GEOTECHNICAL ENGINEERING INVESTIGATION
PROPOSED SOUTH KITSAP COUNTY
REGIONAL PARK IMPROVEMENTS
NW CORNER OF JACKSON AVE SE & SE LUND AVENUE
PORT ORCHARD, WASHINGTON

PROJECT NO. 092-10038
AUGUST 17, 2010

Prepared for:

KITSAP COUNTY PARKS & RECREATION
ATTN: MS. MARTHA DROGE
614 DIVISION STREET, MS-1
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Prepared by:

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GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

August 17, 2010

KA Project No. 092-10038

Kitsap County Parks & Recreation
614 Division Street, MS-1
Port Orchard, Washington 98366

Attention: **Martha Droge – Parks Project Coordinator**

Reference: **GEOTECHNICAL ENGINEERING INVESTIGATION**
South Kitsap Regional Park Additions Project
NW Corner of Jackson Avenue SE & SE Lund Avenue
Port Orchard, Washington 98366

Dear Ms. Droge:

In accordance with your request, we have completed a Geotechnical Engineering Investigation for the referenced site. The results of our investigation are presented in the attached report.

If you have any questions, or if we can be of further assistance, please do not hesitate to contact our office.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

Amjad I. Khan, P.E.G., P.G.
Regional Director Professional Services

JL/gs

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GEOTECHNICAL ENGINEERING INVESTIGATION
PROPOSED SOUTH KITSAP REGIONAL PARK IMPROVEMENTS PROJECT
NW CORNER OF JACKSON AVENUE SE AND SE LUND AVENUE
PORT ORCHARD, WASHINGTON

INTRODUCTION

This report presents the results of our Geotechnical Engineering Investigation for the proposed Park Improvements Project, located at the northwest corner of Jackson Avenue SE and SE Lund Avenue in Port Orchard, Washington. Discussions regarding site conditions are presented herein, together with conclusions and recommendations pertaining to site preparation, excavations, structural fill, utility trench backfill, infiltration, drainage and landscaping, erosion control, foundations, concrete floor slabs and exterior flatwork, and pavement design.

A site plan showing the approximate soil boring locations is presented in Figure 2, following the text of this report. A description of the field investigation and the exploratory soil boring logs are presented in Appendix A. Appendices B and C contain guides to aid in the development of earthwork and impervious pavement specifications. When conflicts in the text of the report occur with the general specifications in the appendices, the recommendations in the text of the report have precedence.

PURPOSE AND SCOPE

This investigation was conducted to evaluate the shallow soil and groundwater conditions at the site to develop geotechnical engineering recommendations for use in the design of specific construction elements, and to provide criteria for site preparation and structural fill placement.

Our scope of services was performed in general accordance with our proposal for this project, dated July 20, 2010 (Proposal Number G10-089WAB) and included the following:

- A field investigation consisting of drilling and sampling 5 exploratory test borings that provided general coverage of the areas of the park to be developed. The exploratory test borings ranged in depth from approximately 9.0 to 16.5 feet below the existing site grades.

- Evaluation of the data obtained from the investigation and completion of engineering analyses to develop geotechnical conclusions and recommendations, including foundation design

parameters, drainage considerations, erosion control, utility trench backfill, soil compaction criteria and suitability of the on-site soil for reuse as fill.

- Preparation of this report summarizing our findings, the results of our analyses and our geotechnical conclusions and recommendations for this investigation.

PROPOSED CONSTRUCTION

We have been provided with preliminary site plan for the project by BCRA Engineering to aid in our preparation of this report. The site plan generally includes a new stormwater management system, parking areas, ball fields, spectator bleachers and landscaping.

We anticipate that site grading will include minimal cuts and fills. Foundation loads are expected to be light.

SITE LOCATION AND DESCRIPTION

The site is located at the northwest corner of Jackson Avenue SE and SE Lund Avenue in Port Orchard, Washington. The general location of the site is shown on Figure 1.

The site is irregularly shaped with approximate dimensions of 2,000 feet from north to south, and 2,000 feet from east to west. The park is developed, including the existing pavement areas, sidewalks, maintenance shed, landscaping and playfields. Site conditions include nearly level playfields and parking areas, to moderately undulating land, including small wooded ravines.

GEOLOGIC SETTING

The site lies within the central Puget Lowland. The lowland is part of a regional north-south trending trough that extends from southwestern British Columbia to near Eugene, Oregon. North of Olympia, Washington, this lowland is glacially carved, with a depositional and erosional history including at least four separate glacial advances/retreats. The Puget Lowland is bounded to the west by the Olympic Mountains, and to the east by the Cascade Range. The lowland is filled with glacial and nonglacial sediments consisting of interbedded gravel, sand, silt, till, and peat lenses.

The Geologic Map of Washington – Northwest Quadrant by Joe D. Dragovich, et al. (Washington Department of Natural Resources – Washington Division of Geology and Earth Resources, 2002) indicates that the site vicinity is underlain by Quaternary glacial advance outwash (Qga). Advance outwash generally consists of compact, moderately to well sorted, inter-layered, glaciofluvial (glacial meltwater stream and river) deposits and areas of lacustrine (lake and pond) deposits. Glaciofluvial materials typically include sand and gravel, and lacustrine deposits generally include clay, silt, and sand.

The USDA (United States Department of Agriculture) Soil Conservation Services (SCS) Soil Survey for Kitsap County, Washington maps native soils in the project vicinity as Ragnar Fine Sandy Loam with 0 to 6 percent slopes. Ragnar soils originated in glacial outwash.

FIELD INVESTIGATION

A field investigation consisting of five (5) geotechnical borings and one (1) hand test pit was completed to evaluate the subsurface soil and groundwater conditions in the site area. The soil borings ranged in depth from approximately 9.0 to 16.5 feet below existing grade. The test pit was about four feet deep and was excavated for infiltration testing. The site drilling work was completed on August 3, 2010 by Environmental Drilling, Inc. (a Krazan subcontractor).

Representative samples of the subsurface soils encountered in the geotechnical explorations were collected and sealed in plastic bags. These samples were transported to our laboratory for further examination and verification of the field classifications. The soils encountered in the exploratory borings were continuously examined and visually classified in accordance with the Unified Soil Classification System (USCS). A more detailed description of the field investigation is presented in Appendix A.

Laboratory sieve analyses were performed on selected soil samples to evaluate the physical characteristics and engineering properties. The laboratory testing program was formulated with an emphasis on the evaluation gradation of the materials encountered. Details of the laboratory testing program and results of the laboratory tests are summarized in Appendix A. This information, along with the field observations, was used to prepare the final exploratory soil logs, which are presented in Appendix A.

SOIL PROFILE AND SUBSURFACE CONDITIONS

The soils encountered in the exploratory borings were generally typical of those found in the described glacial advance outwash geologic unit.

Exploratory Boring B-1 encountered loose silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose silty sand was underlain by loose, fine to medium grained sand with silt (alluvium) to a depth of approximately 9.0 feet. Below this material, the soil boring encountered a layer of stiff silt with a little fine grained sand and clay (lacustrine deposits) to a depth of approximately 12.0 feet. This material was underlain by medium dense, fine to medium grained sand (advance outwash) to the termination depth of Exploratory Boring B-1 at about 16.5 feet below existing grade.

Exploratory Boring B-2 encountered loose silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose silty sand was underlain by loose to medium dense, fine to medium grained sand with silt (alluvium) to the termination depth of Exploratory Boring B-2 at approximately 9.0 feet below the existing ground surface.

Exploratory Boring B-3 encountered loose to medium dense silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose to medium dense silty sand was underlain by medium dense, fine to medium grained sand with silt

(alluvium) to a depth of approximately 9.0 feet. Below this material, the soil boring encountered a layer of stiff silt with a little fine grained sand and clay (lacustrine deposits) to a depth of approximately 12.0 feet. This material was underlain by medium dense, fine to medium grained sand (advance outwash) to the termination depth of Exploratory Boring B-3 at about 16.5 feet below the existing ground surface.

Exploratory Boring B-4 encountered loose to medium dense silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose to medium dense silty sand was underlain by medium dense, fine to medium grained sand with silt (alluvium) to the termination depth of Exploratory Boring B-4 at approximately 9.0 feet below existing grade.

Exploratory Boring B-5 encountered loose to medium dense silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose to medium dense silty sand was underlain by medium dense, fine to medium grained sand with silt (alluvium) to the termination depth of Exploratory Boring B-5 at approximately 11.5 feet below the existing ground surface.

Test Pit TP-1 was excavated near B-1 for stormwater infiltration testing. Exploratory Test Pit TP-1 encountered loose silty sand (weathered alluvium) to a depth of approximately 3.5 feet below existing grade. Below this material, loose sand with silt was encountered to the termination depth of Exploratory Test Pit TP-1 of about 4.0 feet below existing grade.

We understand that the alluvium also could be interpreted as recessional outwash.

For additional information about the soils encountered, please refer to the logs of the geotechnical explorations in Appendix A.

GROUNDWATER

The exploratory test borings were checked for the presence of groundwater during and immediately following the drilling operations. Groundwater was not encountered in the borings within the explored depths at the time of our investigation.

It should be recognized that water table elevations may fluctuate with time. The groundwater level will be dependent upon seasonal precipitation, irrigation, land use, and climatic conditions, as well as other factors. The primary factor that influences groundwater levels at this site is precipitation. Therefore, water levels at the time of the field investigation may be different from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

GEOLOGIC HAZARDS

Erosion Concern/Hazard

The Soil Conservation Service (SCS) map indicates that these soils will have a "Slight" erosion potential in a disturbed state due to their composition.

It has been our experience that soil erosion can be minimized through landscaping and surface water runoff control. Typically, erosion of exposed soils will be most noticeable during periods of rainfall and may be controlled by the use of normal temporary erosion control measures, i.e., silt fences, hay bales, mulching, control ditches or diversion trenching, and contour furrowing. Erosion control measures should be in place before the onset of wet weather.

Seismic Hazard

The soils encountered in the explorations below the undocumented fill were generally medium dense to dense. The soil profile corresponds to a soil profile Site Class *D* as defined by Table 1613.5.2 of the 2006 International Building Code (2006 IBC) with regard to the proposed structure. A Site Class *D* applies to a profile which includes stiff or medium dense to dense soils.

We referenced the U.S. Geological Survey (USGS) Earthquake Hazards Program Website to obtain values for S_S, S_1, F_a, and F_v. The USGS website includes the most updated published data on seismic conditions. The site specific seismic design parameters and adjusted maximum spectral response acceleration parameters are as follows:

PGA	(Peak Ground Acceleration, in percent of g)
34.68	(10% Probability of Exceedence in 50 years)
67.72	(2% Probability of Exceedence in 50 years)
S_S	151.50% of g
S_1	53.40% of g
F_A	1.0
F_V	1.5

Additional seismic considerations include liquefaction potential and amplification of ground motions by soft soil deposits. The liquefaction potential is highest for loose sand with a high groundwater table. Based on the results of our explorations, we interpret that the site to be underlain by relatively dense deposits within the potential groundwater depths and the liquefaction potential is low.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the findings of this investigation, it is our opinion that the on-site infiltration is feasible and that proposed structures may be supported on shallow foundation systems bearing on the medium dense native soils or on properly compacted structural fill placed on the medium dense native soils. For areas of shallow loose soils, we recommend over-excavation of the loose soils and placement of structural fill to support planned structures/ loads. The over-excavation of the loose soils need not exceed 5 feet in depth for footing subgrade preparation.

Site Preparation

Site clearing should be limited to the areas necessary for construction of the structure and associated parking areas. Clearing should include removal of vegetation; trees and associated root systems; wood; existing utilities; structures including foundations, basement walls and floors; rubble; and rubbish. Site stripping should extend to a minimum depth of 0.5 feet (preliminary; based on our test boring locations), or until all organics in excess of 3 percent by volume are removed. These materials will not be suitable for use as structural fill. However, stripped topsoil may be stockpiled and reused in landscape or non-structural areas.

After stripping operations and removal of any loose soils and undocumented fill (if present), the subgrade areas for structures should be visually inspected to identify any loose areas. Any remaining loose soils should be overexcavated to the level of the medium dense native soils. The resulting excavations should be filled with approved on site material, or imported structural fill. Structural fill material should be within ± 2 percent of the optimum moisture content, and the soils should be compacted to a minimum of 95 percent of the maximum dry density based on ASTM Test Method D1557.

During wet weather conditions, typically October through May, subgrade stability problems and grading difficulties may develop due to excess moisture, disturbance of sensitive soils and/or the presence of perched groundwater. Construction during the extended wet weather periods could create the need to overexcavate exposed soils if they become disturbed and cannot be recompacted due to elevated moisture contents. The on site native soils have variable silt contents and are considered moisture sensitive. If overexcavation is necessary, it should be confirmed through continuous monitoring and testing by a qualified geotechnical engineer or senior geologist. Soils that have become unstable may require drying and recompaction. Selective drying may be accomplished by scarifying or windrowing surficial material during extended periods of dry, warm weather (typically during the summer months).

If the soils cannot be dried back to a workable moisture condition, remedial measures may be required. General project site winterization should consist of the placement of aggregate base and the protection of exposed soils during the construction phase. It should be understood that even if Best Management Practices (BMP's) for wintertime soil protection are implemented and followed there is a significant chance that moisture disturbed soil mitigation work will still be required.

Any buried structures encountered during construction should be properly removed and backfilled. Excavations, depressions, or soft and pliant areas extending below the planned finish subgrade levels should be cleaned to firm undisturbed soil, and backfilled with structural fill. In general, any septic tanks, underground storage tanks, debris pits, cesspools, or similar structures should be completely removed. Concrete footings should be removed to an equivalent depth of at least 3 feet below proposed footing elevations or as recommended by the geotechnical engineer. The resulting excavations should be backfilled with structural fill.

A representative of our firm should be present during all site clearing and grading operations to test and observe earthwork construction. This testing and observation is an integral part of our service, as acceptance of earthwork construction is dependent upon compaction and stability of the material. The geotechnical engineer may reject any material that does not meet compaction and stability requirements. Further recommendations, contained in this report, are predicated upon the assumption that earthwork construction will conform to the recommendations set forth in this section and in the Structural Fill Section.

Temporary Excavations

The on site soils have variable cohesion strengths, therefore the safe angles to which these materials may be cut for temporary excavations is limited, as the soils may be prone to caving and slope failures in temporary excavations deeper than 4 feet. Temporary excavations in the medium dense to dense soils should be sloped no steeper than 1H:1V (horizontal to vertical) where room permits. For loose soils, or if the soil in the excavation is subject to vibration from heavy traffic, the temporary excavation should be sloped no steeper than 1½H:1V.

All temporary cuts should be in accordance with the Washington Administrative Code (WAC) Part N, Excavation, Trenching, and Shoring. The temporary slope cuts should be visually inspected daily by a qualified person during construction work activities and the results of the inspections should be included in daily reports. The contractor is responsible for maintaining the stability of the temporary cut slopes and minimizing slope erosion during construction. The temporary cut slopes should be covered with visqueen to help minimize erosion during wet weather and the slopes should be closely monitored until the permanent retaining systems are complete. Materials should not be stored and equipment operated within 10 feet of the top of any temporary cut slope.

A Krazan & Associates geologist or geotechnical engineer should observe, at least periodically, the temporary cut slopes during the excavation work. The reasoning for this is that all soil conditions may not be fully delineated during the previous geotechnical exploratory work. In the case of temporary

slope cuts, the existing soil conditions may not be fully revealed until the excavation work exposes the soil. Typically, as excavation work progresses the maximum inclination of the temporary slope will need to be reevaluated by the geotechnical engineer so that supplemental recommendations can be made. Soil and groundwater conditions can be highly variable. Scheduling for soil work will need to be adjustable, to deal with unanticipated conditions, so that the project can proceed smoothly and required deadlines can be met.

If any variations or undesirable conditions are encountered during construction Krazan & Associates should be notified so that supplemental recommendations can be made.

Structural Fill

Best Management Practices (BMP's) should be followed when considering the suitability of native material for use as structural fill. The native soils have variable fines (silt and clay) contents and are considered moisture sensitive. The native soils may also have elevated natural moisture contents, and may need to be dried back during dry, warm weather (typically during the summer months). The native glacial soils are generally considered suitable for reuse as structural fill, provided the soil is relatively free of organic material and debris, and it is within ± 2 percent of the optimum moisture content. If the native glacial soils are stockpiled for later use as structural fill, the stockpiles should be covered to help protect the soil from wet weather conditions. We recommend that a representative of Krazan & Associates be on site during the excavation work to determine which soils are suitable for structural fill.

It should not be taken for granted that the on site soils may be used as the sole source for structural fill (especially during winter construction activities). During wet weather conditions the soils with higher silt and clay contents will be moisture sensitive, easily disturbed and most likely will not meet compaction requirements. Furthermore, during the winter, the native soils typically have elevated natural moisture contents, which will limit the use of these materials as structural fill without proper mitigation measures. The contractor should use Best Management Practices to protect the soils during construction activities and be familiar with wet weather and wintertime soil work. An allowance for importing structural fill should be incorporated into the construction cost of the project (for wintertime construction this may be as high as 100 percent import).

Imported structural fill material should consist of well-graded gravel or a sand and gravel mixture with a maximum grain size of 3 inches and less than 5 percent fines (material passing the U.S. Standard No. 200 Sieve). All structural fill material should be submitted for approval to the geotechnical engineer at least 48 hours prior to delivery to the site.

Fill soils should be placed in horizontal lifts not exceeding 8 inches loose thickness, moisture-conditioned as necessary, (moisture content of soil shall not vary by more than ±2 percent of optimum moisture) and the material should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. In place density tests should be performed on all structural fill to verify

proper moisture content and adequate compaction. Additional lifts should not be placed if the previous lift did not meet the compaction requirements or if soil conditions are not considered stable.

Groundwater Influence on Structures/Construction

Groundwater was not encountered during our field exploration work. If groundwater is encountered during the construction work, the groundwater will be most likely perched on silt layers encountered in the borings. This perched groundwater develops where vertical infiltration of surface precipitation is impeded by a relatively impermeable soil layer, resulting in horizontal migration of the groundwater within overlying more permeable soils. If groundwater is encountered during construction, we should observe the conditions to determine if de-watering will be needed. Design of temporary dewatering systems to remove groundwater should be the responsibility of the contractor.

If earthwork is performed during or soon after periods of precipitation, the subgrade soils may become saturated. These soils may "pump," and the materials may not respond to densification techniques. Typical remedial measures include: discing and aerating the soil during dry weather; mixing the soil with drier materials; removing and replacing the soil with an approved fill material. A qualified geotechnical engineering firm should be consulted prior to implementing remedial measures to observe the unstable subgrade conditions and provide appropriate recommendations.

Erosion Control

Erosion and sediment control (ESC) is used to minimize the transportation of sediment to wetlands, streams, lakes, drainage systems, and adjacent properties. Erosion and sediment control measures should be taken and these measures should be in general accordance with local regulations. As a minimum, the following basic recommendations should be incorporated into the design of the erosion and sediment control features of the site:

1) Phase the soil, foundation, utility, and other work, requiring excavation or the disturbance of the site soils, to take place during the dry season (generally May through September). However, provided precautions are taken using Best Management Practices (BMP's), limited grading activities can be undertaken during the wet season (generally October through April). It should be noted that this typically increases the overall cost of the project.

2) All site work should be completed and stabilized as quickly as possible.

3) Additional perimeter erosion and sediment control features may be required to reduce the possibility of sediment entering the surface water. This may include additional silt fences, silt fences with a higher Apparent Opening Size (AOS), construction of a berm, or other filtration systems.

4) Any runoff generated by dewatering discharge should be treated through construction of a sediment trap if there is sufficient space. If space is limited other filtration methods will need to be incorporated.

5) Vegetation should be re-established in landscaped and slope areas prior to the onset of wet weather (typically October through April).

Drainage and Landscaping

The ground surface should slope away from building pads and pavement areas, toward appropriate drop inlets or other surface drainage devices. It is recommended that adjacent exterior grades be sloped a minimum of 2 percent for a minimum distance of 5 feet away from structures. Roof drains should be tightlined away from foundations and slope surfaces. Roof drains should not be connected to the footing drains, but may use the same outfall piping if connected well away from the structure such that roof water will not backup into the footing drains. Subgrade soils in pavement areas should be sloped a minimum of 1 percent and drainage gradients should be maintained to carry all surface water to collection facilities, and/or dispersion trenches, away from slope surfaces. These grades should be maintained for the life of the project. The collection facilities and/or dispersion trenches should be tightlined away from slopes that exceed 30 percent and disposed of where down slope properties, structures and slopes are not jeopardized.

Specific recommendations for and design of storm water disposal systems or septic disposal systems are beyond the scope of our services and should be prepared by other consultants that are familiar with design and discharge requirements. Infiltration systems should not be located on slopes that exceed 30 percent nor should systems be "stacked" or lined up with one another down the slope. Infiltration systems should not be located up slope of residences or retaining structures.

Utility Trench Backfill

Utility trenches should be excavated in accordance with Occupational Safety and Health Administration (OSHA) standards, by a contractor experienced in such work. The responsibility for the safety of open trenches should be borne by the contractor. Traffic and vibration adjacent to trench walls should be minimized; cyclic wetting and drying of excavation side slopes should be avoided. Depending upon the location and depth of some utility trenches, groundwater flow into open excavations could be experienced, especially during or shortly following periods of precipitation.

Relatively silty and sandy soil conditions were encountered at shallow depths at this site. These soils have variable cohesion and can cave in trench wall excavations. Shoring or sloping back trench sidewalls may be required within these soils.

All utility trench backfill should consist of imported structural fill or suitable on-site material. Utility trench backfill placed in or adjacent to buildings and exterior slabs should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. The upper 5 feet of utility

trench backfill placed in pavement areas should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Below 5 feet, utility trench backfill in pavement areas should be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. Pipe bedding should be in accordance with the pipe manufacturer's recommendations.

The contractor is responsible for removing all water-sensitive soils from the trenches regardless of the backfill location and compaction requirements. The contractor should use appropriate equipment and methods to avoid damage to the utilities and/or structures during fill placement and compaction.

Floor Slabs and Exterior Flatwork

If slab on grade structures are proposed and reducing floor dampness is desired, such as in areas covered with moisture sensitive floor coverings, we recommend that concrete slab-on-grade floors be underlain by a water vapor retarder system. The water vapor retarder system should be installed in accordance with ASTM Specification E164-94 and Standard Specifications E1745-97. According to ASTM Guidelines, the water vapor retarder should consist of a vapor retarder sheeting underlain by a minimum of 4-inches of compacted clean (less than 5 percent passing the U.S. Standard No. 200 Sieve), open-graded coarse rock of ¾-inch maximum size. The vapor retarder sheeting should be protected from puncture damage.

The exterior floors should be placed separately in order to act independently of the walls and foundation system. All fills required to bring the building pads to grade should be structural fill.

Moisture within the structures may be derived from water vapors, which were transformed from the moisture within the soils. This moisture vapor can travel through the vapor membrane and penetrate the slab-on-grade. This moisture vapor penetration can affect floor coverings and produce mold and mildew in the structures. To minimize moisture vapor intrusion, it is recommended that a vapor retarder be installed in accordance with ASTM guidelines. It is recommended that the utility trenches within the structures be compacted as specified in our report to minimize the transmission of moisture through the utility trench backfill. Special attention to the immediate drainage and irrigation around the buildings is recommended. Positive drainage should be established away from the structures and should be maintained throughout the lives of the structures. Ponding of water should not be allowed adjacent to the structures. Over-irrigation within landscaped areas adjacent to the structures should not be performed. In addition, ventilation of the structures (i.e. ventilation fans) is recommended to reduce the accumulation of interior moisture.

Foundations

The proposed structures may be supported on shallow foundation systems (continuous, column or slab) bearing on the medium dense native soils or on properly compacted structural fill placed on the medium dense to dense native soils. Foundations resting on medium dense or better native soils or structural fill extending to native bearing soils may be designed for a net allowable bearing pressure of 2,000 pounds

per square foot (psf) dead plus live load, if the footings bear directly on medium dense to dense native soils or on structural fill placed on the medium dense to dense native soils.

We recommend that the structures rest on medium dense or better native soil or on structural fill extending to medium dense or better native soils. Overexcavation will be necessary to remove loose soils or undocumented fill (if present) from the footing and slab areas. The loose soils/fill should be removed below all foundation elements and the overexcavation should extend horizontally a distance equal to the depth of the overexcavation in all directions around the footings. The resulting excavations may be backfilled with structural fill or geotechnically approved native soils. Over-excavation of any remaining loose soils or undocumented fill during footing subgrade preparation need not exceed 5 feet in depth prior to placement of structural fill provided that the overexcavated subgrade is well compacted in-situ.

A 1/3 increase in the above value may be used for short duration, wind and seismic loads. Structural fill placed on bearing, native subgrade should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Footing excavations should be inspected to verify that the foundations will bear on suitable material.

Exterior footings should have a minimum depth of 18 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower. Interior footings should have a minimum depth of 12 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower. Footings should have a minimum width of 12 inches regardless of load.

If constructed as recommended, the total settlement is not expected to exceed 1 inch. Differential settlement, along a 20-foot exterior wall footing, or between adjoining column footings, should be less than ½ inch, producing an angular distortion of 0.002. Most settlement is expected to occur during construction, as the loads are applied. However, additional post-construction settlement may occur if the foundation soils are flooded or saturated or if a strong seismic event results in liquefaction of the underlying soils. It should be noted that the risk of liquefaction is considered low, given the composition and density of the native, on site soils.

Seasonal rainfall, water run-off, and the normal practice of watering trees and landscaping areas around the proposed structure, should not be permitted to flood and/or saturate footings. To prevent the buildup of water within the footing areas, continuous footing drains (with cleanouts) should be provided at the bases of the footings. The footing drains should consist of a minimum 4-inch diameter perforated pipe, sloped to drain, with perforations placed down and enveloped by 1-inch sized washed rock in all directions and filter fabric to prevent the migration of fines.

Resistance to lateral footing displacement can be computed using an allowable friction factor of 0.30 acting between the bases of foundations and the supporting subgrade. Lateral resistance for footings can alternatively be developed using an allowable equivalent fluid passive pressure of 225 pounds per cubic foot (pcf) acting against the appropriate vertical footing faces. The allowable friction factor and allowable equivalent fluid passive pressure values include a factor of safety of 1.5. The frictional and

passive resistance of the soil may be combined without reduction in determining the total lateral resistance. A 1/3 increase in the above values may be used for short duration, wind and seismic loads.

Infiltration Rates

We understand that infiltration systems may be utilized on site, potentially near the area of Boring B-1 and Test Pit TP-1 based on a review of the site plan. We visually examined the samples from B-1 and TP-1, and performed sieve analyses to determine the United Stated Department of Agriculture (USDA) classification. The soil samples at 3.5 and 4.0 feet depth in TP-1 are classified as sand with silt, based on the sieve analysis results. Our infiltration rate determination is based on the criteria in Volume III of the Department of Ecology's Stormwater Design Manual, and estimated long-term infiltration rates are based on particle size analysis of selected site soils (ASTM D422) and the Kitsap County Stormwater Design Manual. The Kitsap County Manual recommends for the soils that have less than 12.5% fines, a design infiltration rate of 2 inches per hour. The soils encountered in B-1 and in TP-1 below a depth of 3.5 feet contain less that 12.5 % fines (passing #200 sieve).

The soil infiltration rates based on visual textural analyses are presented in the following table.

INFILTRATION RATE BASED ON TEXTURAL ANALYSIS			
Test Pit Number	**Sample Depth (feet)**	**Long Term Design Infiltration Rate (inches/hour)**	**Visual USDA Soil Classification**
TP-1	3.5	2	Sand
TP-1	1	0.5	Loamy Sand

We recommend that the stormwater infiltration system be located within the sandy soils, approximately 3.5 feet below the existing site grades. We should evaluate the soil conditions during construction of the system to ensure that soil conditions do not differ from those that are anticipated.

On-Site Infiltration

The measured soil infiltration rates from Boring B-1 based on the *Falling Head Percolation Test* Procedure, are presented in the following table.

INFILTRATION RATES BASED ON IN-PLACE FALLING HEAD TESTING			
Test Pit Number	**Test Elevation (feet below grade)**	**Observed Infiltration Rate (min/inch, inches/hr) No Factor of Safety**	**USDA Soil Classification**
TP-1	3.5	4 min/in (15 in/hr)	Sand

The typical soil infiltration rates for soil types in the infiltration exploration, based on USDA soil classification in conjunction with the Kitsap County Stormwater Management Design Manual are presented in the following table. These infiltration rates are less reliable than actual in-place field infiltration test results.

The typical infiltration rates presented above are based on soil textural analysis and do not incorporate a factor of safety. Therefore, at a minimum the above infiltration rates should incorporate a factor of safety for the infiltration system design, to account for possible soil clogging, biological activity and deterioration as well as site variability according to Kitsap County Stormwater Design Manual.

Field Infiltration Testing

The more reliable actual infiltration rates presented are based on field falling head infiltration testing with clear water and do not incorporate a factor of safety. We recommend that Safety Factors for Field Infiltration Measurements be applied according to Kitsap County Stormwater Design Manual. Considering the results of infiltration testing, it can be summarized that the Falling Head Percolation Tests indicate that the soils found in Infiltration Test Pit TP-1 have a moderate percolation/infiltration rate in their current condition.

According to the Washington State Department of Ecology (DOE) Stormwater Management Manual for Western Washington, a range of safety factors may apply. If the system is well-designed and well-maintained, a combined correction factor of six (6) would be applied to the test results. Should the system not be regularly maintained and without good influent control, a combined correction factor of eighteen (18) may be more appropriate. The manual provides this range of correction factors based on site variability and number of locations tested, degree of long-term maintenance to prevent siltation and bio-buildup, and degree of influent control to prevent siltation and bio-buildup. The soils encountered in the test borings are interpreted to have a moderate percolation/infiltration rate in their current conditions.

Based on in-place field infiltration testing, the observed raw infiltration rate is approximately 15 inch per hour without any factors of safety. Accordingly, we recommend that a long-term design infiltration rate of 2 inches per hour for a well-designed and well-maintained system. If the system is not regularly maintained and without good influent control, we recommend a long-term design infiltration rate of 1 inch per hour.

Geotechnical Design of Pervious Asphalt and Pervious Concrete Pavements

We understand that pervious pavements are planned for light duty parking areas. We have referenced the Low Impact Development Technical Guidance Manual for Puget Sound by Hinman (2005) and 1993 AASHTO Pavement Design Guidelines.

Traffic loading information is not available. However, we understand that these parking areas will have to service cars only (light duty).

The upper soils within a depth of approximately 3 feet could be classified as Loamy Sand per USDA. A design infiltration rate of 0.5 inch per hour is applicable for these soils.

The following tables provide minimum pervious pavement sections based on geotechnical stability. We understand that hydrological design will be performed by others. Thicker pavement sections may be required based on hydrological design by others. Gradation of the aggregate course shall be also based on the hydrological design. We recommend that the final design sections be reviewed by the geotechnical engineer with respect to geotechnical aspects.

PERVIOUS ASPHALTIC CONCRETE (FLEXIBLE) PAVEMENT – MINIMUM SECTION
LIGHT DUTY

Pervious Asphaltic Concrete	Leveling Aggregate/ Filter Course (1-1/2" Minus – AASHTO No. 57)	Stone Reservoir Course (2-1/2" Minus – AASHTO No. 3)**
3.0 in.	3.0 in.	6.0 in.**

*** Geotextile Separation fabric(Mirafi 160N or equivalent) is recommended below the Stone Course*
90% compaction based on AST M Test Method D1557 is adequate for Subgrade

PERVIOUS PORTLAND CEMENT CONCRETE PAVEMENT – MINIMUM SECTION

LIGHT DUTY

Min. PPCC Depth	Leveling Aggregate/ Filter Course (1-1/2" Minus – AASHTO No. 57)	Stone Reservoir Course (2-1/2" Minus – AASHTO No. 3)**
6.0 in.	3.0 in.	6.0 in.

*** Geotextile Separation fabric(Mirafi 160N or equivalent) is recommended below the Stone Course*
90% compaction based on AST M Test Method D1557 is adequate for Subgrade

Stone Reservoir course aggregate layer should be crushed (angular) thoroughly washed stone (AASHTO No. 3).

Recommended Gradation for Stone Reservoir Course Aggregate

U.S. Standard Sieve	Percentage Material Passing
2-1/2"	100
2"	90-100
1-1/2"	35-70
1"	0-15
½"	0-5

Filter Course aggregate layer should be crushed (angular) thoroughly washed stone (AASHTO No. 57).

Recommended Gradation for Filter Course Aggregate

U.S. Standard Sieve	Percentage Material Passing
1-1/2"	100
1"	95-100
½"	25-60
No. 4	0-10
No. 8	0-5

Pervious Hot Mix Asphalt (PHMA) be Class ½ inch and meet Section 5-04 of WSDOT Specifications with the following exceptions:

Gradation shall be according to the following table:

Recommended Gradation for Pervious Asphalt Gradation

U.S. Standard Sieve	Percentage Material Passing
1/2"	100
3/8"	92-98
No. 4	32-38
No. 8	12-18
No. 16	7-13
No. 30	0-5
No. 200	0-3

Compaction of aggregates and pervious asphalt be performed using static rollers. Overcompaction should be avoided.

We recommend that the pervious concrete and pervious asphalt specifications be also according to the hydrological design requirements.

Slopes should be avoided as much as possible or kept to a minimum, not to exceed 2%.

Subgrade Preparation for Pervious Pavements

Subgrade preparation is an important aspect as infiltration capacity will be affected by the methods employed. We recommend avoiding overcompaction and sealing to minimize the reduction of infiltration capacity during subgrade preparation. All construction traffic should be directed away from pavement subgrade areas to mitigate transport of fine materials (from other areas of the site to pervious pavement areas), resulting in reduction in infiltration capacity of the pavement subgrade materials. Heavy construction traffic should be minimized on the subgrade. Static rolling is recommended for the upper 2 feet of soils where heavy vibratory rolling should be avoided.

A regular maintenance program is required to maintain adequate level of performance.

In general, we recommend that the design and construction of pervious pavements be in general conformance with the Low Impact Development Technical Guidance Manual for Puget Sound by Hinman (2005).

Impervious Pavement Design

The near surface subgrade soils generally consist of silty sand with variable amounts of gravel and fine to medium grained sand with variable amounts of gravel. These soils are rated as fair for pavement subgrade material. We estimate that the subgrade will have a California Bearing Ratio (CBR) value of 10 and a modulus of subgrade reaction value of k = 200 pci, provided the subgrade is prepared in general accordance with our recommendations.

We recommend that, at a minimum, 18 inches of the existing subgrade material be moisture conditioned (as necessary) and re-compacted to prepare for the construction of pavement sections. The subgrade should be compacted to at least 95 percent of the maximum dry density as determined by ASTM Test Method D1557. In place density tests should be performed to verify proper moisture content and adequate compaction. However, if the subgrade soil consists of firm and unyielding native glacial soils a proof roll of the pavement subgrade soil may be performed in lieu of re-compacting the subgrade and compaction tests. The recommended flexible and rigid pavement sections are based on design CBR and modulus of subgrade reaction (k) values that are achieved, only following proper subgrade preparation. It should be noted that subgrade soils that have relatively high silt contents may be highly sensitive to moisture conditions. The subgrade strength and performance characteristics of a silty subgrade material may be dramatically reduced if this material becomes wet.

Traffic loads were not provided, however, based on our knowledge of the proposed project, we expect the traffic to range from light duty (passenger automobiles) to heavy duty (large trucks). The following tables show the recommended pavement sections for light duty and heavy duty use.

ASPHALTIC CONCRETE (FLEXIBLE) PAVEMENT
LIGHT DUTY

Asphaltic Concrete	Aggregate Base*	Compacted Subgrade* **
2.0 in.	6.0 in.	18.0 in.

** 95% compaction based on ASTM Test Method D1557*
*** A proof roll may be performed in lieu of in place density tests*

HEAVY DUTY

Asphaltic Concrete	Aggregate Base*	Compacted Subgrade* **
3.0 in.	6.0 in.	18.0 in.

** 95% compaction based on ASTM Test Method D1557*
*** A proof roll may be performed in lieu of in place density tests*

PORTLAND CEMENT CONCRETE (RIGID) PAVEMENT

Aggregate Base*	Min. PCC Depth	Compacted Subgrade* **
6.0 in.	6.0 in.	18.0 in.

** 95% compaction based on AST M Test Method D1557*
*** A proof roll may be performed in lieu of in place density tests*

The asphaltic concrete depth in the flexible pavement tables should be a surface course type asphalt, such as Washington State Department of Transportation (WSDOT) Commercial HMA. The rigid pavement design is based on a Portland Cement Concrete (PCC) mix that has a 28 day compressive strength of 4,000 pounds per square inch (psi). The design is also based on a concrete flexural strength or modulus of rupture of 550 psi.

Testing and Inspection

A representative of Krazan & Associates, Inc. should be present at the site during the earthwork activities to confirm that actual subsurface conditions are consistent with the exploratory fieldwork. This activity is an integral part of our services as acceptance of earthwork construction is dependent upon compaction testing and stability of the material. This representative can also verify that the intent of these recommendations is incorporated into the project design and construction. Krazan & Associates, Inc. will not be responsible for grades or staking, since this is the responsibility of the Prime Contractor. Furthermore, Krazan & Associates is not responsible for the contractor's procedures, methods, scheduling or management of the work site.

LIMITATIONS

Geotechnical engineering is one of the newest divisions of Civil Engineering. This branch of Civil Engineering is constantly improving as new technologies and understanding of earth sciences improves. Although your site was analyzed using the most appropriate current techniques and methods, undoubtedly there will be substantial future improvements in this branch of engineering. In addition to improvements in the field of geotechnical engineering, physical changes in the site either due to

excavation or fill placement, new agency regulations or possible changes in the proposed structure after the time of completion of the soils report may require the soils report to be professionally reviewed. In light of this, the owner should be aware that there is a practical limit to the usefulness of this report without critical review. Although the time limit for this review is strictly arbitrary, it is suggested that two years be considered a reasonable time for the usefulness of this report.

Foundation and earthwork construction is characterized by the presence of a calculated risk that soil and groundwater conditions have been fully revealed by the original foundation investigation. This risk is derived from the practical necessity of basing interpretations and design conclusions on limited sampling of the earth. Our report, design conclusions and interpretations should not be construed as a warranty of the subsurface conditions. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. The recommendations made in this report are based on the assumption that soil conditions do not vary significantly from those disclosed during our field investigation. The findings and conclusions of this report can be affected by the passage of time, such as seasonal weather conditions, manmade influences, such as construction on or adjacent to the site, natural events such as earthquakes, slope instability, flooding, or groundwater fluctuations. If any variations or undesirable conditions are encountered during construction, the geotechnical engineer should be notified so that supplemental recommendations can be made.

The conclusions of this report are based on the information provided regarding the proposed construction. If the proposed construction is relocated or redesigned, the conclusions in this report may not be valid. The geotechnical engineer should be notified of any changes so that the recommendations can be reviewed and reevaluated.

Misinterpretations of this report by other design team members can result in project delays and cost overruns. These risks can be reduced by having Krazan & Associates, Inc. involved with the design teams meetings and discussions after submitting the report. Krazan & Associates, Inc. should also be retained for reviewing pertinent elements of the design team's plans and specifications. Contractors can also misinterpret this report. To reduce this, risk Krazan & Associates. Inc. should participate in pre-bid and preconstruction meetings, and provide construction observations during the site work.

This report is a geotechnical engineering investigation with the purpose of evaluating the soil conditions in terms of foundation design. The scope of our services did not include any environmental site assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater or atmosphere, or the presence of wetlands. Any statements, or absence of statements, in this report or on any boring log regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous and/or toxic assessments.

The geotechnical information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical developments. We emphasize that this report is valid for this project as outlined above, and should not

be used for any other site. Our report is prepared for the exclusive use of our client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (425) 485-5519.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

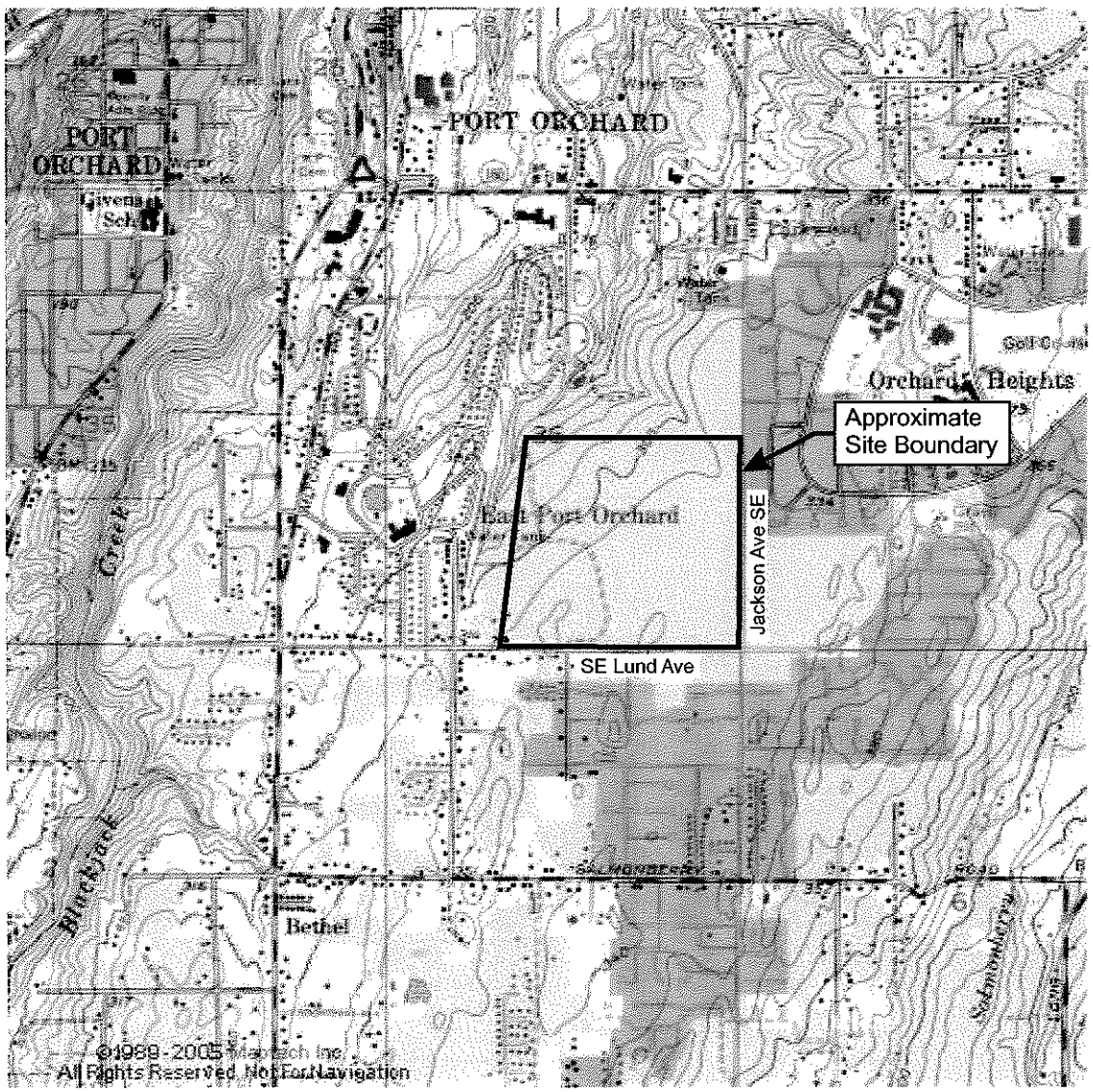
Jeffrey League
Geotechnical Staff

Gopal A. Singam, P.E.
Geotechnical Division Manager

JL/gs

Vicinity Map

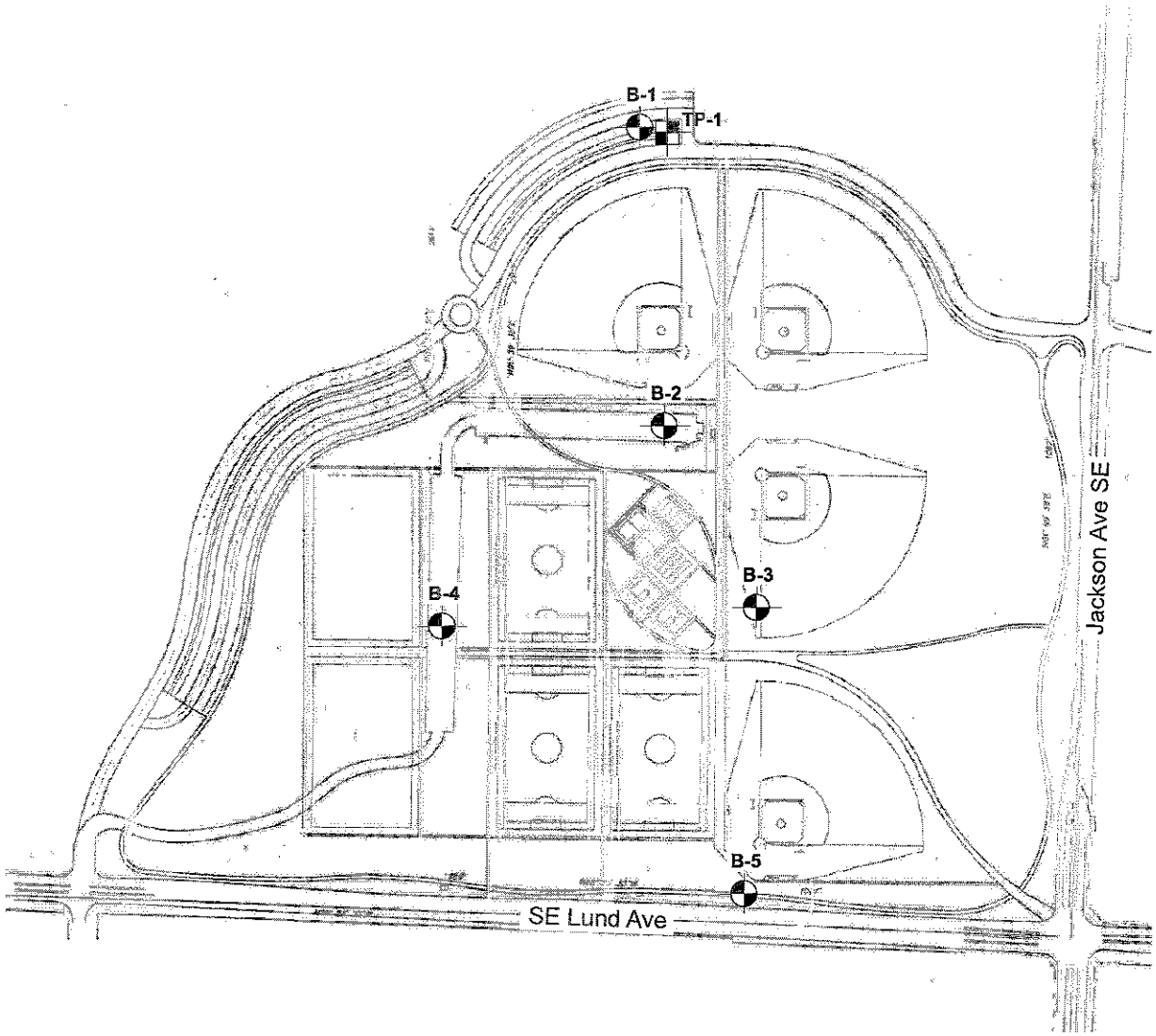
N



Port Orchard Area, Kitsap County, WA

Krazan & ASSOCIATES, INC.		
South Kitsap Regional Park, Port Orchard, WA		
Date: August 2010	Reference: Maptech	
Drawn By: JL	Figure 1	Project Number: 092-10038

Site Plan
(Not To Scale)



LEGEND

B-1 Number and Approximate Location of Soil Boring

TP-1 Number and Approximate Infiltration TP Location

Note: Site Plan is based on a drawing provided by Kitsap County

Not to scale.

Krazan & ASSOCIATES, INC.		
South Kitsap Regional Park, Port Orchard, WA		
Date: August 2010	Project Number: 092-10038	
Drawn By: JL	Figure 2	Not To Scale

APPENDIX A

FIELD INVESTIGATION

Field Investigation

The field investigation consisted of a surface reconnaissance and a subsurface exploration program. Five exploratory soil borings and one test pit were excavated and sampled for the subsurface geotechnical investigation at this site. The geotechnical explorations reached depths of approximately 4.0 to 16.5 feet below the existing grades. The approximate exploration locations are shown on the site plan (Figure 2). The depths shown on the attached soil logs are from the existing ground surface at the time of our exploration.

The soils encountered were logged in the field during the exploration are described in accordance with the Unified Soil Classification System (USCS).

All samples were returned to our Bothell laboratory for evaluation. The logs of the explorations are presented in this appendix. Sieve results of a sample collected in Test Pit 1 are also presented in this appendix.

KRAZAN AND ASSOCIATES
11715 North Creek Parkway South
Suite C-106
Bothell, Washington 98011

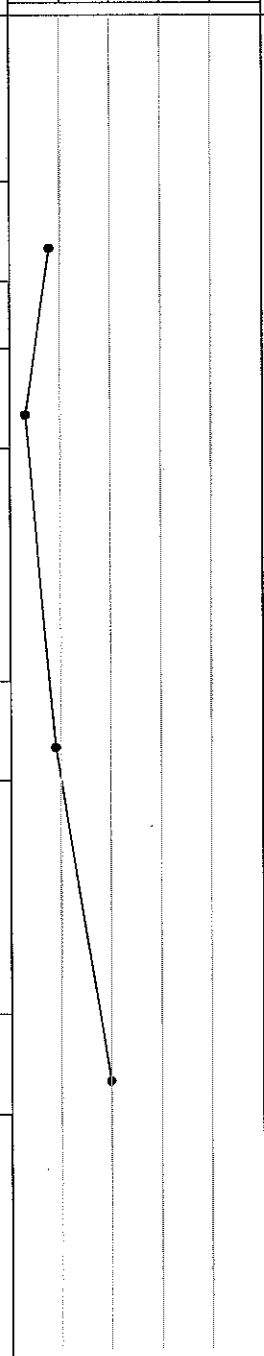
LOG OF EXPLORATORY BORING B-1

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

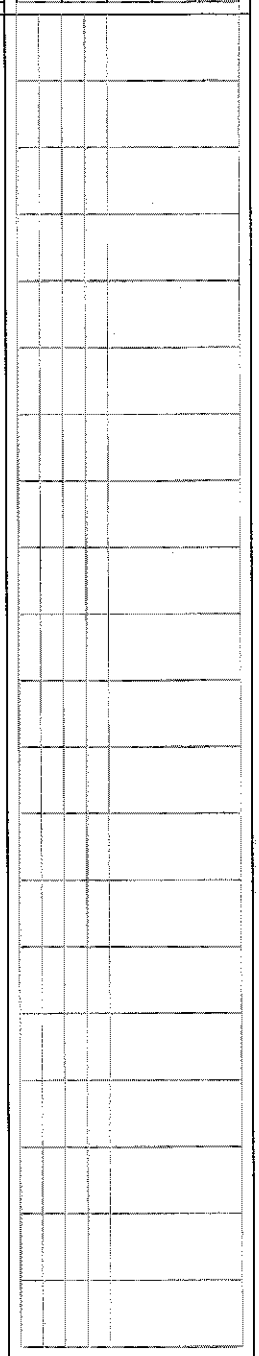
DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES
			Silty Sand with Gravel (SM) Loose, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	3, 4, 4	8	
5			**Poorly Graded Sand with Silt (SP-SM)** Loose, fine to medium grained sand with silt, light brown to gray, moist. (Alluvium)	2, 1, 2	3	
10			**Silt (ML)** Stiff silt with a little clay and fine grained sand, brown, moist to wet. (Lacustrine Deposit)	4, 4, 5	9	
15			**Poorly Graded Sand (SP)** Medium dense, fine to medium grained sand, gray, moist. (Advance Outwash)	8, 10, 10	20	
20			End of Exploratory Boring			

N-VALUE (GRAPH)



Natural Moisture Content and Atterberg Limits



Water Level Initial: ▽ Final: ▼

Water Observations: None Observed

Notes:

KRAZAN AND ASSOCIATES
11715 North Creek Parkway South
Suite C-106
Bothell, Washington 98011

LOG OF EXPLORATORY BORING B-2

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES	N-VALUE (GRAPH) 10 20 30 40	Natural Moisture Content and Atterberg Limits 0 20 40 60 80 100
			Silty Sand with Gravel (SM) Loose, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	5 4 4	8			
5			**Poorly Graded Sand with Silt (SP-SM)** Loose to medium dense, fine to medium grained sand with silt, light brown to gray, moist. (Alluvium)	3 5 7	12			
10			End of Exploratory Boring					
15								
20								

Water Level Initial: ▽ Final: ▼

Water Observations: None Observed

Notes:

KRAZAN AND ASSOCIATES
11715 North Creek Parkway South
Suite C-106
Bothell, Washington 98011

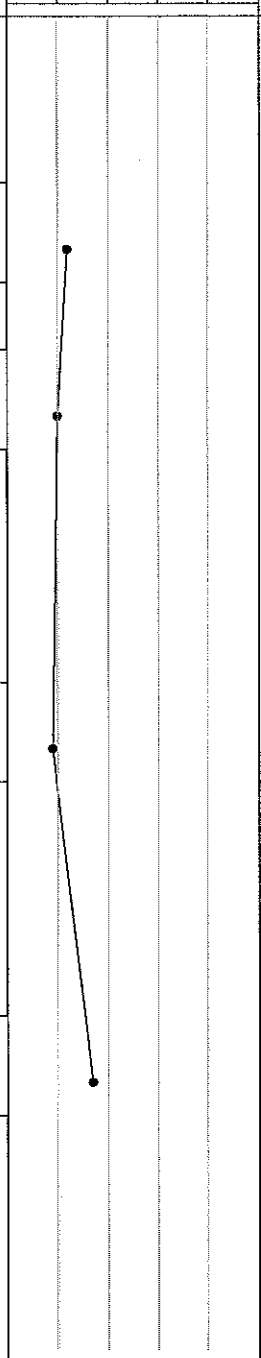
LOG OF EXPLORATORY BORING B-3

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

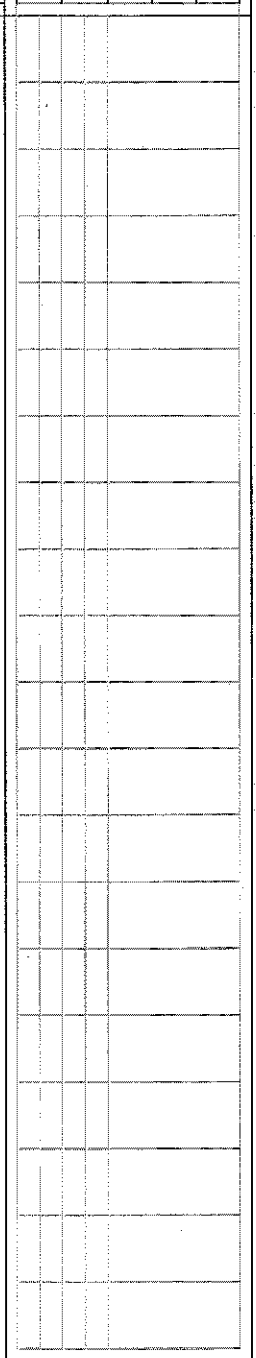
DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES
			Silty Sand with Gravel (SM) Loose to medium dense, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	4, 5, 7	12	
5			**Poorly Graded Sand with Silt (SP-SM)** Medium dense, fine to medium grained sand with silt, gray, moist. (Alluvium)	3, 4, 6	10	
10			**Silt (ML)** Stiff silt with a little clay and fine grained sand, brown, moist to wet. (Lacustrine Deposit)	2, 4, 5	9	
15			**Poorly Graded Sand (SP)** Medium dense, fine to medium grained sand, gray, moist. (Advance Outwash)	4, 7, 10	17	
20			End of Exploratory Boring			

N-VALUE (GRAPH)



Natural Moisture Content and Atterberg Limits



Water Level Initial: ▽ Final: ▼

Water Observations: None Observed

Notes:

KRAZAN AND ASSOCIATES
11715 North Creek Parkway South
Suite C-106
Bothell, Washington 98011

LOG OF EXPLORATORY BORING B-4

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES
			Silty Sand with Gravel (SM) Loose to medium dense, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	4 6 7	13	
5			**Poorly Graded Sand with Silt (SP-SM)** Medium dense, fine to medium grained sand with silt, gray, moist. (Alluvium)	6 8 12	20	
10			End of Exploratory Boring			
15						
20						

N-VALUE (GRAPH): 10 20 30 40

Natural Moisture Content and Atterberg Limits: 0 20 40 60 80 100

Water Level Initial: ▽ Final: ▼

Water Observations: None Observed

Notes:

KRAZAN AND ASSOCIATES
11715 North Creek Parkway South
Suite C-106
Bothell, Washington 98011

LOG OF EXPLORATORY BORING B-5

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES
			Silty Sand with Gravel (SM) Loose to medium dense, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	4, 6, 6	12	
			Poorly Graded Sand with Silt (SP-SM) Medium dense, fine to medium grained sand with silt, gray, moist. (Alluvium)	5, 6, 10	16	
				5, 6, 9	15	
			End of Exploratory Boring			

N-VALUE (GRAPH): 10 20 30 40

Natural Moisture Content and Atterberg Limits: 0 20 40 60 80 100

Water Level Initial: Final:

Water Observations: None Observed

Notes:

KRAZAN AND ASSOCIATES
11715 North Creek Parkway South
Suite C-106
Bothell, Washington 98011

LOG OF EXPLORATORY TEST PIT TP-1

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
CONTRACTOR:
SAMPLE METHOD: Grab

DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
LOCATION: Port Orchard, WA

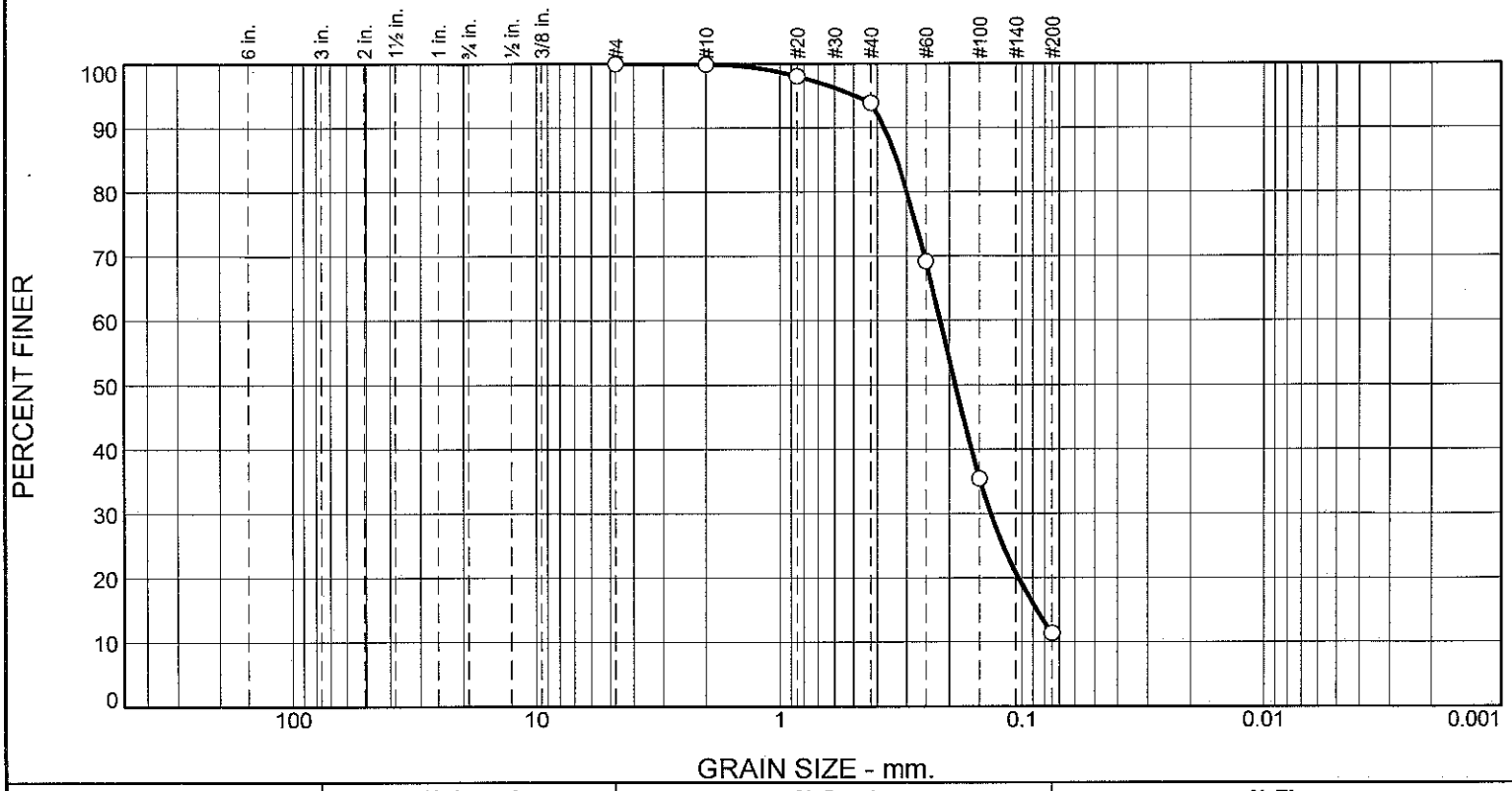
DEPTH (ft)	USC SYMBOL	WATER LEVEL	MATERIAL DESCRIPTION	SAMPLE No.	SAMPLE TYPE	Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 0 10 20 30 40 50 60 70 80 90)
			Silty Sand (SM) Loose, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)			
1						
2						
3						
			Poorly Graded Sand with Silt (SP-SM) Loose, fine to medium grained sand with silt, light brown to gray, moist. (Alluvium)	S-1	G	
4				S-2	G	
			End of Exploratory Test Pit			
5						
6						
7						
8						
9						
10						
11						

Water Level Initial: ▽ Final: ▼

Water Observations: None Encountered.

Notes:

Krazan & Assoc. Sieve Analysis



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	6.0	82.5	11.4	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	98.1		
#40	93.9		
#60	69.2		
#100	35.5		
#200	11.4		

* (no specification provided)

Material Description

Dark yellowish-brown poorly graded SAND with silt.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.3748 D_{85}= 0.3322 D_{60}= 0.2181
D_{50}= 0.1888 D_{30}= 0.1347 D_{15}= 0.0867
D_{10}= C_u= C_c=

Remarks

Sample ID: 38554-A.
TP-1 @ 3'

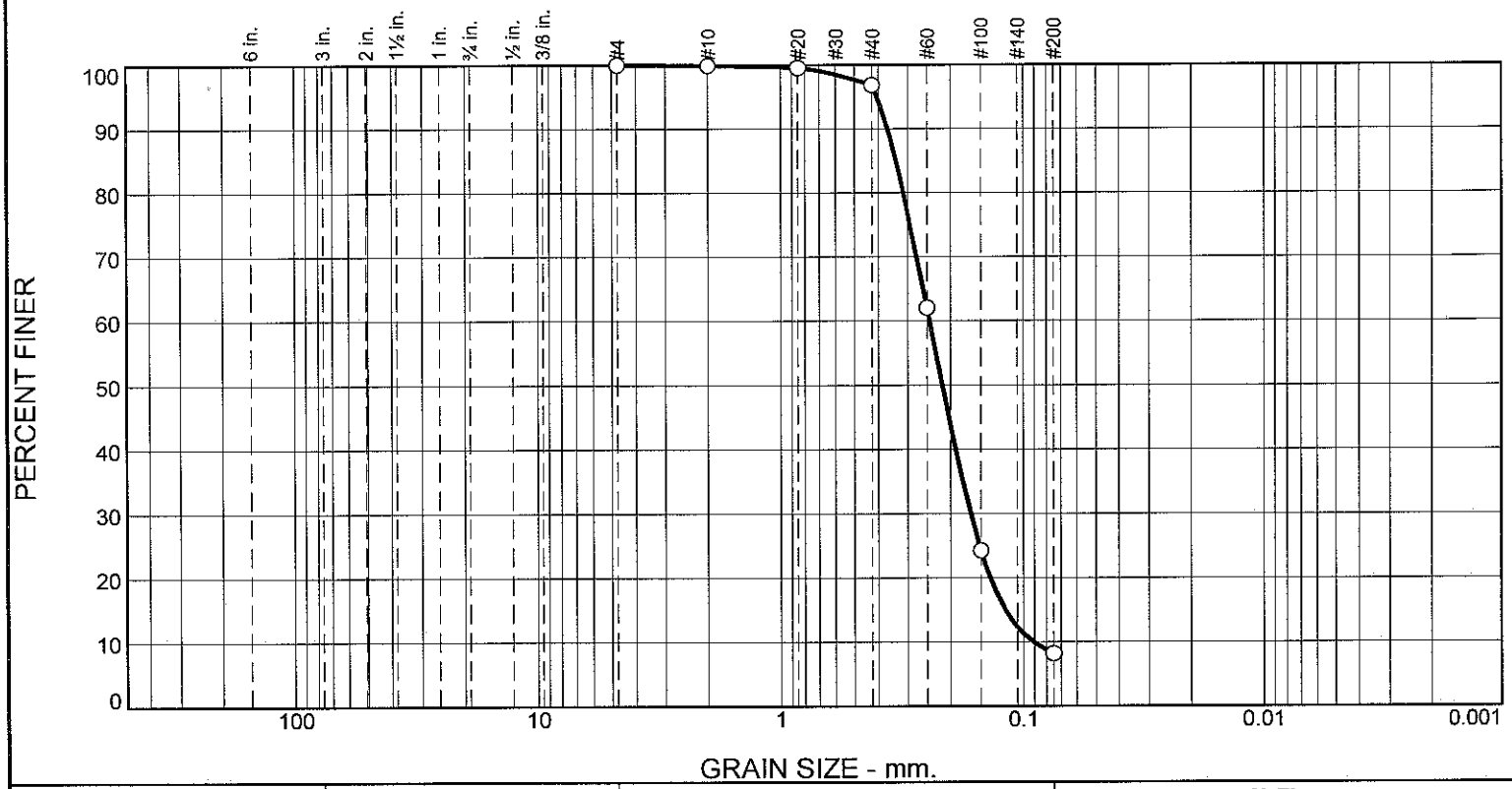
Date Received: 8/5/10 **Date Tested:** 8/6/10
Tested By: Chris McMillen
Checked By: Corbett Mercer
Title: Lab Manager

Location: Test Pit 1
Sample Number: 38554-A **Depth:** 3'
Date Sampled: 8/5/10

Krazan

Client: Kitsap County Facilities, Parks and Recreation
Project: South Kitsap Regional Parks Addition
Project No: 09210038

Krazan & Assoc. Sieve Analysis



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	3.0	88.7	8.2	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	99.6		
#40	96.9		
#60	62.0		
#100	24.3		
#200	8.2		

* (no specification provided)

Material Description

Light olive-brown poorly graded SAND with silt.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.3674 D_{85}= 0.3385 D_{60}= 0.2440
D_{50}= 0.2161 D_{30}= 0.1653 D_{15}= 0.1188
D_{10}= 0.0909 C_u= 2.68 C_c= 1.23

Remarks

Sample ID: 38554-B.
Tp-1 @ 4'

Date Received: 8/5/10 **Date Tested:** 8/6/10
Tested By: Chris McMillen
Checked By: Corbett Mercer
Title: Lab Manager

Location: Test Pit 1
Sample Number: 38554-B **Depth:** 4'
Date Sampled: 8/5/10

Krazan

Client: Kitsap County Facilities, Parks and Recreation
Project: South Kitsap Regional Parks Addition
Project No: 09210038

APPENDIX B

EARTHWORK SPECIFICATIONS

GENERAL

When the text of the report conflicts with the general specifications in this appendix, the recommendations in the report have precedence.

SCOPE OF WORK: These specifications and applicable plans pertain to and include all earthwork associated with the site rough grading, including but not limited to the furnishing of all labor, tools, and equipment necessary for site clearing and grubbing, stripping, preparation of foundation materials for receiving fill, excavation, processing, placement and compaction of fill and backfill materials to the lines and grades shown on the project grading plans, and disposal of excess materials.

PERFORMANCE: The Contractor shall be responsible for the satisfactory completion of all earthwork in accordance with the project plans and specifications. This work shall be inspected and tested by a representative of Krazan and Associates, Inc., hereinafter known as the Geotechnical Engineer and/or Testing Agency. Attainment of design grades when achieved shall be certified to by the project Civil Engineer. Both the Geotechnical Engineer and Civil Engineer are the Owner's representatives. If the contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, he shall make the necessary readjustments until all work is deemed satisfactory as determined by both the Geotechnical Engineer and Civil Engineer. No deviation from these specifications shall be made except upon written approval of the Geotechnical Engineer, Civil Engineer or project Architect.

No earthwork shall be performed without the physical presence or approval of the Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least 2 working days prior to the commencement of any aspect of the site earthwork.

The Contractor agrees that he shall assume sole and complete responsibility for job site conditions during the course of construction of this project, including safety of all persons and property; that this requirement shall apply continuously and not be limited to normal working hours; and that the Contractor shall defend, indemnify and hold the Owner and the Engineers harmless from any and all liability, real or alleged, in connection with the performance of work on this project, except for liability arising from the sole negligence of the Owner of the Engineers.

TECHNICAL REQUIREMENTS: All compacted materials shall be densified to a density not less than 95 percent of maximum dry density as determined by ASTM Test Method D1557 as specified in the technical portion of the Geotechnical Engineering Report. The results of these tests and compliance with these specifications shall be the basis upon which satisfactory completion of work will be judged by the Geotechnical Engineer.

SOIL AND FOUNDATION CONDITIONS: The Contractor is presumed to have visited the site and to have familiarized himself with existing site conditions and the contents of the data presented in the soil report.

The Contractor shall make his own interpretation of the data contained in said report, and the Contractor shall not be relieved of liability under the contractor for any loss sustained as a result of any variance between conditions indicated by or deduced from said report and the actual conditions encountered during the progress of the work.

DUST CONTROL: The work includes dust control as required for the alleviation or prevention of any dust nuisance on or about the site or the borrow area, or off-site if caused by the Contractor's operation either during the performance of the earthwork or resulting from the conditions in which the Contractor leaves the site. The Contractor shall assume all liability, including Court costs of codefendants, for all claims related to dust or windblown materials attributable to his work.

SITE PREPARATION

Site preparation shall consist of site clearing and grabbing and preparations of foundation materials for receiving fill.

CLEARING AND GRUBBING: The Contractor shall accept the site in this present condition and shall demolish and/or remove from the area of designated project, earthwork all structures, both surface and subsurface, trees, brush, roots, debris, organic matter, and all other matter determined by the Geotechnical Engineer to be deleterious. Such materials shall become the property of the Contractor and shall be removed from the site.

Tree root systems in proposed building areas should be removed to a minimum depth of 3 feet and to such an extent which would permit removal of all roots larger than 1 inch. Tree root removed in parking areas may be limited to the upper 1½ feet of the ground surface. Backfill or tree root excavation should not be permitted until all exposed surfaces have been inspected and the Geotechnical Engineer is present for the proper control of backfill placement and compaction. Burning in areas, which are to receive fill materials, shall not be permitted.

SUBGRADE PREPARATION: Surfaces to receive Structural fill shall be prepared as outlined above, excavated/scarified to a depth of 12 inches, moisture-conditioned as necessary, and compacted to 95 percent compaction.

Loose and/or areas of disturbed soils shall be moisture conditioned and compacted to 95 percent compaction. All ruts, hummocks, or other uneven surface features shall be removed by surface grading prior to placement of any fill material. All areas which are to receive fill materials, shall be approved by the Geotechnical Engineer prior to the placement of any of the fill material.

EXCAVATION: All excavation shall be accomplished to the tolerance normally defined by the Civil Engineer as shown on the project grading plans. All over excavation below the grades specified shall be backfilled at the Contractor's expense and shall be compacted in accordance with the applicable technical requirements.

FILL AND BACKFILL MATERIAL: No material shall be moved or compacted without the presence of the Geotechnical Engineer. Material from the required site excavation may be utilized for construction site fills provided prior approval is given by the Geotechnical Engineer. All materials utilized for constructing site fills shall be free from vegetable or other deleterious matter as determined by the Geotechnical Engineer.

PLACEMENT, SPREADING AND COMPACTION: The placement and spreading of approved fill materials and the processing and compaction of approved fill and native materials shall be the responsibility of the Contractor. However, compaction of fill materials by flooding, ponding, or jetting shall not be permitted unless specifically approved by local code, as well as the Geotechnical Engineer.

Both cut and fill shall be surface compacted to the satisfaction of the Geotechnical Engineer prior to final acceptance.

SEASONAL LIMITS: No fill material shall be placed, spread, or rolled while it is frozen or thawing or during unfavorable wet weather conditions. When the work is interrupted by heavy rains, fill operations shall not be resumed until the Geotechnical Engineer indicates that the moisture content and density of previously placed fill are as specified.

APPENDIX C

IMPERVIOUS PAVEMENT SPECIFICATIONS

1. DEFINITIONS – The term "pavement" shall include asphalt concrete surfacing, untreated aggregate base, and aggregate subbase. The term "subgrade" is that portion of the area on which surfacing, base, or subbase is to be placed.

2. SCOPE OF WORK – This portion of the work shall include all labor, materials, tools and equipment necessary for and reasonable incidental to the completion of the pavement shown on the plans and as herein specified, except work specifically notes as "Work Not Included."

3. PREPARATION OF THE SUBGRADE – The Contractor shall prepare the surface of the various subgrades receiving subsequent pavement courses to the lines, grades, and dimensions given on the plans. The upper 12 inches of the soil subgrade beneath the pavement section shall be compacted to a minimum compaction of 95% of maximum dry density as determined by test method ASTM D1557. The finished subgrades shall be tested and approved by the Geotechnical Engineer prior to the placement of additional pavement of additional pavement courses.

4. AGGREGATE BASE – The aggregate base shall be spread and compacted on the prepared subgrade in conformity with the lines, grades, and dimensions shown on the plans. The aggregate base should conform to WSDOT Standard Specification for Crushed Surfacing Base Course or Top Course (Item 9-03.9(3)). The base material shall be compacted to a minimum compaction of 95% as determined by ASTM D1557. Each layer of subbase shall be tested and approved by the Geotechnical Engineer prior to the placement of successive layers.

5. ASPHALTIC CONCRETE SURFACING – Asphaltic concrete surfacing shall consist of a mixture of mineral aggregate and paving grade asphalt, mixed at central mixing plant and spread and compacted on a prepared base in conformity with the lines, grades, and dimensions shown on the plans. The viscosity grade of the asphalt shall be AR-4000. The mineral aggregate shall be WSDOT Class B. The drying, proportioning, and mixing of the materials shall conform to WSDOT Specifications.

The prime coat, spreading and compacting equipment, and spreading and compacting the mixture shall conform to WSDOT Specifications, with the exception that no surface course shall be placed when the atmospheric temperature is below 50 degrees F. The surfacing shall be rolled with combination steel-wheel and pneumatic rollers, as described in WSDOT Specifications. The surface course shall be placed with an approved self-propelled mechanical spreading and finishing machine.

6. TACK COAT – The tack (mixing type asphaltic emulsion) shall conform to and be applied in accordance with the requirements of WSDOT Specifications.

TECHNICAL MEMORANDUM

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TO: Mr. Justin Goroch, P.E., BCRA

FROM: Brian A. Bennetts, P.E.

DATE: July 19, 2013

RE: **INFILTRATION RATE EVALUATION**
JACKSON LUND PARK
KITSAP COUNTY, WASHINGTON

BRIAN A. BENNETTS
STATE OF WASHINGTON
43153
REGISTERED
PROFESSIONAL ENGINEER
7/19/13

INTRODUCTION

This technical memorandum summarizes the results of the field exploration program and provides the recommended design infiltration rate for the proposed infiltration facility planned for the Jackson Lund Park located at the northwest corner of the intersection of Southeast (SE) Lund Avenue and Jackson Avenue SE in the Port Orchard area of Kitsap County, Washington. The infiltration facility will be constructed in an existing stormwater pond located on the west shoulder of Jackson Avenue SE just north of the park entrance. The project location is shown on the Vicinity Map (Figure 1). The Site and Exploration Plan (Figure 2) shows the project area and the approximate location of the explorations completed for this study.

SCOPE OF SERVICES

The purpose of our services was to excavate a series of test pits to characterize soil and groundwater conditions at the rain garden locations; determine the *in situ* infiltration rate of the near-surface soils by completing a modified Pilot Infiltration Test (PIT) and grain size testing; completing engineering analysis and recommendations; and preparing this technical memorandum. This technical memorandum includes:

- A site map showing the approximate location of the test pits advanced for this study.
- Descriptive summary logs of the soil and groundwater conditions observed at each of the exploration locations.
- Recommended infiltration rate of the near-surface based on the results of the modified PIT investigation and grain size testing in accordance with the 2010 Kitsap County *Stormwater Design Manual* (Kitsap County 2010).
- An assessment of the similarity of the soils encountered in a previous geotechnical investigation at Jackson Lund Park (Krazan & Associates 2010) and the conditions observed in the test pits advanced for this study.
- Recommendations for site preparation for sidewalks.

EXISTING CONDITIONS

This section provides a discussion of the general surface and subsurface conditions observed at the project site at the time of our investigations. Interpretations of the site conditions are based on our review of available information and the results of our subsurface explorations.

SURFACE CONDITIONS

At the time of our field explorations, Jackson Avenue SE and SE Lund Avenue consist of an asphalt-paved roadway with a single-travel lane in each direction. SE Lund Avenue also has a center turn lane. Gravel shoulders and ditches vegetated with grass are present along both sides of the roadway. The overall topography along the existing roadway is generally flat at approximately elevation 335 feet (ft). Vegetation along both sides of the roadways in the project area is a mixture of large evergreen and deciduous trees with undergrowth typical of western Washington. Land use in the project area is primarily residential along the east side of Jackson Avenue SE and the south side of SE Lund Avenue, with some small commercial buildings at the intersection of Jackson Avenue SE and SE Lund Avenue. Jackson Lund Park is located along the west side of Jackson Avenue SE and the north side of SE Lund Avenue.

GEOLOGIC SETTING

The geologic setting of the project area has been largely influenced by advancing and retreating glacial ice. During the Pleistocene Epoch (early Quaternary), 2 million to 10,000 years before the present (ybp), vast continental ice sheets advanced into the Puget Sound region. Evidence indicates that there were at least six advances of the continental ice into the region during the Pleistocene Epoch.

The latest glacial advance, referred to as the Vashon Stade of the Fraser Glaciation, occurred between about 22,000 and 13,000 ybp and had the greatest effect on the present-day landscape. As the continental glacier advanced into Puget Sound, the ice blocked the Strait of Juan de Fuca forming a large fresh water lake. The lake drained to the south, out through the Black Hills south of Olympia and to the Pacific Ocean through the ancestral Chehalis River. Fine-grained sediments (silt and clay) from the glacier and from rivers and streams flowing from the Cascade and Olympic mountains were deposited in the lake. As the glacier continued to advance, meltwater streams issuing from the glacier laid down extensive deposits of chiefly sand and gravel outwash (advance outwash), filling the lake and burying much of the preglacial topography. The glacier advanced over the lake and outwash deposits, scouring out some areas and depositing glacial till over the surface in other areas. The deposits were highly consolidated by the weight of the overlying ice, resulting in highly compact soils. As the glacier retreated (ablated), recessional deposits of sand and gravel outwash, along with ablation deposits of silt, sand and

gravel, were laid down in some areas. Normal erosional and depositional processes further modified the post-glacial landscape.

Geologic information for the project area was obtained from the *Geologic Map of Surficial Deposits in the Seattle 30' x 60' Quadrangle, Washington* (Logan et al. 1993) published by the U.S. Geological Survey. According to the above referenced geologic map, the near surface soil in the project area is mapped as consisting of advance outwash. Advance outwash typically consists of clean sand with increasing gravel content higher in the unit. Silt and fine-grained sand are common in portions of the unit. Sorting, cross, and horizontal stratification, and cut and fill structures are distinctive features of outwash. Advance outwash is typically dense to very dense in density and exhibits moderately high permeability and high shear strength.

The soil observed in the test pits is less dense and had more frequent layers of fine-grained soil than what is typically observed in advance outwash deposits. Therefore, it is our opinion that the soil observed in the test pits is more consistent with recessional outwash. Recessional outwash typically consists of stratified deposits of sand and gravel. Silt and fine-grained sand are common in portions of the unit, as are lacustrine deposits (deposits composed primarily of silt and/or clay). Recessional outwash deposits composed primarily of sand and gravel are typically medium dense to dense in density, exhibit moderate to high shear strength, and have moderately high permeability. Recessional lacustrine deposits are generally soft to stiff in consistency, exhibit low to moderate shear strength, and have a very low permeability.

FIELD EXPLORATION AND LABORATORY TESTING PROGRAM

Subsurface conditions within the limits of the project area were explored between March 30 and March 31, 2011. The exploration program consisted of advancing and sampling six exploratory test pits (TP-1 through TP-6) at the approximate locations illustrated on the Site and Exploration Plan (Figure 2). The test pits were excavated to depths ranging from about 10½ to 11½ ft below ground surface (BGS) using a rubber-tired backhoe. Kelly's Excavating of Pacific, Washington advanced the test pits under subcontract to Landau Associates. The test pits were located approximately in the field by hand taping from existing physical features referenced from a site plan provided by BCRA. The ground surface elevation at the exploratory test pit locations was not measured.

The test pits were coordinated and monitored by a geologist from our staff, who also obtained representative soil samples, maintained a detailed record of observed subsurface soil and groundwater conditions, and described the soil encountered by visual and textural examination. Each representative soil type observed was described using the soil classification system shown on Figure 3, in general accordance with ASTM International (ASTM) D2488, *Standard Recommended Practice for Description*

of Soils (Visual-Manual Procedure). Logs of the test pit explorations are presented on Figures 4 through 6. These logs represent our interpretation of subsurface conditions identified during the field exploration program. The stratigraphic contacts shown on the individual logs represent the approximate boundaries between soil types; actual transitions may be more gradual. Also, the soil and groundwater conditions depicted are only for the specific dates and locations reported and, therefore, are not necessarily representative of other locations and times.

Representative disturbed grab samples of the soil encountered in the test pit explorations were obtained at selected intervals. These samples were taken to our laboratory for further examination and testing. The laboratory testing program, which was performed in general accordance with the ASTM standard test procedures described below, included a visual inspection to confirm our field soil descriptions and the determination of the natural moisture content and grain size distribution on selected samples obtained from our test pits. The natural moisture contents of selected soil samples were determined in general accordance with ASTM D2216 test procedures. The results from the moisture determinations are indicated on the summary test pit logs, adjacent to the corresponding sample number. The grain size distribution of selected samples was determined in accordance with ASTM D 422. The results of the grain size analysis are shown on Figures 7 through 9.

SUBSURFACE SOIL CONDITIONS

Test pits TP-1 through TP-3 were advanced on the north shoulder of SE Lund Avenue. Loose/soft, recessional outwash was encountered throughout the entire depth explored, between 10½ and 11½ ft BGS, in each of the test pits advanced in this area. In test pit TP-1, recessional outwash consists of a sequence of silty sand (0 to 2 ft BGS); sand with silt (2 to 7½ ft BGS); and very silty sand (below 7½ ft BGS). Recessional outwash in test pit TP-2 consists of very sandy silt (0 to 5 ft BGS) and sand (below 5 ft BGS). Recessional outwash encountered in test pit TP-3 consists of sand with gravel to trace gravel.

Test pits TP-4 and TP-5 were advanced on the west shoulder of Jackson Avenue SE. Recessional outwash was encountered throughout the depths explored (about 10½ ft BGS) in each of these test pits. Recessional outwash consists of a sequence of loose, silty sand (0 to 7 ft BGS) and soft, very sandy silt (below 7 ft BGS) in test pit TP-4. Recessional outwash encountered in test pit TP-5 consists of loose sand with silt to trace silt. Test pit TP-6 was advanced within the footprint of an existing stormwater pond. Recessional outwash consisting of loose, sand with silt, was encountered throughout the depth explored, about 10½ ft BGS.

GROUNDWATER CONDITIONS

Groundwater was not encountered within the depths explored (10½ to 11½ ft BGS) in any of the test pits completed for this study at the time of exploration (March 30 and 31, 2011); however, the test pits were left open a very short period of time and very slow seepage may not have been evident prior to backfilling the test pits. It should be noted that the groundwater conditions reported on the summary logs are for the specific locations and dates indicated, and therefore may not necessarily be indicative of other locations and/or times. Furthermore, it is anticipated that groundwater conditions will vary depending on local subsurface conditions, the weather, and other factors.

INFILTRATION RATE EVALUATION

The design infiltration rate near the location of the infiltration feature was estimated by completing a PIT investigation. The PIT investigation was completed near the location of test pit TP-5, which was advanced approximately 400 ft south of the infiltration feature. Subsurface conditions in the test pits advanced near the infiltration feature (TP-5 and TP-6) are similar (loose, fine to medium sand with silt); so it is our opinion that the results of the PIT investigation near test pit TP-5 can likely be used to estimate the design infiltration rate of the infiltration facility.

A modified pilot infiltration test was completed at the location of test pit TP-5 on March 31, 2011. Infiltration testing was completed in general accordance with the procedure outlined in Appendix 7-B of the 2010 Kitsap County *Stormwater Design Manual*. Some modifications were made to the above-referenced procedure to account for the site conditions and the available water supply. The following summarizes the test procedure:

- The pit was excavated to the target depth, about 3 ft BGS, using a rubber-tired backhoe. The bottom of the test pit was approximately 3 ft wide and 8¼ ft long. The base of the pit measured approximately 24 square feet (ft^2).
- Loose soil was cleaned from the bottom of the pit and the dimensions of the pit were measured and recorded.
- A 6-inch diameter PVC pipe with a tee and 90 degree elbows at the base was placed in the pit to control water inflow to the pit excavation and to reduce bottom scour and excess suspension of sediment in the water pit. The PVC pipe extended from roughly the pit center at a 45 degree angle to the top of the pit.
- The pit was filled with water supplied from a nearby fire hydrant to a depth of about 2 ft above the pit bottom. An initial pit water level of 2 ft is lower than the 3 to 4 ft suggested by the 2010 Kitsap County *Stormwater Design Manual* (3 to 4 ft). The lower water level is appropriate for low-impact development features.
- The procedure outlined in the 2010 Kitsap County *Stormwater Design Manual* calls for regulating the flow such that a constant water level is maintained in the pit. An average inflow rate of 25 gallons per minute (gpm) was necessary to maintain the water level in the pit at 2 ft.

- The water level in the pit was monitored with a stadia gage rod (0.01 foot increments) installed on a 2 inch x 4 inch post securely anchored in the middle of the pit.
- After completion of the test, the water was shut off and the water in the pit was allowed to infiltrate. The water in the pit completely infiltrated in about 25 minutes.
- Upon completion of the test, the bottom of test pit TP-5 was excavated to a depth of about 11½ ft BGS to check for the presence of low permeable layers and to obtain a soil sample from the pit bottom.
- After completion of testing, the pit was backfilled with excavated soil.

Based on the procedure described in Appendix 7-B of the 2010 Kitsap County *Stormwater Design Manual*, the measured infiltration ($I_{measured}$) rate of the soil at the location of test pit TP-5 is approximately 100 inches per hour (25 gpm per 24 ft^2).

The measured infiltration rate should be factored as described by Equation 7-9 of the 2010 Kitsap County *Stormwater Design Manual*. For the parameter, $F_{testing}$, we recommend utilizing a value of 0.50. The soil observed in the test pits consists primarily of fine sand. An $F_{plugging}$ factor of 0.80 is appropriate for soil consisting of fine sand. The $F_{geometry}$ factor should be dependent on the width of the stormwater feature and the vertical distance between the base of the infiltration feature and the groundwater table or low permeability layer. The $F_{geometry}$ factor should be estimated using Equation 7-10 of the 2010 Kitsap County *Stormwater Design Manual*. For determining the $F_{geometry}$ factor, we recommend assuming that the groundwater table or low permeability layer is located 10½ ft BGS. The design infiltration rate estimated from Equation 7-10 of the 2010 Kitsap County *Stormwater Design Manual* should not exceed 10 inches per hour.

Even though the conditions in the vicinity of the infiltration facility appear to be relatively uniform and consist of fine sand with silt to trace silt, interbeds of silt or silty sand were observed in the other test pits advanced for this study. These soil types could be present underneath the infiltration feature and could significantly impact the performance of the infiltration facility. For this reason, we recommend that we be on site during construction to observe the subsurface soil conditions at the base of the pond. If low-permeability soil is encountered, it could be removed and replaced with import structural fill meeting the requirements for Gravel Backfill for Drains in Section 9-03.12(4) of the 2012 *Standard Specifications for Roadway, Bridge, and Municipal Construction* (2012 WSDOT *Standard Specifications*) by the Washington State Department of Transportation (WSDOT 2012). Alternatively, a lower infiltration rate could be utilized, necessitating a larger infiltration facility. We recommend that a contingency be included in the project budget to account for the potential need to overexcavate unsuitable soil.

COMPARISON TO ONSITE SOILS

Krazan & Associates completed a geotechnical evaluation for improvements to the South Kitsap County Regional Park in 2010 (Krazan & Associates 2010). Their geotechnical evaluation included the advancement of five soil borings and one test pit evenly spaced throughout the park. In their explorations, Krazan & Associates reportedly encountered silty sand with gravel, sand with silt to trace silt, and silt that is loose to medium dense/stiff in density/consistency. The conditions reported by Krazan & Associates appear to be generally consistent with the conditions observed in the test pits advanced for this study.

Krazan & Associates also estimated the infiltration rate of the near-surface soil in the northern portion of the park by correlation to textural classification. For stormwater infiltration facilities situated in sand with silt to trace silt, Krazan & Associates recommended assuming a long-term infiltration rate of 2 inches per hour, which is consistent with the infiltration rate of clean sand provided in this study. Krazan & Associates also completed a falling-head percolation test in the northern portion of the park. According to the test results reported by Krazan & Associates, a short-term infiltration rate of 15 inches per hour is appropriate. This is relatively consistent with the measured infiltration rate determined from our PIT investigation. In our opinion, the conditions observed in the test pits and PIT test are consistent with the conditions reportedly encountered by Krazan & Associates.

SIDEWALK PREPARATION

Earthwork for the proposed sidewalks is expected to consist of site preparation, subgrade preparation, and cuts and fills to achieve final site grades. Recommendations for earthwork are provided in the following section of this report.

WET WEATHER CONSTRUCTION CONSIDERATIONS

Site preparation activities, as well as other earthwork-related construction, will be influenced by weather conditions. The existing surficial soil (recessional outwash) consists of sand with silt to trace silt, silty to very silty sand, or very sandy silt. These soils have an appreciable amount of fine sand and silt and are anticipated to be moisture sensitive. Moisture-sensitive soil should be graded during extended periods of dry weather. Completing these activities during wet weather could lead to increased construction costs due to weather-related delays, repair of disturbed areas, and the increased use of “all-weather” import fill materials.

Because of its moisture sensitivity, the near-surface soil in either a compacted or uncompacted state can degrade quickly in the presence of water and construction traffic. Additional excavation to expose undisturbed soil and replacement with properly compacted structural fill will be required, if the

onsite soils are disturbed. For wet weather construction, the contractor may reduce the potential for disturbance of subgrades by the following:

- Protecting exposed subgrades from disturbance by construction activities by placing a gravel working mat.
- Using a trackhoe with a smooth-bladed bucket to limit disturbance of the subgrade during excavation.
- Suspending earthwork and other construction activities that may damage subgrades during periods of wet weather.
- Limiting and/or prohibiting construction traffic over unprotected soil.
- Providing designated haul roads for construction equipment.
- Sloping excavated surfaces to promote runoff.
- Sealing the exposed surface by rolling with a smooth drum compactor or rubber-tire roller at the end of each working day and removing wet surface soil prior to commencing filling each day.

SITE PREPARATION ACTIVITIES

Site preparation activities are expected to consist of clearing and grubbing of existing vegetation at the site. At the location of our test pits, the topsoil layer is very thin or non-existent. At other locations, the topsoil may be more substantial. Topsoil, and/or other organic-rich soil should be stripped to expose the underlying inorganic soil in the area that will receive improvements. The removal of the existing topsoil and/or other organic-rich material should extend laterally a minimum of 5 ft beyond areas to be developed. Material generated during stripping is not considered suitable for use as structural fill and should either be stockpiled for use as topsoil or mulch in landscape areas, or wasted at an approved location. All incidental excavations associated with clearing, grubbing, and stripping should be backfilled in accordance with the following recommendations contained in this technical memorandum.

SUBGRADE PREPARATION

We understand that minor cuts and fills will be required to establish the planned site grades for the sidewalks. Upon reaching the proposed final site grade but before placing any structural fill, the upper 12 inches of exposed subgrade should be scarified, moisture-conditioned, and compacted to at least 95 percent of the maximum dry density determined by the ASTM D1557 test procedure (modified Proctor). The prepared subgrade should be proof-rolled with a loaded dump truck, large self-propelled vibrating roller, or equivalent piece of equipment to check for the presence of soft and/or disturbed areas. Proof-rolling should be carefully observed by a qualified geotechnical or civil engineer familiar with site conditions. Soft and/or disturbed subgrades identified during the proof-roll should be repaired by either

moisture-conditioning and recompacting the soft and/or disturbed soil or by replacing the disturbed soil properly compacted structural fill.

STRUCTURAL FILL

Structural fill is defined as fill placed to support sidewalks or other improvements. The suitability of excavated or imported soil for use as structural fill will depend on the gradation and the moisture content of the soil when it is placed. As the amount of fines (material passing the U.S. No. 200 sieve) increases, the soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. Soil containing more than about 5 percent fines (by weight) cannot consistently be compacted to a dense, non-yielding condition when the water content is greater than about 2 to 3 percent above optimum moisture content. Optimum moisture content is the moisture content at which the greatest compacted dry density can be achieved.

As discussed earlier in this technical memorandum, much of the near-surface soil encountered across the site consists of sand with silt to trace silt, silty to very silty sand, or very sandy silt. These soil types have relatively high fines content and are highly sensitive to moisture. Based on the results of the laboratory testing, the sand with silt to trace silt (SP or SP-SM on summary test pit logs) is near to well-above the optimum moisture content for compaction, indicating that extensive moisture-conditioning (i.e., drying) will be needed to utilize the native soil for structural fill. Very sandy silt (ML on summary test pit logs) and silty to very silty sand (SM on summary test pits logs) are present in isolated locations across the site. These soil types are generally unsuitable for use as structural fill and should be wasted at an approved offsite location or used in landscaped areas. If native material is used as structural fill, the contractor should be prepared to segregate suitable from non-suitable structural fill material. Also, we recommend that full-time construction observation be provided by a qualified geotechnical engineer to check that the unsuitable soil is properly segregated from suitable fill material and that the structural fill is properly placed and compacted.

If the onsite soil cannot be properly prepared to achieve the required compaction, or if the amount of site soil is insufficient to establish site grades, import fill will be required. For warm, dry weather conditions (late June through early October) import fill should consist of Select Borrow meeting the requirements of Section 9-03.14(2) of the 2012 WSDOT *Standard Specifications*. If wet weather construction is anticipated, the amount of fines should not exceed 5 percent, based on the minus ¾-inch fraction.

BACKFILL AND COMPACTION REQUIREMENTS

Prior to placing structural fill, the exposed subgrade should be prepared as recommended in this technical memorandum. In improved areas, structural fill should be placed in relatively uniform horizontal lifts, not exceeding 10 inches thick, loose measure. Each lift should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D1557 test procedure. In unimproved areas, such as landscape areas, fill should be placed in relatively uniform horizontal lifts not exceeding 12 to 18 inches thick, loose measure, and compacted to at least 90 percent of the maximum dry density (ASTM D1557).

USE OF THIS TECHNICAL MEMORANDUM

This technical memorandum was prepared for the exclusive use of Kitsap County for specific application to the design of the stormwater facilities planned as part of the Jackson Lund Park project in Kitsap County, Washington. The use by others, or for purposes other than intended, is at the user's sole risk. The findings, recommendations, and opinions presented herein are based on conditions observed in the test pits completed for the project and the results of the PIT investigation. Within the limitations of scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this technical memorandum were prepared in accordance with generally accepted professional geotechnical engineering principles and practices in this area at the time this report was prepared. We make no other warranty, either express or implied.

Given the geologic setting, there may be some variation in subsurface soil and groundwater conditions at the site, and the nature and extent of the variations may not become evident until construction. Accordingly, a contingency for unanticipated conditions should be included in the construction budget and schedule.

We appreciate the opportunity to provide geotechnical services on this project and look forward to continued involvement on the project. If you have any questions or comments, or if we may be of further service, please call us at (253) 926-2493.

BAB/jrc

REFERENCES

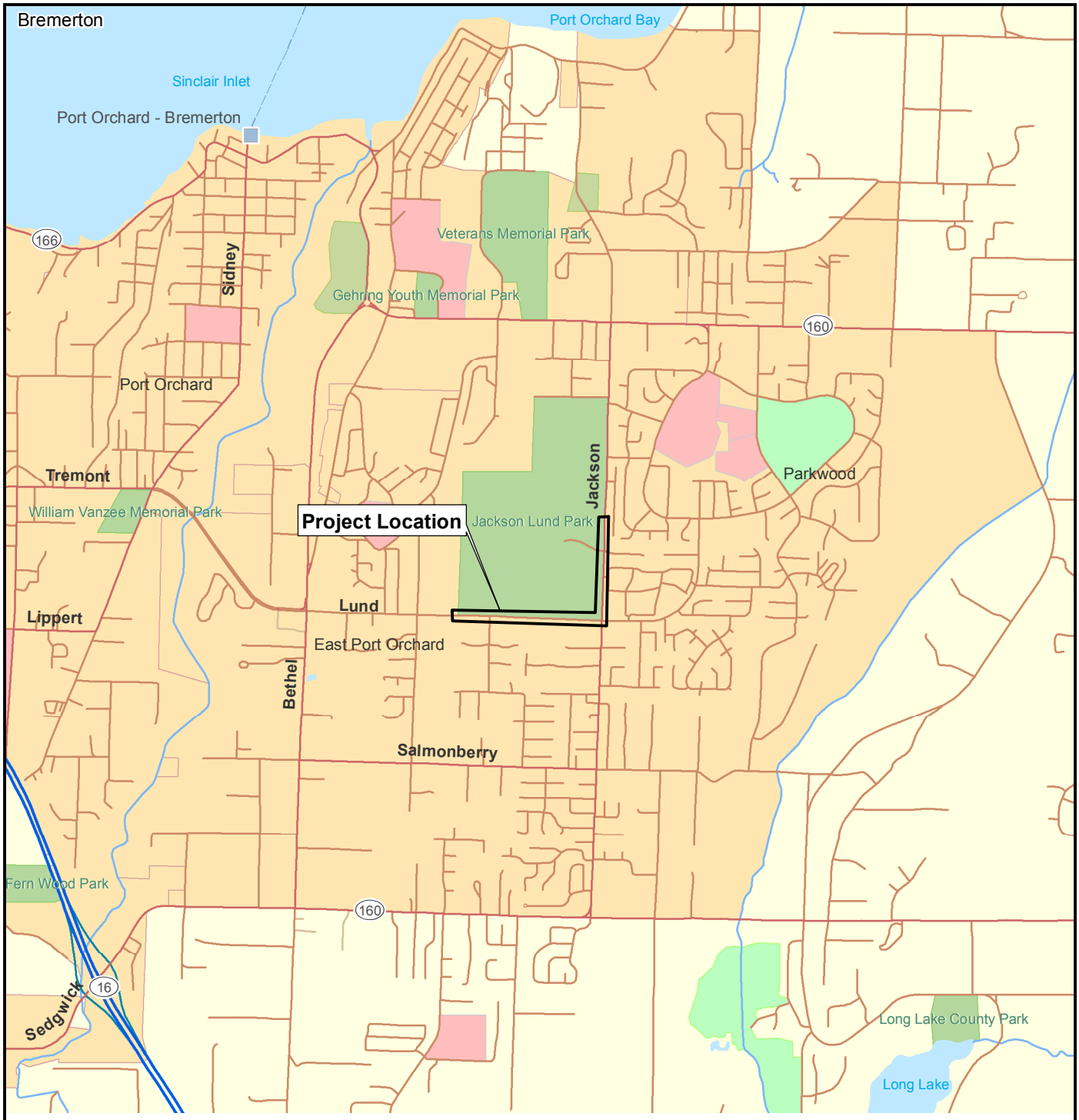
Kitsap County. 2010. *Stormwater Design Manual*. Kitsap County, Washington.

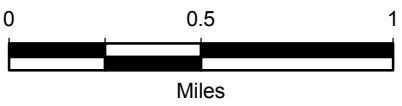
Krazan & Associates. 2010. *Geotechnical Engineering Evaluation, Proposed South Kitsap County Regional Park Improvements, NW Corner of Jackson Ave SE & SE Lund Avenue, Port Orchard, Washington.* Report prepared for Kitsap County Parks & Recreation. Report No. 092-10038. August 17.

Washington State Department of Transportation (WSDOT). 2012. *Standard Specifications for Road, Bridge, and Municipal Construction*. Washington State Department of Transportation.

Yount, J.C., Minard, J.P., and G.R. Dembroff. 1993. *Geologic Map of Surficial Deposits in the Seattle 30' x 60' Quadrangle, Washington*. Unites States Geological Survey. Open File Report 93-233.

Attachments: Figure 1: Vicinity Map
Figure 2: Site and Exploration Plan
Figure 3: Soil Classification System and Key
Figures 4 through 6: Log of Test Pits
Figures 7 through 9: Grain Size Distribution





Data Source: ESRI 2008

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Infiltration Rate Evaluation Jackson Lund Park Kitsap County, Washington	**Vicinity Map**	Figure 1

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 150 300
Scale in Feet

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Infiltration Rate Evaluation
Jackson Lund Park
Kitsap County, Washington

Site and Exploration Plan

Figure
2

Kitsap County | \\TACOMA3\Project\1269\0011\T\Figures\Figure 2.dwg (A) "Figure 2" 7/18/2013

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL[1]	TYPICAL DESCRIPTIONS [2][3]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30% - "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15% - "with gravel," "with sand," "with silt," etc.
	≤ 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.

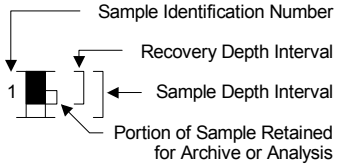
4. Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key

SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Single-Tube Core Barrel
f	Double-Tube Core Barrel
g	2.50-inch O.D., 2.00-inch I.D. WSDOT
h	3.00-inch O.D., 2.375-inch I.D. Mod. California
i	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Vibrocore (Rotosonic/Geoprobe)
5	Other - See text if applicable

SAMPLE NUMBER & INTERVAL



Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

Groundwater

▽ Approximate water level at time of drilling (ATD)

▼ Approximate water level at time other than ATD

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Infiltration Rate Evaluation
Jackson Lund Park
Kitsap County, Washington

Soil Classification System and Key

Figure 3

TP-1

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Measured Excavated By: Kelly's Excavating Logged By: KMH	
0					SM	Brownish-gray, silty, fine to coarse SAND (loose, moist to wet)	Groundwater not encountered.
2	S-1	d	W = 12			**(RECESSIONAL OUTWASH)**	
	S-2	d	W = 13 GS		SP-SM	Brown iron oxide mottled, fine SAND with silt (loose, moist to wet)	
4							
6							
8					SM	Brownish-gray, very silty, fine SAND (loose, moist to wet)	
	S-3	d	W = 15 GS				
10							
	S-4	d	W = 20			- grades with iron oxide mottling	
12							
14							

Test Pit Completed 03/30/11
Total Depth of Test Pit = 11.5 ft.

TP-2

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Measured Excavated By: Kelly's Excavating Logged By: KMH	
0					ML	Grayish-brown iron oxide mottled, very sandy SILT (soft, wet)	Groundwater not encountered.
2						**(RECESSIONAL OUTWASH)**	
4	S-1	d	W = 22 GS				
6	S-2	d	W = 6 GS		SP	Grayish-brown, fine to medium SAND (loose, damp to moist)	
8	S-3	d	W = 7				
10	S-4	d	W = 9				
12							
14							

Test Pit Completed 03/30/11
Total Depth of Test Pit = 10.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Infiltration Rate Evaluation
Jackson Lund Park
Kitsap County, Washington

Log of Test Pits

Figure 4

TP-3

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Measured Excavated By: Kelly's Excavating Logged By: KMH	
0					SP	Grayish-brown iron oxide mottled, fine to medium SAND (loose, moist) **(RECESSIONAL OUTWASH)**	Groundwater not encountered.
2							
4	S-1	d	W = 7 GS			- caving sidewalls	
6	S-2	d	W = 4 GS		SP	Grayish-brown, fine to medium SAND with gravel (loose, damp)	
8							
10	S-3	d	W = 4		SP	Dark brownish-gray, fine to medium SAND (loose, damp)	
12							
14							

Test Pit Completed 03/30/11
Total Depth of Test Pit = 10.5 ft.

TP-4

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Measured Excavated By: Kelly's Excavating Logged By: KMH	
0					SM	Brownish-gray iron oxide mottled, silty, fine SAND (loose, moist to wet) **(RECESSIONAL OUTWASH)**	Groundwater not encountered.
2							
4	S-1	d	W = 14 GS				
6							
8					ML	Gray, very sandy SILT (soft, wet)	
10	S-2	d	W = 21 GS				
12	S-3	d	W = 24				
14							

Test Pit Completed 03/30/11
Total Depth of Test Pit = 10.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1158003.01 7/17/13 Y:\1269\001\T\1269001.010.GPJ TEST PIT LOG

TP-5

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Measured Excavated By: Kelly's Excavating Logged By: KMH	
0					SP-SM	Brown iron oxide mottled, fine SAND with silt (loose, moist) **(RECESSIONAL OUTWASH)** - caving sidewalls - grades brownish-gray	Groundwater not encountered.
2							
4	S-1	d	GS				
6							
8					SP	Brownish-gray, fine SAND (loose, moist)	
10	S-2	d	GS				
12	S-3	d			SP	Brownish-gray, fine to medium SAND (loose, moist)	
14							

Test Pit Completed 03/31/11
Total Depth of Test Pit = 11.5 ft.

TP-6

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Measured Excavated By: Kelly's Excavating Logged By: KMH	
0					SP-SM	Grayish-brown, fine SAND with silt (loose, moist to wet) **(RECESSIONAL OUTWASH)**	Groundwater not encountered.
2							
4	S-1	d	W = 11 GS				
6							
8	S-2	d	W = 5 GS			- grades damp	
10	S-3	d	W = 3				
12							
14							

Test Pit Completed 03/30/11
Total Depth of Test Pit = 10.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1158003.01 7/17/13 Y:\1269\001\T\1269001.010.GPJ TEST PIT LOG

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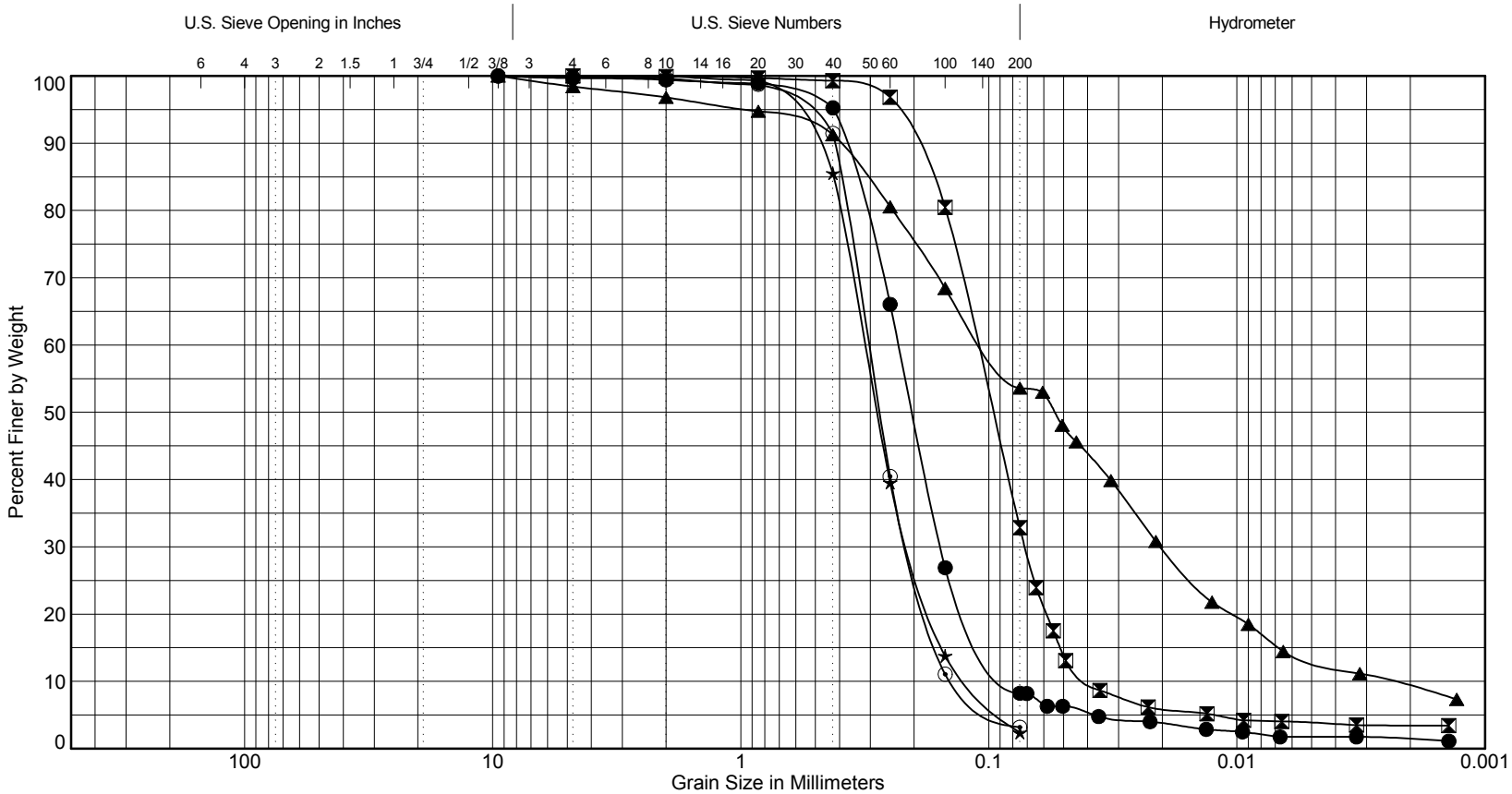
Infiltration Rate Evaluation
Jackson Lund Park
Kitsap County, Washington

Log of Test Pits

Figure 6



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	TP-1	S-2	3.0	13	Fine SAND with silt	SP-SM
⧗	TP-1	S-3	9.0	15	Very silty, fine SAND	SM
▲	TP-2	S-1	3.0	22	Very sandy SILT	ML
★	TP-2	S-2	5.5	6	Fine to medium SAND	SP
⊙	TP-3	S-1	3.0	7	Fine to medium SAND	SP

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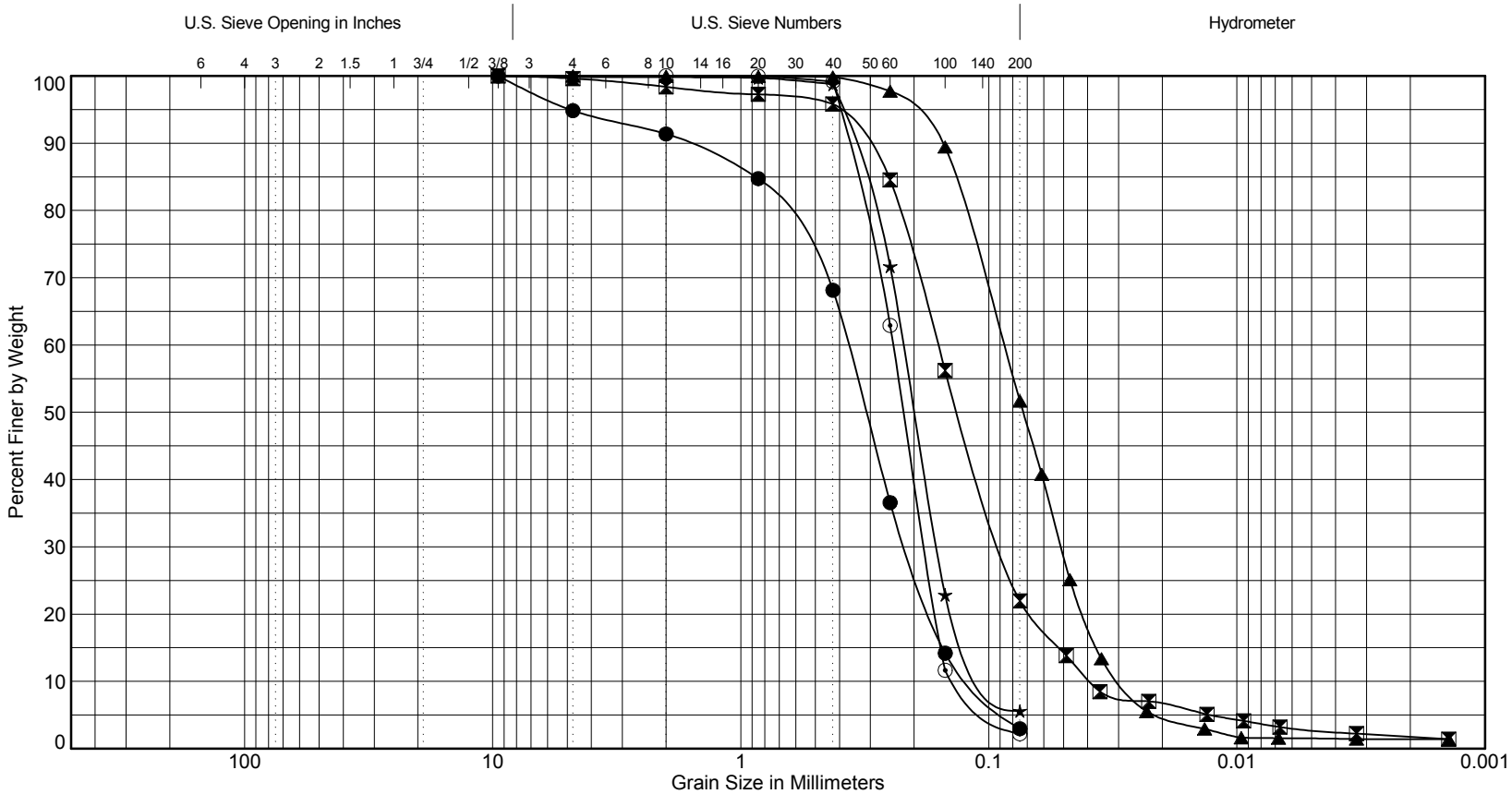
Infiltration Rate Evaluation
Jackson Lund Park
Kitsap County, Washington

Grain Size Distribution

Figure
7



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	TP-3	S-2	6.0	4	Fine to medium SAND with gravel	SP
⧗	TP-4	S-1	3.0	14	Silty, fine SAND	SM
▲	TP-4	S-2	8.5	21	Very sandy SILT	ML
★	TP-5	S-1	3.0		Fine SAND with silt	SP-SM
⊙	TP-5	S-2	8.5		Fine SAND	SP

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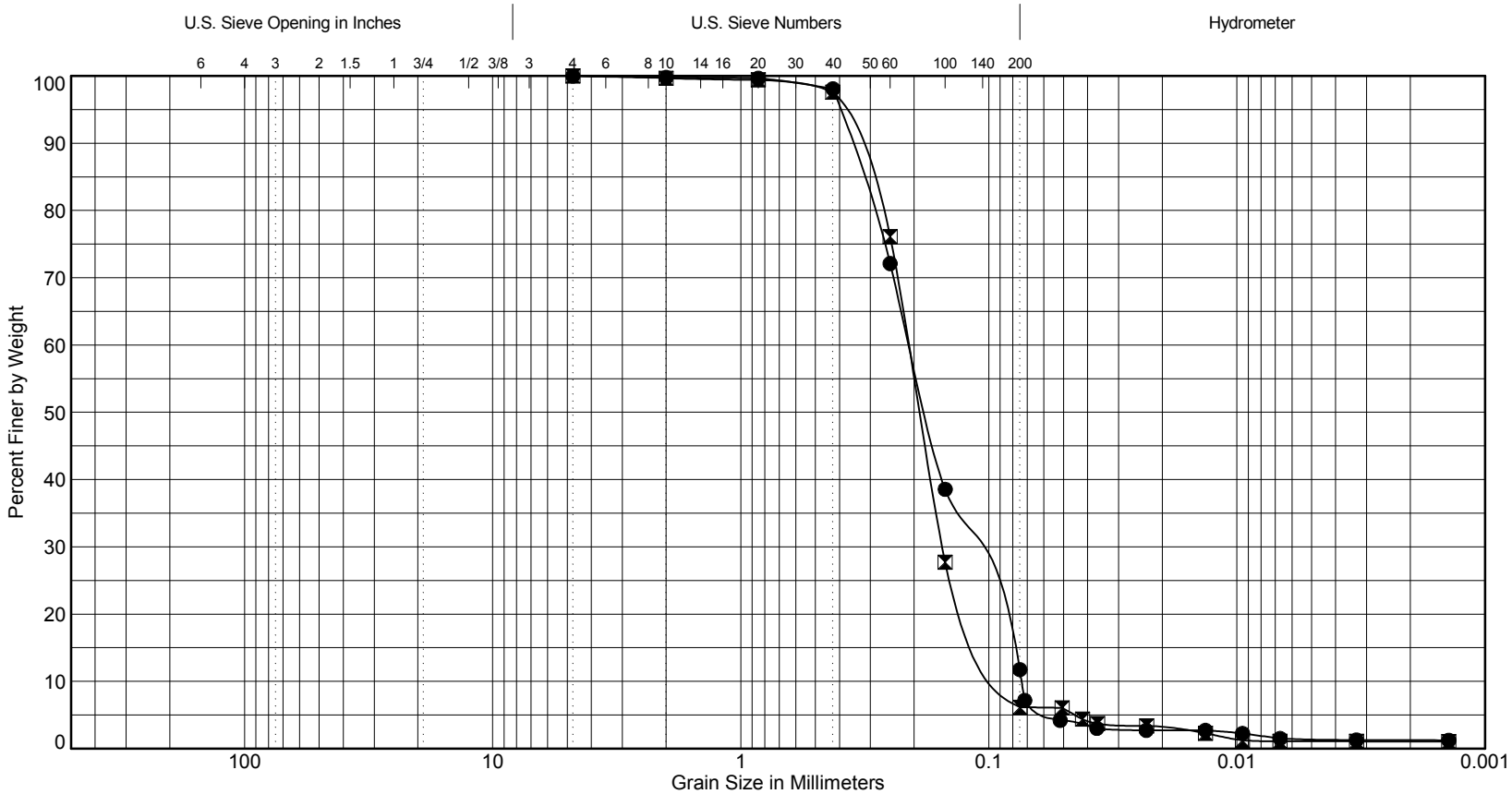
Infiltration Rate Evaluation
Jackson Lund Park
Kitsap County, Washington

Grain Size Distribution

Figure
8



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	TP-6	S-1	3.0	11	Fine SAND with silt	SP-SM
⧗	TP-6	S-2	8.5	5	Fine SAND with silt	SP-SM

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Infiltration Rate Evaluation
Jackson Lund Park
Kitsap County, Washington

Grain Size Distribution

Figure
9