GEOTECHNICAL ENGINEERING STUDY

PUGET WAY SW STREET IMPROVEMENT
W. MARGINAL WAY SW TO SW ALASKA STREET
SEATTLE, WASHINGTON

Job No. G-0290-1

Prepared for

Mr. Kurt Mayer
c/o Larson and Associates, Inc.
4401 South 66th Street
Tacoma, WA 98409

December 30, 1993

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GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists
& Environmental Scientists

December 30, 1993 G-0290-1

Mr. Kurt Mayer
c/o Larson Associates, Inc.
4401 South 66th Street
Tacoma, WA 98409

SUBJECT: Geotechnical Engineering Study
Puget Way SW Street Improvement
West Marginal Way SW to SW Alaska Street
Seattle, Washington

Dear Mr. Mayer:

We are pleased to summit this report titled "Geotechnical Engineering Study, Puget Way Improvement, West Marginal Way SW to SW Alaska Street, Seattle, Washington" This report presents our findings of the site conditions, the results of our engineering analyses, and our recommendations regarding slope stabilization measures and roadway reinforcement for the proposed improvement.

At the request of Mr. Richard Larson (16th Ave SW) we performed subsurface soil exploration along the 400 foot section of roadway south of SW Edmunds Street by drilling two test borings and excavating five backhoe test pits on November 22 and 24, 1993. The field investigation revealed that the proposed right-of-way was mostly covered with a 16 to 17 foot thick layer of soft to medium stiff white ash above the native soil consisting of clayey silt to silty clay.

Based on the results of our exploration and analysis, we are of the opinion that the street improvement project can be realigned as proposed. The cement ash in the subgrade from Station 0+00 to Station 4+00 (John Herbert Survey) was placed in an uncontrolled manner and should be stabilized to strengthen the subgrade and minimize potential settlement. Stabilization measures for the ash include over-excavated of soft areas and reinforcement with geotextiles.

The finished subgrade above the ash should have layer of geotextile and a minimum section of three feet of compacted pit run structural fill below the finished street elevation. We recommend that geogrids be used to reinforce the fills that will be placed on the steep slopes. The geogrid reinforced fills can be placed with a variety of geometries, including 1H:1V slopes and vertical

faces. This will require that the geogrids be wrapped around the face of the fill or that the geogrids be connected to concrete facing elements.

The street widening from West Marginal Way SW to SW Alaska Street will involve some cuts and fills. At the present time we anticipate cuts of 2H:1V (Horizontal:Vertical) be made. These cuts may need with retaining walls to achieve the desired grades. Steeper cuts may be considered based on further analysis. Areas of fills may require the use of geogrid reinforcement if the geometry of the terrain does not allow 2H:1V sloped fills. The details of our recommendations on the design criteria are discussed in the text of the attached report.

We appreciate the opportunity to have been of service to you on this project. Should you have any questions regarding this report or need additional consultation, please feel free to call us.

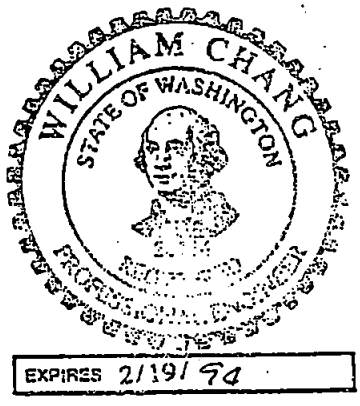
Sincerely,
GEO GROUP NORTHWEST, INC.

D. Huang

Dalong (Daniel) Huang, P.E.
Geotechnical Engineer

William Chang

William Chang, P.E.
Principal



GEOTECHNICAL ENGINEERING STUDY
PUGET WAY STREET IMPROVEMENT
WEST MARGINAL WAY TO SW ALASKA STREET
SEATTLE, WASHINGTON
Job No. G-0290-1

1. INTRODUCTION

1.1 Project Description

The Puget Way street improvement project site extends from West Marginal Way SW to SW Alaska Street. The realignment of the roadway takes place along a 400 foot long section south of SW Edmunds Street in Seattle, Washington. The general location of the site is shown on Plate 1 - Vicinity Map. The existing road is 15 to 20 feet wide and paved with asphalt. The location of the realignment is shown on Plate 2 - Site and Exploration Plan. The proposed street realignment as shown in Plate 2 includes about 400 feet of roadway to be shifted to the west.

1.2 Scope of Study

This study is performed under a contract with Mr. Kurt Mayer in care of Larson & Associates, Inc. of Tacoma. Geo Group Northwest, Inc. prepared a proposal for this study on September 23, 1993, which was accepted by Mr. Kurt Mayer on September 27, 1993. In accordance with the proposal, the study area included the 400 foot long road realignment section:

- Subsurface exploration and conditions including soils and groundwater;
- Site geologic conditions;
- Slope stability analysis and stabilization measures;
- Subgrade study and improvement;
- Pavement design recommendations;
- Site preparation and construction requirements.

Further discussion with Mr. James Schweichart of Larson and Associates and Mr Daniel Balmelli of Barghausen Consulting Engineers, Inc. on December 21, 1993 have expanded the study area to

the widening of the street from West Marginal Way SW to SW Alaska Street, a total distance of approximately 2000 linear feet. At the present time no additional soils exploration have been conducted in the expanded study area.

2. SITE CONDITIONS

2.1 Surface Conditions

The site topography was surveyed by John Herbert, L.S. in March 1991 for Mr. Jack McFarland as shown on Plate 2. The proposed roadway realignment is marked by stations from Station 0+00 at the north edge of SW Edmunds Street to Station 4+00 (John Herbert Survey) near the south end of the improvement (which corresponds to Station 6+70 to Station 10+78 of the Larson Associates Survey). The following surface conditions were observed:

The ground surface between the existing roadway and the proposed roadway is a slope grading down to the south with the steepest gradient of 70 percent at just south of SW Edmunds Street. The ground surface along the west edge of the new roadway is a slope facing a ravine to the southwest. The slope has an average gradient about 50 to 65 percent over a vertical distance of 30 to 50 feet. A gully on the slope between Station 0+50 to Station 1+00 was created by erosion due to the surface runoff water from Puget Way SW and SW Edmunds Street. The ground at the subject site has an elevation of 120 feet near Station 0+00 and an elevation of 40 feet at the slope toe near Station 4+00.

The area between the old and new roadways and the area along the new roadway are covered with grasses, blackberry vines, and small trees. Most of the southwest-facing slope was covered with blackberry wines and small and medium trees.

Street water from SW Edmunds Street and Puget Way drains in the ditches along Puget Way down to the hill. Street water from Puget Way SW drains through the gully on the slope to the

ravine.

The street widening from Station 0+00 to Station 20+00 (Larson Associates Survey) includes the realignment section from Station 6+70 to Station 10+78 (Stations 0+00 to 4+00 of the John Herbert survey) and the proposed cuts on the uphill side from approximately station 0+00 to Station 6+00.

2.2 Subsurface Conditions

We explored the subsurface soil conditions along the 400 foot street realignment with two borings and five test pits at the locations shown on Plate 2. The borings were drilled to 34.5 feet by Environmental Drilling, Inc. of Snohomish County on November 26, 1993, using a truck-mounted, 8" hollow stem, continuous flight, auger under the direction of a field representative from Geo Group Northwest, Inc. Standard Penetration Tests were conducted using a 140-lb hammer and a 2" outside diameter split spoon sampler in accordance with the ASTM test method D-1586. Continuous Standard Penetration Tests and soil sampling were conducted during drilling. The backhoe test pits were conducted in addition to the borings to explore the breadth and depth of the filled cement ash at the site.

All soil samples were visually classified on site in accordance with the Unified Soil Classification System, as illustrated on Plate A6. The soil samples were placed in sealed plastic bags and returned to our laboratory for further examination and testing. Soil natural moisture contents were determined on all samples returned to our laboratory. The results of our field and laboratory tests are recorded in the logs shown on Plates A1 to A5.

Dames & Moore performed a subsurface investigation for the same improvement project in September 1992. The locations of their borings are also shown on Plate 2. and the boring logs are attached to this report on Plates A7 to A13.

The site was covered with a layer of uncontrolled fill consisting of light gray to white cement ash overlain the native soils. The light gray cement ash was soft near the ground surface and becomes medium stiff to stiff with increasing depth. The ash had a dry unit weight about 45 pcf and moisture content from 55% near the surface to over 100% on top of the native soil at the time of the exploration. Its PH value was tested with PH Test Paper when some deionized water was added into the mass. The PH was measured about 13 indicating that the ash is very alkaline. The native soils consisted of weathered medium stiff to stiff silty clay/clayey silt in the top several feet and unweathered stiff to very stiff silty clay/clayey silt.

The soil profile along the roadway centerline is illustrated on Plate 3. Two cross sections of the slopes at Stations 1+50 and 2+90, at the locations shown on Plate 2, are plotted on Plates 4 and 5. The cement ash under the roadway is estimated to be 22 feet deep at Station 1+50 and 17 feet deep at Station 2+90. The thickness decreases to a couple of feet at Station 4+00.

According to the Preliminary Geologic Map of Seattle and Vicinity, Washington by H. H. Waldron, B. A. Liesch, D. R. Mullineaux, and D. R. Crandell, published by the U.S. Geological Survey in 1962, the soil covering the site is mapped as Q_c, Older Clay, which consists of compact silt and clay.

2.3 Groundwater

Standing groundwater was not encountered in the test borings and test pits during our site exploration. However, some perched water was encountered in Boring 1 in the cement ash just on top of the native soil.

3. ANALYSES AND RECOMMENDATIONS

3.1 General

Based on our observations on the site conditions and the above information, we have the opinion that the proposed street relocation is feasible as planned. However, the roadway subgrade should be improved by over-excavating soft spots at the surface of the cement ash and replacing it with well graded granular soils or other approved structural fills over a layer of geotextile. Geogrids should be used to reinforce the soils in the steep slope west of the roadway. Underground utilities should not be placed on the west side of the new roadway centerline, if possible.

3.2 Subgrade of the Roadway

The planned roadway alignment and finished grade are shown on Plates 2 and 3. This design generally requires cutting the existing ground east of the centerline and constructing a filled slope west of the centerline. The excavation is expected to be up to 9 feet between Stations 0+00 to 2+00. The thickness and amount of the required fill on the west side of the centerline depends on the slope gradient to be constructed. It is expected to be about 15 feet between Stations 0+75 and 1+50 if a 1H:2V (Horizontal:Vertical) slope is constructed. The amount of fill required is significantly decreased if a 1H:1V slope is constructed.

In preparing roadway subgrade, any soil containing grasses, vegetation roots, and construction debris should be removed. The cement ash in the subgrade of the proposed roadway is soft in some areas near the ground surface. Its consistency varies significantly due to the uncontrolled manner in which the ash was dumped in placed. We recommend that a minimum 2 feet of over-excavation be conducted in the cement ash and the excavated areas be checked for soft spots by the means of proof rolling. Proof rolling is conducted by driving a fully loaded 20-ton dump truck on the subgrade while an experienced geotechnical engineer looks for the soil reaction

under truck tires. If loose/soft spots are revealed in the subgrade, the areas should be compacted and/or excavated and filled with compacted structural fills specified at the end of this section.

We recommend that a layer of geotextile, such as, Mirafi 600X or equal, be placed on the above prepared subgrade before placing subbase materials. The subbase should consist of well graded granular materials.

Structural fill should consist of clean soils with particles no large than four inches and should be free of organic and other deleterious substances. The structural fill should be placed with a moisture content near its optimum moisture content and compacted to 95 percent of maximum dry density based on ASTM D1557-78 (Modified Proctor Method). The on-site cement ash is not suitable for structural fill. To facilitate the compaction during the construction, we recommend free-draining granular soil containing not more than 5 percent finer than the No. 200 sieve based on the fraction of the material passing No. 4 sieve.

3.3 Slope Stabilization Measures

In preparing the subgrade of the roadway between Stations 0+00 and 2+00, the filled slope west of the centerline may be constructed in two ways: (1) a 2.5H:1V slope of import structural fill with surface erosion protection; or (2) a 1H:1V slope of structural fill with geogrid reinforcement and erosion protection. Before import fill is placed, vegetation and organic should be removed from the existing slope. Benches with a minimum width of 5 feet should be cut on the slope to create horizontal bearing foundations for the fills, which will increase the stability of the constructed slope.

If the slope is constructed with a gradient of 2H:1V, no geogrid reinforcement is required. However, the fill should be placed in 12 inches lift and compacted to 95 percent of maximum dry density as discussed above. The constructed slope should be hydroseeded for vegetation immediately after the construction.

If the slope is constructed with a gradient of 1H:1V, the slope should be reinforced with geogrid materials. In the design of the reinforcement, the traffic loads can be counted for as equivalent 250 psf uniform surcharge. The minimum width of the reinforcement should be the same as the slope height. A typical cross section of the reinforcement is shown in Plate 5. We recommend that two layers of Miragrid 5T be placed at 4 feet vertical spacing from depth 0 to 8 feet; three layers of Miragrid 7T at a vertical spacing of 4 feet from depth 8 to 18 feet; and Miragrid 10T at vertical spacing of 3 feet below depth 18 feet. The soils between the geogrid layers should also be compacted to 95 percent of dry maximum density as specified above. At the present time we are evaluating the relative merits of the Miragrid product versus the Tensar product from the point of view of resistance to deterioration in an alkaline environment.

The placement of the geogrid should be with the strong direction (long direction) of the geogrid oriented toward the face of the slope, and wrapped around the face to minimize erosion. following the placement of the geogrid, the slope should be vegetated with native blackberries or ivy vines for erosion protection.

The slope between Stations 2+00 and 3+50 (J.H. Survey) has an average gradient of 1H:1H. The soils in the top several feet near the slope edge are soft/loose cement ash. The soils in the areas should be compacted and pass the proof-rolling test. The soils in the existing slope should also be compacted with a hoe-pack to increase the stability. Erosion control measures should be implemented on the slope.

3.4 Slope Stability Before and After Construction

Slope stability analyses were performed on two typical cross sections of the slope, Section AA' at Station 1+00 and Section BB' at Station 2+90, as marked on Plate 2. A computer program, XSTABL, was used in the slope stability analyses. XSTABL was a user-friendly version of STABL that was originally developed at the University of Purdue for the Indiana Department of Transportation. The computer program computes the Factor of Safety (F. S.) of a slope against soil movement under various groundwater and earthquake conditions.

The two sections with soil profiles are shown on Plate 4. The soil and groundwater data shown in the two sections were obtained from the field exploration and the geologic interpretation at the site. A set of strength parameters, cohesion c and internal friction ϕ, as shown in the following table, were selected slightly on the conservative side based on the laboratory and field testing data and our experience.

TABLE-1, Soil Strength Parameters

Layer	Soil	Unit Weight (psf)		Cohesion	Friction
Units	USCS and Descriptions	Moist	Saturated	c (psf)	ϕ (degree)
1	ML, Fill, cement ash	85	90	300	12
2	CL/ML, Qc, weathered clay	122	127	1000	5
3	CL/ML, Qc, unweathered clay	125	130	5000	10

The above soil parameters were used to compute the F. S. of the slope at the current condition. The cross section at Station 1+50 was used in the analyses due to the fact that this section has steepest slope and deepest cement ash. Three feet of perched groundwater on the native soil layer was simulated in the analysis. The results indicated that the slope has a Factor of Safety of 1.58, as shown in the computer graphics on Plate 5. It is our opinion that the slopes at the site are stable at the time of this study. It should be noted, however, that the actual F. S. varies with changing soil and groundwater conditions.

We also conducted the slope stability analyses on the constructed slope of 1H:1V with geogrid reinforcement as shown on Plate 6. Global stability of the slope was considered in the analyses shown on Plate 6 and the internal stability should be studied in the reinforcement design. For the section at Station 1+50, the F. S. of the global stability was 1.43. The stability is slightly decreased by constructing the 1H:1V slope due to higher unit weight of the construction fill.

3.5 Site Grading And Drainage Control

The surface water runoff from SW Edmunds Street and Puget Way SW should be controlled and not to directly discharge to the slope west of the roadway. We understand that a storm drain system may be used enough to drain storm water from the Puget Way SW to the bottom of the ravine or to the city storm sewer system.

A silt fence should be established along the west side of the proposed slope toe to prevent soil erosion into the creek during construction. In case of rain, unprotected slopes or cuts should be covered with plastic sheets and storm water should be diverted from the construction areas. Vegetation should be hydroseeded immediately after the construction.

3.6 Construction Procedures

We recommend that the earthwork be conducted in the dry season to avoid possible slope instability caused by machine and human disturbance on the slope. The contractor should keep the disturbance to the slope to a minimum degree and should not remove any trees or vegetation more than it needs for the construction. Any area where vegetation is removed for construction should be re-planted soon after the construction is completed.

If any slope instability is indicated, Geo Group Northwest, Inc. should be notified immediately to evaluate the situation and make necessary recommendations. Preparation of the subgrade should be monitored by a geotechnical engineer at the site to verify soil bearing conditions.

The contractor should carefully schedule the construction sequence. Any underground utilities should be installed first before placing geotextile and import fill for subgrade improvement in order to avoid cutting through the geotextile later. Cutting through the geotextile will decrease its effectiveness and weaken the subgrade.

Contractor should comply with all working safety regulations governed by the city, state, and federal agencies. No workman should be allowed to be near an unprotected steep slopes.

3.7 Pavement Design

The design of the pavement should follow the Seattle Municipal Code and related pavement design guideline. Based on the soil conditions at the site and preparation of the subgrade discussed above, we have the opinion that the pavement may be consist of the following options: (1) Three inches of Asphalt Concrete (AC) over six inches of Crushed Rock Base (CRB) material, or (2) Three inches of AC over four inches of Asphalt Treated Base (ATB) material.

4. CLOSURE

4.1 Additional Services

We recommend that Geo Group Northwest, Inc. be retained to provide consulting services for any changes in the geometry of the geogrid reinforcement and to monitor the construction of the slopes and the subgrade preparation, test compaction of backfill, and provide other geotechnically related services during construction. This is to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

4.2 Limitations

This report has been prepared for the specific application to this project for the exclusive use of Larson and Associates, Inc. and its representatives. We recommend that this report, in its entirety, be included in the project contract documents for the information of contractors.

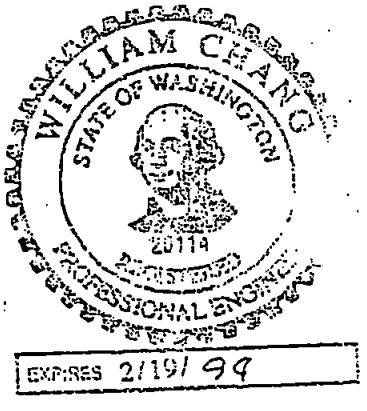
Our recommendations and conclusions are based on the subsurface soil conditions encountered in the site exploration, the site surface conditions observed, and our engineering analyses. The conclusions and recommendations are professional opinions derived in a manner consistent with the level of care and skill ordinarily exercised by other members of the geotechnical profession currently practicing under similar conditions in this area and within the budget constraint. No other warranty, expressed or implied, is made.

Soil and groundwater conditions in test borings may vary from those actually encountered during construction. The nature and extent of variations between the exploratory test borings may not become evident until construction. If variations appear then, Geo Group Northwest, Inc. should be requested to re-evaluate the recommendations of this report and to verify or modify them in writing prior to proceeding with construction.

Respectfully Submitted,
GEO GROUP NORTHWEST, INC.

D. Huang

Dalong (Daniel) Huang, P.E.
Geotechnical Engineer



William Chang

William Chang, P.E.
Principal

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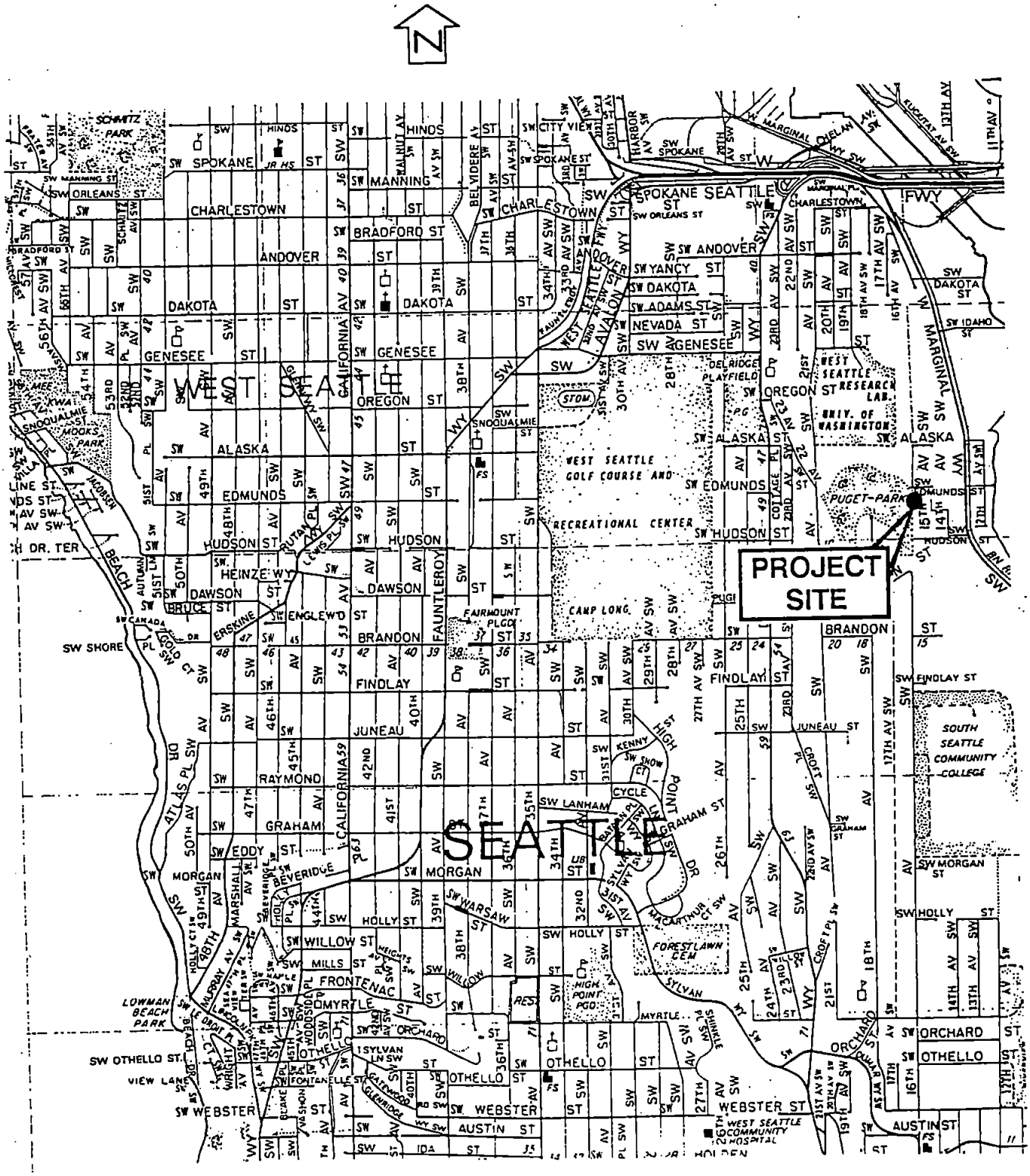


GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

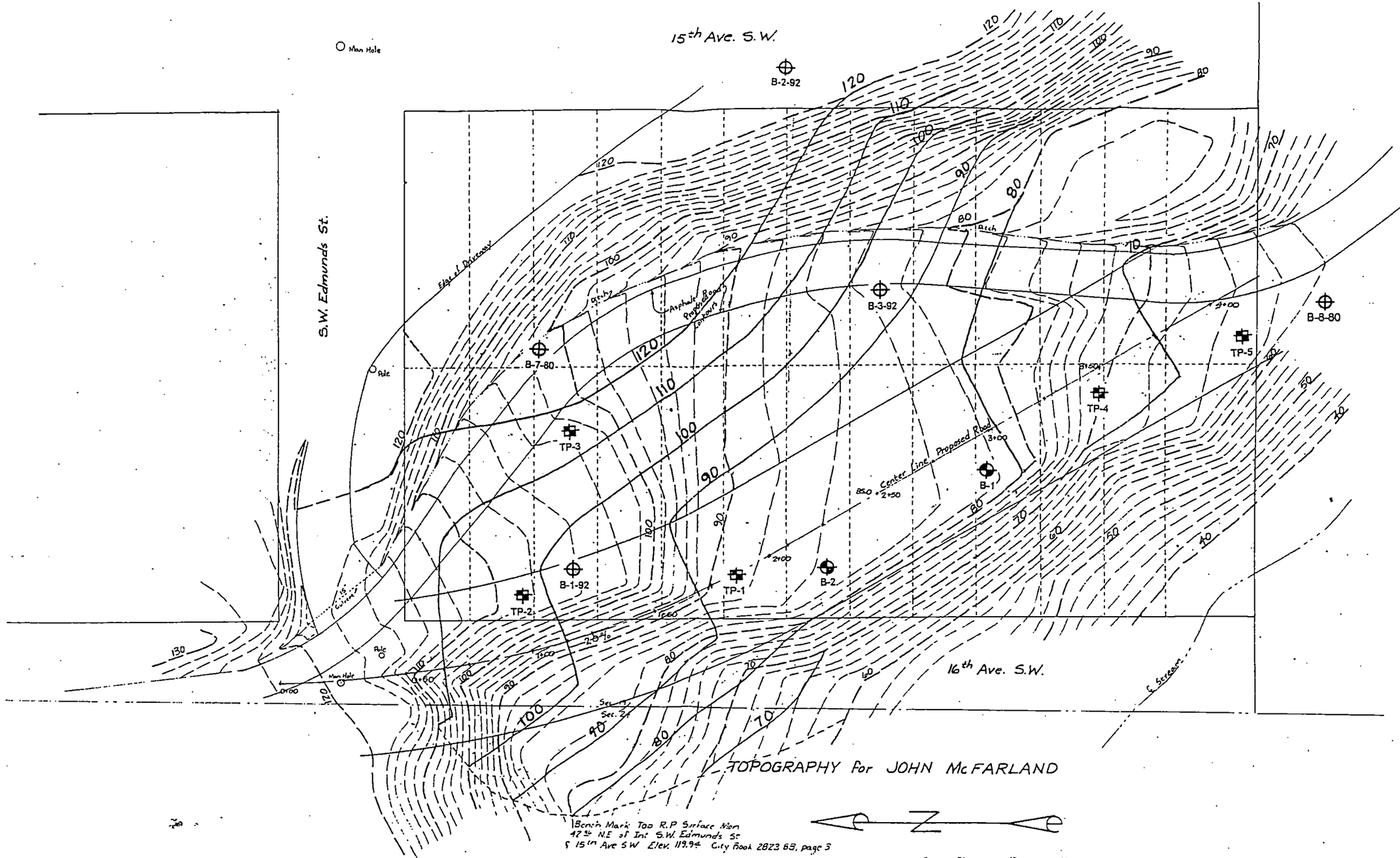
VICINITY MAP

PUGET WAY SW REALIGNMENT

WEST MARGINAL WAY SW TO SW ALASKA ST.

SEATTLE, WASHINGTON

SCALE	DATE	MADE	CHKD	JOB NO.	PLATE
NONE	11/19/93	DH	WC	G-0290-1	1



TOPOGRAPHY For JOHN McFARLAND

Bench Mark: Top R.P. Surface Mon. 42½ N.E. of Int. S.W. Edmunds St. & 15th Ave S.W. Elev. 119.94 City Book 2823 63, page 3

LEGAL DESCRIPTION: Block 10, Goodspeeds Addition to West Seattle, per plat recorded in Volume 8 of Plats, page 21, in King County, Washington

0 5 10 20 30 40 50

SCALE: 1"=40'

2' Contours

- Indicates approximate boring location
- Indicates approximate test pit location
- Indicates previous boring location

The site was surveyed by John Herbert Miller, L.S. in March 1991.

GEO Group Northwest, Inc.

SITE AND EXPLORATION PLAN
PUGET WAY SW REALIGNMENT
WEST MARGINAL WAY SW TO SW ALASKA ST.
SEATTLE, WASHINGTON

SCALE 1"=40'(±)	DATE 11/29/93	MADE DH	CHKD WC	JOB NO. G-0290-1	PLATE 2

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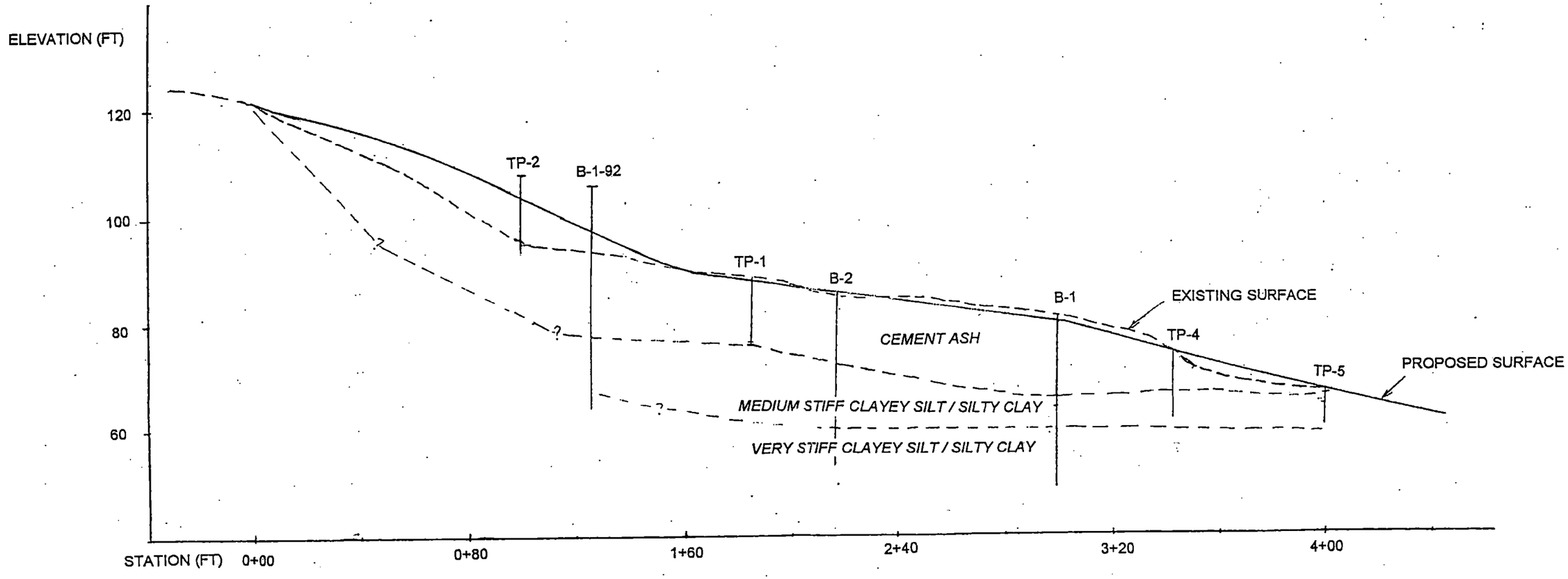

PROFILE ALONG ROADWAY CENTER-LINE

GEO Group Northwest, Inc.

PROFILE ALONG ROADWAY CENTER-LINE
PUGET WAY SW REALIGNMENT
WEST MARGINAL WAY SW TO SW ALASKA ST.
SEATTLE, WASHINGTON

SCALE as shown	DATE 12/6/93	MADE DH	CHKD WC	JOB NO. G-0290-1	PLATE 3

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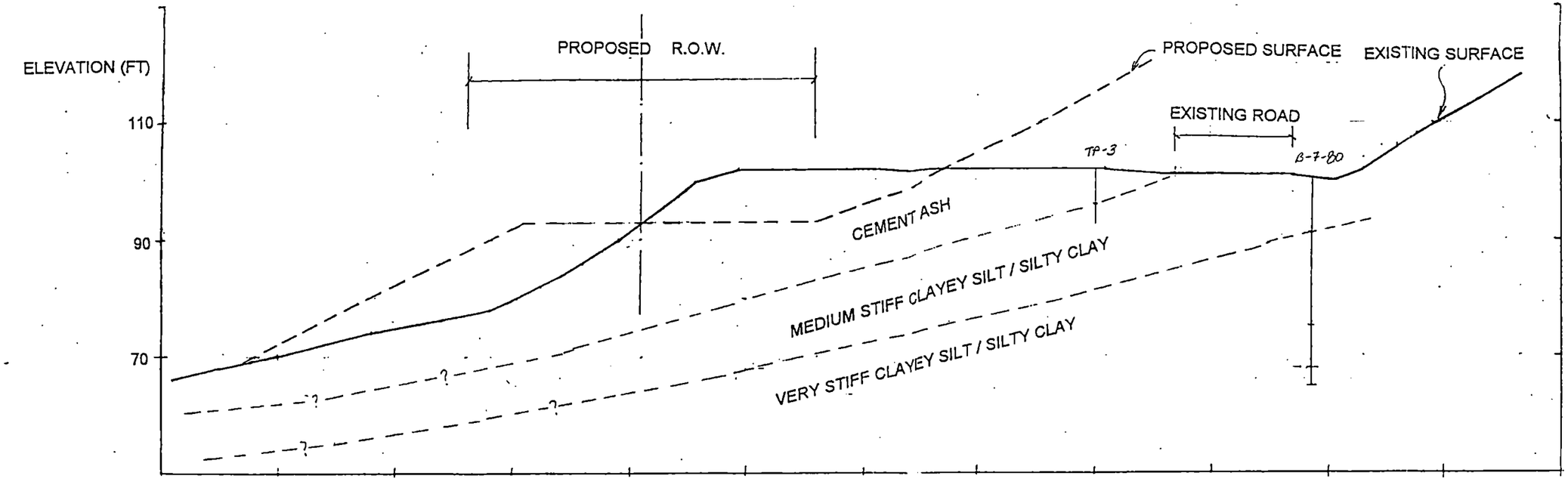
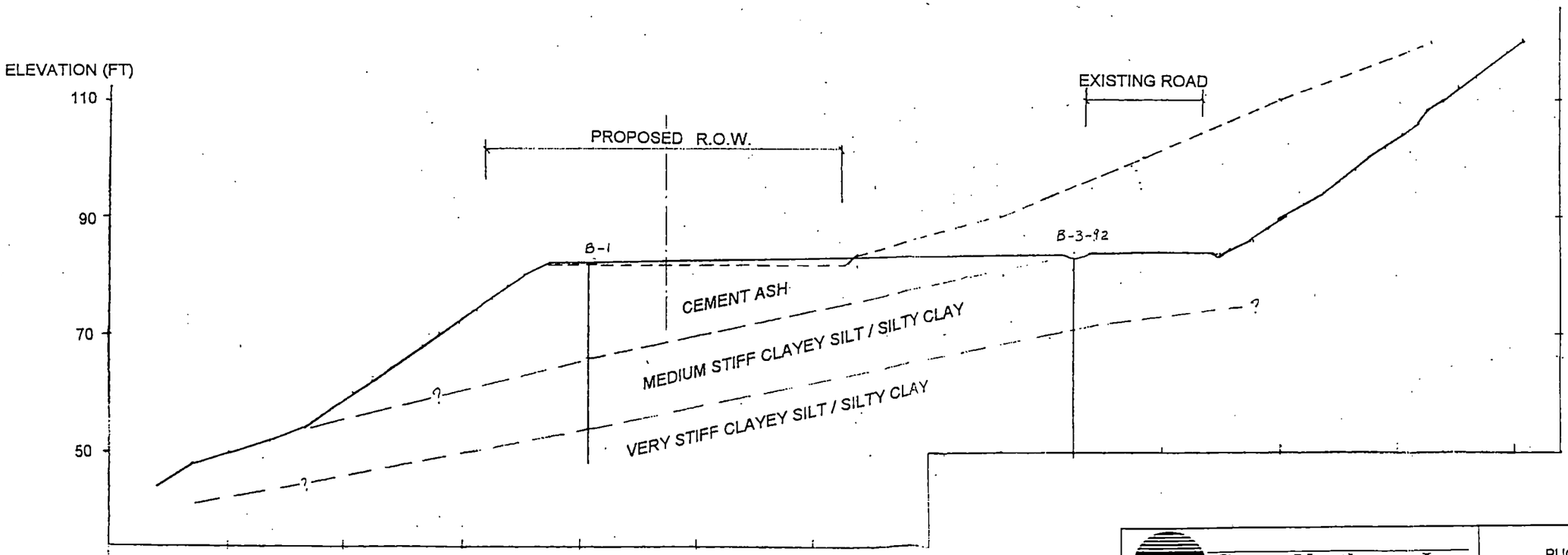


STATION 1+50



STATION 2+90

GEO Group Northwest, Inc.

SLOPE CROSS SECTIONS
PUGET WAY SW REALIGNMENT
WEST MARGINAL WAY SW TO SW ALASKA ST.
SEATTLE, WASHINGTON

SCALE	DATE	MADE	CHKD	JOB NO.	PLATE
1"=20'	12/6/93	DH	WC	G-0290-1	4

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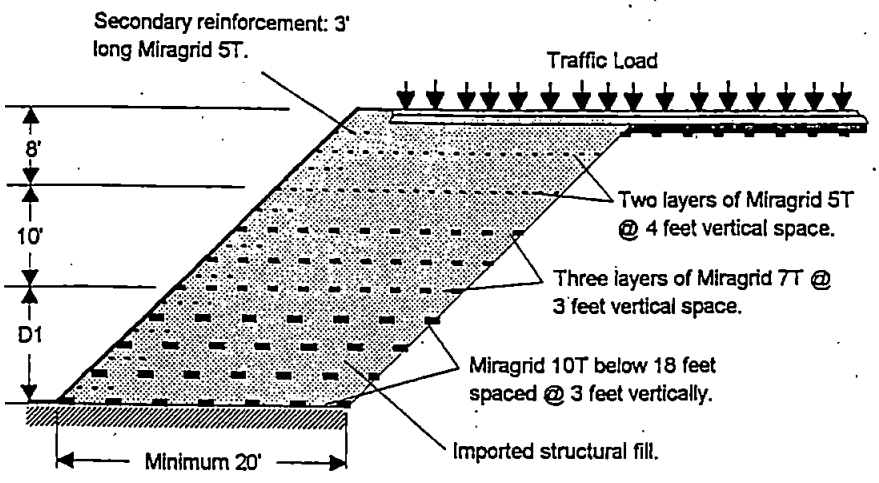

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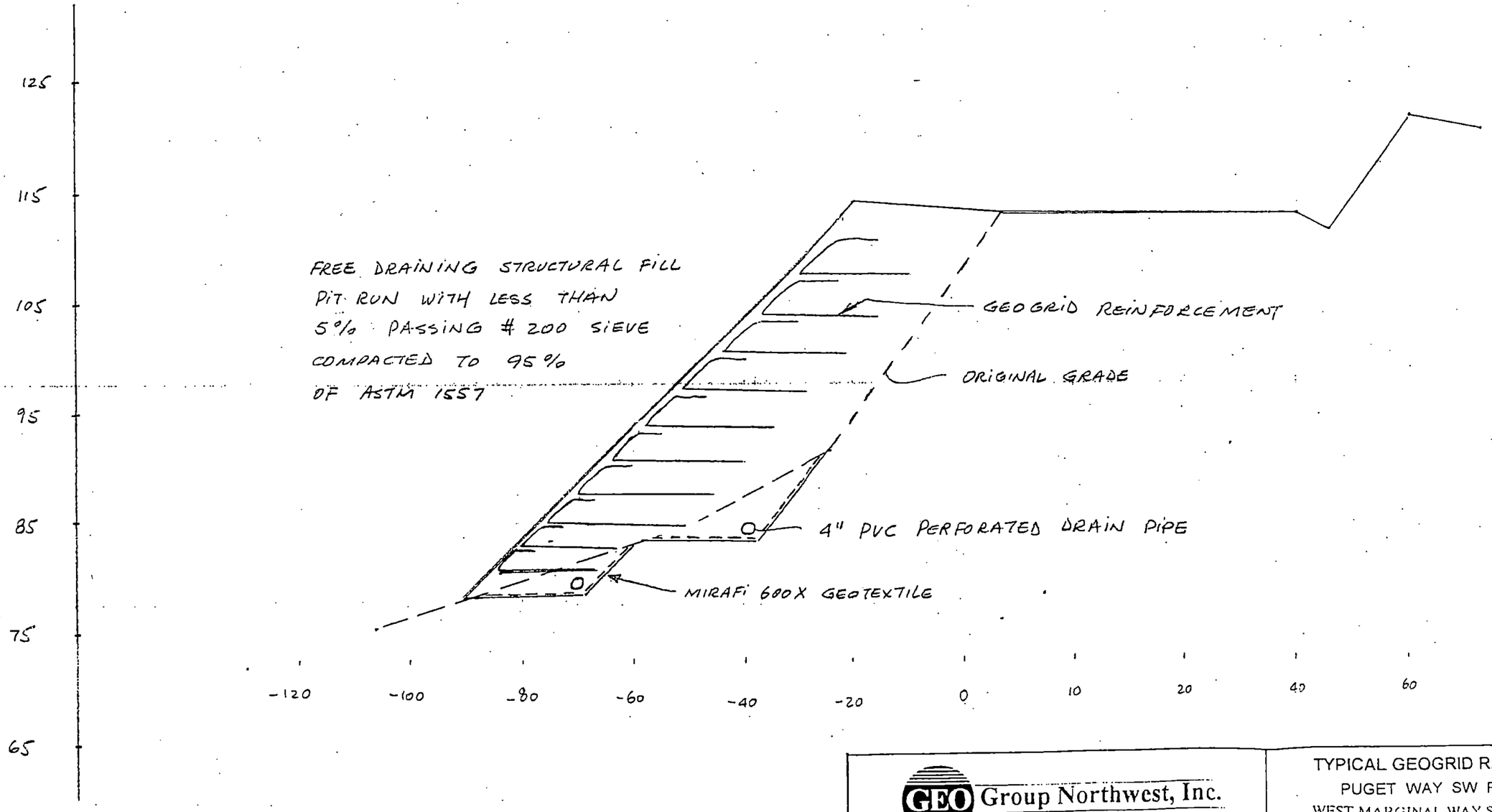
Geotechnical Engineers, Geologists, & Environmental Scientists

TYPICAL GEOGRID REINFORCEMENT
PUGET WAY SW REALIGNMENT
WEST MARGINAL WAY SW TO SW ALASKA ST.
SEATTLE, WASHINGTON

SCALE NONE	DATE 12/31/93	MADE DH	CHKD WC	JOB NO. G-0290-1	PLATE 5



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TYPICAL GEOGRID REINFORCEMENT
PUGET WAY SW REALIGNMENT
WEST MARGINAL WAY SW TO SW ALASKA ST.
SEATTLE, WASHINGTON

SCALE NONE	DATE 12/31/93	MADE DH	CHKD WC	JOB NO. G-0290-1	PLATE 5A

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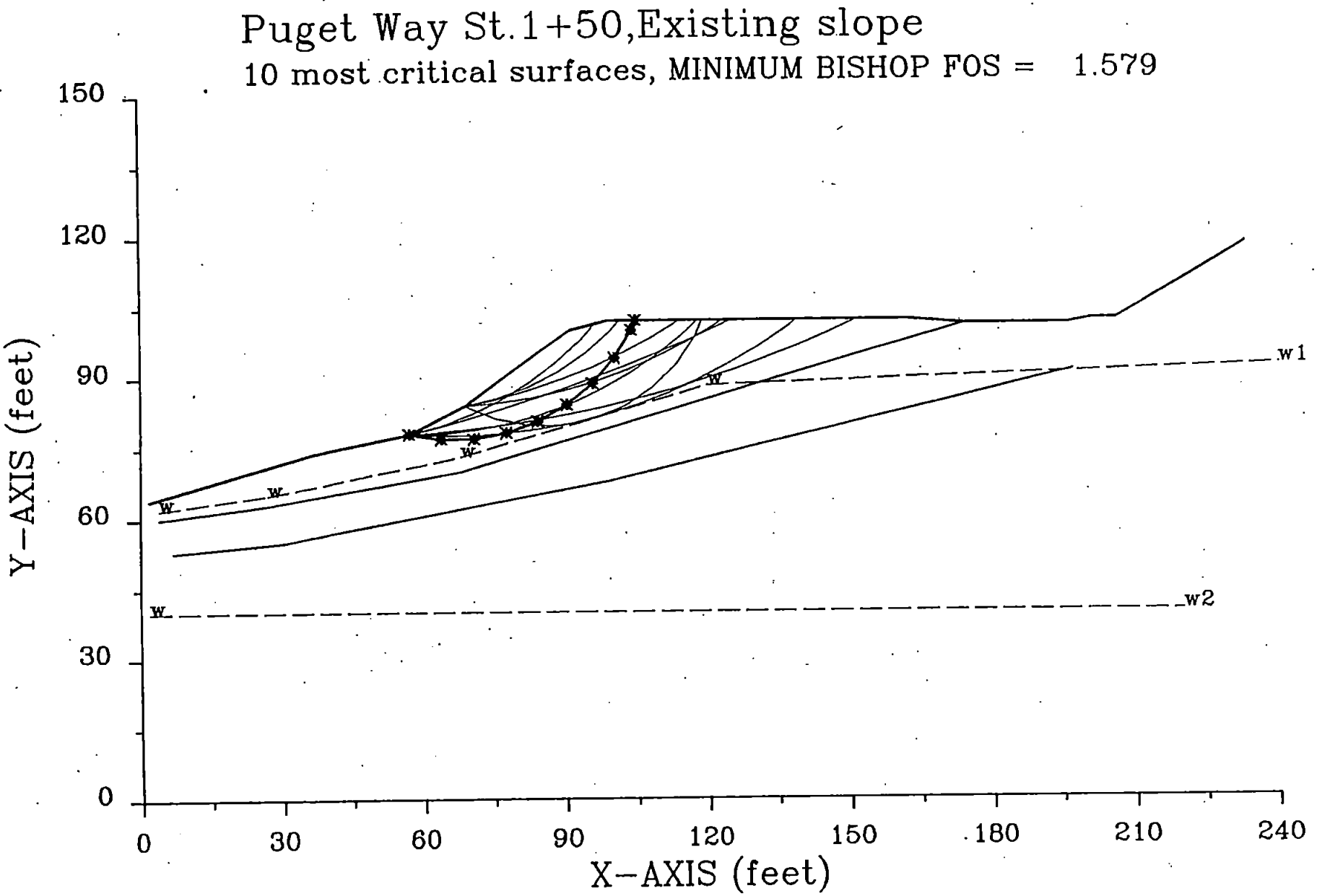

PLATE 6. SLOPE STABILITY ANALYSIS
EXISTING SLOPE AT STATION 1+50

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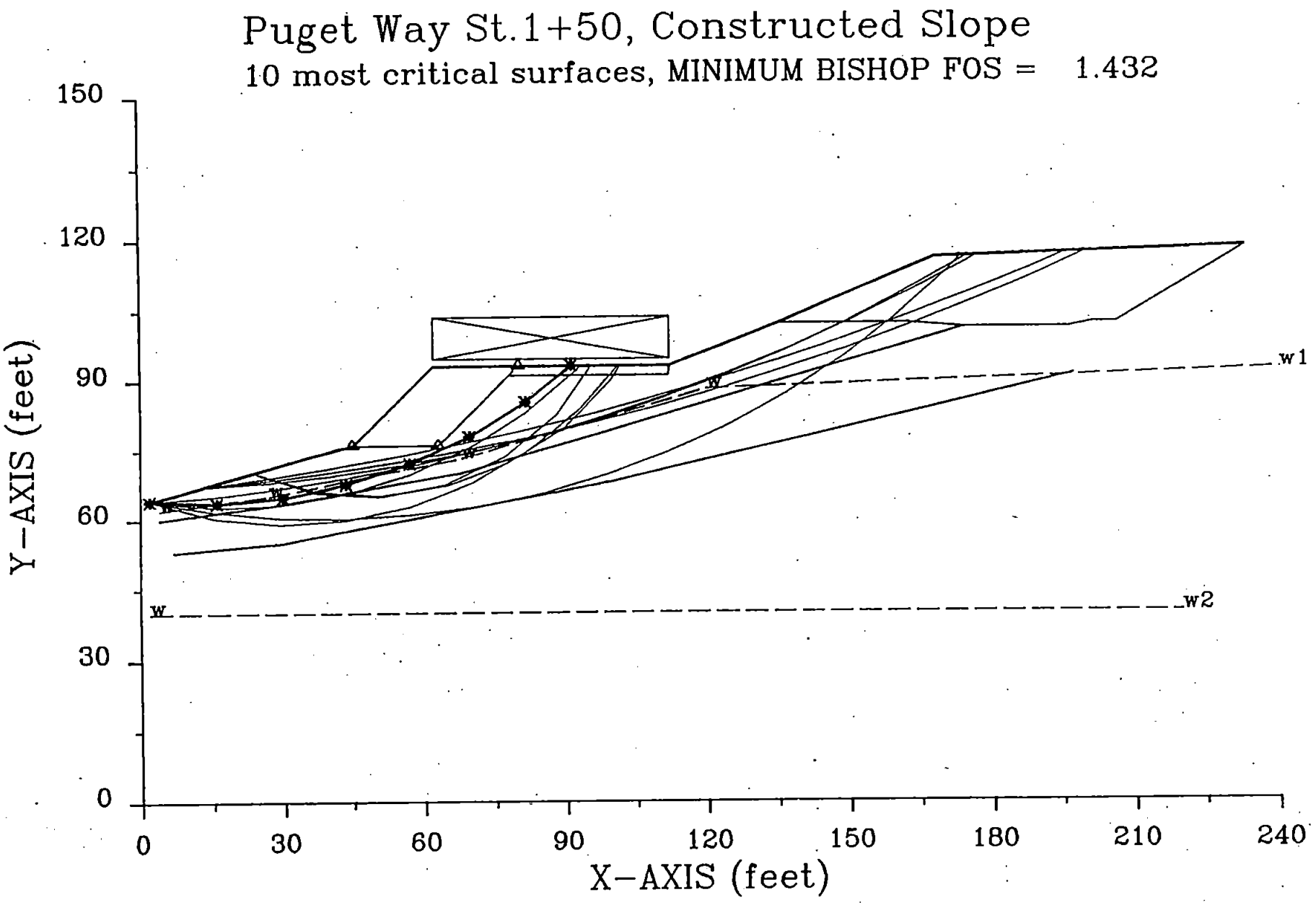


PLATE 7. SLOPE STABILITY ANALYSIS
CONSTRUCTED SLOPE AT STATION 1+50

APPENDIX

SUBSURFACE EXPLORATION

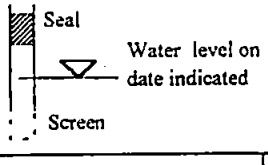
BORING NO. 1

SURFACE ELEVATION 83'(±)

DEPTH, Ft	GRAPHIC	USCS	SOIL DESCRIPTION	SAMPLES AND TESTS: Number	Type	SPT - N	Natural Water %	Other	■ SPT-N, blows/ft ▲ Water % (0 20 40 60)	PIEZOMETER OR STANDPIPE
			Light brown silt with cement ash.							
		ML	Light gray to white CEMENT ASH, med. stiff to stiff, moist. (Ph value = 13 to 14 when submerged in deionized water)	1		13				
5				2		9				
				3		6	59.8			
				4		9	64.0			
10				5		15	67.3			
				6		5	59.7			
				7		11	57.9			
			Changes to very wet (perched water)	8		4	100.4			
15				9		7	94.5			
		OL	Dark brown to black ORGANIC SILT.	10		8	30.1			
		ML	Olive gray CLAYEY SILT with sand lenses, medium stiff, very wet @ 18'.	11		6	21.9			
20				12		7	23.1			
			Changes to stiff	13		13	24.2			
				14		12	22.2			
25				15		15	21.6			
				16		14	26.7			
				17		19	21.8			
30		CL	Dark gray silty CLAY, very stiff, moist.	18		18	18.0			
				19		32	33.6			
				20		27	37.7			
35										
			BORING ENDS @ 33 feet, sampled to 34.5 feet Perched water @ 14 feet and 24 feet.							
40										
45										

LEGEND:

- 2" O.D. Split-Spoon Sample
- 3" O.D. Shelby-Tube Sample
- 3" O.D. California-Sampler Sample



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BORING LOG
PUGET WAY SW REALIGNMENT
SW EDMUNDS ST.
SEATTLE, WASHINGTON

LOGGED BY DH
BORING DATE 11/24/93
JOB NO. G-0290-1
PLATE A1

C:\DANIEL\FIELD\BORING\LOG290A.XLS

12/31/93

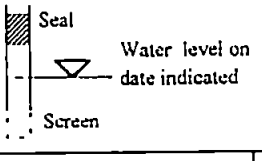
BORING NO. 2

SURFACE ELEVATION 85'(±)

DEPTH, Ft	GRAPHIC	USCS	SOIL DESCRIPTION	SAMPLES AND TESTS: Number	Type	SPT - N	Natural Water %	Other	■ SPT-N, blows/ft ▲ Water % (0 20 40 60)	PIEZOMETER OR STANDPIPE
			Light brown silt with cement ash.							
		ML	Light gray to white CEMENT ASH, med. stiff to stiff, damp. (Ph value = 13 to 14 when submerged in deionized water)	1		4	54.0			
5				2		6	60.1			
				3		4	64.8			
				4		8	73.3			
10				5		8	75.8			
				6		10	67.2			
				7		7	58.3			
			Wet @ 14'	8		11	86.7			
15				9		10	77.7			
				10		9	72.9			
		ML	Mottled tan, olive gray CLAYEY SILT with sand lenses, medium stiff to stiff, very moist.	11		9	19.3			
20				12		7	16.0			
				13		12	22.0			
				14		27	15.9			
25		ML	Dark gray CLAYEY SILT, very stiff, moist.	15		25	19.7			
				16		20	21.1			
				17		30	19.5			
30				18		29	15.9			
				19		18	38.4			
				20		36	32.9			
35			*BORING ENDS @ 32 feet, sampled to 33.5 feet* No groundwater was encountered.							
40										
45										

LEGEND:

- 2" O.D. Split-Spoon Sample
- 3" O.D. Shelby-Tube Sample
- 3" O.D. California-Sampler Sample



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BORING LOG
PUGET WAY SW REALIGNMENT
SW EDMUNDS ST.
SEATTLE, WASHINGTON

LOGGED BY	DH
BORING DATE	11/24/93
JOB NO.	G-0290-1
PLATE	A2

TEST PIT NO. TP-1

LOGGED BY DH TEST PIT DATE: 11/24/93 GROUND ELEV. 89 (±) feet

DEPTH ft.	USCS	SOIL DESCRIPTION	SAMPLE No.	Water %	OTHER TESTS
	ML	Light gray to white CEMENT ASH, soft near ground surface, moist.			
		changes to medium stiff - stiff with increasing depth.			
5					
10					
	ML	Mottled brown & gray, native CLAYEY SILT, soft/med. stiff, very moist.			
15		(Bottom of pit @ 13 Feet) No groundwater was encountered in the test pit.			

TEST PIT NO. TP-2

LOGGED BY DH LOG DATE: 11/24/93 GROUND ELEV. 109 (±) feet

DEPTH ft.	USCS	SOIL DESCRIPTION	SAMPLE No.	Water %	OTHER TESTS
		Brown SILT with grass roots and occasional gravel, soft.			
	ML	Light gray to white CEMENT ASH, medium stiff to stiff, moist.			
5					
10					
		Light brown, native CLAYEY SILT with little organic, medium stiff, moist.			
15		(Bottom of pit @ 13.3 Feet) No groundwater was encountered in the test pit.			

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TEST PIT LOG
PUGET WAY SW REALIGNMENT
SW EDMUNDS ST.
SEATTLE, WASHINGTON

JOB NO. G-0290-1 DATE 12/31/93 PLATE A3

C:\DANIEL\FIELD\TESTPIT\PIT290A.XLS

TEST PIT NO. TP-3

LOGGED BY DH TEST PIT DATE: 11/24/93 GROUND ELEV. 103 (±) feet

DEPTH ft.		USCS	SOIL DESCRIPTION	SAMPLE No.	Water %	OTHER TESTS
		ML	Light gray to white CEMENT ASH, soft near ground surface, moist.			
			changes to medium stiff - stiff with increasing depth.			
5			Large concrete chips encountered.			
		ML	Light brown to tan, native CLAYEY SILT, medium stiff, moist.			
			(Bottom of pit @ 7.2 Feet)			
			No groundwater was encountered in the test pit.			
10						
15						

TEST PIT NO. TP-4

LOGGED BY DH LOG DATE: 11/24/93 GROUND ELEV. 70 (±) feet

DEPTH ft.		USCS	SOIL DESCRIPTION	SAMPLE No.	Water %	OTHER TESTS
			Brown SILT with grass roots, medium stiff.			
		ML	Light gray to white CEMENT ASH, medium stiff, moist.			
			Changes to stiff.			
5						
		ML	Olive gray CLAYEY SILT, medium stiff to stiff, moist.			
		ML/CL	Dark gray, CLAYEY SILT/SILTY CLAY, stiff, moist.			
10						
			(Bottom of pit @ 12 Feet)			
15			No groundwater was encountered in the test pit.			

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TEST PIT LOG
PUGET WAY SW REALIGNMENT
SW EDMUNDS ST.
SEATTLE, WASHINGTON

JOB NO. G-0290-1 DATE 12/31/93 PLATE A4

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TEST PIT NO. TP-5

LOGGED BY DH TEST PIT DATE: 11/24/93 GROUND ELEV. 65 (±) feet

DEPTH ft.		USCS	SOIL DESCRIPTION	SAMPLE No.	Water %	OTHER TESTS
			Brown SILT with grass roots, soft.			
		ML	Light gray CEMENT ASH mixed with tan silt, medium stiff, moist.			
		ML	Dark gray CLAYEY SILT/SILTY CLAY, medium stiff to stiff, moist.			
5			(Bottom of pit @ 4.5 Feet)			
			No groundwater was encountered in the test pit.			
10						
15						

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TEST PIT LOG
PUGET WAY SW REALIGNMENT
SW EDMUNDS ST.
SEATTLE, WASHINGTON

JOB NO. G-0290-1 DATE 12/31/93 PLATE A5

C:\DANIEL\FIELD\TESTPIT\PIT290C.XLS

LEGEND OF SOIL CLASSIFICATION AND PENETRATION TEST

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVELS (More Than Half Coarse Grains Larger Than No. 4 Sieve)	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURE, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES LITTLE OR NO FINES
		DIRTY GRAVELS (WITH SOME FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
More Than Half by Weight Larger Than No. 200 Sieve	SANDS (More Than Half Coarse Grains Smaller Than No. 4 Sieve)	CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		DIRTY SANDS (WITH SOME FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS	SILTS (Below A-Line on Plasticity Chart, Negligible Organic)	Liquid Limit < 50%	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY
		Liquid Limit > 50%	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOIL
	CLAYS (Above A-Line on Plasticity Chart, Negligible Organic)	Liquid Limit < 30%	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, CLEAN CLAYS
		Liquid Limit > 50%	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
More Than Half by Weight Smaller Than No. 200 Sieve	ORGANIC SILTS & CLAYS (Below A-Line on Plasticity Chart)	Liquid Limit < 50%	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
		Liquid Limit > 50%	OH	ORGANIC CLAYS OF HIGH PLASTICITY
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

LABORATORY CLASSIFICATION CRITERIA

DETERMINE PERCENTAGES OF GRAVEL AND SAND FROM GRAIN SIZE DISTRIBUTION CURVE.

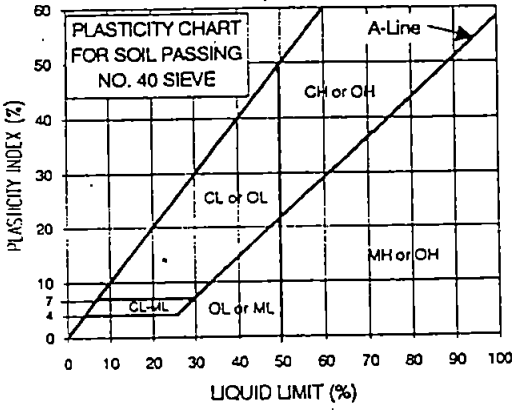
COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWINGS:

< 5% Fine Grained: GW, GP, SW, SP;

> 12% Fine Grained: GM, GC, SM, SC;

5 to 12% Fine Grained: use dual symbols.

	Cu = (D60 / D10) greater than 4 Cc = (D30 * D30 / D10 / D60) between 1 and 3	
	NOT MEETING ABOVE REQUIREMENTS	
CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE or P.I. LESS THAN 4	
	ATTERBERG LIMITS ABOVE "A" LINE or P.I. MORE THAN 7	
	Cu = (D60 / D10) greater than 6 Cc = (D30 * D30 / D10 / D60) between 1 and 3	
	NOT MEETING ABOVE REQUIREMENTS	
CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE with P.I. LESS THAN 4	
	ATTERBERG LIMITS ABOVE "A" LINE with P.I. MORE THAN 7	



SOIL PARTICLE SIZE

FRACTION	U.S. STANDARD SIEVE Passing: Sieve	Passing: Size (mm)	Retained: Sieve	Retained: Size (mm)
SILT / CLAY	#200	0.075		
SAND				
FINE	#40	0.425	#200	0.075
MEDIUM	#10	0	#40	0.425
COURSE	#4	4.75	#10	2
GRAVEL				
FINE		19	#4	4.75
COURSE		76		19
COBBLES	76 mm to 203 mm			
BOULDERS	> 203 mm			
ROCK FRAGMENTS	> 76 mm			
ROCK	>0.76 cubic meter in volume			

GENERAL GUIDANCE OF SOIL ENGINEERING PROPERTIES FROM STANDARD PENETRATION TEST (SPT)

SANDY SOILS: Blow Counts N	Relative Density %	Friction Angle Ø, degree	Description	SILTY & CLAYEY SOILS: Blow Counts N	Unconfined Strength Su, tsf	Description
0 - 4	0 -15		Very Loose	< 2	< 0.25	Very soft
4 - 10	15 - 35	26 - 30	Loose	2 - 4	0.25 - 0.50	Soft
10 - 30	35 - 65	26 - 35	Medium Dense	4 - 8	0.50 - 1.00	Medium Stiff
30 - 50	65 - 85	35 - 42	Dense	8 - 15	1.00 - 2.00	Stiff
> 50	85 - 100	38 - 46	Very Dense	15 - 30	2.00 - 4.00	Very Stiff
				> 30	> 4.00	Hard

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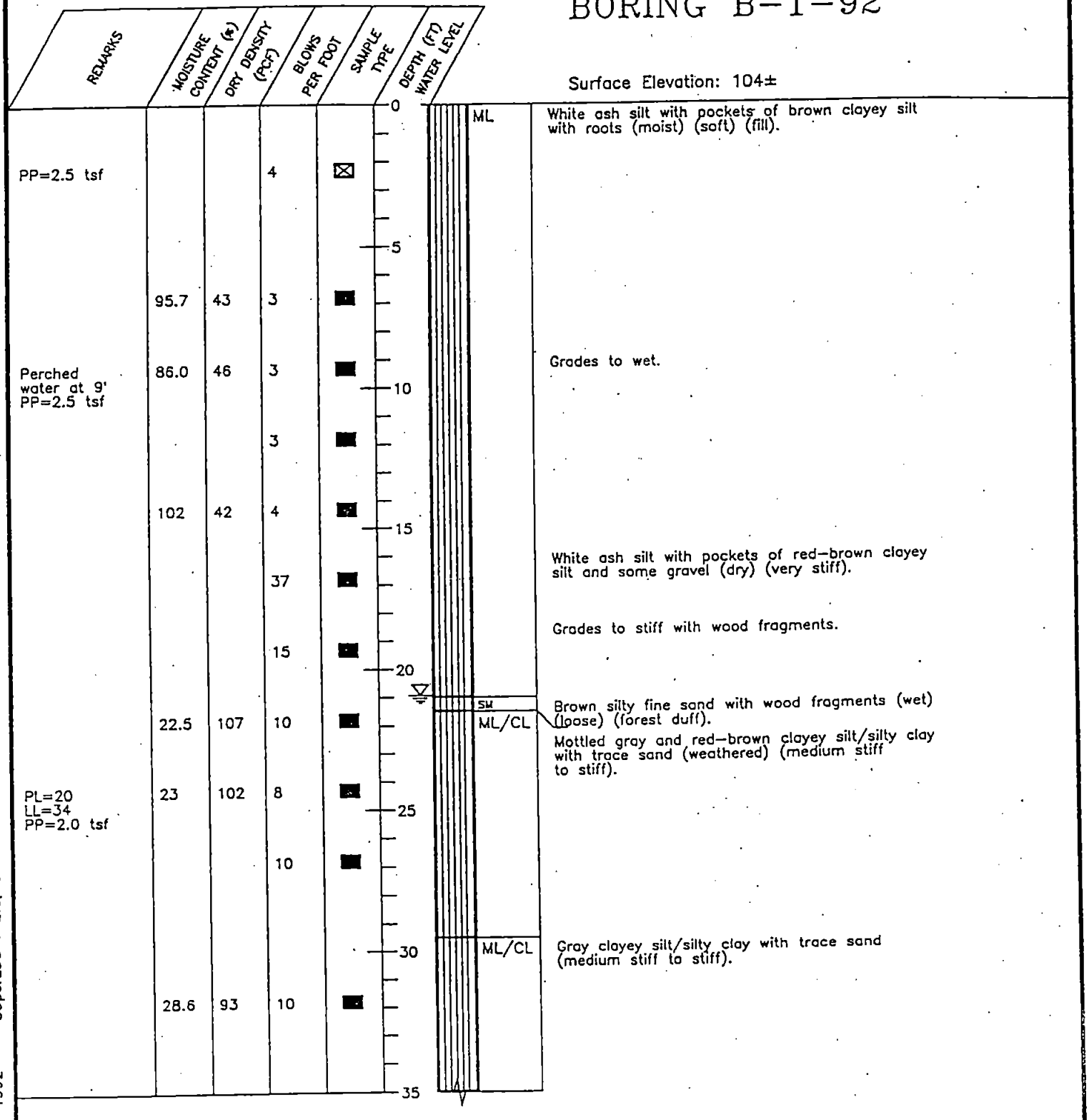
PLATE A6

BORING B-1-92

Surface Elevation: 104±



Logged by TSP 05-18-1992 SUperLOG V 2.0, 3-1991

LOG OF BORING

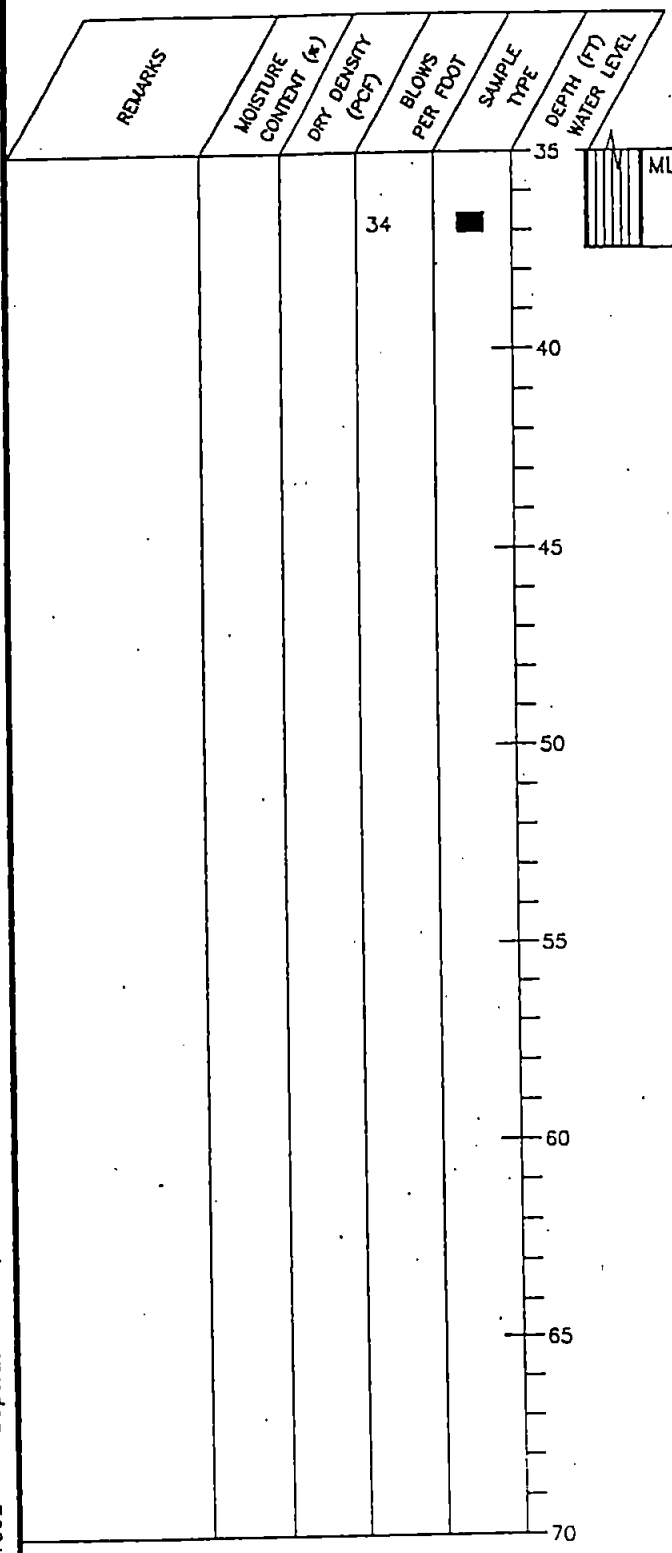
Dames & Moore

Job No. 24128-001-016

PLATE A7

BORING B-1-92

(Continued)



Grades to very stiff.

Boring completed at depth of 37.5 feet.

Perched water encountered at depth of 9 to 15 feet and water table encountered at depth of 21 feet during drilling.

Logged by TSP 05-18-1992 SUperLOG V 2.0, 3-1991

LOG OF BORING

Dames & Moore

PLATE A8

Job No. 24128-001-016

BORING B-2-92

Surface Elevation: 120

REMARKS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	BLOWS PER FOOT	SAMPLE TYPE	DEPTH (FT) WATER LEVEL		
			14		0	ML/CL	Mottled gray & red-brown clayey silt/silty clay with trace sand & gravel (damp) (stiff) (weathered).
					5		Grades to hard.
	18.8	115	38				
					10		
PP=3.5 tsf			35				
					15		
PP=4.5+ tsf	16.6	115	80			ML/CL	Gray clayey silt/silty clay with trace sand (damp) (very stiff to hard).
					20		
PP=4.5+ tsf	24.9	101	28				
					25		
			33				
					30		
	17.1	115	17				
					35		

Logged by TSP 05-18-1992 SUperLOG V 2.0, 3-1991

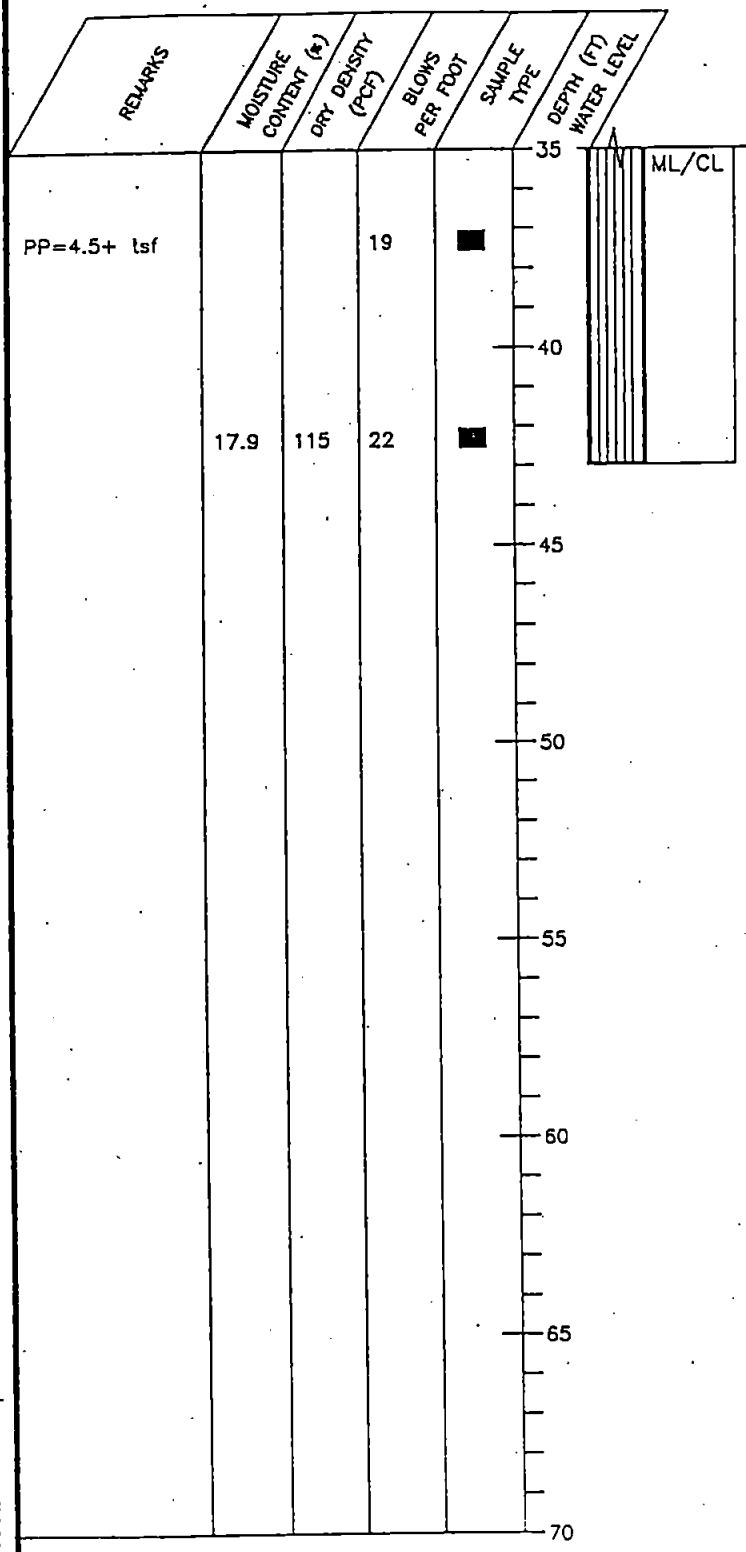
LOG OF BORING Dames & Moore

Job No. 12009-004-016

PLATE A9

BORING B-2-92

(Continued)



Boring completed at depth of 43 feet.
No ground water encountered during drilling.

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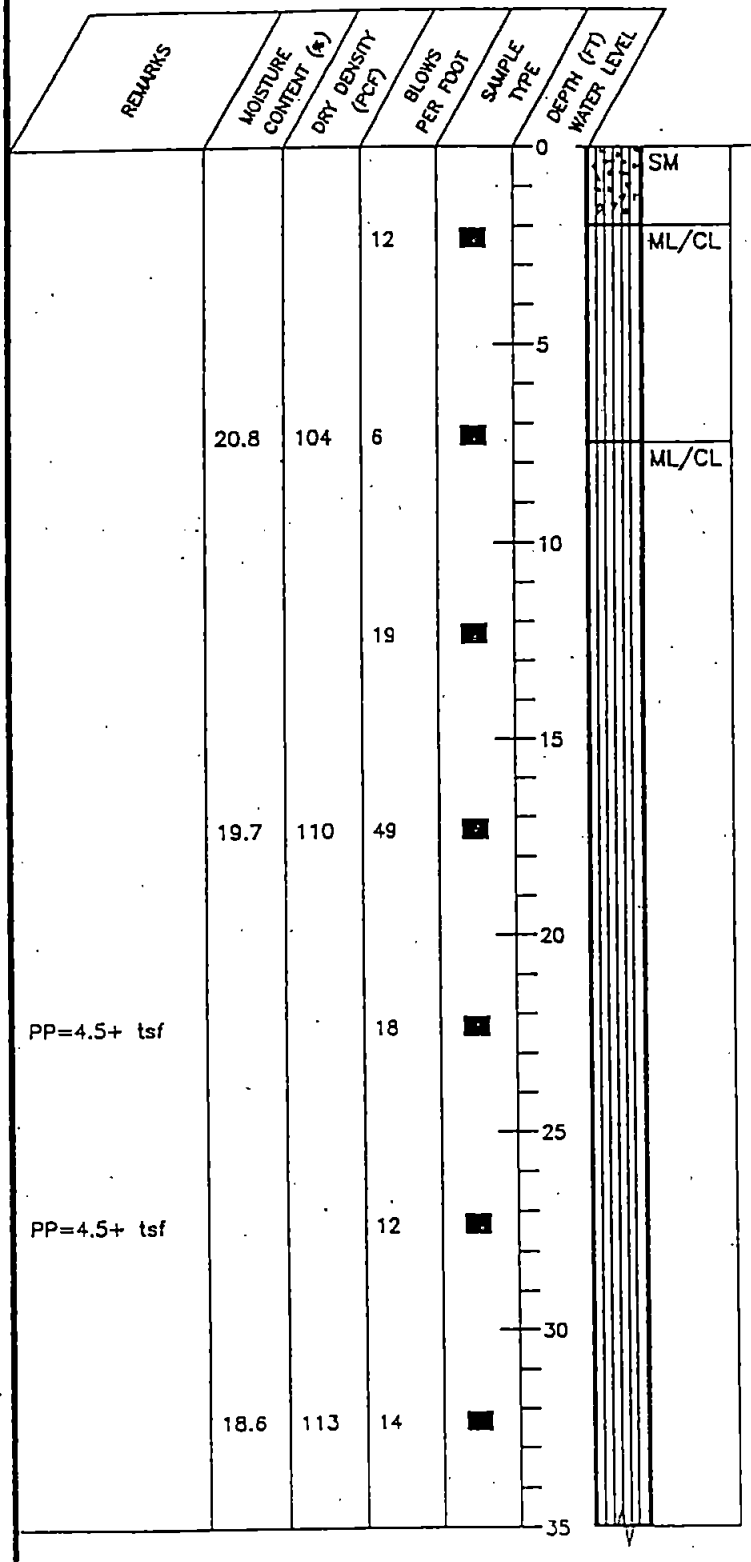
LOG OF BORING Dames & Moore

Job No. 12009-004-016

PLATE A10

BORING B-3-92

Surface Elevation: 82±



Brown silty sand with gravel (moist) (loose) (fill).

Mottled gray & red-brown clayey silt/silty clay with trace sand (moist) (stiff) (weathered).

Grades to medium stiff.

Dark gray clayey silt/silty clay with trace sand & gravel (moist) (medium stiff).

Grades to very stiff and damp.

Grades to hard.

Grades to stiff.

Logged by TSP 05-18-1992 SUperLOG V 2.0, 3-1991

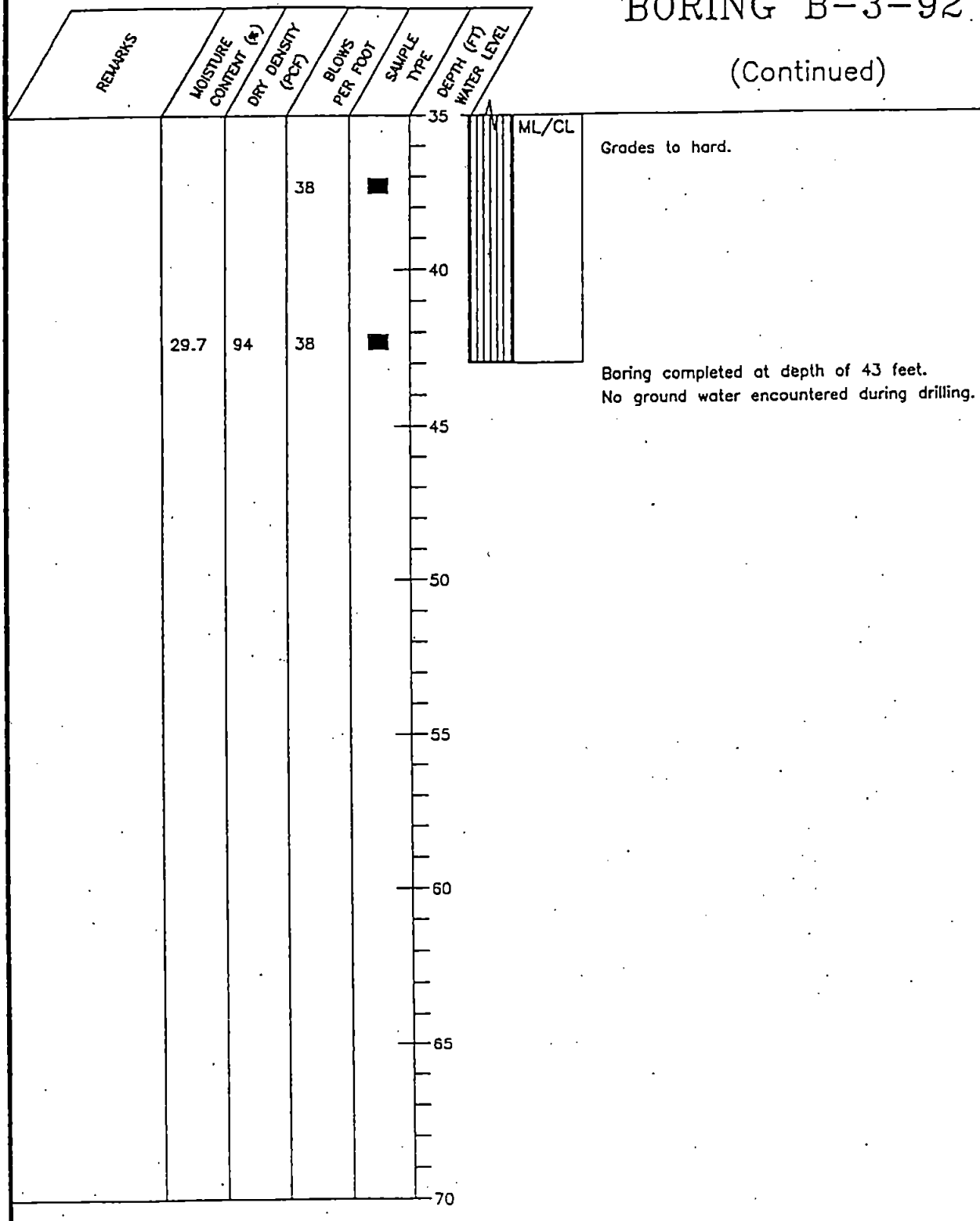
LOG OF BORING Dames & Moore

Job No. 12009-004-016

PLATE A11

BORING B-3-92

(Continued)



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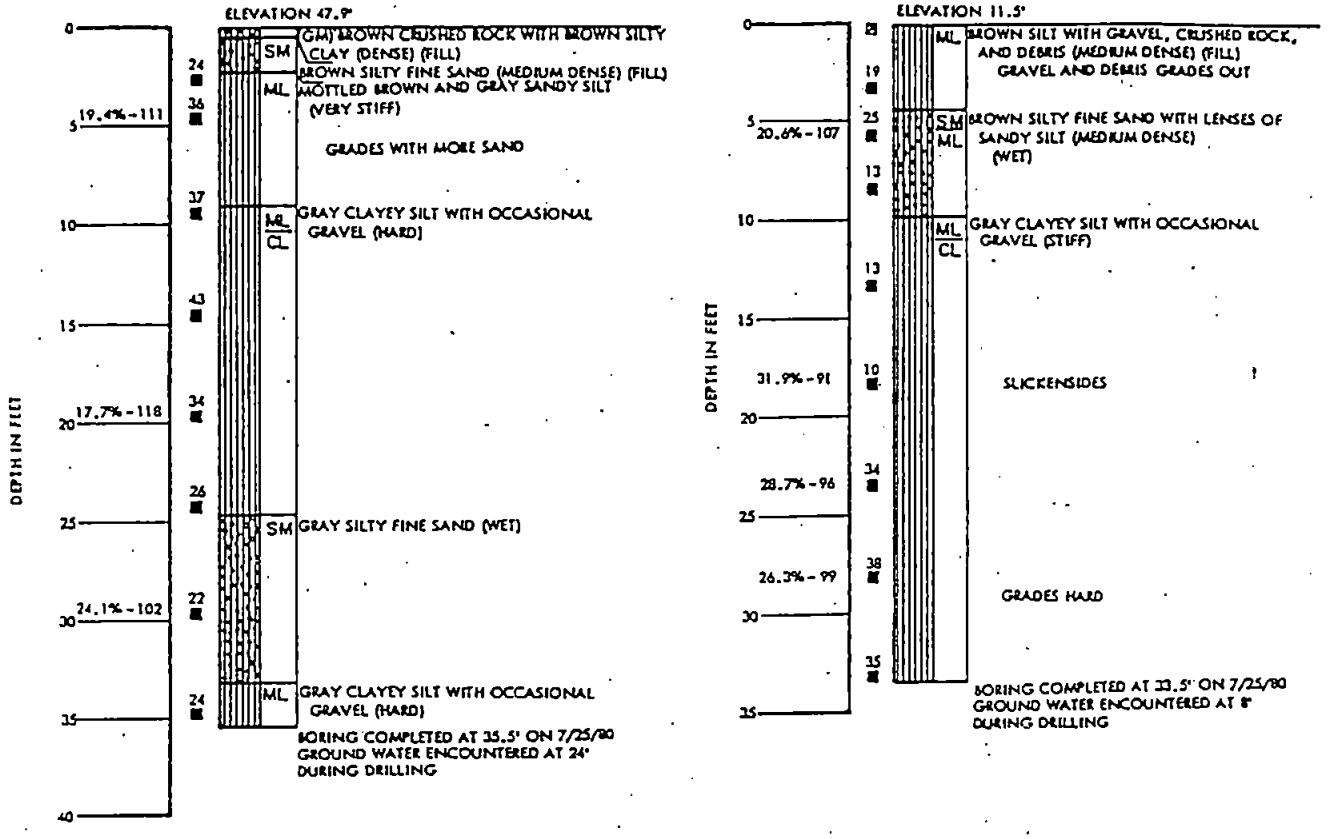
LOG OF BORING Dames & Moore

Job No. 12009-004-016

PLATE A12



LOG OF BORINGS

DAMES & MOORE

PLATE A13

McFARLAND V. HALTERMAN (enviro. files)
LU020-88

GEOTECH/SOILS REPORT 9

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Letter of Transmittal

To: Department of Ecology
3190 160th Avenue SE
Bellevue, WA 98008-5452

Date: December 21, 1999

Job No.:

Attn: Dan Cargill

Re: Puget Way SW Street Improvement

We are sending the following items:

Date	Copies	Description
December 30, 1993	1	Geotechnical Engineering Study Puget Way SW Street Improvement West marginal Way SW to SW Alaska Street Seattle, Washington

These are transmitted:

☐ *For your information* ☐ *For action specified below* ☐ *For review and comment* ☐ *For your use* ☒ *As requested*

Remarks

Please call if you have any questions or comments. Thank you.

By: Mariya Shaw

MARIYA SHAW

Title: Project Coordinator

Copies to:

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