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May 16, 1997

JN 97133

Harris Klein
5360 Lansdowne Lane
Mercer Island, Washington 98040

Subject: **Geotechnical Engineering Study**
Proposed Residence
74th Avenue Southeast at Southeast 38th Street
Mercer Island, Washington

Dear Mr. Klein:

We are pleased to present this geotechnical engineering report for the proposed residence to be constructed on 74th Avenue Southeast on Mercer Island, Washington. The scope of our work consisted of exploring site subsurface conditions, and then developing this report to provide recommendations for general earthwork and design criteria for foundations and retaining walls. This work was authorized by your acceptance of our proposal, P-4189, dated April 10, 1997.

The subsurface conditions of the proposed building site were explored with two test pits that encountered relatively loose silt to a depth of 10 to 11 feet below the ground surface. Below this depth the silt became medium-dense but fractured. We recommend building the house on drilled piers and designing the piers for the downslope side of the house to withstand lateral loads that could be imposed on the piers should there be slope movement or creep.

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

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

James R. Finley

James R. Finley, Jr., P.E.
Principal

JRF:mmm

GEOTECHNICAL ENGINEERING STUDY
Proposed Residence
74th Avenue Southeast at Southeast 38th Street
Mercer Island, Washington

This report presents the findings and recommendations of our geotechnical engineering study for the site of the proposed residence to be constructed at the northeastern corner of the intersection of 74th Avenue Southeast and Southeast 38th Street on Mercer Island. The Vicinity Map, Plate 1, illustrates the general location of the site.

We were provided with a topographic map and a plat map of the site. No house plans were available to us at the time this report was prepared. The house will be located in the northwestern corner of the site and will have a daylight basement.

SITE CONDITIONS

Surface

The site is rectangular, has a length of 110 feet in the east-west direction, and a width of 80 feet in the north-south direction. The lot is at the southwestern corner of a large, undeveloped greenbelt/park area, and is covered with relatively mature evergreen and deciduous trees. The site slopes downward to the southeast. Properties to the south and west are developed with single-family residences.

Subsurface

The subsurface conditions were explored by excavating two test pits at the approximate locations shown on the Site Exploration Plan, Plate 2. The field exploration program was based upon the proposed construction and required design criteria, the site topography and access, the subsurface conditions revealed during excavation, the scope of work outlined in our proposal, and the time and budget constraints.

The test pits were excavated on April 24, 1997 with a rubber-tired backhoe. A geotechnical engineer from our staff observed the excavation process, logged the test pits, and obtained representative samples of the soil encountered. "Grab" samples of selected subsurface soil were collected from the backhoe bucket. The Test Pit Logs are attached to this report as Plate 3.

The two test pits encountered similar soil conditions. They revealed 10 to 11 feet of relatively loose silt, which is a colluvial deposit (weathered soil derived from erosion). The loose silt was underlain by silt that was more dense but that was fractured and slickensided. This is evidence that a landslide occurred there. The test pits were terminated in this soil slide.

The final logs represent our interpretations of the field logs and laboratory tests. The stratification lines on the logs represent the approximate boundaries between soil types at the exploration locations. The actual transition between soil types may be gradual, and subsurface conditions can vary between exploration locations. The logs provide specific subsurface information only at the locations tested. The relative densities and moisture descriptions indicated on the test pit logs are interpretive descriptions based on the conditions observed during excavation. The compaction of backfill was not in the scope of our services. Loose soil will therefore be found in the area of the test pits. If this presents a problem, the backfill will need to be removed and replaced with structural fill during construction.

Groundwater

No groundwater seepage was observed in the test pit excavations. However, the test pits were left open for only a short time period. It should be noted that groundwater levels vary seasonally with rainfall and other factors. We anticipate that perched groundwater could be found in more permeable soil layers or fracture zones in the silt, especially if excavation occurs in wet weather.

CONCLUSIONS AND RECOMMENDATIONS

General

The silt extending to a depth of 10 feet is loose, and the soils throughout the test pits to the maximum explored depth have relatively low shear strength. Because of the slope conditions and the looseness of the soil, we recommend supporting the house on drilled piers. We anticipate that the piers can be installed by relatively simple, open hole methods. The piers for the downslope side of the house should be reinforced as a precaution against lateral earth movement or soil creep.

Silty soils are highly moisture-sensitive, so earthwork will be more difficult if the excavation occurs during wet weather. Since piers will have to be installed to support the house, it may be necessary to place quarry spalls in the excavation to support the drill equipment in wet weather.

The excess soil from the basement excavation should not be placed on the steeper portion of the site, and native vegetation should be left in place wherever possible. We also recommend that roof downspout drainage be dispersed throughout the site, not concentrated in one area.

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

Drilled Concrete Piers

Drilled, concrete-filled piers may be used to support the residence, if it is uneconomical to excavate to bearing soil. Based on our test pits, it appears that the piers can be constructed by open hole methods. These piers should be drilled with conventional auger drills, but the drilling contractor should have access to casing, in case sloughing occurs in the near-surface soil. Concrete should not be allowed to free-fall to the bottom of the hole; it should be either pumped or tremied into the hole. If water is in the hole at the time of pouring, the concrete should be tremied to the bottom of the hole.

A wide variety of depths and pier diameters are possible, but we recommend using a minimum pier diameter of 16 inches. For a minimum embedment of 10 feet into the moderately fractured silt and a pier diameter of 16 inches, we recommend assuming an allowable compressive capacity of 10 tons per pier. Center-to-center pier spacing should be no less than three times the pier diameter.

The lateral capacity of a pier is a function of both the soil that surrounds the pier and the composition of the pier itself. We recommend designing the piers for the exterior, downslope grade beam and decks to cantilever for the upper 15 feet, with an equivalent fluid pressure of 60 pounds per cubic foot (pcf) acting over two times the pier diameter within the cantilever portion. For the reinforcement design and the computation of allowable lateral pier loads, the soil adjacent to the drilled pier below the cantilever portion can be assumed to have a passive earth pressure equal to that pressure exerted by a fluid with a density of 250 pcf acting on two times the pier diameter. These piers should be embedded a minimum depth of 20 feet, except for the lower piers which will be designed for lateral soil loads. Those piers should be a minimum of 25 feet in length.

Seismic Considerations

The site is located within Seismic Zone 3, as illustrated on Figure No. 16-2 of the 1994 Uniform Building Code (UBC). In accordance with Table 16-J of the 1994 UBC, the site soil profile is best represented by Profile Type S2. The site soils are not subject to seismic liquefaction.

Slabs-on-Grade

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

All slabs-on-grade should be underlain by a capillary break or drainage layer consisting of a minimum 6-inch thickness of coarse, free-draining, structural fill with a gradation similar to that discussed later in **Permanent Foundation and Retaining Walls**. In areas where the passage of moisture through the slab is undesirable, a vapor barrier, such as a 6-mil plastic membrane, should be placed beneath the slab. Additionally, sand should be used in the fine-grading process to reduce damage to the vapor barrier, to provide uniform support under the slab, and to reduce shrinkage cracking by improving the concrete curing process.

Isolation joints should be provided where the slabs intersect columns and walls. Control and expansion joints should also be used to control cracking from expansion and contraction. Saw cuts or preformed strip joints used to control shrinkage cracking should extend through the upper one-fourth of the slab. The spacing of control or expansion joints depends on the slab shape and the amount of steel placed in it. Reducing the water-to-cement ratio of the concrete and curing the concrete, by preventing the evaporation of free water until cement hydration occurs, will also reduce shrinkage cracking.

Permanent Foundation and Retaining Walls

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

Parameter	Design Value
Active Earth Pressure*	45 pcf
Passive Earth Pressure	350 pcf
Coefficient of Friction	0.40
Soil Unit Weight	130 pcf

Where:

1. pcf is pounds per cubic foot.
2. Active and passive earth pressures are computed using the equivalent fluid densities.

* For a restrained wall that cannot deflect at least 0.002 times its height, a uniform lateral pressure equal to 10 psf times the height of the wall should be added to the above active equivalent fluid pressure.

The passive pressure given is appropriate for the depth of level, structural fill placed in front of a retaining or foundation wall only. We recommend a safety factor of at least 1.5 for overturning and sliding, when using the above values to design the walls.

The design values given above do not include the effects of any hydrostatic pressures behind the walls and assume that no surcharge slopes or loads, such as vehicles, will be placed behind the walls. If these conditions exist, those pressures should be added to the above lateral soil pressures. Also, if sloping backfill is desired behind the walls, we will need to be given the wall dimensions and the slope of the backfill in order to provide the appropriate design earth pressures.

Heavy construction equipment should not be operated behind retaining and foundation walls within a distance equal to the height of a wall, unless the walls are designed for the additional lateral pressures resulting from the equipment. The wall design criteria assume that the backfill will be well-compacted in lifts no thicker than 12 inches. The compaction of backfill near the walls should be accomplished with hand-operated equipment to prevent the walls from being overloaded by the higher soil forces that occur during compaction.

Retaining Wall Backfill

Backfill placed behind retaining or foundation walls should be coarse, free-draining, structural fill containing no organics. This backfill should contain no more than 5 percent silt or clay particles and have no gravel greater than 4 inches in diameter. The percentage of particles passing the No. 4 sieve should be between 25 and 70 percent. The on-site soils are not suitable for retaining wall backfill.

The purpose of these backfill requirements is to ensure that the design criteria for a retaining wall are not exceeded because of a build-up of hydrostatic pressure behind the wall. The top 12 to 18 inches of the backfill should consist of a compacted, relatively impermeable soil or topsoil, or the surface should be paved. The ground surface must also slope away from backfilled walls to reduce the potential for surface water to percolate into the backfill. The sub-section entitled **General Earthwork and Structural Fill** contains recommendations regarding the placement and compaction of structural fill behind retaining and foundation walls. The above recommendations are not intended to waterproof the below-grade walls. If some seepage through the walls or moist conditions are not acceptable, damp-proofing or waterproofing should be provided. This could include limiting cold-joints and wall penetrations, and possibly using bentonite panels or membranes on the outside of the walls. Applying a thin coat of asphalt emulsion is not considered waterproofing, but it will help to prevent moisture, generated from water vapor or capillary action, from seeping through the concrete.

Excavations and Slopes

Excavation slopes should not exceed the limits specified in local, state, and national government safety regulations. Temporary cuts to a depth of about 4 feet may be attempted vertically in unsaturated soil, if there are no indications of slope instability. Based upon Washington Administrative Code (WAC) 296, Part N, the soil type at the subject site would be classified as Type B. Therefore, temporary cut slopes greater than 4 feet in height cannot be excavated at an inclination steeper than 1:1 (Horizontal:Vertical), extending continuously between the top and the bottom of a cut.

The above-recommended temporary slope inclination is based on what has been successful at other sites with similar soil conditions. Temporary cuts are those that will remain unsupported for a relatively short duration to allow for the construction of foundations, retaining walls, or utilities. Temporary cut slopes should be protected with plastic sheeting during wet weather. The cut slopes should also be backfilled or retained as soon as possible to reduce the potential for instability. Please note that loose soil can cave suddenly and without warning. Utility contractors should be made especially aware of this potential danger.

All permanent cuts into native soil should be inclined no steeper than 2:1 (H:V). Fill slopes also should not be constructed with an inclination greater than 2:1 (H:V). Depending upon the requirements of the local sensitive areas ordinances, any completed slopes greater than 10 feet in height with inclinations of 40 percent or steeper may be classified as "steep slopes," which could affect future construction next to the slopes. To reduce the potential for shallow sloughing, fill must be compacted to the face of these slopes. This could be accomplished by overbuilding the compacted fill and then trimming it back to its final inclination. Water should not be allowed to flow uncontrolled over the top of any temporary or permanent slope. Also, all permanently exposed slopes should be seeded with an appropriate species of vegetation to reduce erosion and improve the stability of the surficial layer of soil.

Any disturbance to the existing slope outside of the building limits may reduce the stability of the slope. Damage to the existing vegetation and ground should be minimized, and any disturbed areas should be revegetated as soon as possible. Soil from the excavation should not be placed on the slope, and this may require the off-site disposal of any surplus soil.

Drainage Considerations

We recommend the use of footing drains at the base of footings, where (1) crawl spaces or basements will be below a structure, (2) a slab is below the outside grade, or (3) the outside grade does not slope downward from a building. Drains should also be placed at the base of all backfilled, earth-retaining walls. These drains should be surrounded by at least 6 inches of 1-inch-minus, washed rock and then wrapped in non-woven, geotextile filter fabric (Mirafi 140N, Supac 4NP, or similar material). At its highest point, a perforated pipe invert should be at least as low as the bottom of the footing, and it should be sloped for drainage. Drainage should also be provided inside the footprint of a structure, where (1) a crawl space will slope or be lower than the surrounding ground surface, (2) an excavation encounters significant seepage, or (3) an excavation for a building will be close to the expected high groundwater elevations. We can provide recommendations for interior drains, should they become necessary, during excavation and foundation construction.

All roof and surface water drains must be kept separate from the foundation drain system. A typical drain detail is attached to this report as Plate 4. For the best long-term performance, perforated PVC pipe is recommended for all subsurface drains.

The excavation and site should be graded so that surface water is directed off the site and away from the tops of slopes. Water should not be allowed to stand in any area where foundations, slabs, or pavements are to be constructed. Final site grading in areas adjacent to the residence should slope away at least 2 percent, except where the area is paved. Additionally, a drainage swale should be provided upslope of the house to intercept surface run-off and direct it into the storm drains. Water from roof, storm water, and foundation drains should not be discharged onto slopes; it should be tightlined to a suitable outfall located away from any slopes.

General Earthwork and Structural Fill

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

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

The allowable thickness of the fill lift will depend on the material type selected, the compaction equipment used, and the number of passes made to compact the lift. The loose lift thickness should not exceed 12 inches. We recommend testing the fill as it is placed. If the fill is not compacted to specifications, it can be recompacted before another lift is placed. This eliminates the need to remove the fill to achieve the required compaction. The following table presents recommended relative compactions for structural fill:

Location of Fill Placement	Minimum Relative Compaction
Beneath slabs, or walkways	95%
Behind retaining walls	90%
Beneath pavements	95% for upper 12 inches of subgrade, 90% below that level

Where:
Minimum Relative Compaction is the ratio, expressed in percentages, of the compacted dry density to the maximum dry density, as determined in accordance with ASTM Test Designation D 1557-78 (Modified Proctor).

Ideally, structural fill that will be placed in wet weather should consist of a coarse, granular soil with a silt or clay content of no more than 5 percent. The percentage of particles passing the No. 200 sieve should be measured from that portion of soil passing the three-quarter-inch sieve. The on-site soils are not suitable for structural fill.

LIMITATIONS

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

The recommendations presented in this report are directed toward the protection of only the proposed house from damage due to slope movement. Predicting the effects of development on the stability of slopes is an inexact and imperfect science that is currently based mostly on the past behavior of slopes with similar characteristics. Landslides and soil movement can occur on steep slopes before, during, or after the development of property. At additional cost, we can provide recommendations for reducing the risk of future movement on the steep slopes, which could involve regrading the slopes or installing subsurface drains or costly retaining structures. However, the owner must ultimately accept the possibility that some slope movement could occur, resulting in possible loss-of-ground or damage to the facilities around the proposed residence.

This report has been prepared for the exclusive use of Harris Klein, Larry Reymore, and their representatives for specific application to this project and site. Our recommendations and conclusions are based on observed site materials, and selective laboratory testing and engineering analyses. Our conclusions and recommendations are professional opinions derived in accordance with current standards of practice within the scope of our services and within budget and time constraints. No warranty is expressed or implied. The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. We recommend including this report, in its entirety, in the project contract documents so the contractor may be aware of our findings.

ADDITIONAL SERVICES

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

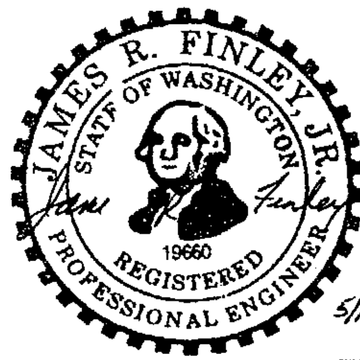
The following plates are attached to complete this report:

Plate 1	Vicinity Map
Plate 2	Site Exploration Plan
Plate 3	Test Pit Logs
Plate 4	Footing Drain Detail

We appreciate the opportunity to be of service on this project. If you have any questions, or if we may be of further service, please do not hesitate to contact us.

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

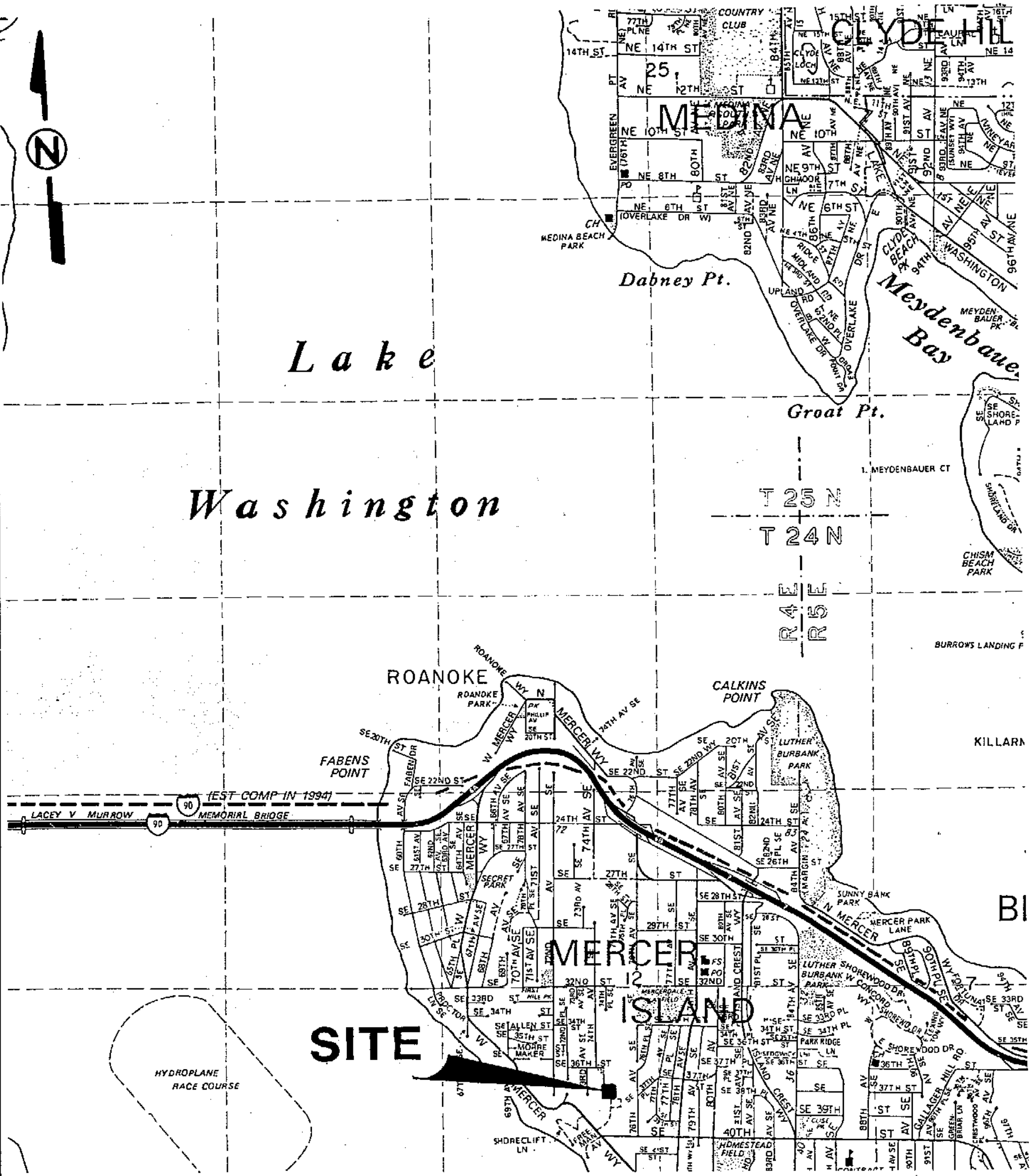


5/16/97

EXPIRES 8/17/97

James R. Finley, Jr., P.E.
Principal

JRF:mmm



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VICINITY MAP
74th AVENUE SE AT
SE 38th STREET
MERCER ISLAND, WA

Job No.:	Date:	Logged By:	Plate:
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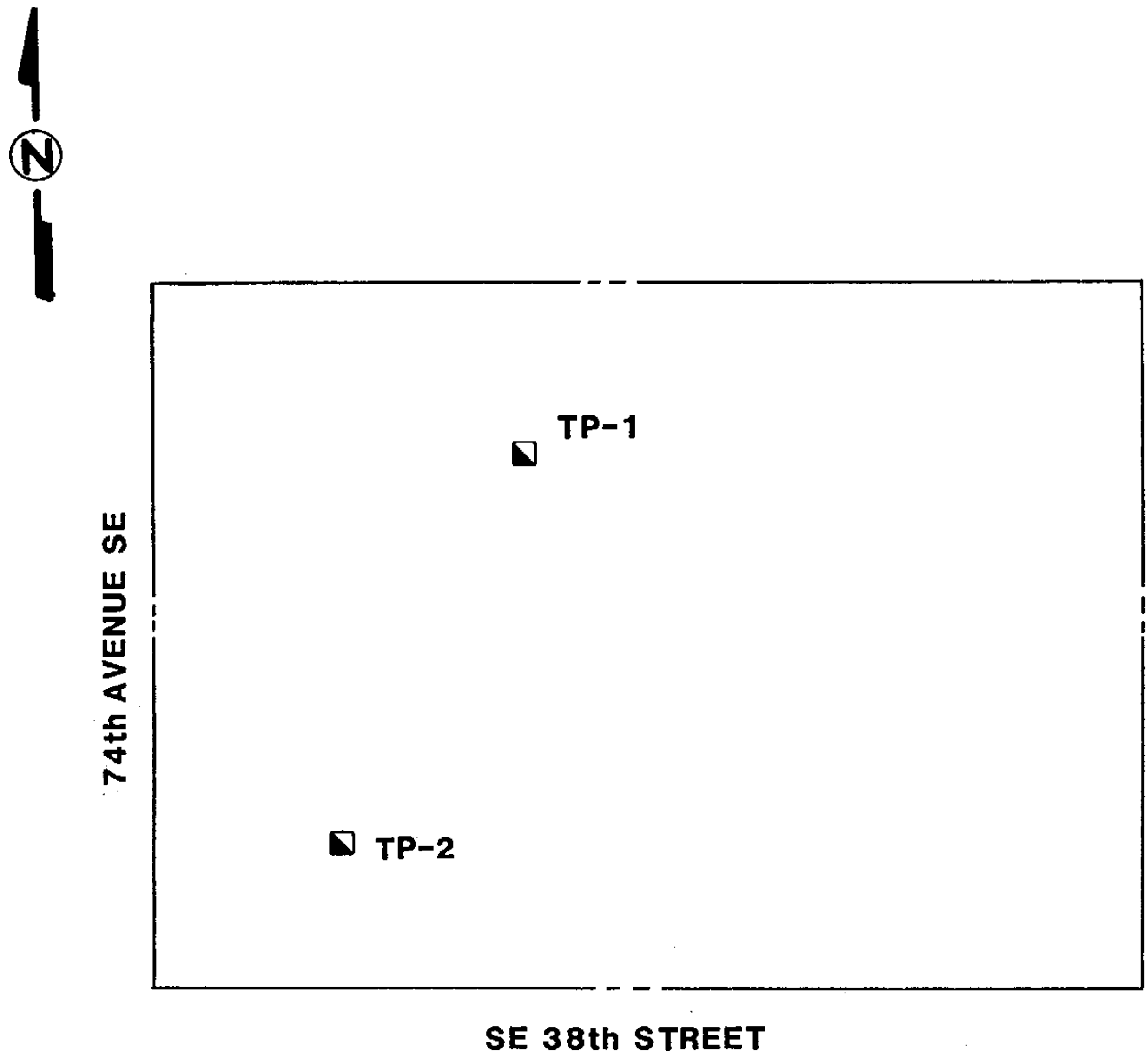

LEGEND:

APPROXIMATE TEST PIT LOCATIONS

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SITE EXPLORATION PLAN
74th AVENUE SE AT
SE 38th STREET
MERCER ISLAND, WA

Job No.:	Date:		Plate:
97133	MAY 1997		2

TEST PIT 1

Depth (ft.)	Moisture Content	USCS	Description (Elevation ~220')
0–11.5		ML	Reddish-brown, low plasticity SILT with fine SAND, moist, loose - becomes brownish-gray - becomes mixed with hard SILT pieces, occasional roots, loose to medium-dense
11.5–12		ML	Brownish-gray, SILT, very fractured, slickensided, loose- to medium-dense

Test pit terminated at 12 feet below grade on 4-24-97.
No groundwater seepage encountered during excavation.
No caving.

TEST PIT 2

Depth (ft.)	Moisture Content	USCS	Description (Elevation ~212')
0			Topsoil
0–10		ML	Reddish-brown, low plasticity SILT with fine-grained SAND and roots, very moist, loose - becomes brownish-gray, moist - becomes mixed with blocks of hard SILT - becomes medium-dense
10–10.5		ML	Brownish-gray, low plasticity SILT, fractured with slickensides, moist, medium-dense - becomes gray at 10.5 feet

Test pit terminated at 10.5 feet below grade on 4-24-97.
No groundwater seepage encountered during excavation.
No caving.

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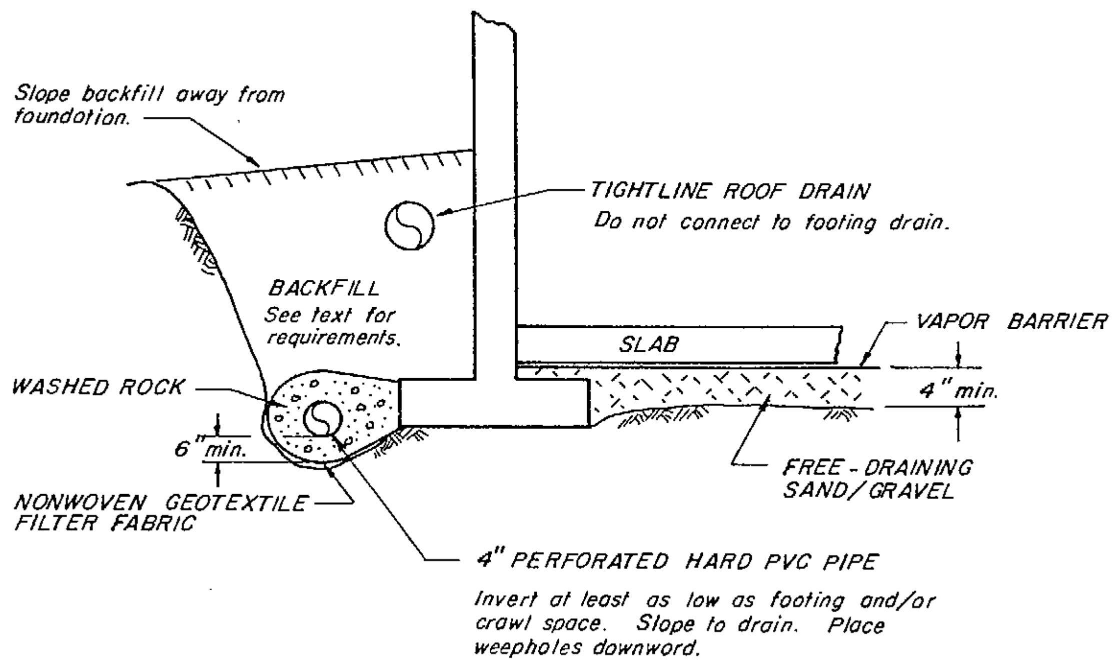
TEST PIT LOGS
74TH AVENUE SE AT
SE 38th STREET
MERCER ISLAND, WA

Job No:	Date:	Logged by:	Plate:
97133	MAY 1997	JHS	3



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FOOTING DRAIN DETAIL
74th AVENUE SE AT
SE 38th STREET
MERCER ISLAND, WA

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97133	MAY 1997	N.T.S.	4