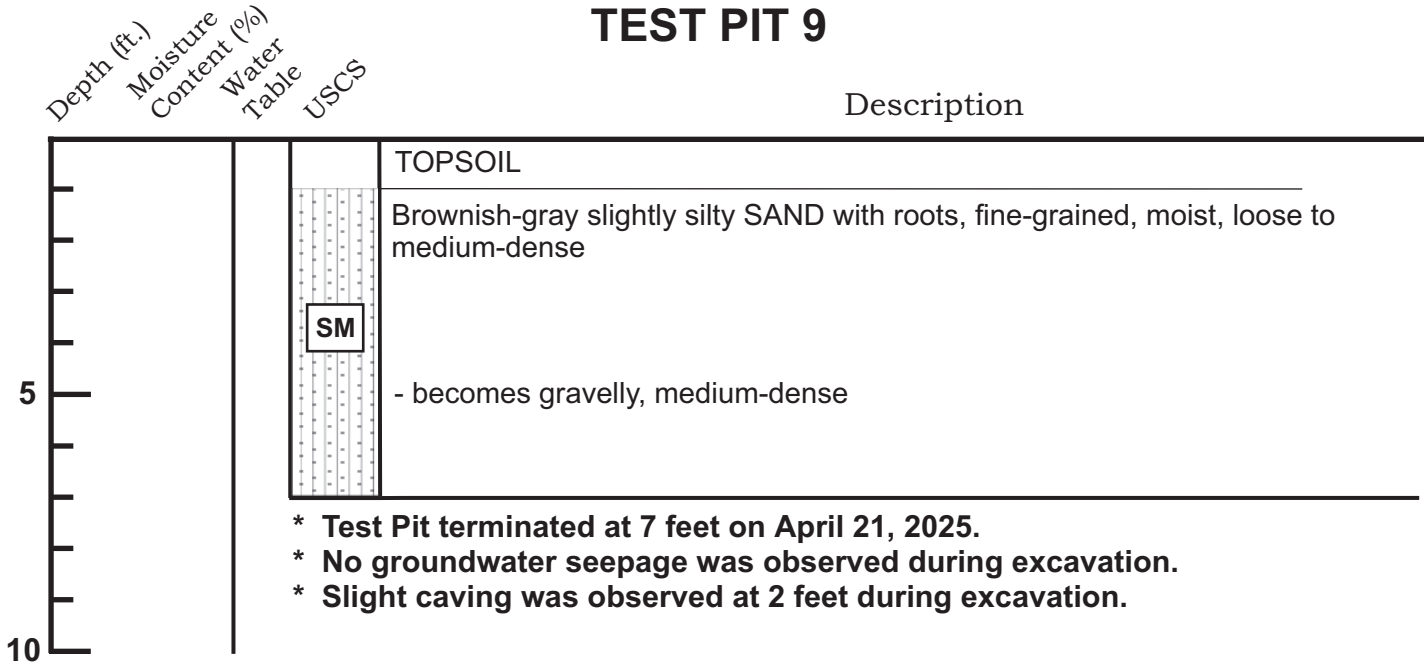
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TEST PIT LOG

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Oak Harbor, Washington

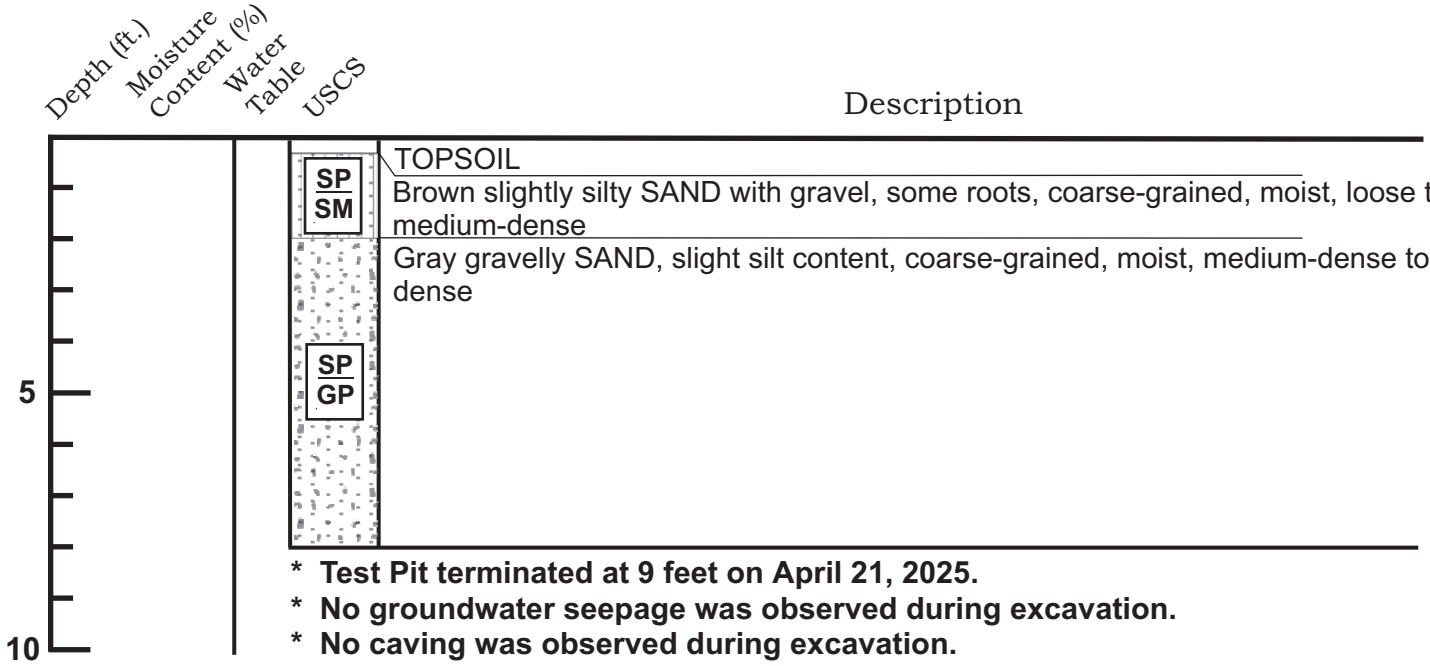
Job	Date:	Logged by:	Plate:
25110	May 2025	DRW	6

TEST PIT 9



* **Test Pit terminated at 7 feet on April 21, 2025.**
* **No groundwater seepage was observed during excavation.**
* **Slight caving was observed at 2 feet during excavation.**

TEST PIT 10



* **Test Pit terminated at 9 feet on April 21, 2025.**
* **No groundwater seepage was observed during excavation.**
* **No caving was observed during excavation.**

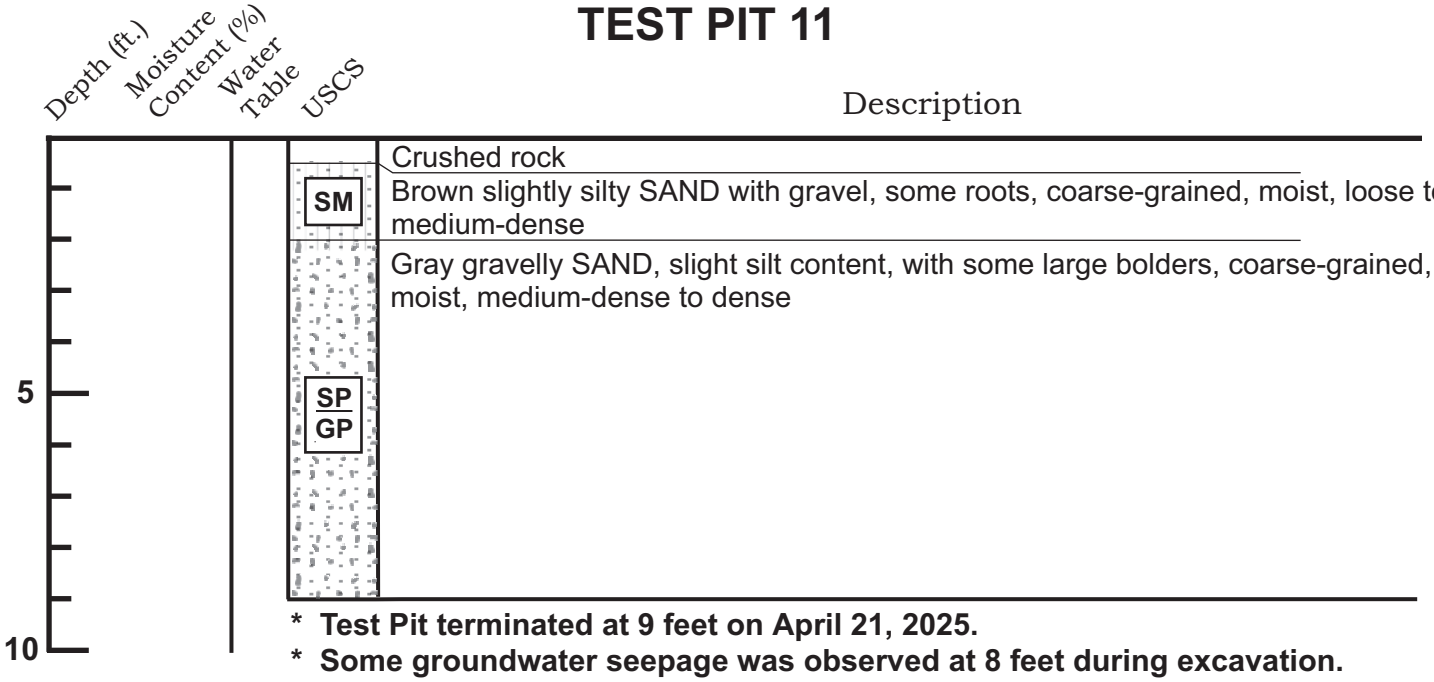
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TEST PIT LOG

~1200 Southwest Swantown Avenue
Oak Harbor, Washington

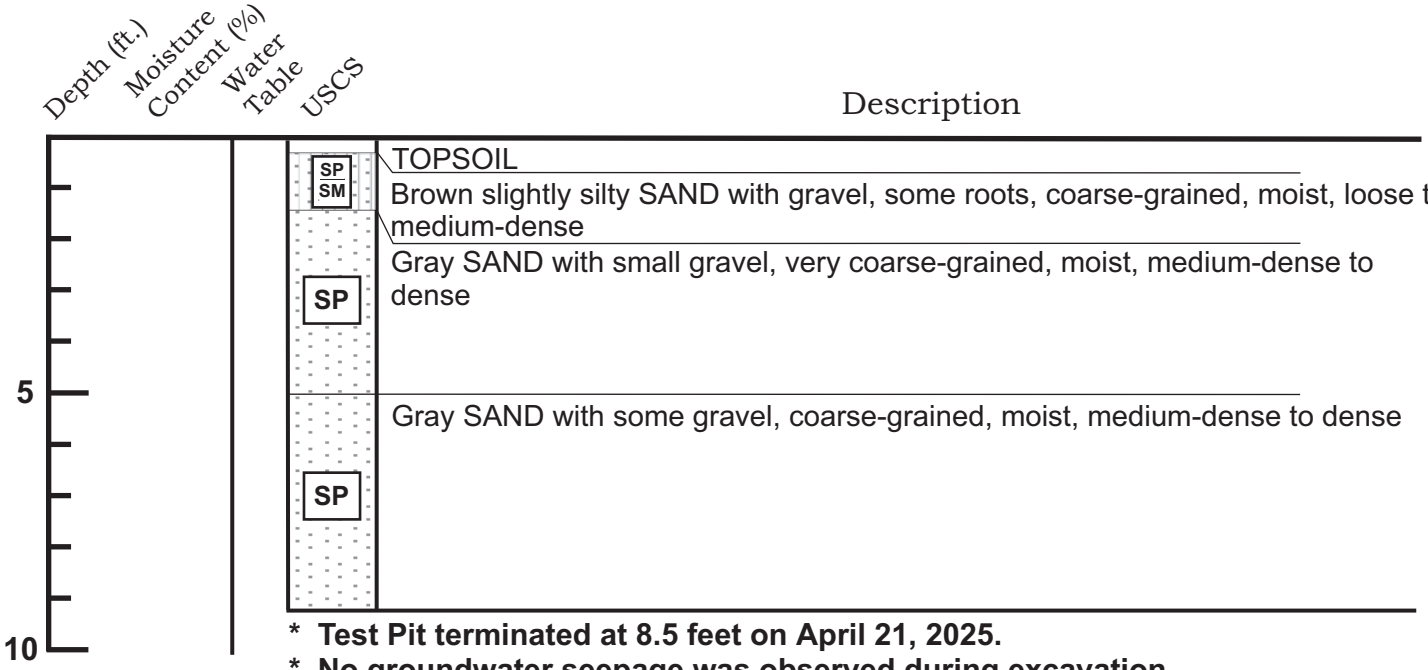
Job	Date:	Logged by:	Plate:
25110	May 2025	DRW	7

TEST PIT 11



* **Test Pit terminated at 9 feet on April 21, 2025.**
* **Some groundwater seepage was observed at 8 feet during excavation.**
* **Some caving was observed during excavation.**

TEST PIT 12



* **Test Pit terminated at 8.5 feet on April 21, 2025.**
* **No groundwater seepage was observed during excavation.**
* **No caving was observed during excavation.**

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TEST PIT LOG

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Oak Harbor, Washington

Job	Date:	Logged by:	Plate:
25110	May 2025	DRW	8