The City of Hoquiam Waterline Crossing, Sewerline Crossing, and UV Disinfection Improvements Project

Geotechnical Data Report

Prepared for

The City of Hoquiam

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CH2MHILL

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Waterline Crossing (182347)
Sewerline Crossing (185231)
UV Disinfection Improvements Project (184515)

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1.0 INTRODUCTION

This data report summarizes the results of the geotechnical investigations conducted by CH2M HILL for the River Sewerline Crossing, River Waterline Crossing, and UV Disinfection Facility projects for the City of Hoquiam. This report presents geotechnical data of subsurface conditions for these three projects.

1.1 Project Descriptions

The purpose of the subsurface exploration was to explore and evaluate the subsurface conditions at the sites and provide geotechnical data pertaining to the geotechnical aspects of installing the proposed pipelines and construction at the UV Disinfection Facility. A brief description of each of these projects is provided in the following sections.

River Sewerline Crossing

The existing sewerline is laid upstream from the mouth of the Hoquiam River, just north of the Puget Sound Pacific Railroad Bridge near river mile (RM) 0.2, and is in need of replacement. The proposed replacement is a 12-inch diameter sewerline to be installed using horizontal directional drilling (HDD) methods on an alignment located just north of the existing alignment. The HDD segment is approximately 1000 feet in length and is proposed to be installed a minimum of 35 feet below the river bottom. The proposed alignment with planned entrance and exit pit locations as well as a proposed profile is shown in Figure 3.

River Waterline Crossing

The City of Hoquiam has identified the need for an additional potable water pipeline to deliver water to customers located on the eastern side of the Hoquiam River. The waterline will cross the Hoquiam River near RM 0.7, north of the sewerline crossing. The proposed alignment crosses the river from 18th Street on the north side of the river to a point near the police station on the south side of the river. This installation is approximately 900 feet long and will also be installed using HDD methods. Figure 4 provides a plan and profile of the current proposed alignment for the river waterline crossing.

UV Disinfection Facility

The Hoquiam wastewater treatment plant (WWTP) is located on Moon Island Drive and discharges into Grays Harbor Estuary (North Channel). It is built on fill to raise the plant site above extreme high tide conditions. The proposed project will be constructed within the fenced boundary of the existing plant site. The UV disinfection facility will be constructed in the north half of the existing chlorine contact channel, retaining the south half for continued periodic disinfection of lagoon effluent. The proposed new chemical systems will be housed in a new structure at the southeast end of the chlorine contact channel. A new electrical building is planned to house switchgear, and chemical equipment. A plan view of the boring location and the proposed new structure is shown in Figure 5.

1.2 Scope of Geotechnical Investigation

The scope of the geotechnical task for the project included:

- Evaluation of existing conditions at the project site based on review of regional geology, near-surface soil conditions, and previous subsurface conditions.
- Conduct a field subsurface exploration program to characterize the soil conditions at the proposed site. The exploration program consisted of drilling a total of ten exploratory test borings; four for the sewerline river crossing, five for the waterline river crossing, and one for the UV disinfection facility. Appendix A of this geotechnical data report contains the field logs of the test borings.
- Performing laboratory index and classification tests on samples collected from the field exploration program.
- Preparing this geotechnical report to summarize the above tasks.

2.0 REGIONAL GEOLOGY

The project sites are situated at the mouth of the Hoquiam River and within Grays Harbor, at the southwestern foothills of the Olympic Mountains. In this area the Olympic Mountains and foothills consists chiefly of tertiary rocks that include siltstones, sandstones, conglomerates, and basaltic flows. Large valley glaciers developed in these mountains in the "Ice Age" of the Pleistocene epoch. A fluctuating climate caused multiple advances and retreats of the glaciers. The resulting meltwater carried sand and gravel and deposited it in lower valleys. These deposits have been and continue to be eroded by recent rivers and streams. This material has been carried down into the valleys to be incorporated with larger stream sediments and deposited as unconsolidated, interbeded river-laid silt, sand, and gravel alluvium deposits. (Eddy, 1966). The wastewater treatment plant is located at the site of an old sand spit that projected into the Grays Harbor estuary as can be seen in Figure 2, a 1966 base map showing geologic material types. Current maps show the landmass having a different shape as a result of placement of earthfill in this area.

The geologic map of Figure 2 shows the proposed project locations and associated mapped geologic units. Two geologic units are mapped at or near the project sites. These units are Alluvium (Qal) and Tertiary rocks, undifferentiated (Tu) (see legend on geologic map depicted in Figure 2). Alluvium is described in this reference as interbedded river-laid silt, sand, and gravel. Tertiary rocks are undifferentiated and this unit is made up of siltstones, sandstones, conglomerates, and basaltic flows.

3.0 EXISTING INFORMATION

A review of existing information was conducted to provide additional subsurface data at the sites. Existing information includes:

- A discussion of site history.
- Boring logs and locations for the Hoquiam River Bridge and Approach - SR 101 MP 87.2 to 87.45 (located up stream of the waterline crossing).
- A geotechnical letter report for work at the wastewater treatment plant site.

Pertinent site plans and boring logs from the previous explorations are included in Appendix A of this report.

3.1 Site History

It is our understanding that the course of the Hoquiam River may have been altered during the early development of the community. This may have included filling and regrading. Local knowledge suggests that debris of all kind has been encountered and should be anticipated in the regraded/redeveloped areas. Such debris may include logs, stumps, rocks, waste fill, concrete, and construction debris. It is likely that the fill may have been placed with little or no compaction effort. Discussion with a local utility contractor suggests that in many areas, near surface excavations in soils encountered numerous logs and stumps buried in regraded fill.

Remnants of old wood piles are evident along the shores of the Hoquiam River (and in some cases in the river channel). In some places, the old piles were removed; however, in most cases the pile remnants remain or have been cut off at or near the ground line.

3.2 State Route 101 Bridges

This highway project completed in the late 1960's involved four test borings drilled to bedrock. Bedrock consists of sandstone at depths of 78 to 162 feet below the ground surface. The closest boring H-1 is at least 1500 feet west of the waterline river crossing. The boring logs and a plan showing their locations are provided in Appendix A. These logs indicate a mixture of loose to very loose silts and sands with wood and other organic material overlying sandstone bedrock. At these locations, depth to sandstone ranged from approximately 71 feet to 161 feet.

3.3 Wastewater Treatment Facility

Neil H. Twelker & Associates prepared a geotechnical letter report for construction of treatment works at the sewage lagoon (Twelker & Associates, 1977). This report summarizes the explorations, subsurface conditions, and design recommendations for the construction of the existing treatment facilities. A copy of this letter report is provided in Appendix A. A summary of the report is provided below.

Four test borings were completed using a truck mounted hollow-stem auger. Four principal soil units were reported at the site in the letter report. Lagoon dikes are composed of an imported gravelly medium fine sand with a trace of silt. The uppermost 6 ft of natural soil is a gray soft organic silt near the southwest corner. A layer of loose medium fine sand interbedded with layers of sandy silt and silt and occasional organic matter underlies the silt and extends to a depth of more than 19 ft near the southeast corner of the pond. This layer is exposed at the surface elsewhere. A layer of gray soft silt with layers of gray sandy silt, silty sand and fine sand extends to an unknown depth beneath the sand.

4.0 GEOTECHNICAL EXPLORATION PROGRAM

The subsurface exploration program performed by CH2M HILL for the projects described herein, including technical details of the exploration program, are described, presented, and discussed in this section.

4.1 Explorations

The field subsurface exploration program consisted of drilling four (4) test borings for the sewerline at locations shown in Figure 3, five (5) test borings for the waterline shown in Figure 4, and one (1) test boring for the WWTP shown in Figure 5. Complete logs for each of the test borings are presented in Appendix B.

4.2 Soil Classification

Soil samples taken from the test borings were classified visually in the field, in general accordance with ASTM D2488 – *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, by CH2M HILL geotechnical staff. Following the classification of each sample, a portion of the sample was sealed in plastic bags for storage and laboratory testing. Copies of the exploration logs summarizing visual field classifications, SPT blow counts, laboratory test results, and other field observations during the exploration are included in Appendix B. Where necessary, the soil field classifications were revised to reflect the classifications determined by results of laboratory soil testing.

4.3 Laboratory Testing Program

Laboratory testing was conducted on selected soil samples recovered from the test borings. GeoEngineers of Redmond, Washington provided the laboratory testing services under subcontract to CH2M HILL. The testing consisted of:

- ASTM D 422 – *Standard Test Method for Particle-Size Analysis of Soils (Sieve and Hydrometer Analysis)*
- ASTM D 1140 - *Standard Test Method for Amount of Material in Soils finer than the No. 200 (75-μM) Sieve*
- ASTM D 2216 - *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock*
- ASTM D 4318 – *Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*
- ASTM D 2435– *Standard Test Method for One-Dimensional Consolidation Properties of Soils*

Test results are summarized in Table 1. Brief descriptions of the procedures to perform each of these tests along with the test results are presented in Appendix C. Results of the laboratory tests are also incorporated in the comment section of the soil boring logs presented in Appendix B.

Table 1. Summary of Laboratory Test Results

Exploration No.	Sample No.	Depth (ft)	USCS Classification	Natural Moisture Content (%)	Grain Size/Hydrometer Distribution					Atterberg Limits			Dry Density (pcf)
					Percent Gravel (%)	Percent Sand (%)	Percent Fines (P200) (%)	Percent Silt-size (%)	Percent Clay-size (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	
BORING LOGS													
SB-1	S-3	15.0	MH	62	-	-	-	-	-	53	43	10	
SB-1	S-7	35.0	SM	40	0	71	29						
SB-2	S-11	55.0	ML	53	-	-	79	63	16				
SB-2	S-14	70.0	SM	41	0	70	30						
SB-3	S-4	20.0	MH	73	-	-	-	-	-	66	45	21	
SB-3	S-11	55.0	SM	32	0	82	18						
SB-4	S-5	25.0	MH & (SM)	70	-	-	62						
SB-4	S-8	40.0	ML & (SM)	52	-	-	57						
WB-1	S-1	5.0	MH	106	-	-	-	-	-	100	49	51	
WB-1	S-3	15.0	SM	47	-	-	48						
WB-2	S-4	20.0	SM	39	-	-	17						
WB-2	S-7	35.0	ML	61	0	47	53						
WB-3	S-6	30.0	SM	49			40						
WB-3	S-10	50.0	ML	47	0	47	53	40	13				
WB-4	S-4	20.0	MH	65	-	-	-	-	-	59	40	19	
WB-4	S-5	25.0	MH	73	-	-	93	79	14				
WB-5	S-9	45.0	SP-SM	39	0	89	11						
PB-1	S-1	5.0	(SM)	20									
PB-1	S-2	10.0	SM	34	2	81	17						
PB-1	S-3	15.0	(SM)	33									
PB-1	S-4	20.0	(OH)	54									
PB-1	ST-1	22.0	OH	53	0	14	86	68	18	57	36	21	70.2
PB-1	S-5	25.0	(OH)	63									
PB-1	S-6	30.0	SM	47	1	62	37						
PB-1	S-7	35.0	SM	46	-	-	41						

Notes:

1. Depths listed in table for boring samples reference the top of the split-spoon sample. Refer to boring logs in Appendix B for more details on depths of each sample listed in the table.
2. "Silt-Size" and "Clay-Size" are based on grain size only - not plasticity data (silt and clay division at 2μm).
3. USCS Classification in parentheses ie. (SM) have not been verified by laboratory tests.

5.0 RESULTS OF THE EXPLORATION PROGRAM

This section summarizes the subsurface soil conditions at the project site based on information gathered from the test borings and on results of laboratory soil testing on samples recovered from the borings.

5.1 Sewerline River Crossing

General soil conditions for each test boring is provided in the soil boring logs provided in Appendix B. Figure 3 shows the test boring locations within the limits of the project in plan view.

Test Boring SB-1 and SB-2 were drilled on the East side of the river adjacent to the alignment of the sewerline crossing. The ground surface was covered with thick grass and broken tree branches from nearby trees. The subsurface at SB-1 and SB-2 consisted of soft organic soil with roots and decomposing wood pieces up to about 6 ft depth. The organic soil was underlain by soft elastic silt (MH) up to a depth of 20 ft. The elastic silt contained wood and roots. Interbedded loose to medium dense silty sand (SM) and very soft to soft sandy silt (ML) were encountered underneath the elastic silt and extended to about 98 ft in SB-2. The

interbedded silty sand and sandy silt was underlain by soft silt to soft clay extending to an unknown depth. SB-1 and SB-2 were terminated at 60 ft and 100 ft depth respectively. Observation wells were not installed in these borings. The depth to the groundwater level was estimated to be within 5 feet of the ground surface based on moisture contents of the cuttings and from the samples collected from the borings.

Test Boring SB-3 and SB-4 were drilled on the West side of the river adjacent to the alignment of the sewerline crossing. The ground surface at SB-3 was covered with thick grass, broken tree branches from nearby trees, and cobbles and boulders. At SB-4 the ground surface was covered with light grass. The subsurface at SB-3 and SB-4 consisted of silt with sand and silty sand with roots and decomposing wood pieces up to about 6 ft depth. A layer of soft elastic silt (MH) interbedded with occasional layers of silty sand extended from about 7 ft up to a depth of about 33 ft at SB-3 and about 37 ft at SB-4. Decomposed wood and preserved wood was found in that layer. Interbedded loose to medium dense silty sand (SM) and very soft to soft sandy silt (ML) were encountered underneath the elastic silt and extended to about 98 ft. This layer contained wood debris as well. The interbedded silty sand and sandy silt was underlain by soft silt to soft clay extending to an unknown depth. SB-3 and SB-4 were terminated at 100 ft depth and 60 ft depth respectively.

It has been reported that this area may have been filled in the past as a result of re-alignment of the river channel. The exact location of the old river channel is not known but regrading to fill and reshape the landform may have resulted in filling with soil, rock, debris, and other materials that could result in obstruction to the proposed subsurface work. Observation wells were not installed in these borings. The depth to the groundwater level was estimated to be within 5 feet of the ground surface based on moisture contents of the cuttings and from the samples collected from the borings.

5.2 Waterline River Crossing

General soil conditions for each test boring is provided in the soil boring logs provided in Appendix B. Figure 4 shows the test boring locations within the limits of the project in plan view.

WB-1, WB-5, and WB-2 were drilled north of the river adjacent to the alignment of the waterline crossing. The ground surface at WB-1 was covered with thick grass and broken tree branches from nearby trees. WB-5 was drilled in the pavement in the 18th St., and WB-2 was drilled in the grass part of the sidewalk north of the river.

The subsurface at WB-1 consisted of a soft elastic silt (MH) with roots and wood up to about 7 feet depth. The elastic silt was underlain by a layer of silty sand (SM) interbedded with silt (ML) layers and extended to about 20 ft depth. The interbedded silty sand and silt layers was underlain by very dense sandstone which extended to an unknown depth. WB-1 was terminated at 40 ft depth.

The subsurface at WB-5 consisted of 18- to 24-inches of subbase underlain by a layer of soft elastic silt (MH) with roots and scattered organics up to about 12 ft. The elastic silt was underlain by loose silty sand (SM) with occasional wood debris up to a depth of about 33 ft. The silty sand was underlain by a layer of loose poorly graded sand with silt (SP-SM) up to a depth of about 50 ft. The poorly graded sand with silt consisted predominantly of fine

sand with occasional wood. The poorly graded sand with silt was underlain by very dense sandstone which extended to an unknown depth. WB-2 was terminated at 55 ft depth.

The subsurface at WB-2 consisted of a 33-ft deep layer of very loose silty sand (SM) with roots and wood interbedded by silt layers. The driller reported drilling through a thick wood log at about 15 ft depth. The silty sand was underlain by sandy silt (ML) with some sandy silt (SM) lenses up to a depth of about 54.5 ft. The sandy silt layer contained decomposed and preserved wood debris. Very dense sandstone was encountered at 54.5 ft depth. The boring was terminated at 60 ft depth.

Based on reports from local contractors, it is believed that many logs, stumps, and large woody debris exists throughout this area. Utilities and other underground work in the area have apparently encountered many large stumps and logs in this area. Observation wells were not installed in these borings. The depth to the groundwater level was estimated to be 5 to 10 feet below the ground surface based on moisture contents of the cuttings and from the samples collected from the borings. The groundwater may be higher during seasonally wet times of the year.

WB-3 and WB-4 were drilled south of the river adjacent to the alignment of the waterline crossing in the paved parking area of the Hoquiam Police Station as shown in Figure 4. The subsurface at WB-3 and WB-4 consisted of lean clay (CL) and silt (ML) up to about 18 ft in WB-3 and 32 ft in WB-4 and contained wood. The silt was underlain by a layer of silty sand (SM) interbedded by sandy silt layers (ML) and extended to an unknown depth. The silty sand layer contained decomposed and well preserved wood. WB-3 was terminated at 100 ft and WB-4 was terminated at 60 ft.

It has been reported that this area may have been filled in the past as a result of re-alignment of the river channel. The exact location of the old river channel is not known but regrading to fill and reshape the landform may have resulted in filling with soil, rock, debris, and other materials that could result in obstruction to the proposed subsurface work. Observation wells were not installed in these borings. The depth to the groundwater level was estimated to be within 5 feet of the ground surface based on moisture contents of the cuttings and from the samples collected from the borings.

5.3 UV Disinfection Facility

General soil conditions for the test boring PB-1 is provided in the soil boring logs provided in Appendix B. Figure 5 shows the test boring locations within the limits of the project in plan view. PB-1 was drilled in the southwest corner of the facility adjacent to the proposed new electrical building. The ground surface consisted of fine to coarse gravel underlain by about 2 ft of silty sand (SM) fill material. The fill material was underlain by loose silty sand (SM) with some silt (ML) layers to a depth of about 18 ft. The silty sand layer was underlain by a very soft organic soil with sand (OH) to a depth of 28 ft. The organic soil was underlain by loose to medium dense silty sand (SM) interbedded by sandy silt layers and extended to an unknown depth. Wood debris was throughout the hole depth of the boring. PB-1 was terminated at 50 ft.

An observation well was not installed in this boring. The depth to the groundwater level was estimated to be at about 5 feet below the existing ground surface based on elevations of the adjacent sewage lagoon, water lev3els in the adjacent bay, and moisture contents of the cuttings and from the samples collected from the borings.

6.0 LIMITATIONS

This Geotechnical Data Report has been prepared for the exclusive use of the City of Hoquiam for specific application to the River Sewerline Crossing, River Waterline Crossing, and UV Disinfection Facility projects, in accordance with generally accepted geotechnical engineering practice. No other warranty, express or implied, is made.

The logs of soil borings by CH2M HILL indicate the subsurface conditions only at the specific locations and times of sampling, and only to the depths penetrated. They do not necessarily reflect strata variations that may exist between test exploration locations, nor do they necessarily reflect changes in groundwater conditions with time. If variations in subsurface conditions from those described are noted during construction or subsequent explorations, the information in this Geotechnical Data Report may need to be re-evaluated.

CH2M HILL is not responsible for any claims, damages, or liability associated with the interpretation of subsurface data or reuse of the subsurface data by others without the express written authorization of CH2M HILL.

7.0 REFERENCES

Eddy, Paul A. (1996). *Preliminary Investigation of the Geology and Ground-Water Resources of the Lower Chehalis River Valley and Adjacent Areas, Grays Harbor County, Washington*. Division of Water Resources, Department of Conservation, State of Washington, Water Supply Bulletin No. 30.

Hoquiam River Bridge and Approach (1969). SR 101 MP 87.20 to 87.45. Washington State Highway Commission, Department of Highways.

Twelker & Associates (1977). *Soils and Foundation Investigation, Moon Island Sewage Treatment and Outfall, Hoquiam, Washington*. Prepared for Mr. Martin Dirks. July 15, 1977.

Figures

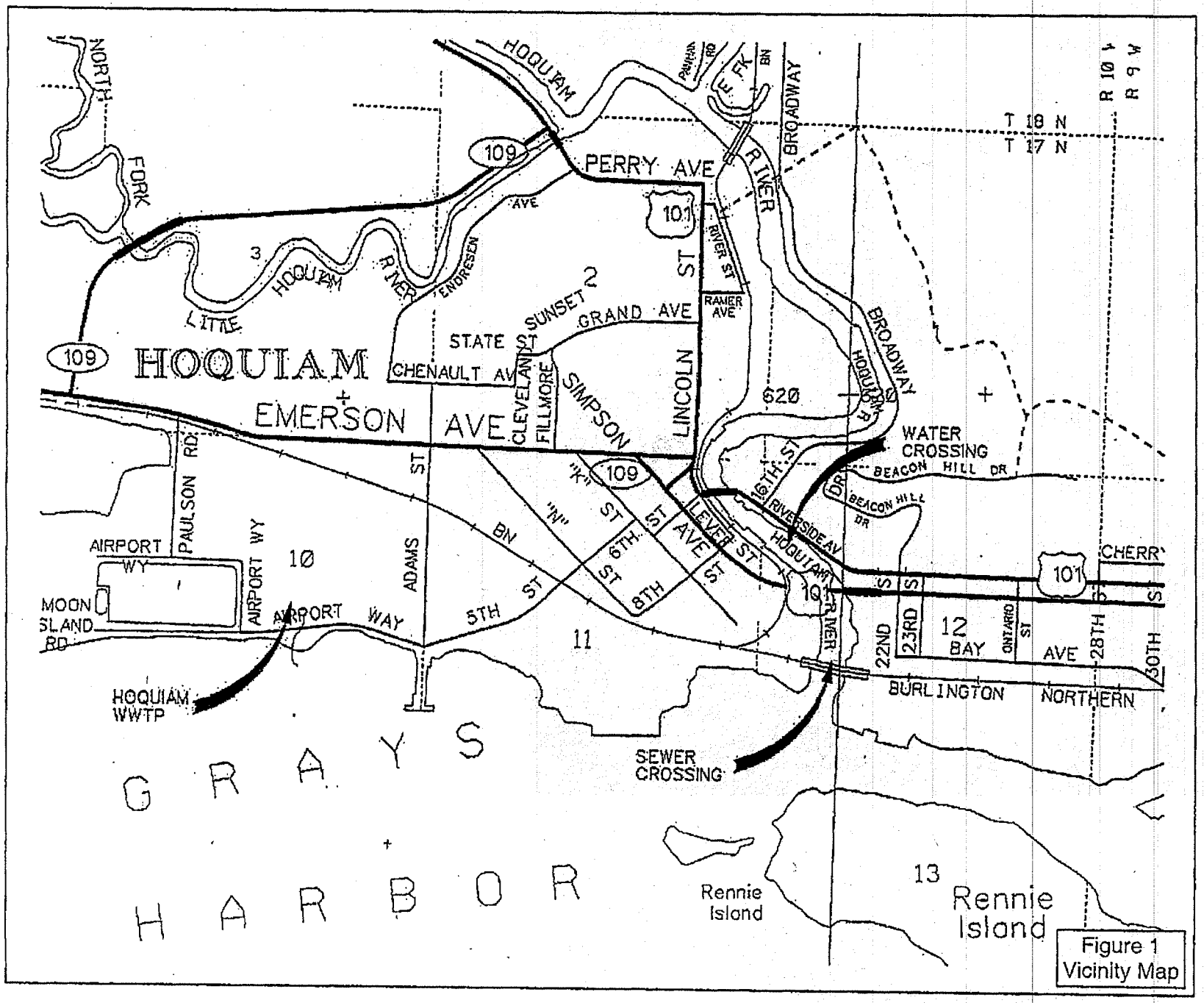


Figure 1
Vicinity Map

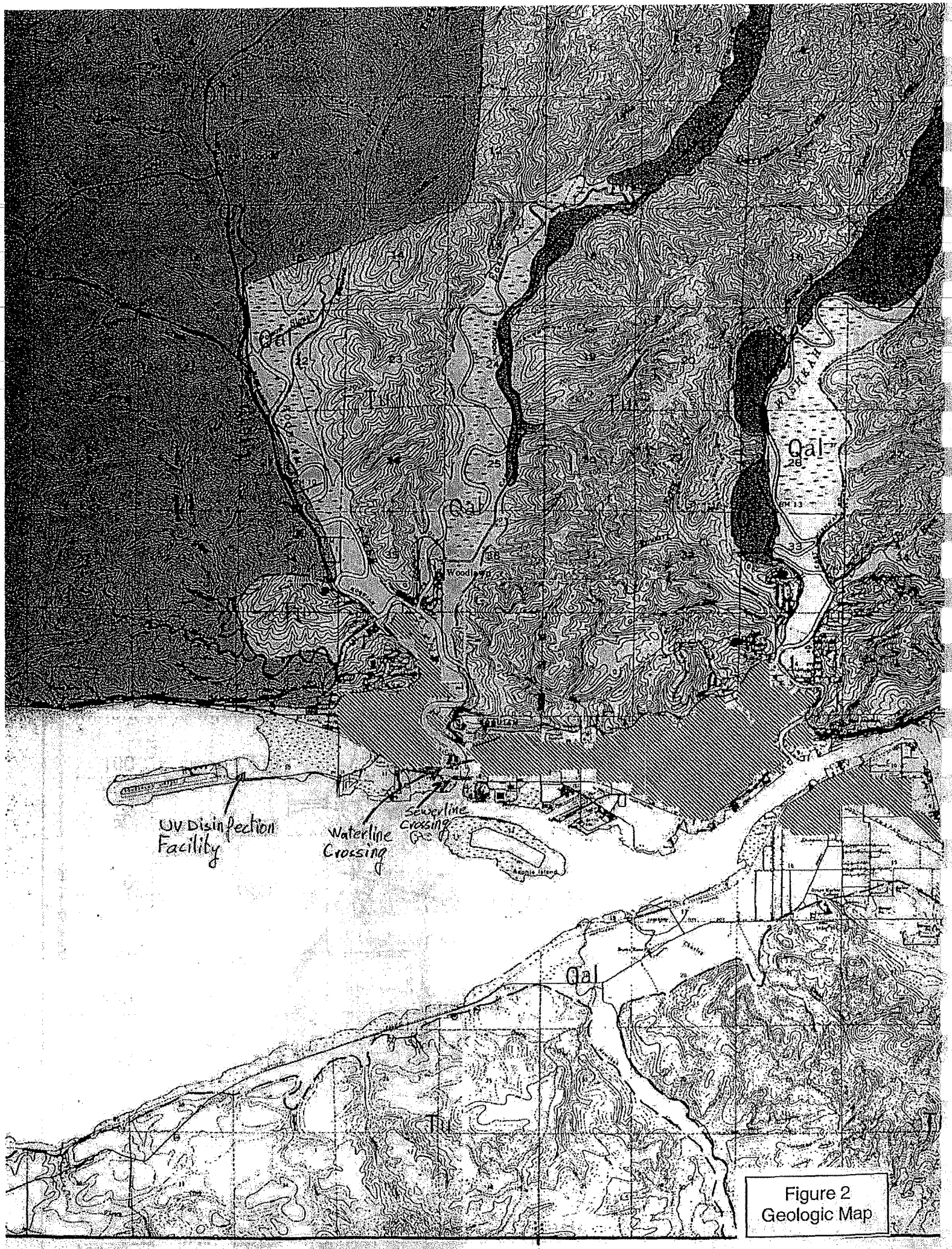
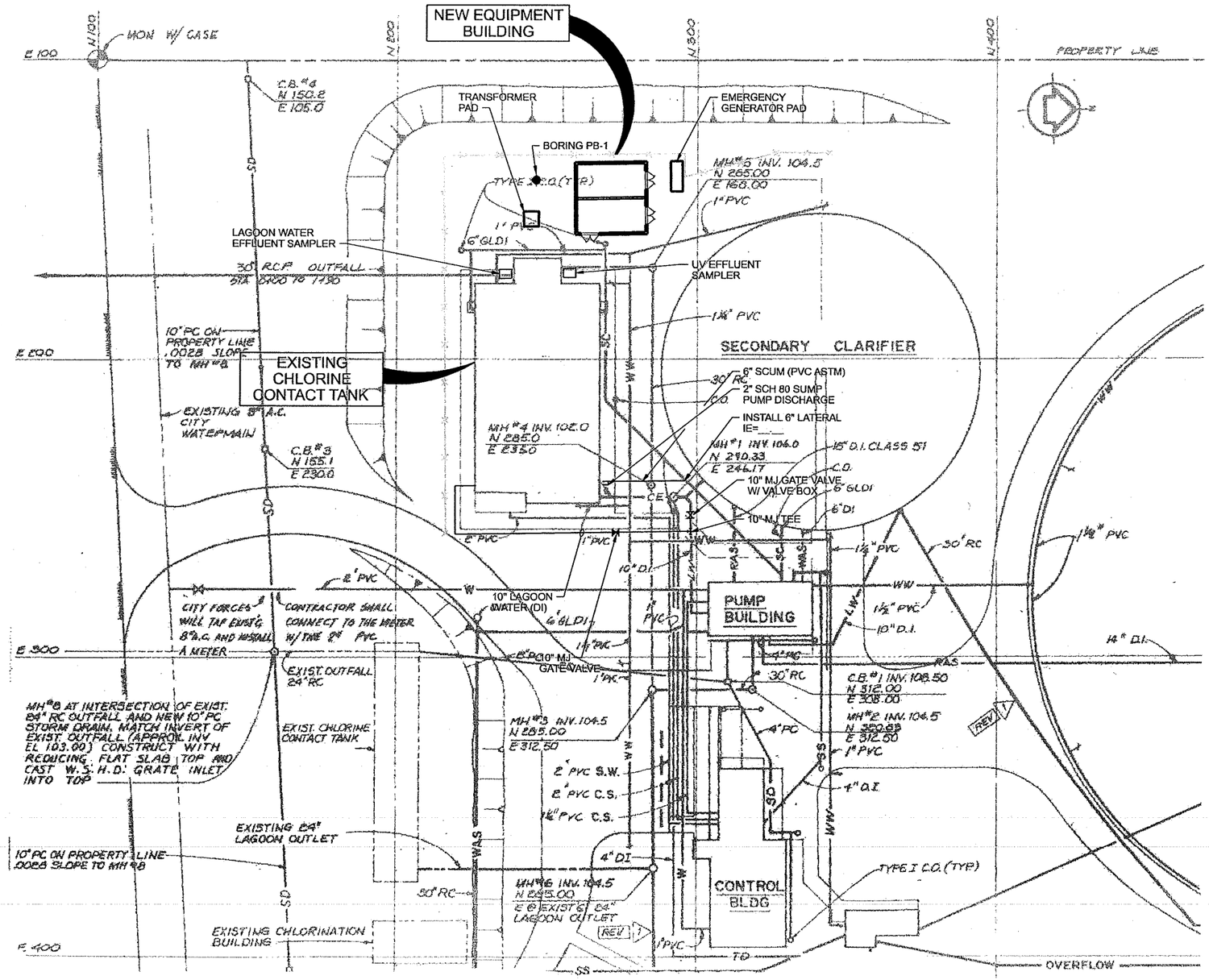


Figure 2
Geologic Map



SITE PLAN
1"=20'

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL

CITY OF HOQUIAM, WASHINGTON
HOQUIAM WWTP
UV DISINFECTION ENGINEERING REPORT

Figure 5
SITE MAP
FOR PROPOSED UV DISINFECTION FACILITY

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Appendix A

PREVIOUS GEOTECHNICAL INVESTIGATION

TELEPHONE MAIN 4-3946

NEIL H. TWELKER & ASSOCIATES

CONSULTING SOILS ENGINEERS

Alaska Trade Building
Mail To: P.O. Box 21328
Seattle, Washington 98111

July 15, 1977

Kramer, Chin and Mayo
1917 - 1st Ave
Seattle, Washington

Attention: Mr. Martin Dirks

Re: Soils and Foundation Investigation, Moon Island Sewage Treatment and Outfall, Hoquiam, Washington

Gentlemen:

At your request we have conducted a soils and foundation investigation for a proposed sewage treatment facility and outfall for the City of Hoquiam, Washington. We submit herewith a report of our findings, conclusions and recommendations.

Site Description The site is located on a low-lying level area north of Moon Island Road and adjacent to the tidal flats west of downtown Hoquiam. The existing sewage lagoon measures approximately 2400 feet in an east-west direction and 1200 feet north-south. The site to be developed for the treatment works is located at the southwest corner of the existing lagoon. South of Moon Island Road, a six to seven foot high rip-rap seawall drops to the level of the tidal flats. The proposed outfall line extends south across the flats to the channel edge, where a diffuser section will be installed. Soils exposed on the upland are a tan sandy silt; on the tideflats a gray to brown soft silt.

Subsurface Exploration In order to determine the subsurface soils characteristics at the site, four test borings were made using a truck mounted hollow-stem power agger. Samples were taken at 5 foot intervals with the Standard Penetration Test, in which a 2 inch OD split-spoon sampler is driven into the undisturbed soil formation at the bottom of the boring by repeated blows of a 140-lb pin-guided hammer falling 30 inches. The number of blows required to advance the sampler a given distance is a measure of the soil consistency. Additional explorations were conducted by hand equipment on the tidal flats along the proposed outfall line. Logs of the borings were combined with topographic information to construct the geologic sections shown in Figs. 1 and 2, attached.

Subsurface Conditions Four principal soil units occur on the site; these are described briefly as follows:

1. The lagoon dikes are composed of a gravelly medium fine sand with a trace of silt, imported to the site.

2. The uppermost natural soil unit is a gray soft organic silt extending to a depth of 6 feet near the southeast corner of the pond. It appears to taper out to the north and west.

3. Underlying the silt, and exposed elsewhere at the surface is a unit of loose medium fine sand with layers of sandy silt and silt and occasional organic matter. It extends to a depth of more than 19 feet near the southeast corner of the pond.

4. Beneath the sand, and exposed at the surface on the tide-flats is a unit of gray soft silt with layers of gray sandy silt, silty sand and fine sand up to 2 feet thick. It extends to an unknown depth.

Groundwater was encountered as a free standing water table 1.5 to 3 feet below ground surface on the upland and the tide flats.

Conclusions and Recommendations On the basis of our observations at this site; we draw the following principal conclusions:

1. The entire lagoon area is underlain by a sequence of loose fine sands, underlain in turn by a deep deposit of soft silt in which layers of sandy silt and silty sand are found. The soil horizons may be described as highly compressible and of low shear strength. Appreciable increases of area load will result in pronounced settlement of grade supported structures and, to a considerable extent of surrounding area.

2. Where the upper soil units are of granular composition, they are of low to moderate permeability. Excavations made below the permanent groundwater table in the upper units may be dewatered to some degree by means of wells or well points. The underlying silt unit, however, is of very low permeability and probably cannot be dewatered by construction methods in normal use in the Pacific Northwest.

3. Construction of above-grade buildings, tanks, weirs, dikes, and other important and/or settlement critical facilities will result in substantial settlement (and resulting architectural damage and/or loss of function) unless definite steps are taken to provide adequate structural support. For very light loads (e.g., training walls, weirs, etc) adhesion piling may be used. Adhesion piles will effectively distribute loads of limited total magnitude and local extent to the soft soil layers beneath the site. Large loads or loads distributed over a substantial area can be carried directly to the under-

lying soil by in-situ improvement of the soil units using a pre-load system. Additional details on both piling and pre-load (or surcharge) methods of treatment are discussed in subsequent paragraphs.

4. Site Preparation We anticipate that site preparation operations in the treatment plant area will proceed according to the following steps:

a. Construction of a new outlet weir for the existing sewage lagoon immediately east of the existing chlorine house.

b. Closing off of the existing channel which connects the lagoon with the present contact basin, followed by de-watering of the contact basin and cleaning of the bottom to expose the underlying soil.

c. Making of a subaqueous excavation in the area to be occupied by the future clarifier. During this operation (or following it, as contractor's preference may dictate) the "pre-placed drainage fill" is installed. This should consist of river run gravelly sand of 2-inch maximum size.

d. Placement of unclassified fill above the preplaced drainage fill.

e. Placement of the structural fill in the area to be occupied by buildings.

f. Placement of preload throughout the entire area of the clarifier, the chlorine contact tank, control building and pump building.

g. The intensity of preload should be sufficient to induce vertical pressures throughout the foundation twenty per cent above those anticipated upon completion of construction.

h. The foregoing steps complete the initial site preparation. The preload must be allowed to remain for a period of time estimated to be 4 to 6 months, during which time observations will be made of settlement plates installed at strategic locations throughout the construction area. When analysis of results indicates that settlement equivalent to that calculated for final construction has occurred, the preload may be removed and disposed of off site and the wastewater facility construction may be commenced.

i. We point out that many of the site preparation steps (as well as subsequent construction operations) may involve the use of equipment which will intrude into air space needed for the nearby air field approach; we recommend that the appropriate steps be taken to resolve any conflict in this regard.

5. Clarifier Construction The construction of the clarifier will involve removal of the preload and the unclassified fill beneath it, to expose the preplaced drainage fill. In order to accomplish this operation the preplaced drainage fill must be dewatered by means of wells or well-points. The configuration of the preplaced drainage fill will allow open slopes to be used in the excavation. Backfill of the structure may be made with unclassified material or with granular material, depending upon the ability of the structure to withstand the higher loads imposed by fine-grained materials which will be available at the project site. Lateral forces exerted by the native silts may be calculated as 50 H per sq ft for a rectangular stress block (where H = the height of wall). Granular fill will exert a load of 20 H psf (same basis).

Upon cessation of the dewatering effort the piezometric level within preplaced drainage fill is expected to return to its present level. In this event, suitable precautions must be taken to prevent flotation of the clarifier.

We estimate that differential settlement of the clarifier will approximate 1 inch.

6. Oxidation ditch Features of interest in the oxidation ditch are (1) the supports for the two rotor assemblies and their bridges, (2) the peripheral pile-supported wall, and (3) the two sets of pile-supported turning vanes at either end of the exidation ditch. The rotors, the turning vanes, the perhipheral walls and the central shear wall will all be supported on treated timber piling. Soil conditions at the site are such that all piling will function as adhesion elements. These can be driven to the desired grades with little or no resistance. Upon completion of pile driving, resistance will accrue gradually through "set-up" following which time (estimated to be one or two weeks) both vertical and lateral loads may be sustained. We estimate that treated timber piling which penetrate 30 feet into the soft silt may carry vertical loads of 10,000 lbs each, and lateral loads of as much as 750 lbs. Continuous lateral loads against the piling may result in a gradual loss of alignment. This would be a serious matter in the rotor supports and could also result in some structural distress in the deflection vanes and in the peripheral walls.

The piling which support the rotors would be able to function without the need for lateral resistance if driven as battered elements (1 to 8). Structural distress caused by yielding of piling in the turning vanes can best be prevented by strapping the 3 X 12 caps together, thereby allowing the entire structure to function as a unit. We estimate the lateral pressure against the peripheral wall to be 150 lbs per lineal foot. This will be resisted by embedded portions of the piling and will also be resisted by the wedge of granular materials at the base of the pre-cast panel which forms the peripheral training wall.

7. Outfall and Diffuser Soil conditions throughout the area of the outfall and diffuser are shown in Fig. 1. The area can be traversed by suitable equipment at appropriate stages of the tide. Satisfactory condtions of foundation and trenching will be encountered throughout; no special provisions need be made for pipe support, other than bedding, for which river-run sand and gravel may be used.

8. Construction Materials Construction operations in the wastewater facility will involve materials to be used as preplaced drainage fill, structural backfill, surcharge, and backfill of structures. Materials available on the project site will consist primarily of fine-grained silt whose moisture content will be far above optimum and which can be moved and worked only with some difficulty. The preplaced drainage fill and structural fill should be clean pervious material of 2-inch maximum size. River run sand and gravel from the local suppliers will be satisfactory for this purpose. Where the terms "unclassified" or "native soil" are used in describing earth work operations (on contract drawings), any material available on the project may be used at the contractor's option. Inasmuch as the purpose of surcharge is merely to add weight, any convenient material may be used. Backfill material may consist either of river-run sand and gravel or native material, depending on the tolerance for lateral pressures and uses to be made of the completed surface of the backfilled area.

We shall be pleased to provide such additional assistance as you may request during the completion of plans and specifications for this project, to assist in explaining the concepts to prospective bidders, to observe construction operations for conformance with criteria presented herein, and to assist in resolution of unforeseen conditions at the time of construction.

Very truly yours,

NEIL H. TWELKER & ASSOCIATES

Neil H. Twelker

Neil H. Twelker

NEIL H. TWELKER STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER

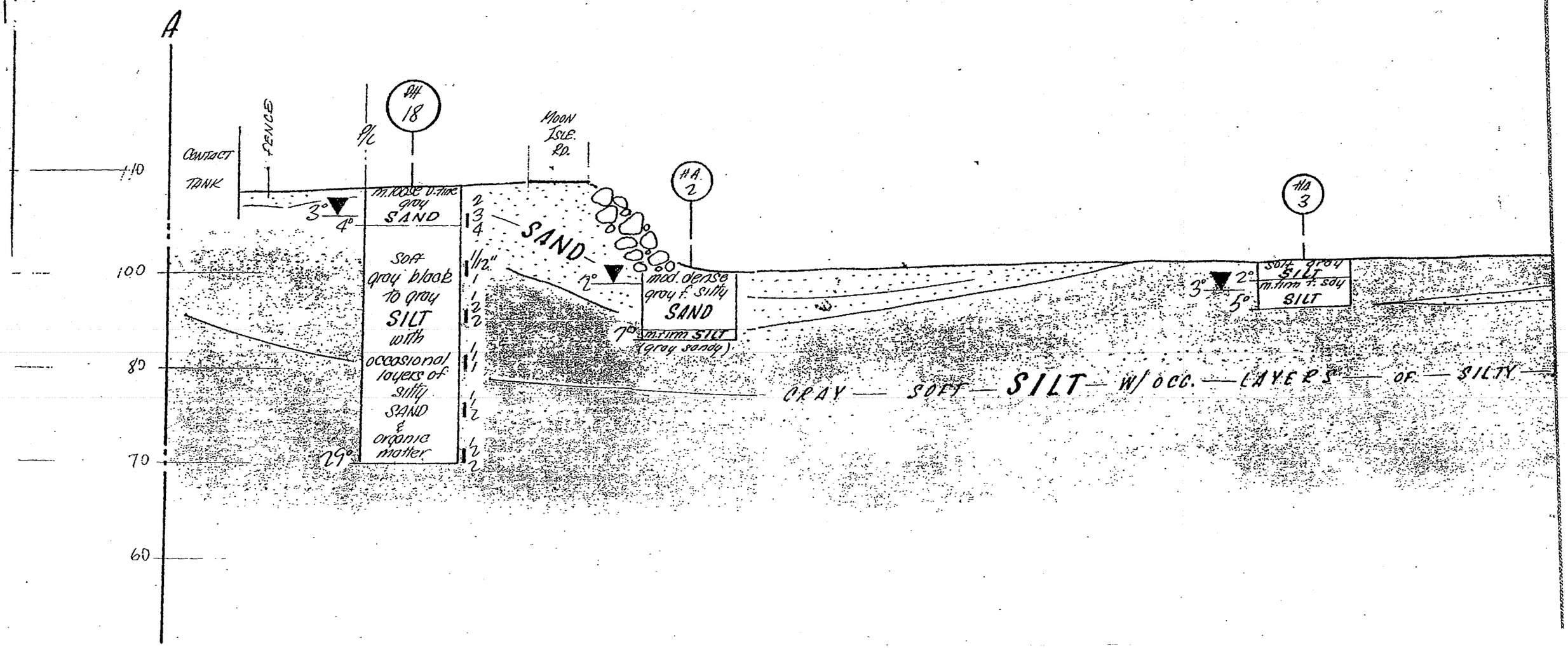
NHT:amt
Incls: Figs. 1 & 2

· LEGEND ·

▼ — GROUNDWATER LEVEL

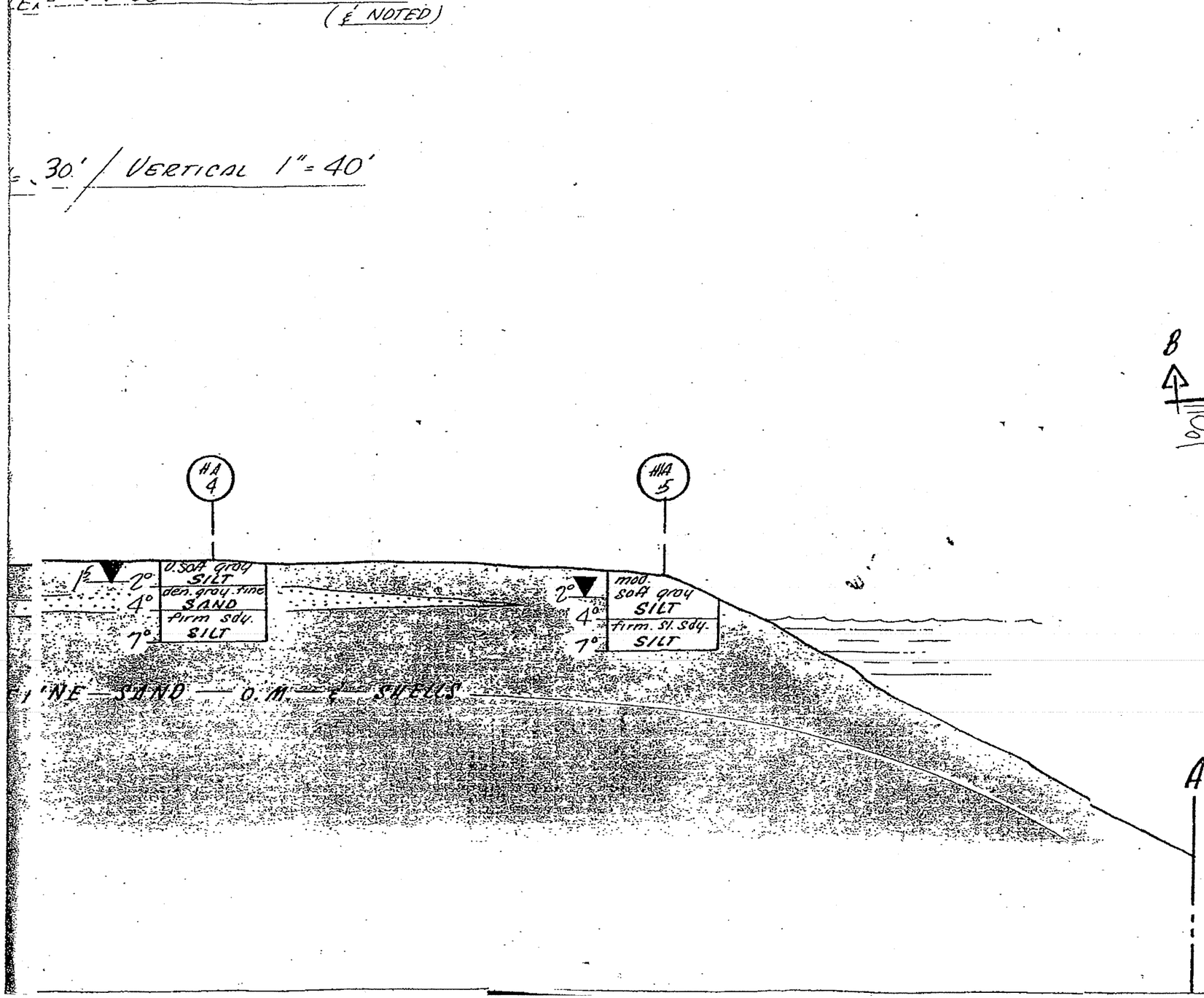
1/2/3 etc — STANDARD PENETRATION TEST: WT. FALLING 30" TO DRIVE 2" O.D. SAMP

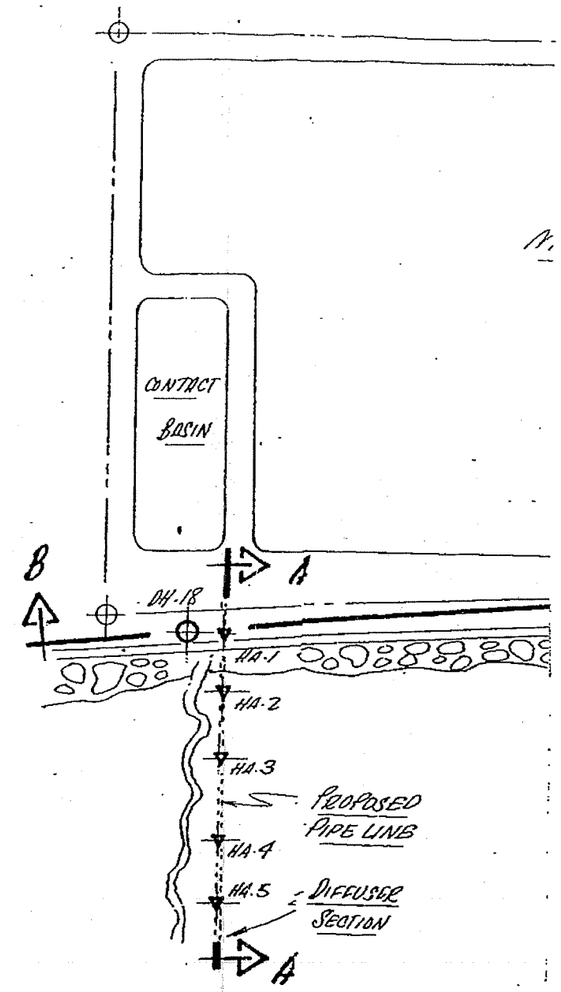
SCALE (A-A' ONLY) HORIZONTAL 1"



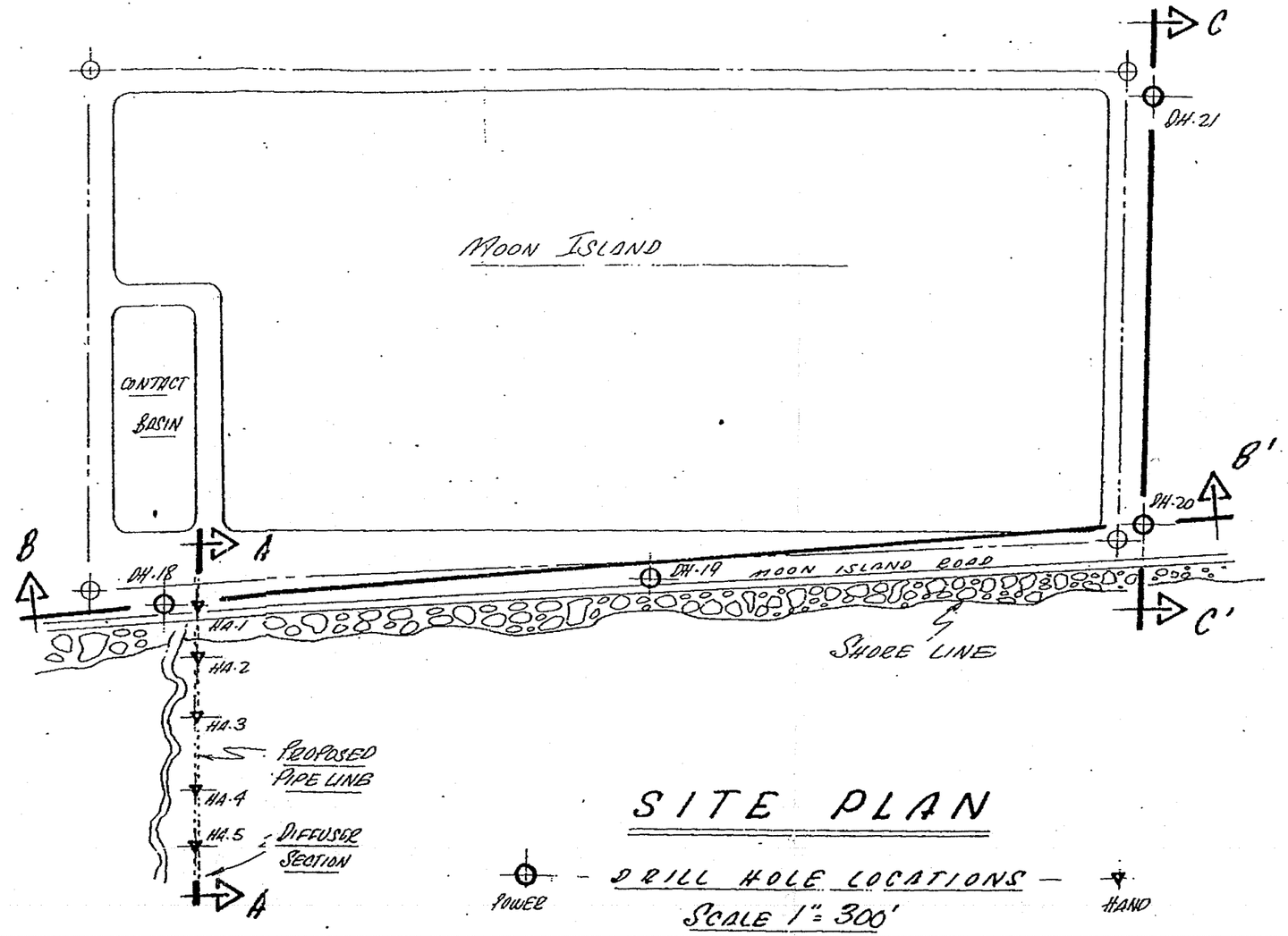
N b. OF BLOWS REQ'D WITH 140 lb.
EX ? 18". BLOWS RECORDED EVERY 6".
(E NOTED)

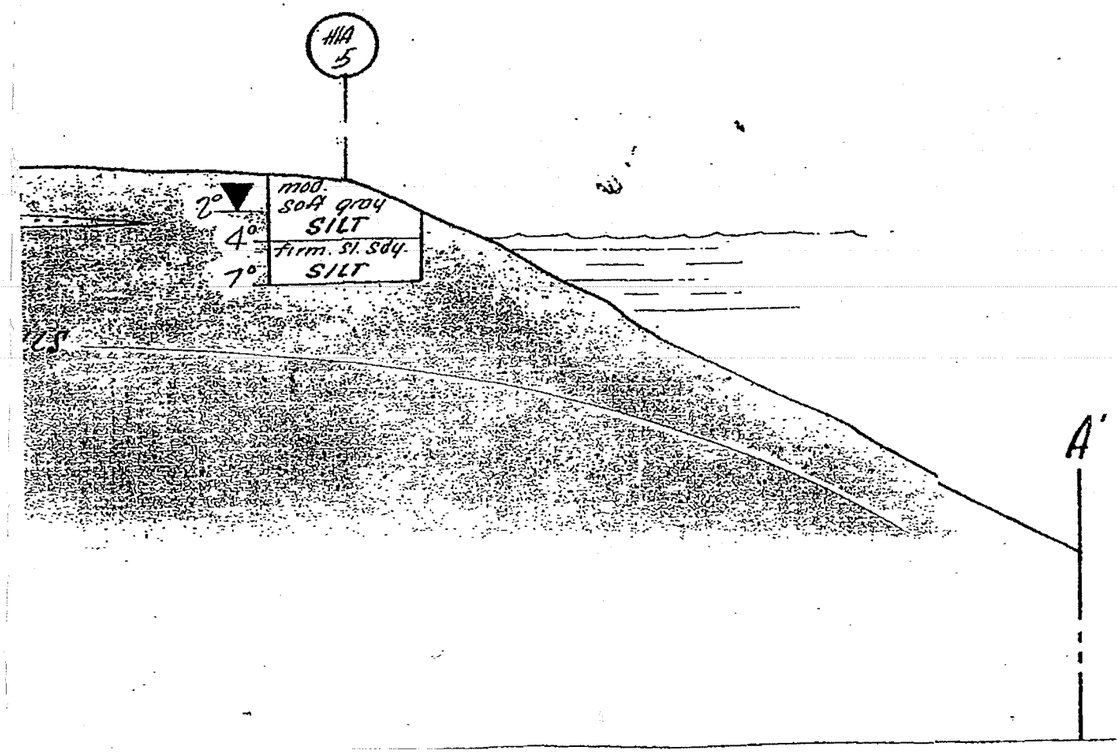
= 30' / VERTICAL 1" = 40'





1b.





SITE PLAN

POWER — DRILL HOLE LOCATIONS — HAND

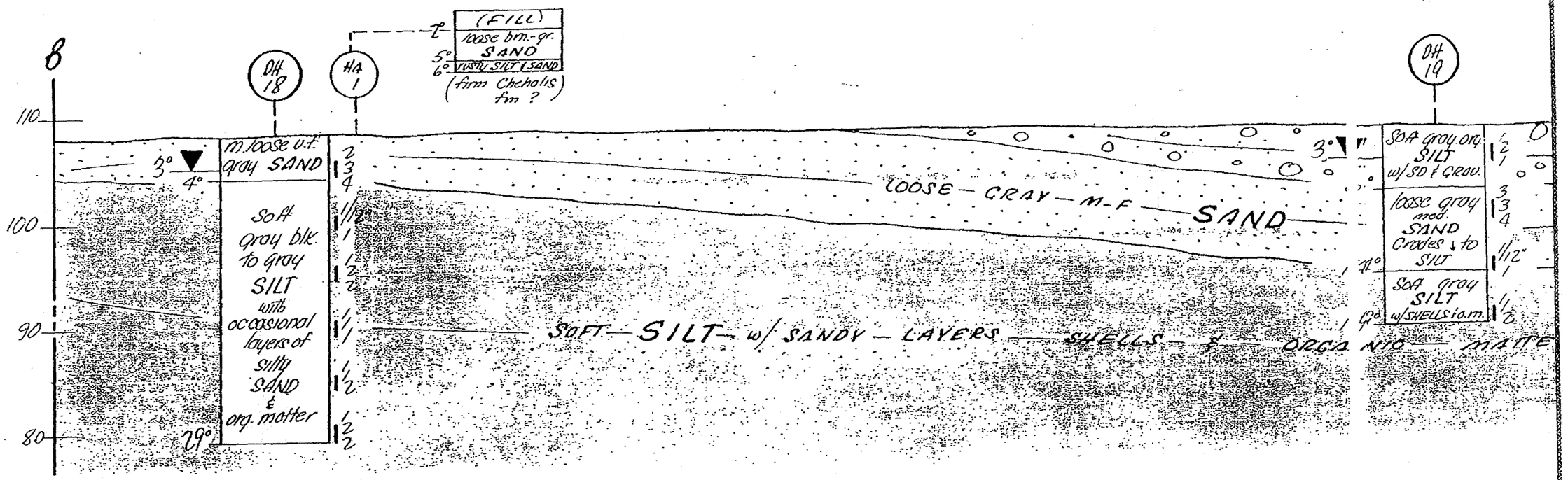
SCALE 1" = 300'

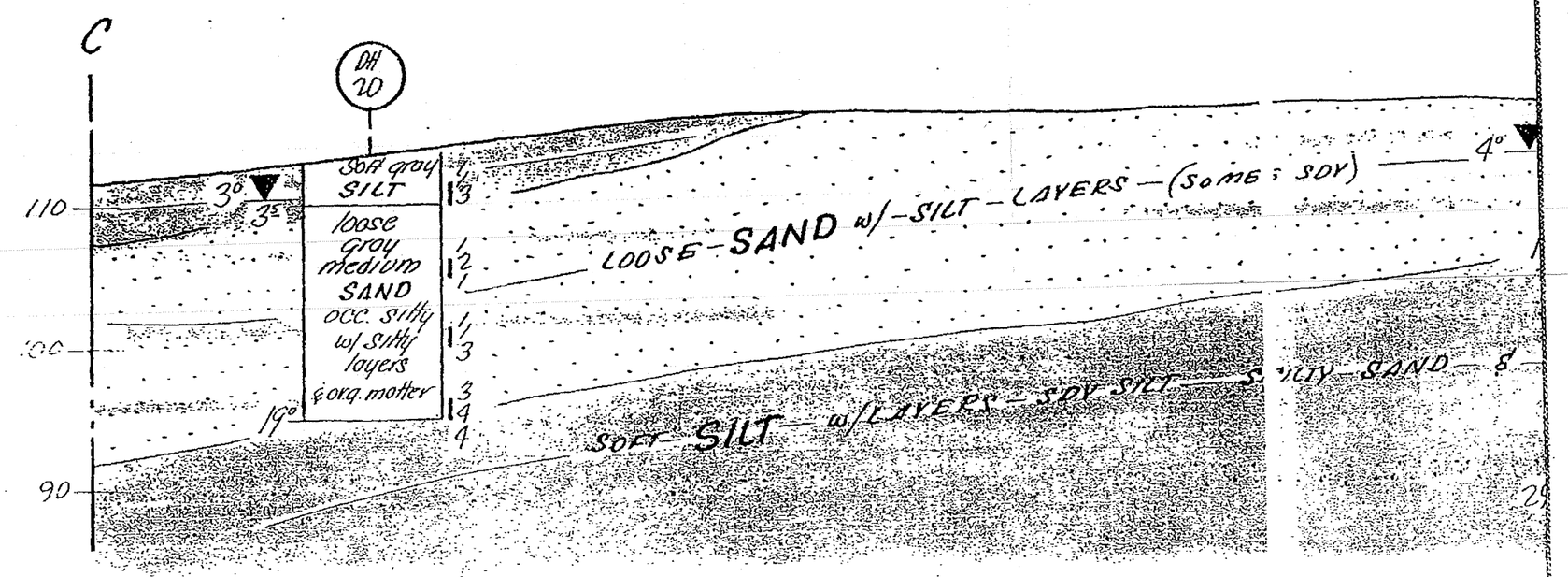
HOQUIAM WASHINGTON

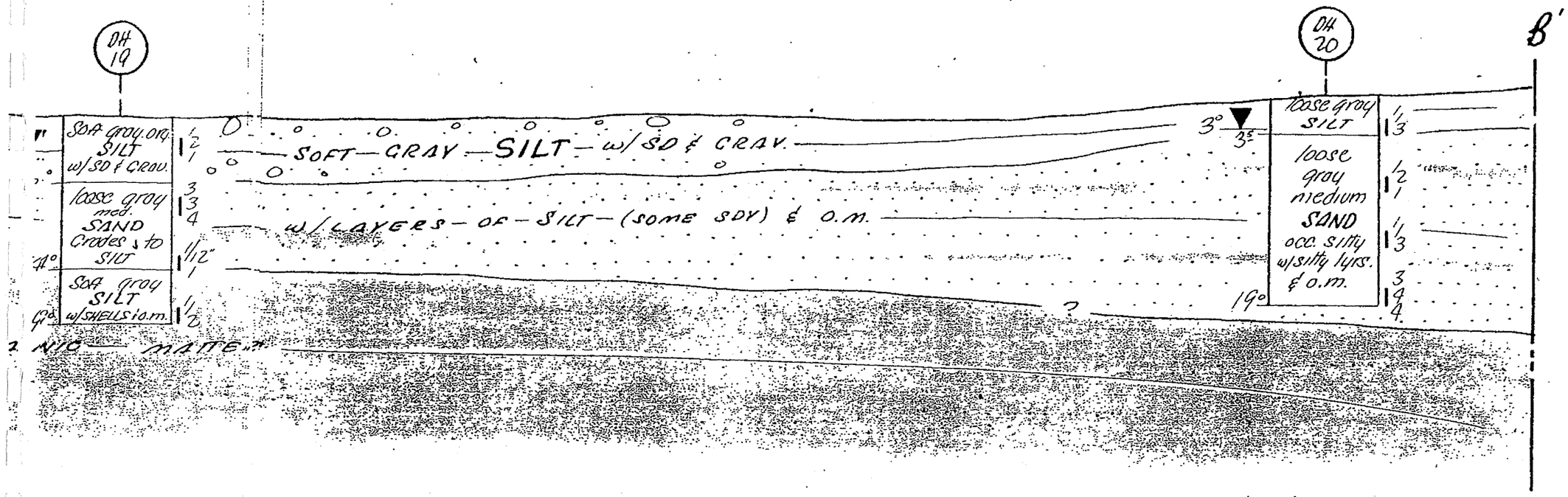
MOON IS. SEWAGE LAGOON

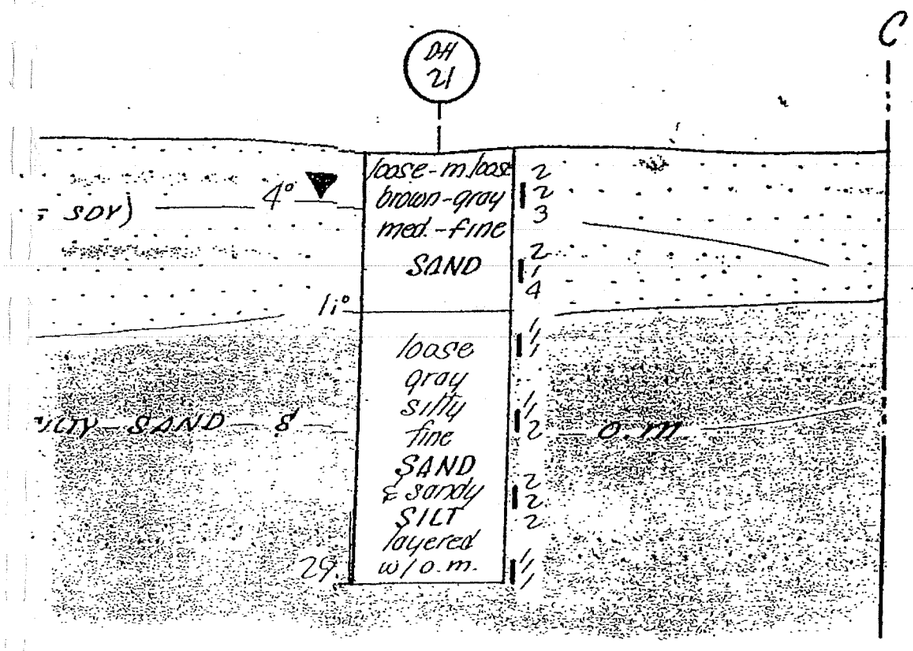
KRAMER CHIN & MAYO ENGRS.

SUBSURFACE EXPLORATION
GEOLOGIC SECTIONS & SITE PLAN
BY: NEIL H. TWELKER & ASSOC.


B
DH 18
HA 1
DH 19
(FILL)
loose brn.-gr. SAND
rusty SILT & SAND
(firm Chehalis fm ?)
110
100
90
80
m. loose v.f. gray SAND
Soft gray blk. to gray SILT with occasional layers of silty SAND & org. matter
LOOSE - GRAY - M-F - SAND
SOFT - SILT - w/ SANDY - LAYERS - SHELLS - & - ORGANIC - MATTE
Soft gray org. SILT w/ SD & GRAV.
loose gray med. SAND Grades ↓ to SILT
Soft gray SILT w/ SHELLS i.o.m.


C
DH 20
110
100
90
Soft gray SILT
loose gray medium SAND occ. silty w/ silty layers & org. matter
LOOSE - SAND w/ - SILT - LAYERS - (SOME : SOY)
SOFT - SILT - w/ LAYERS - SOY SILT
SILTY - SAND





SCALE: HORIZONTAL 1" = 100'
VERTICAL 1" = 10'

HOQUIAM WASHINGTON
MOON IS. SEWAGE LAGOON
KRAMER CHIN & MAYO ENGRS.

SUBSURFACE EXPLORATION
GEOLOGIC SECTIONS
BY: NEIL H. TWELKER & ASSOC.

FIG.

CH2MHILL

PROJECT NUMBER: 184515.UV.50 **BORING NUMBER:** PB-1

SOIL BORING LOG

PROJECT: City of Hoquiam wastewater treatment plant. **LOCATION:** SW corner of WWTP.
ELEVATION: Not measured **DRILLING CONTRACTOR:** Gregory Drilling, Inc.
DRILLING METHOD AND EQUIPMENT: CME 850, mud rotary, 3-7/8" drag bit, auto hammer.
WATER LEVELS: See log. **START:** 06/8/04 11:30 **FINISH:** 06/8/04 13:15 **LOGGER:** M. Bouchedid

DEPTH BELOW GROUND SURFACE	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface Surface is gravel 1" to 2" thick.	Driller dug a 1.5' hole with the shovel, found gray silty sand at 1' depth. Zero blow count indicates sampler advanced under weight of hammer. The groundwater table is estimated at 5 ft below ground surface or higher.
5	S-1	SS	5	3-2-7 (9)	**SILTY SAND (SM),** gray, rust orange staining near top, wet, loose, predominantly fine to medium sand, fine to coarse gravel, wood, est. 20% low plastic fines.	S-1 index tests: wc = 20%
10	S-2	SS	6	2-2-3 (5)	**SILTY SAND, SM,** gray to light brown, some bluish lenses, wet, loose, predominantly very fine to fine sand, traces of organics, low plastic fines.	S-2 index tests: Gravel = 2% P200 = 17% Sand = 81% wc = 34%
15	S-3	SS	6	2-3-4 (7)	**SILTY SAND (SM),** similar to above, except dark gray to black silt lenses, no wood.	S-3 index tests: wc = 33%
20	S-4	SS	20	0-0-0 (0)	**ORGANIC SOIL WITH SAND (OH),** gray, moist, very soft, plastic, very fine sand, traces of seashells.	S-4 index tests: wc = 54%
	ST-1	ST	24	PUSH	**ORGANIC SOIL WITH SAND, OH,** gray, moist, very soft, very fine sand. (Shelby Tube)	ST-1 index tests: Gravel = 0% P200 = 86% Sand = 14% wc = 53% Silt-Size = 68% LL = 57% Clay-Size = 18% PL = 36% PI = 21% Dry density = 70.2 pcf Consolidation test (Appendix C)
25						

CH2MHILL

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ELEVATION: Not measured **DRILLING CONTRACTOR:** Gregory Drilling, Inc.
DRILLING METHOD AND EQUIPMENT: CME 850, mud rotary, 3-7/8" drag bit, auto hammer.
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DEPTH BELOW GROUND SURFACE	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	S-5	SS	7	0-0-0 (0)	**ORGANIC SOIL WITH SAND (OH),** similar to above (S-4), sand lenses throughout sample, wood in sand lenses.	S-5 index tests: wc = 63%
30	S-6	SS	17	0-3-9 (12)	**SILTY SAND, SM,** gray, black organics, wet, medium dense, predominantly very fine sand to fine sand, silt lenses, wood, seashells, non-plastic fines, dilatant.	S-6 index tests: Gravel = 1% P200 = 37% Sand = 62% wc = 47%
35	S-7	SS	17	1-1-3 (4)	**SILTY SAND, SM,** similar to above (S-6), except scattered coarse sand.	S-7 index tests: P200 = 41% wc = 46%
40	S-8	SS	18	1-2-3 (5)	**INTERBEDDED SILTY SAND (SM) AND SANDY SILT (ML),** gray, wet, loose/firm, silty sand is predominantly very fine to fine sand, wood, thin interbeds, est. 50% silty sand, est. 50% sandy silt lenses.	
45	S-9	SS	22	0-0-2 (2)	**INTERBEDDED SILTY SAND (SM) AND SANDY SILT (ML),** similar to above (S-8), except less sand, less wood, est. 80% sandy silt lenses, est. 20% silty sand lenses.	
50						

CH2MHILL

PROJECT NUMBER: 184515.UV.50 **BORING NUMBER:** PB-1

SOIL BORING LOG

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DRILLING METHOD AND EQUIPMENT: CME 850, mud rotary, 3-7/8" drag bit, auto hammer.
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DEPTH BELOW GROUND SURFACE	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	S-10	SS	14	9-9-9 (18)	**SILTY SAND (SM),** gray, wet, medium dense, predominantly very fine to fine sand, silt lenses, decomposed wood, est. 10-20% non-plastic fines.	Bottom of hole at 51.5 ft.
					Bottom of Boring	
55						
60						
65						
70						
75						