Subsurface Exploration and Geotechnical Engineering Study

Marine Yard and CFS Area

Port of Tacoma, Washington

Prepared for

The Port of Tacoma and

Tacoma Terminals, Inc.

November 4, 1983

J-1280

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TACOMA TERMINALS, INC.
PORT OF TACOMA, WASHINGTON

INTRODUCTION

This report presents the results of our subsurface exploration program and geotechnical engineering study for the planned development of the Marine Yard and CFS areas at the Port of Tacoma by Tacoma Terminals, Inc. The site is located immediately northeast of the Puyallup River at the Milwaukee Waterway. The site configuration is given in Figure 1, Vicinity Map. The location of pertinent site features are presented on Figures 2 and 3. The site is divided into five general areas for development: the CFS Area, the Marine Yard area, the existing TOTE yard, a CFS area access road, and a levee access road.

The purpose of our study was to assess existing subsurface conditions, and develop geotechnical engineering recommendations for site preparation, structural fill, pavements, foundation types, foundation treatment, and earthwork and foundation construction considerations. This study was accomplished in general accordance with our proposal dated July 11, 1983, as formally authorized by the Port of Tacoma on July 18, 1983. Verbal notice to proceed was received earlier.

This report has been prepared for the exclusive use of the Port of Tacoma, Tacoma Terminals Inc., and their design consultants for specific application to this project. Preliminary conclusions and recommendations have been presented informally to the Port of Tacoma and the several design consultants as the project has progressed. Our work has been accomplished in accordance with generally accepted geotechnical engineering practice. No other warranty, expressed or implied, is made.

The locations of the explorations advanced for this study are shown on Figures 2 and 3, Site and Exploration Plans. The exploration procedures are discussed and the exploration logs are presented in Appendix A. Laboratory tests were completed to determine the basic physical and geotechnical properties and to aid in the classification of the site soils. The results of the laboratory tests are presented in Appendix B.

The subsurface conditions interpreted from the explorations and the soil properties inferred from field and laboratory tests formed the basis for geotechnical analyses. These analyses were performed to determine the

relevant geotechnical parameters for design and to make conclusions and recommendations regarding the geotechnical aspects of design and construction.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The following presents a summary of our principal findings and recommendations for the project:

- Subsurface conditions disclosed in the explorations generally consisted of surficial fill deposits underlain by stratified compressible silt and sand.

- Spread footing support for the proposed major structures in the CFS area appears feasible contingent on pretreatment of foundation soils by preloading techniques.

- Spread footing support of Marine Yard buildings is recommended. Due to the proximity of current site grades (comprised of existing fill) to proposed final grades, the use of a somewhat lower design footing bearing pressure is recommended.

- Post construction settlement of proposed structures can be limited to tolerable amounts by preloading. A one to two month preload duration should be utilized for project planning purposes.

- The settlement response of preload and site fills should be monitored to verify design assumptions presented in this report.

- In topographically lower areas of the CFS site where compressible soil deposits are indicated, estimated settlements of up to 1-1/2 feet may occur due to the weight of up to 10 feet of fill. Utility construction and paving should be deferred until observed settlement has ceased.

- Debris fill present in local portions of the project site should be removed and wasted off-site prior to subsequent construction activities.

- Pavement support characteristics depend on the amount of select import fill which will be in place above existing site soils. Limited stripping would be required in portions of the CFS area and Marine Yard in building or pavement areas.

- Significant quantities of select import fill will be required. Mass fill to raise site grades and structural fill in paving and building areas should be densely compacted.

Information appearing in this SUMMARY is subject to conditions stated elsewhere in this report. Specific results of engineering studies pertaining to the various structures and facilities are presented subsequently.

SITE AND PROJECT DESCRIPTION

The major project elements are shown on the Vicinity Map, Figure 1, and the Site and Exploration Plans, Figures 2 and 3. The development of the geotechnical engineering recommendations contained in this report was based on the site subsurface conditions as disclosed in the explorations, a final grade of elevation 19 feet plus or minus, and the planned site development, pavement areas, and building locations.

Our understanding of the site development includes construction of industrial warehouses and loading docks, office and storage buildings, truck maintenance buildings, underground tank storage, and associated paved areas for parking, storage and traffic. The scope and location of field explorations accomplished for this study was based on preliminary plan locations of these features. Design phase calculations and construction recommendations address the project configuration shown on Whitacre Engineer's site plans dated September 20, 1983.

This study does not include design recommedations for the structures located in the TOTE yard as their location and configuration was not yet certain at the time of this report. Explorations for the CFS Area access road have not yet been completed, as right of entry was not available. Specific design recommendations have been deferred for these project elements.

The Marine Yard area is bounded by the Milwaukee Waterway, the Puyallup River and East Eleventh Street. The CFS area is bounded by the Puyallup River on its southwest, and East Eleventh Street along its northwest boundary. The levee access road begins at the southwest corner of the CFS area and extends south along the Puyallup River about 1500 feet. The CFS area access road extends roughly 1600 feet and runs southeast from the southeast corner of the CFS area connecting to Lincoln Avenue.

Existing conditions at the site include areas of light to dense grass and brush with occasional areas of scattered small trees. Areas of existing asphalt paving and concrete pavement are present, together with zones of randomly placed debris. Past site development and activity has included the placement of hydraulic fill and the randomly placed debris.

The variance in ground surface elevations across the CFS area is on the order of 9 feet (average elevations +9 to +18) and is due principally to the previous site filling and development. A ditch is also located within the CFS area; the elevation of the bottom of the ditch is about 6.5 feet. The ditch is connected to the Puyallup River by a 24-inch corrugated metal

pipe. The outlet side of the CMP culvert is fitted with a flap gate to allow drainage at low tides. The existing gravel surface within the Marine yard is relatively uniform at an average elevation of +17 to +18 feet.

Areas of planned pavements were assessed in terms of near-surface soils and expected fill placement. Recommendations for structural foundations were prepared for anticipated building-specific loads and site soil stratigraphy. In the case of some of the small structures, a typical loading and generalized soil stratigraphy were utilized. The foundation structural loads, as provided to us by the project structural engineer, are summarized in Table 1 in a subsequent section of this report.

For the purpose of this report, we have assumed building locations in the Marine Yard area associated with the bridge option configuration. Foundation performance for the Van Maintenance Building was reassessed since the current planned location of the building is outside the limits of the existing preload fill and structural loads had been modified since preliminary design.

SUBSURFACE CONDITIONS

Based on the explorations completed, the subsurface soils relevant to the site engineering have been grouped in five general categories.

- artificial fill
- upper silt layer
- upper sand layer
- lower silt layer
- lower sand layer

The distribution of these layers with respect to a portion of the CFS area is given in Figure 4, Generalized Subsurface Profile. The location of the cross section is given in Figure 3. The variability of site soils can be seen in this figure. The deposition of the natural soil layers was a function of the tidal-river interaction, and some variation with irregular soil layer elevation and thickness may be anticipated throughout the site. A brief description of the major soil units is included below.

Artificial Fill

Artificial fill placed at this site includes a generally uniform hydraulic fill unit, and isolated areas of a random mixture of debris, including trees, grass, railroad ties, metal, and organic-rich material within a gravelly sand matrix. The mixed fill was randomly placed and was noted mostly within the CFS area. The random fill measured in the explorations ranged in thickness of 0.5 to 4 feet and is inferred to be up to 6 to 7 feet thick in places.

Groundwater

Groundwater was noted during the test pit excavations and auger borings, between elevations +2 and +10.5 feet. Subsequent water levels in observation wells placed in the auger borings were between elevations +8.5 to 10.4 feet. Some fluctuations in groundwater levels are expected due to fluctuations in river and tidal levels, as well as rainfall. Piezometers sealed in the upper sand located approximately 1 mile to the east were observed over a 24 hour period as part of an ongoing study. Based on that data, daily tidal cycles may affect groundwater levels on the order of 1 foot for locations distant from the waterways.

GEOTECHNICAL ENGINEERING RECOMMENDATIONS

Site Preparation and Pavement Considerations

Site preparation should consist of removal of all heavy vegetated growth such as trees and brush. Within proposed building and paved areas near proposed final grades in the CFS area and the Marine Yard, we recommend surficial organics be stripped. Any debris fill encountered within building areas at the site should be removed, wasted off-site and replaced with compacted engineered fill.

Stripping would not be recommended in the lower topographic areas (below about elevation 11 feet) in the central portion of the CFS area. Areas covered by tall grass should be mowed and/or rolled prior to construction. The soils anticipated at or near the ground surface in this area consist of fine grained upper silt deposit. Our opinion is that stripping of these site soils would not be beneficial since stripping activities would tend to cause unnecessary disturbance of the surficial soils.

It appears that necessary stripping depths in the Marine Yard area to remove generally sparse accumulations of sod and organic-rich topsoil would be in the range of 1/2 foot or less. Existing concrete pavement, if present within planned building areas, utility trenches, or within about 1-1/2 feet of final grade, should be removed. A large portion of the ground surface is bare of vegetation and would generally require no stripping. Following stripping as necessary, the exposed soils of the project area should be pre-rolled to a dense, non-yielding condition.

The portions of the CFS area with existing ground surface elevations greater than about 11 to 12 feet should be stripped of surficial vegetation and organic-rich topsoil and pre-rolled to a dense non-yielding condition. We estimate stripping depths on the order of about 1/2 foot or less in the existing higher-elevation areas of the CFS area would be required, such as along the levee road, the abandoned railroad embankment (south property line) and at the northern corner of the site. The area surrounding the

existing surcharge fill generally contains sparse vegetation and would not require stripping.

In addition to stripping of the surficial organic-rich material, overexcavation of any debris fill encountered during site work is recommended. Debris fill was disclosed predominantly in the southeast corner area of the CFS site, but it is also noted in various other isolated locations. Overexcavation should include complete removal of debris fill in building areas. The debris could extend up to about 6 or 7 feet or more in depth below the existing ground surface. The small backhoe used for the test pit explorations could not excavate completely through the debris fill. In some areas the debris included large timbers. Our depth estimate is based on an assumption that the debris fill could extend down to the general natural site grade assumed to be elevation 9 to 11 feet. This assumption is not substantiated by direct subsurface information.

We recommend a minimum of 3 feet of overexcavation of debris fill in paved areas at these locations and in any other areas of the site where accumulations or organic-rich material or debris fill are disclosed during construction. If debris fill is left in place beneath paved areas, it should be recognized that there is some potential for differential settlement of the pavement section. Some overexcavation may also be necessary to lower the existing material to grade at the railroad embankment within the lumber storage building outline.

Following stripping and overexcavation as required, we recommend pre-rolling and compaction of all areas to receive fill, building foundations, or paving. Pre-rolling should be accomplished with a large, self-propelled vibratory roller. The purpose of pre-rolling would be to provide a degree of compaction to the near-surface soils and to delineate any areas of excessively soft soils which may be present. Pre-rolling should be accomplished to compact the subgrade to a firm, non-yielding condition.

Soft areas that are evident during pre-rolling should be overexcavated down to firm soils and replaced with densely compacted fill. As an alternative, those soils that are soft primarily because of being too wet could be scarified, allowed to dry and recompacted.

Pre-rolling should result in a minimum degree of compaction, which varies with depth below final grade. Subgrade soils within 2 feet of planned final grade should be compacted to at least 95 percent of modified Proctor maximum dry density. The upper 12 inches of the existing subgrade soils that are more than 2 feet below final grade should be compacted to at least 92 percent.

The central portion of the CFS area, where existing ground surface elevations are less than 12 feet, could be filled with an initial lift of up to 18 inches of free-draining structural fill without prior stripping or

pre-rolling. We recommend that this initial lift contain approximately 30 percent gravel if construction is accomplished in wet site conditions or wet weather. In addition, we recommend clearing grass and brush and removing any mounds or piles of organic-rich material from the area prior to placing fill. Placement and compaction of the initial thicker lift of fill in this area should provide a firm stable surface for placement and compaction of subsequent structural fill lifts.

Structural Fill

The placement of fill as outlined in the previous section of this report refers to fill necessary to achieve final grade in paved and building areas (approximately elevation +19 feet MLLW). This fill plus fill required for backfill behind walls, beneath slabs and additional fill for "dock-height" structures is considered structural fill.

We recommend that all structural fill placed within 2 feet of final grades be compacted to at least 95 percent of the modified Proctor maximum dry density as determined by ASTM D 1557. Structural fill placed within building areas should be uniformly compacted for its full depth to the 95 percent density requirements.

We recommend that the mass of structural fill placed outside building areas at depths greater than 2 feet below final grade be compacted to 92 percent of modified Proctor maximum density. We recommend lift thickness of the fill not exceed 8 to 10 inches.

We recommend the select import structural fill material be a well-graded sand, or a sand and gravel with a maximum size of 4 to 6 inches. We recommend that maximum percentage of fines (material passing the No. 200 sieve based on the minus 3/4-inch fraction and wet sieve analysis) be limited to 5 percent or less for wet weather construction and 10 percent or less for dry weather construction. In addition, it is recommended that the fines, if any contained in the borrow material, be non-plastic as determined by ASTM D 423 and 424.

We understand that a portion of the existing preload fill at the Maintenance Building location may be used for structural fill. The preload fill appears to consist of two soils: an upper soil of slightly silty gravelly sand and a lower soil of very sandy gravel. The upper preload soil contains on the order of 10 percent fines; the lower preload soil has on the order of 2 percent fines. Use of the upper preload soil may be possible only during dry conditions as this soil is sensitive to changes in moisture content. The lower preload soil would be an acceptable structural fill in wet site or wet weather conditions.

We recognize that a large quantity of borrow material will be required for this site, and that low-cost sources and transportation of the borrow materials is desirable. A previous study (J-1120, dated December 20, 1982)

accomplished by Hart-Crowser & Associates for the Port of Tacoma identified three sources of borrow material that could be obtained at reasonable prices utilizing barge transport to the site. The Glacier Sand and Gravel Pit in Steilacoom contains primarily a gravelly coarse to medium sand to a coarse to medium sand with less than 5 percent fines. The Lonestar Pit contains a uniformly grading fine gravel and a uniformly graded sand, both with less than 5 percent fines. The Maury Island Pit contains a very gravelly medium to fine sand that can contain on the order of 6 percent fines. In our opinion, any of these sites would produce acceptable fill material. There may be additional borrow sources in the area of the site that are able to produce inexpensive, acceptable fill soil. It is our recommendation that given the high probability of construction during the wet season, sources of borrow material containing less than 5 percent fines should be utilized.

We recommend all soils utilized as structural fill be moisture-conditioned to within plus or minus 2 percent of the optimum moisture content prior to placement. Suitable compaction equipment would depend on the texture of the soils to be compacted. For the material recommended herein, compaction is best accomplished with vibratory rollers, (or vibrating plate compactors for fill next to walls).

The anticipated construction sequence involves placement of structural fill which would be subsequently covered by preload fill. Upon removal of the temporary preload fill and grading to the desired elevation, the various buildings will be constructed. Construction activities and grading at the site could tend to disturb and loosen the upper portions of the structural fill. For this reason we recommend the surface of the fill should be recompacted to a dense, non-yielding condition corresponding to the recommended 95 percent of the modified Proctor maximum dry density.

We recommend that the general site grades in the central portion of the CFS area be raised to about elevation 15 feet prior to construction of the major preload fills planned in this area. This would provide a suitable working platform, reduce disturbance to the underlying fine grained soils and control settlement behavior and stability.

Foundations and Settlement

Design loading conditions for the various specific and representative buildings are given in Table 1. Spread footing support for these loads would be feasible, contingent on preload pre-treatment of the site soils. It is our understanding that lateral loads, which are not listed in Table 1, can be significant. We understand that in the case of the Lumber Storage Dock and the Car Carrier Shelter, the spread footings will be embedded to resist the lateral loads. The recommended allowable bearing pressures for spread footings for the various structures are given in Table 1. The recommended pressures depend on the amount of densely compacted structural fill that will be placed below the anticipated footing grades at

specific building locations. In general, where 3 feet or more of structural fill would be required below footings to achieve final grade at a buiding site, an allowable bearing pressure of 3500 psf could be utilized. Otherwise, the recommended allowable bearing pressure is 2500 psf.

Isolated spread footings and continuous strip footings should have a minimum width of 24 and 18 inches, respectively. The base of all footings should be located a minimum of 18 inches below the surface of the adjacent floor slab or the adjacent finished exterior grade, whichever is lower. Foundations meeting the above criteria may be designed for the allowable soil bearing pressure presented in Table 1. The allowable bearing pressures may be increased up to one-third to accommodate transient traffic, wind or seismic loads.

Recommended values of passive pressures and friction on the base of footings to resist lateral loads are presented in the Retaining Walls section of this report. These recommendations would also be appropriate for other footings subjected to lateral loads.

Settlements from the anticipated structural loadings will occur from elastic compression of the fill (old and new) and the two native sand layers, together with consolidation settlement within the silt layers. Without pre-treatment of the existing soils, settlement of the structures (post-fill construction) may be as large as 6 inches with up to 4 inches of differential settlement. Expected total settlements without treatment are given in Table 1.

These settlements would be unacceptable in terms of structural performance. We recommend the use of preload fills at the noted building sites to reduce the degree of post-construction settlement to more acceptable levels. Subsequent to removal of the preload fills, the post-construction settlement of the buildings will occur rapidly as the loads are applied. Without the preload fills, building settlements would occur slowly over a period of a few months. An indication of this settlement behavior is available from the preload placed for the Van Maintenance Building. Observed settlements occurred primarily over a period of two months.

Estimated post-construction settlements assuming preload fill pre-treatment are given in Table 1 and are typically on the order of 1/2 to 1 inch. Differential settlements are estimated to be 1/2 to 2/3 of the above total settlement values.

Estimated settlements for the various smaller buildings are on the order of 2 inches or less without preloading. In recommending no preload for these areas, we have assumed that given the use, size, and type of structure anticipated at these sites, these settlements represent tolerable levels of displacement. If less settlements are required, preload fills can be designed for each structure, as desired, to limit this displacement.

Settlements of the structural fill to raise site grades due to its weight alone, have been estimated to be on the order of up to 1 to 1-1/2 feet in the area of significant fill heights in the CFS area. Significantly smaller settlement magnitudes of the fill prior to building construction is expected in the Marine Yard. Structural fill placement and preload fill construction will result in settlements which would increase import fill quantities. We recommend utility construction and site paving be deferred until significant settlement has ceased.

It should also be noted that the placement of extensive long-term loads (say greater than one month duration) such as storage, or stationary equipment on the ground or pavement surface, could result in future settlements of the ground surface and might affect adjacent foundations. Areas which may be utilized for possible bulk storage purposes could be preloaded to limit future settlements.

The preload for the Van Maintenance Building was completed by September, 1982 and remains in-place currently. Based on information provided to us, the planned location of the Maintenance Building is approximately 90 feet further to the northeast of the existing northern edge of the preload fill. We recommend that future preloading be extended at this site to the northeast of the existing preload to limit the possibility of differential settlement.

Preload Fill Requirements

Required heights of preload fill are based on expected structural loads and a preload soil density of 130 pcf for sand and gravel and 110 pcf for sand. If design considerations require structural loads or construction details differing from assumptions listed in this report, the preload fill heights should be modified to reflect the changes. Recommended preload fill heights are given in the following table for the structures as grouped previously. These fill heights are in addition to fill required to reach final grade, and are measured from final grade (floor slab) elevation or dock-height fill elevation. The preload heights are based on a nominal duration of one to two months as outlined subsequently.

An important advantage of preloading is the flexibility in its application to achieve a given result within prescribed time limits. If the project construction schedule can not accommodate the projected preload times, greater preload heights could be used with shorter required durations. It is essential however, to monitor the progress of the preload. Field measured time rate of settlement data would enable us to refine our settlement estimates and requirements for preload duration. For this reason, we recommend installation of a series of settlement plate monuments.

It should be noted that the height of preload fill for the Transfer Docks is above the fill height required between dock walks in the 10-foot wide section. In addition, the fill recommended at the Van Maintenance Building may be extended, in height, to match the existing preload, if so desired.

We recommend preload fill soils be similar to the soils utilized structural fill. From a construction standpoint, the structural fill and preload fill will probably be constructed at the same time and similar considerations regarding wet weather would apply. To make effective use of import soils brought to the site, we recommend the earthwork construction sequence be established to allow use of the preload fill as general site fill in paved areas following completion of the building preloading. As a construction expedient, once 1 foot above the top elevation of structural fill, compaction of the preload fill may be accomplished using larger lifts, provided the density assumed in the analysis (130 pcf for sand and gravel or 110 pcf for sand) can be achieved.

We recommend the preload fill remain in-place for building areas long enough to allow 90 percent of the consolidation settlement to occur. We have estimated preload durations of 4 to 8 weeks based on theoretical time estimates and performance of the existing preload fill at the Van Maintenance Building and we recommend this preload period at the full preload height be assumed for project planning purposes. Longer times to construct the preload fill may require longer times to achieve 90 percent consolidation. We recommend the full height of the preload extend beyond the building limits and pavement areas a minimum of 10 feet and should be sloped down at an angle no steeper than 1-1/2H:1V.

Significant variation in the thickness and characteristics of the compressible layers exists beneath the larger structures and we recommend that the settlement and related times be monitored for the major preload fills. Field measured time rates of settlement would enable us to refine our estimates of settlement under the structural foundation loads. We recommend a minimum of four settlement plates within both the CFS Building and lumber storage dock preload fill and at least two settlement plates within each of the other preloaded areas. A schematic diagram of a typical settlement plate installation is given in Figure 5. Requirements for settlement plate installation and building specific recommendations for settlement plate locations can be provided once construction begins.

Settlement plates should be installed immediately prior to fill construction. Initial settlement plate readings should be obtained immediately at the time of placement of the plates and prior to placement of any structural and/or preload fill. Readings of the settlement plates could be taken by standard optical leveling methods and should be obtained at regular intervals during the entire filling and preload period. During the initial two weeks of the preload, we recommend that a minimum of three readings be taken per week.

Uplift Pressures

It is our understanding that the storage fuel tanks for the development will be located underground at the eastern portion of the CFS yard. Information with regard to depth of burial was not available at the time of this report. Based on limited observations of water levels, it appears that the elevation of the groundwater at this site is on the order of +9 to +10 feet (MLLW) which corresponds roughly with mean high high water. Maximum tidal fluctuations at Tacoma are on the order of 11 feet, and thus, provided the tank bottom is not located below elevation +11 feet, minor uplift pressure from runoff infiltration only would be expected. Uplift pressures for tanks located below elevation +11 feet can be estimated using hydrostatic uplift pressure distribution beginning at elevation +11 feet.

Retaining Walls

It is our understanding that walls retaining fill material will be required for dock-height structures (CFS Building, Lumber Storage Dock, Transfer Dock) and for below-grade truck-scales. We recommend that these walls be designed for the following lateral pressures, assuming compacted structural fill. For yielding walls, (i.e., walls that displace outward a minimum of .001 H), the lateral active earth pressure used for design may be computed using an equivalent fluid pressure of 35 H (pcf); where H equals the height of the wall. For non-yielding walls (i.e. rigid walls restrained by floor slabs or flexural stiffness) the lateral earth pressure may be based on "at-rest" equivalent fluid pressure of 55 H (pcf). Passive earth pressure resistance at the toe of the walls may be based on an allowable equivalent fluid pressure of 300 h, where h is the embedment of the footing and the backfill adjacent to the footing is densely compacted as structural fill. An allowable coefficient of sliding friction along the base of the wall may be used as 0.4.

The preceeding lateral earth pressure recommendations are based on horizontal backfill, uniform soil conditions for backfill, and no build-up of hydrostatic pressure behind the walls. The effect of surcharges, such as traffic or floor loads should also be included. For a uniformly distributed load behind the wall, a corresponding uniformly distributed pressure equal to 35 percent or 50 percent of the surcharge should be added to the lateral soil pressure for yielding and non-yielding walls, respectively.

Pavement Design

Based on final site grades near elevation 19 feet, it appears that most of the CFS area pavements would be underlain by new fill generally in excess of 2 feet or more in thickness. Perimeter areas of the CFS area are currently within about 2 feet of final grade, and the Marine Yard area is currently within about 1 to 2 feet of final grade.

All fill beneath paved areas should be placed and compacted in accordance with our recommendations for structural fill contained in this report. For design purposes, we recommend using a design CBR value of 25 percent for pavements constructed above significant depths of select gravelly import fill, where 2 feet or more of fill would be added. This CBR value is based on laboratory CBR tests on a recompacted sample of the existing preload fill (i.e., slightly silty gravelly sand) taken from the area surrounding the preload. For clean, predominantly medium to fine sand import fill, an estimate of the CBR value is 15 percent.

Pavements in the Marine Yard, and near-grade portions of the CFS area, may be designed using a CBR value of 10 percent for the existing site soils. This CBR value is based on laboratory tests on fine to medium sand from the Marine Yard area and very silty sand from the levee road area of the CFS area. It appears that the new levee road would be on a combination of new fills and existing near-surface soils. We recommend that pavement design for this area consider the lower CBR materials present near design grades along the existing levee road embankment.

Seismic Considerations

Resistance to liquefaction during strong ground shaking exhibited by the natural soils at the site will partly be a function of their in-place density. A measure of their relative density of soils at this site is obtained from the Standard Penetration Test (SPT), which was performed in the auger borings and the results of the cone penetrometer probes.

Values of soil relative density in many areas are low, indicating possible susceptibility to liquefaction during large magnitude earthquakes. Similar conditions exist over other areas of the Port of Tacoma as well as other port areas and alluvial valleys of the Puget sound area. In our opinion, no economical means of treatment exists for this site and therefore, the possibility of damage from liquefaction and resulting ground distortion or settlements during large magnitude earthquakes should be recognized.

ADDITIONAL RECOMMENDATIONS

It is recommended that Hart-Crowser & Associates be provided the opportunity for a general review of the final plans and specifications in order that the geotechnical engineering recommendations may be properly interpreted and implemented in the design and specifications.

We recommend that Hart-Crowser & Associates continue to provide geotechnical services during placement of fill and foundation construction. This includes observations and review of:

- Site preparation, including pre-rolling and removal of undesirable existing fill,

- Placement and compaction of structural fill,
- Preload fill construction and behavior,
- Other geotechnical considerations that may arise during construction.

The purpose of these observations and review would be to observe compliance with design concepts, specifications or recommendations and to allow design changes or evaluation of appropriate construction measures in the event that subsurface conditions differ from those anticipated prior to the start of construction. Field observations may also be useful as a means of documenting construction practices and conditions for use in defense of the owner against possible claims by the contractor or others.

We appreciate this opportunity to be of service to you. We would be pleased to discuss this report or any aspects of the project with you.

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TABLE 1 Foundation Design Criteria

AREA/ STRUCTURE DESIGNATION	DESIGN LOADS			ALLOWABLE BEARING PRESSURE IN PSF	SITE FILL HEIGHT TO DESIGN GRADE IN FEET	CALCULATED SETTLEMENT IN INCHES		
	MAXIMUM COLUMN IN KIPS	MAX. WALL IN KIPS PER LINEAL FOOT	SLAB LIVE LOAD			SITE FILL	STRUCTURE WITHOUT PRELOAD	STRUCTURE AFTER PRELOAD
CFS Area								
CFS Building	209	4.5	.5 ksf	3,500	9	12 to 18	4 to 6	½ to 1
Lumber Storage Dock	282	---	.5 ksf	3,500	4 to 7	12 to 18	∿4	½ to 1
Truck Transfer Dock	16	3 - 4		2,500	2 to 9	3 to 18	2½	½
International Equipment Control Building	106	1.5	HS-20/44	3,500	∿5	3 to 6	≤ 2	½ to 1
Other Structures	≤30	∿1	HS-20/44	3,500	∿5	3 to 6	≤ 2	----
Marine Yard								
Domestic Equipment Control Building	66	∿1	HS-20/44	2,500	2 to 3	1	≤2	----
Other Structures	<30	∿1	HS-20/44	2,500	2 to 3	1	<2	----

* Includes dock height fill, where applicable

Recommended foundation for all structures is spread footings.

Other CFS area buildings include Car Carrier Shelter, International Tire Repair, International Inspection, Yard House, Guard House and Scale.

Other Marine Yard buildings include Domestic Tire Repair and Domestic Inspection.

TABLE 2 Summary of Preload Recommendations

STRUCTURE DESIGNATION	PRELOAD HEIGHT IN FEET		PRELOAD * DURATION IN WEEKS
	SAND and GRAVEL	SAND	
CFS Building	9	10½	4 - 8
Lumber Storage Dock	8	9½	4 - 8
Truck Transfer Dock	4	5	4 - 8
International Equipment Control Building	4	5	4 - 8
Maintenance Building	8	9½	6 - 8

*(After completion of Fill)

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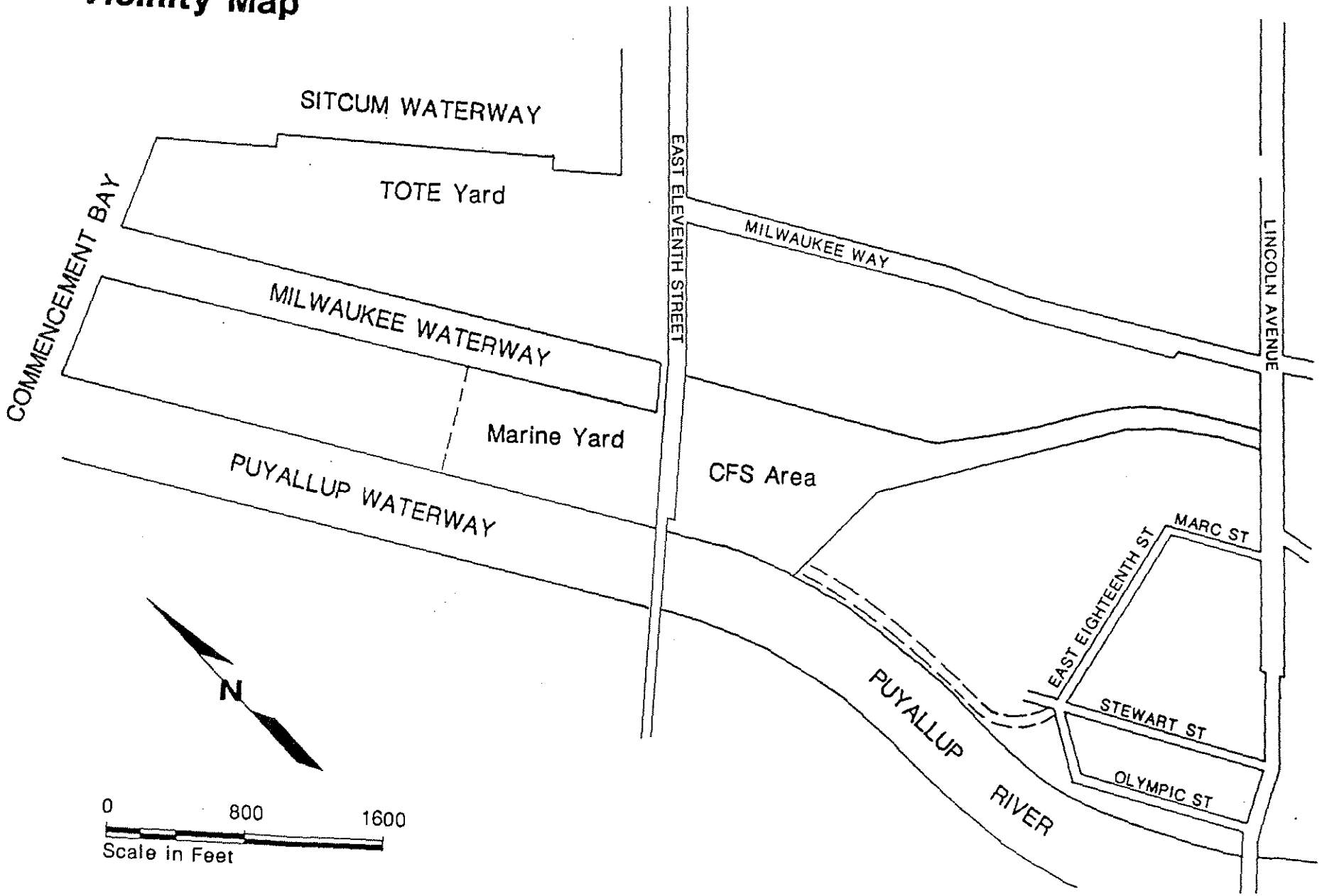
TABLE A-1 Ground Water Level Observations

Boring Number (Completion Date)	Approx. Ground Surface Elevation in Feet	Depth in Feet			Depth to Ground Water in Feet		
		Boring Bottom	Screened Section		At Time of Drilling	8/17/83	10/18/83
			Top	Bottom			
B-1 (7/20/83)	13	39.0	31.8	36.8	8.0	3.9	3.9
B-2 (7/26/83)	10	39.0	33.4	38.4	6.0	0.1	+0.2*
B-3 (7/26/83)	11	39.0	32.0	37.0	--	1.4	1.5
B-4 (7/20/83)	11	44.0	36.1	41.1	8.5	0.9	1.0
B-5 (7/21/83)	11	39.0	32.5	37.5	8.0	1.2	1.3
B-6 (7/22/83)	12	39.0	33.1	38.1	4.5	2.1	1.7
B-7 (7/21/83)	14	39.0	32.4	37.4	11.0	5.2	5.3
B-8 (7/22/83)	17	39.0	13.2	33.2	--	8.8	9.0
B-9 (7/25/83)	18	53.5	45.6	50.6	--	7.3	5.8
B-10 (7/25/83)	18	29.0	24.0	29.0	15.0	--	6.3

Note: * - Measured water level above ground surface.

Vicinity Map



J-1280 November 1983

HART-CROWSER & associates inc.

Figure 1

APPENDIX A
FIELD EXPLORATIONS

The field explorations accomplished for this study were completed from July 19 to July 26, 1983 and consisted of seven Dutch cone penetrometer probes thirteen hollow-stem auger borings, and forty-six test pits. The explorations were accomplished in the CFS area (located southeast of East 11th Street and east of the Puyallup River), the Marine Yard area (located northwest of East 11th Street and between the Puyallup and Milwaukee Waterways), the existing TOTE yard (just west of Sitcum Waterway) and along the new levee access road along the Puyallup River.

The auger boring and Dutch cone probe locations were surveyed by the Port of Tacoma. Location of some borings and probes were relocated in the field. The test pits were located by hand taping from a survey baseline. Elevations were interpolated from topographic maps provided by the Port of Tacoma. The approximate locations of the explorations are given in Site and Exploration Plans, Figures 2 and 3.

The borings and test pits were continuously observed and soil conditions logged by Mssrs. Bruce McDonald and Jon Sondergaard, engineering geologists and Mr. John Zipper, geotechnical engineer, all of Hart-Crowser & Associates. The Dutch cone probes were performed by Subterranean, Inc., of Gig Harbor, Washington.

Soil conditions and stratification were generalized from the logs of the Dutch cone penetrometer probes, from observations during drilling operations and from samples recovered from the borings and test pits. Material changes noted on the exploration logs are often gradational in nature and conditions may vary at locations distant from where the explorations were undertaken.

DUTCH CONE PENETROMETER PROBES

The seven Dutch cone penetrometer probes were advanced to depths of 60 to 61 feet below ground surface. Six probes (P-1 through P-6) were performed at the CFS area and one (P-7) at the Marine Yard. In areas where fill or debris prevented initial advancement of the cone penetrometer, a shallow auger boring was completed and the hole backfilled with sand prior to the probe penetration.

The probes were accomplished by Subterranean, Inc., of Gig Harbor, Washington, under subcontract to Hart-Crowser & Associates. The principles of the Dutch cone system are shown on Figure A-1. The system is mounted on a truck which provided the necessary reaction weight for the applied loads.

From the results of the penetrometer probes a direct correlation is obtained between the point resistance of the cone and the bearing capacity of the soil, and between the sleeve friction and frictional characteristics of the soil. The relative density or consistency of the soil being probed is empirically related to the cone resistance, qc. Further, comparing the values of qc, sleeve friction (fs) and the friction ratio (FR=fs/qc in percent) leads to an interpretative soil classification. Generally, a friction ratio value less than 2 indicates sand; a value between 2 and 4 indicates a silt-sand mixture, clayey sand or silt; values greater than 4 indicate a clayey silt or clay. Organic soils typically have high friction ratios. The soil classification system is summarized graphically at the bottom of Figure A-1. The detailed interpretative logs of the Dutch cone penetrometer probes accomplished for this study are presented in Figures A-2 through A-8.

Auger Borings

The thirteen subsurface borings were accomplished by FLD Industries under subcontract to Hart-Crowser & Associates. A CME 750 all-terrain drill rig with 3 3/8" ID hollow-stem auger was used. Eleven borings ranging from 39 to 44 feet in depth were completed in the CFS area and two borings (B-9 and B-10) were completed to depths of 53 and 29 test, respectively, in the Marine Yard area.

Both driven, disturbed (split-spoon) and pushed, relatively undisturbed samples were taken. The disturbed samples were obtained on 5-foot intervals in general accordance with the Standard Penetration Test procedure as described in ASTM D 1586-67. The number of blows required to drive the sampler with a 140 pound hammer free-falling 30 inches was recorded in three 6-inch intervals. The number of blows required to drive the sampler the final 12 inches is the Standard Penetration Resistance which is plotted on the boring logs at the respective sample elevations. The Penetration Resistance value is a measure of the in-place density of the sampled soils and is used to classify the samples into relative density categories. Samples were recovered from the split-barrel sampler, classified and placed in water-tight jars to return to our laboratory for further testing.

In cohesive (clay or silt) soils, a 3-inch diameter thin-walled steel tube sampler was pushed below the auger to obtain a relatively undisturbed sample for consolidation tests. The tubes were sealed at the ends and returned to our laboratory for subsequent extrusion and classification and testing. Undisturbed samples of silt and clay soil were obtained near the locations of Dutch Cone probes P-2, P-4, and P-5 once the general soil stratigraphy had been established. The borings for the undisturbed sampling are designated B-11, B-12 and B-13.

All samples were transported back to our Seattle laboratories for further classification and testing. The interpretive logs of the hollow-stem auger borings are presented in Figures A-9 through A-21.

Observation wells were installed in ten hollow-stem auger borings, (B-1 through B-10). The wells generally consisted of 3/4" inch P.V.C. pipe, hand slotted at the tip and backfilled with the natural site soils. At B-8, twenty feet of 2" inch I.D. riser pipe was installed above 20 feet slotted pipe with of .020 inch slotted openings. The slotted pipe section is installed at the bottom of the auger boring. Details of the observation well installation are given in Table A-1. Water levels at time of drilling are given on the boring logs and in Table A-1 as water levels measured at two subsequent dates.

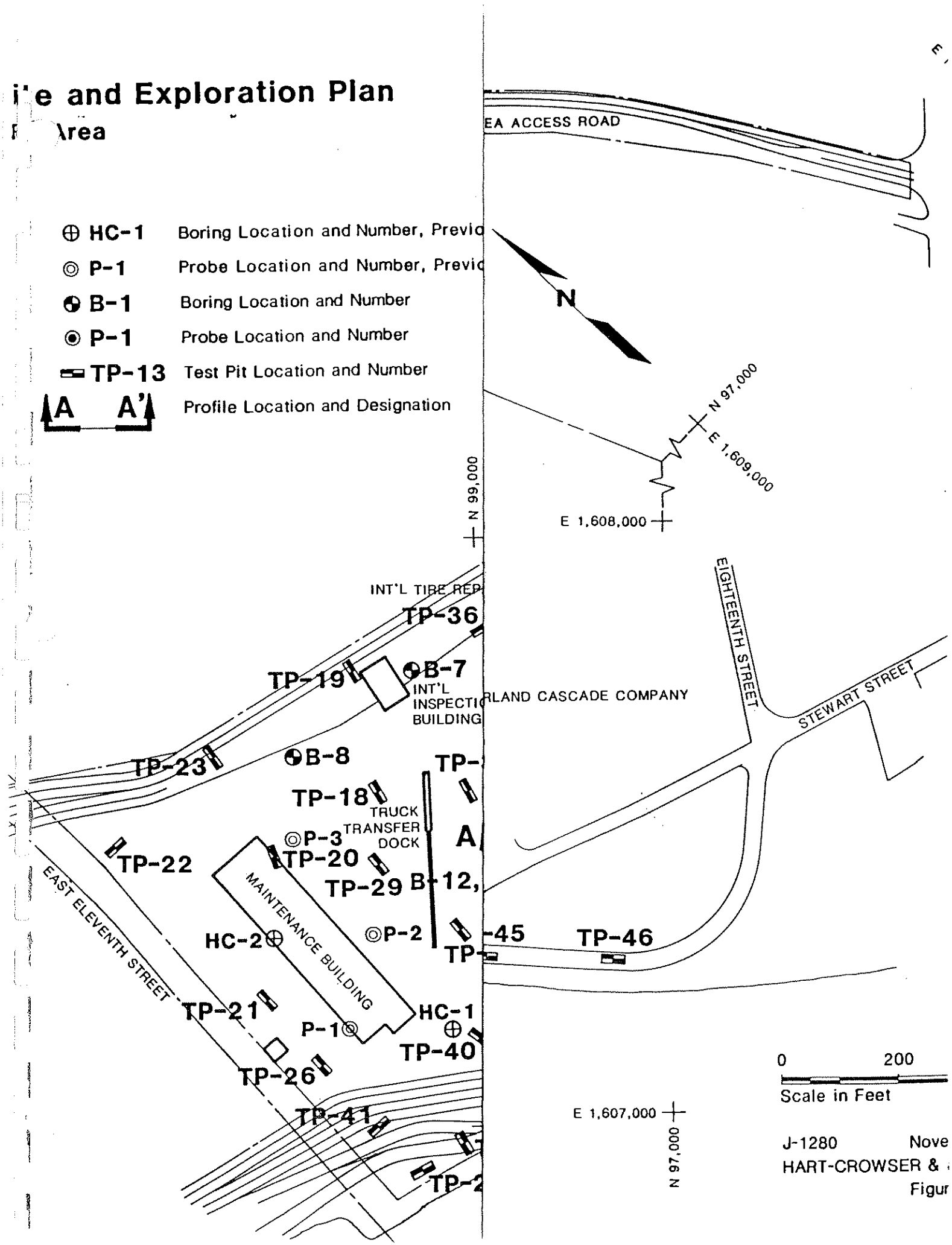
Test Pits

A series of forty-six test pits were excavated across the site utilizing a tractor-mounted backhoe owned by Mr. James Meeker and under subcontract to Hart-Crowser & Associates. Descriptive logs were developed in the field by observation of the soil disclosed in the test pits. Representative samples of soil types encountered were placed in plastic jars or bags and returned to our laboratory for further observation and testing. Based on the field logs and laboratory classification tests, descriptive logs of the test pits have been prepared indicating the soil type encountered and the depth where changes in soil type occurred. Sample depth and number, water content (in percent), other tests performed and groundwater levels encountered during excavation are also presented. The consistency or density of the soil is based on interpretation and can not be measured during the excavation of the pits. The presentation of consistency and density in the test pit logs is enclosed with parentheses to indicate that the value is only estimated. The logs are shown in this Appendix, Figures A-22 through A-44. The legend identifying the symbols used in the test pit logs is presented in Figure A-44.

In addition to the soil classifications mentioned above, soil consistency and strength were approximately assessed using a pocket penetrometer and torvane test equipment. These index tests are able to provide relative differences in consistency and strength of cohesive soils. The pocket penetrometer test consists of a small, probe that is hand-pushed into natural soil; the force that is required to push the probe is measured in terms of soil unconfined strength. The torvane consists of small vanes arranged radially. The torvane is also hand-pushed into natural soil and then twisted until failure. The torque necessary to fail the soil contained on the perimeter of the vanes is measured in terms of soil shear strength. These test results were considered in the interpretation of the soil stratigraphy. Values of pocket penetrometer and torvane tests (in tons per square foot) are given on the test pit logs, where applicable.

i'e and Exploration Plan

F Area



J-1280 Nove

HART-CROWSER &

Figur

Probe Log P-1

SOIL
INTERPRETATION

Approximate Ground Surface Elevation in Feet 15

Depth
Feet

Pre-excavated through Gravel fill.

Medium dense, silty SAND.

Dense SAND.

Silty Sand layer.

Medium dense.

Loose, silty SAND.

Medium stiff, clayey SILT.

Loose to medium dense GRAVEL.

Loose, silty SAND and SAND.

Dense SAND.

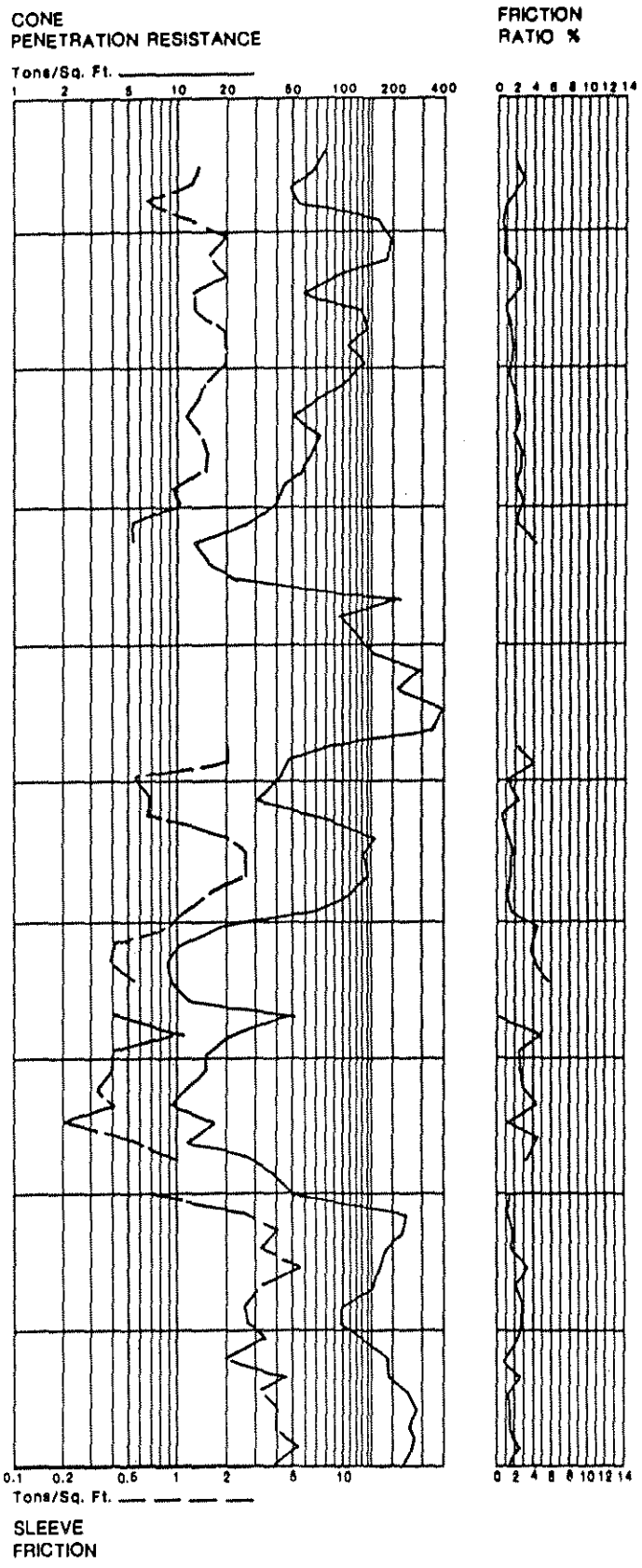
Medium stiff, clayey SILT.

Sand layer.

Loose SAND.

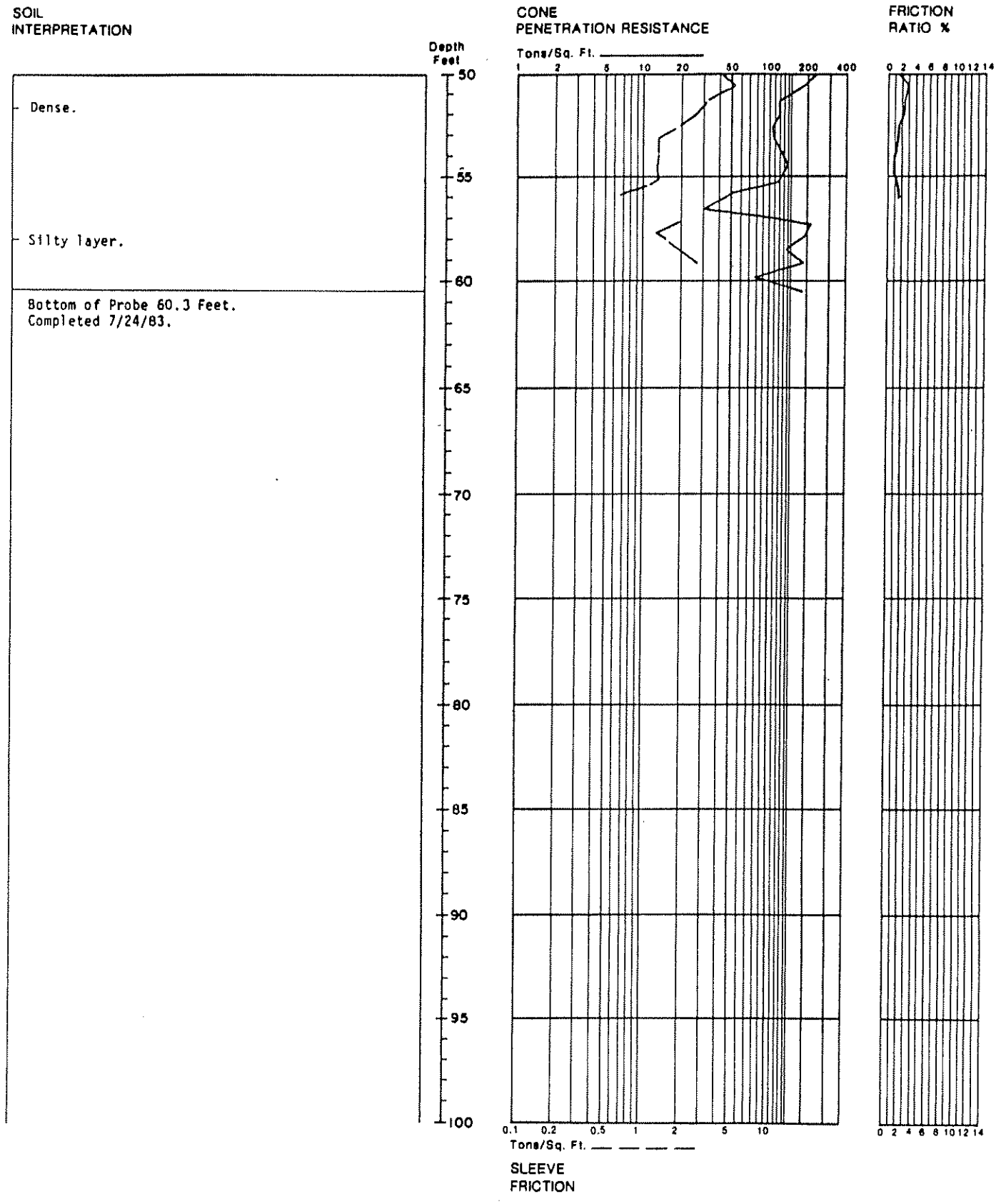
Dense.

Very dense.



J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-2

Probe Log P-1



J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 2 of 2 Figure A-2

Probe Log P-2

SOIL
INTERPRETATION

Approximate Ground Surface Elevation in Feet 12

Predrilled and backfilled with compacted sand.

Soft to medium stiff, clayey SILT.

Sandy layer.

Loose SAND.

Medium stiff to stiff, clayey SILT.

Loose SAND.
Silty layer.
Dense.

Medium stiff, clayey SILT.

Medium dense SAND

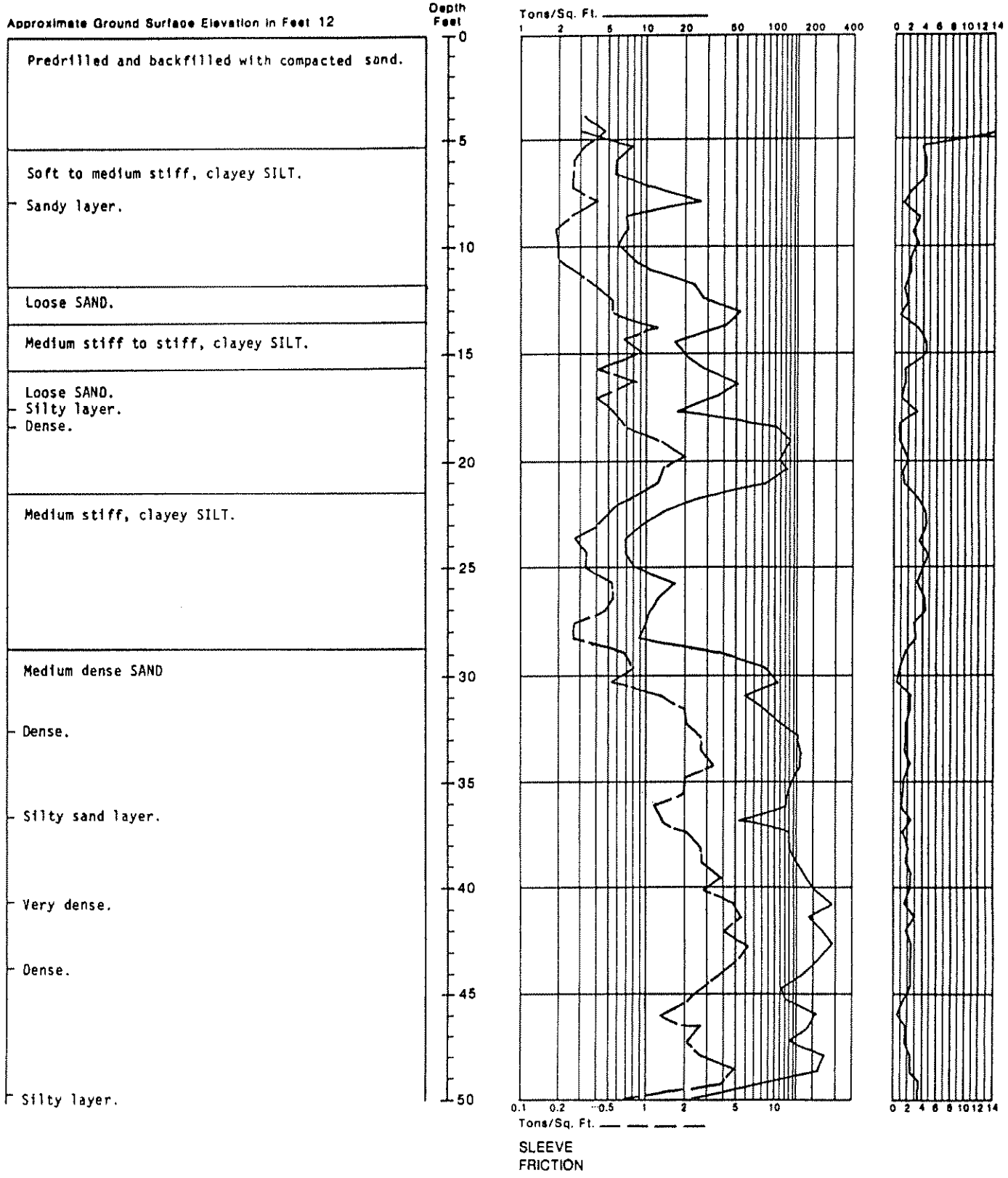
Dense.

Silty sand layer.

Very dense.

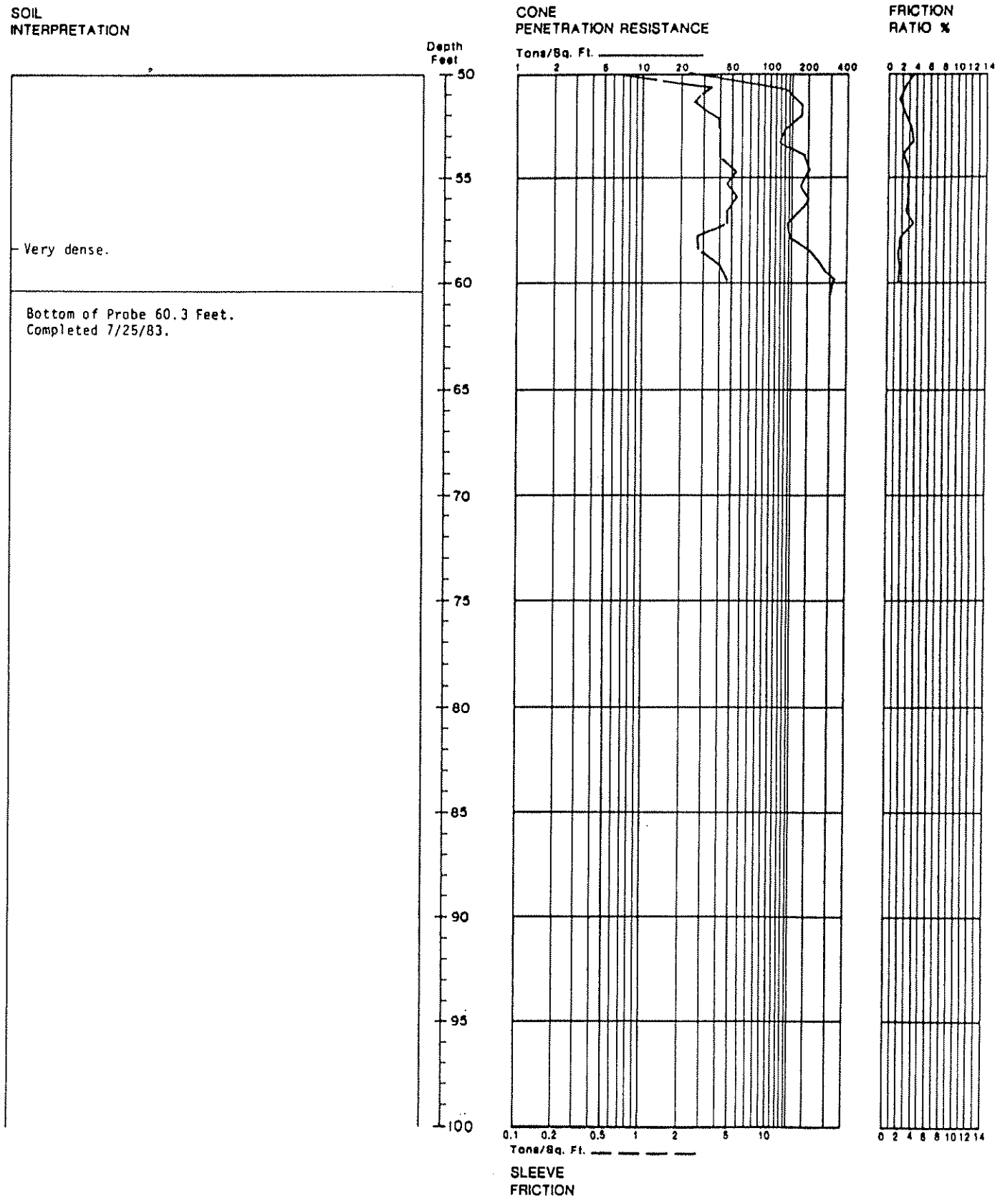
Dense.

Silty layer.



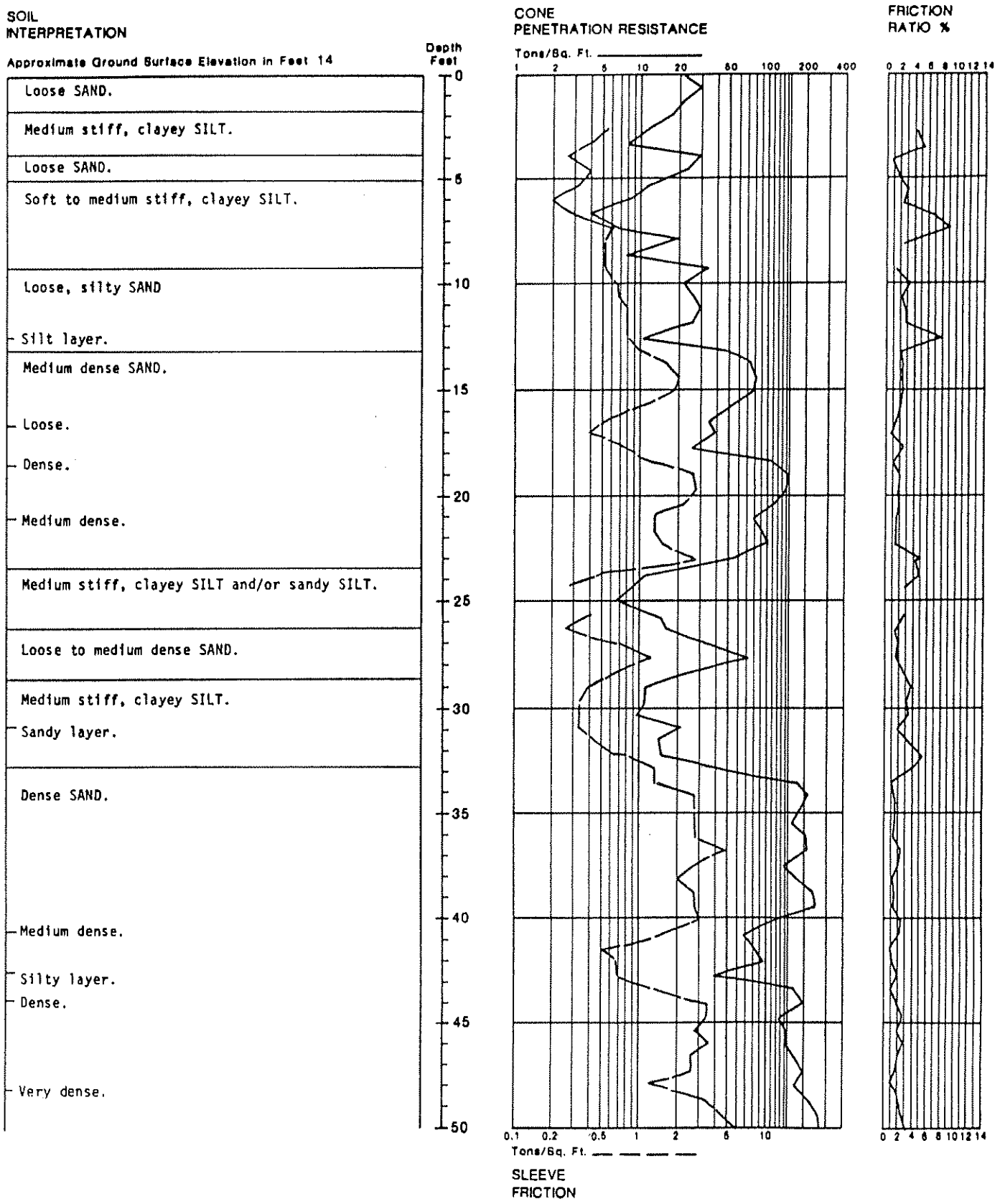
J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-3

Probe Log P-2



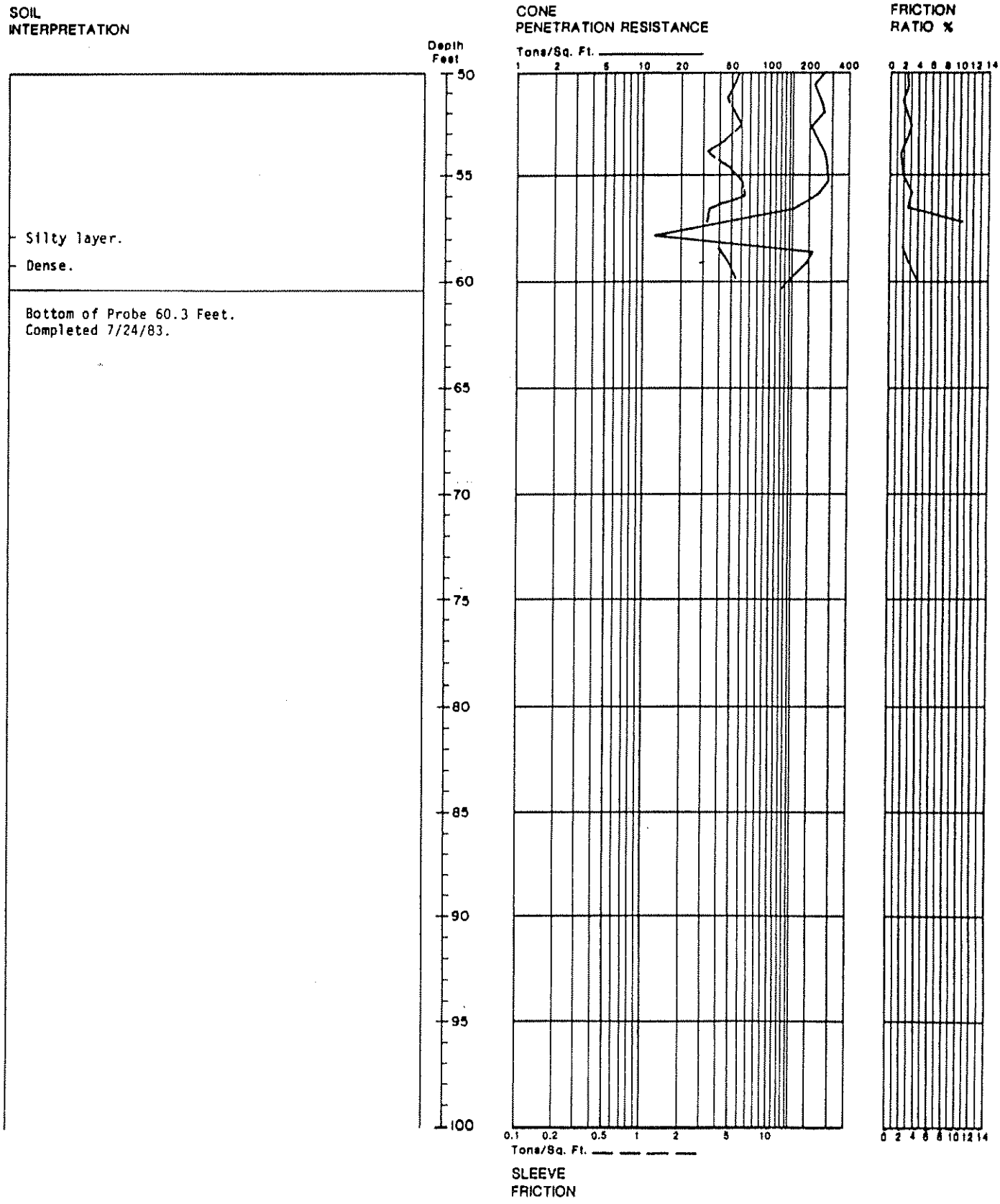
J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 2 of 2 Figure A-3

Probe Log P-3



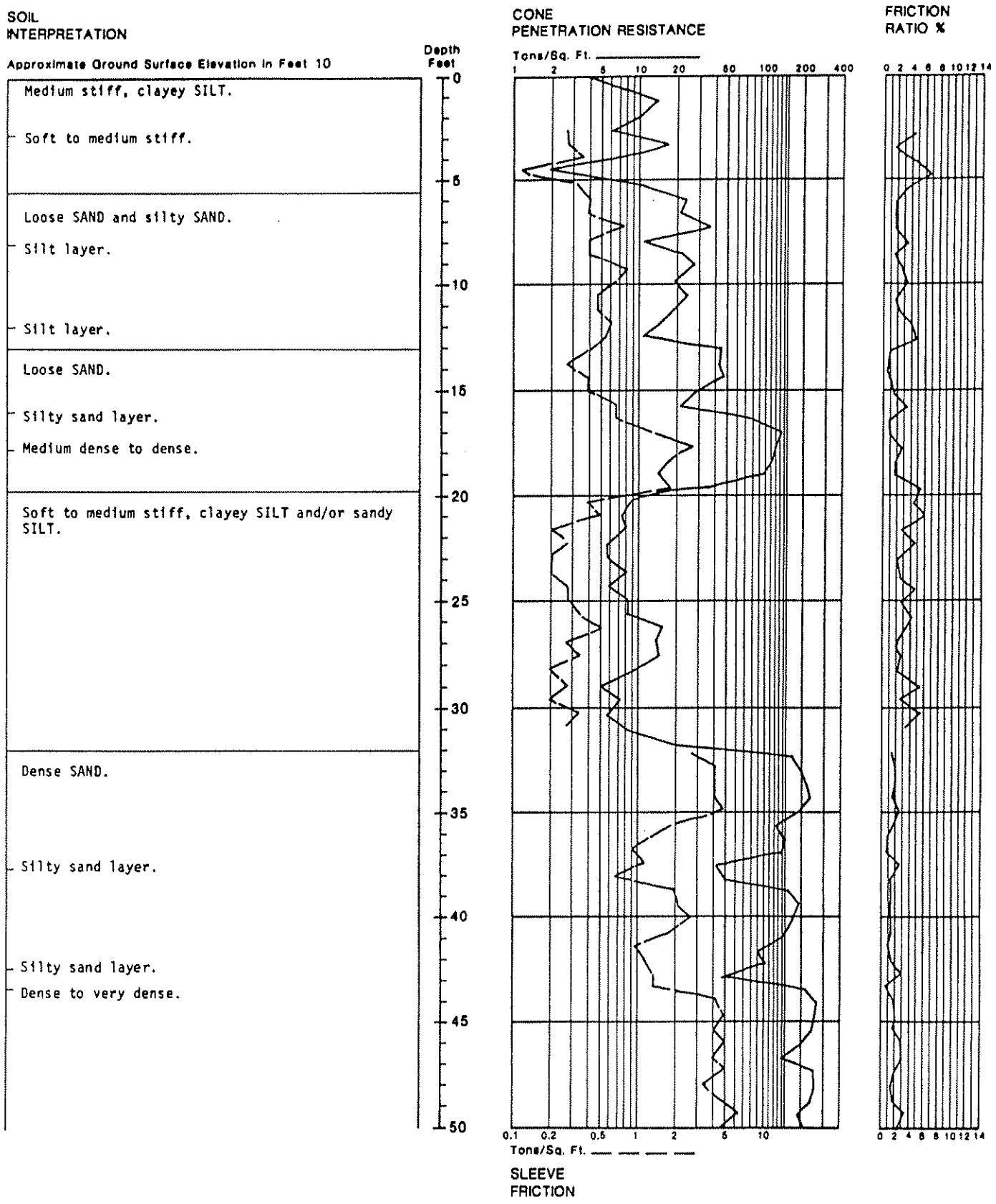
J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-4

Probe Log P-3



J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 2 of 2 Figure A-4

Probe Log P-4



J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-5

Probe Log P-4

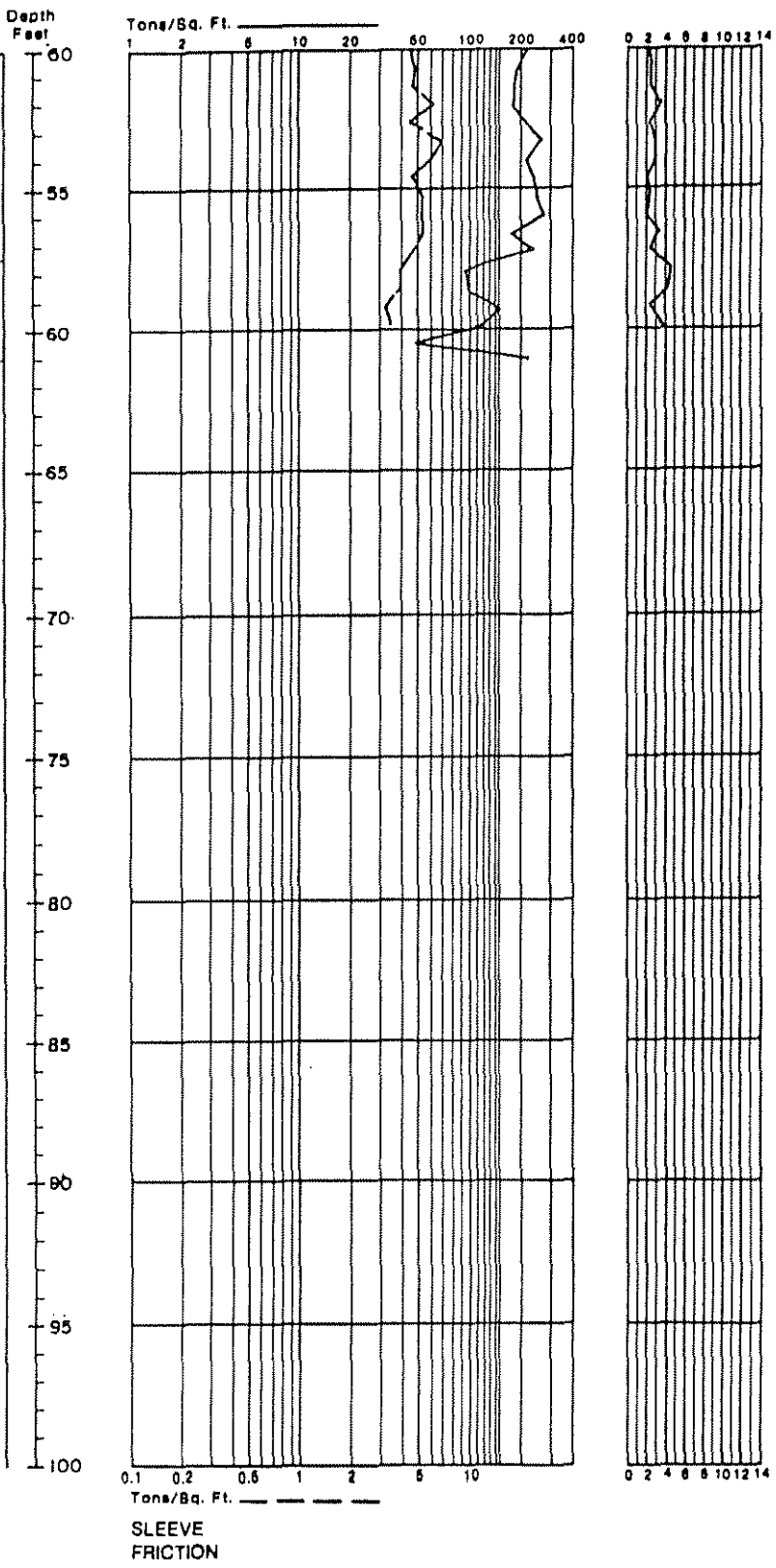
SOIL
INTERPRETATION

Dense to very dense SAND.

Dense, silty SAND.

Silt layer.

Bottom of Probe 61.0 Feet.
Completed 7/25/83.



J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 2 of 2 Figure A-5

Probe Log P-5

SOIL
INTERPRETATION

Approximate Ground Surface Elevation in Feet 11

Soft to medium stiff, clayey SILT

Loose to medium dense SAND.

Loose, silty SAND and/or sandy SILT.

Loose to medium dense SAND.

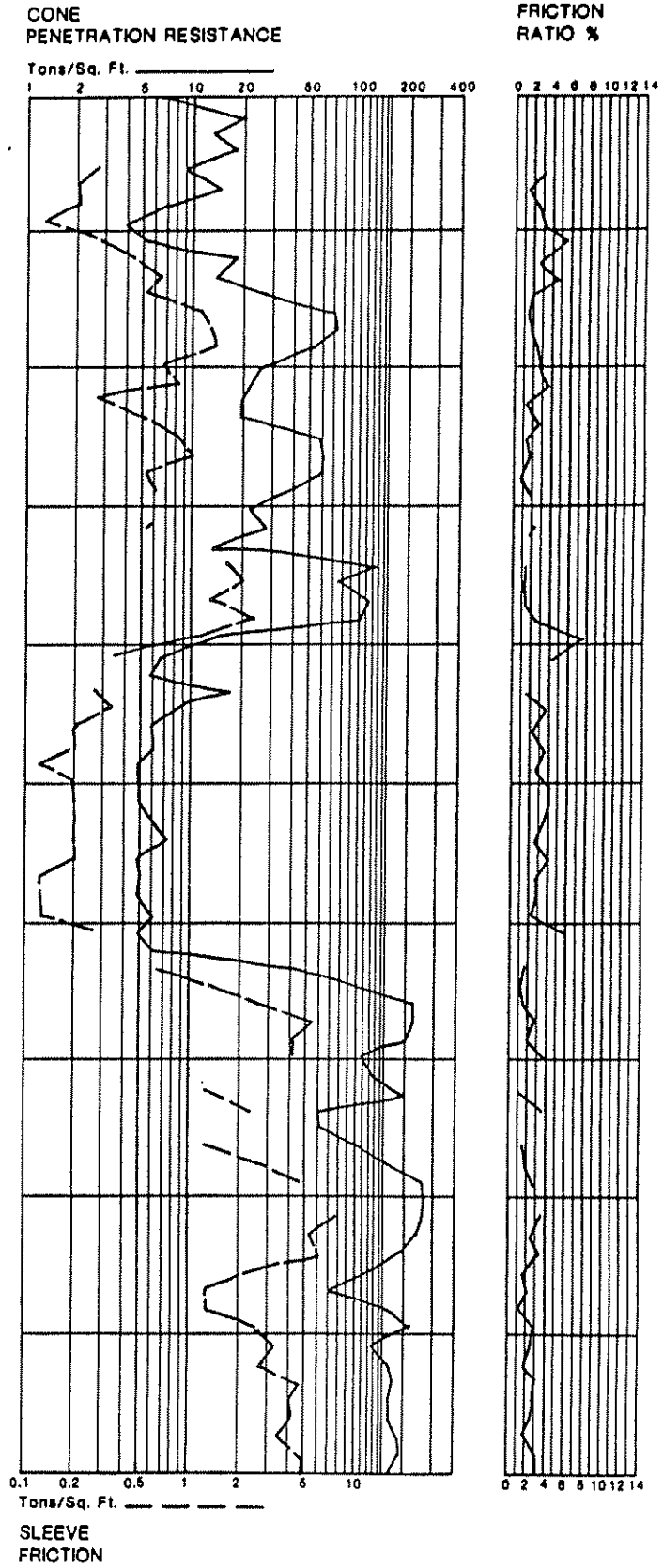
- Silty layer.
- Silty layer.
- Medium dense to dense.

Soft to medium stiff, clayey SILT.

- Sandy layer.
- Soft.

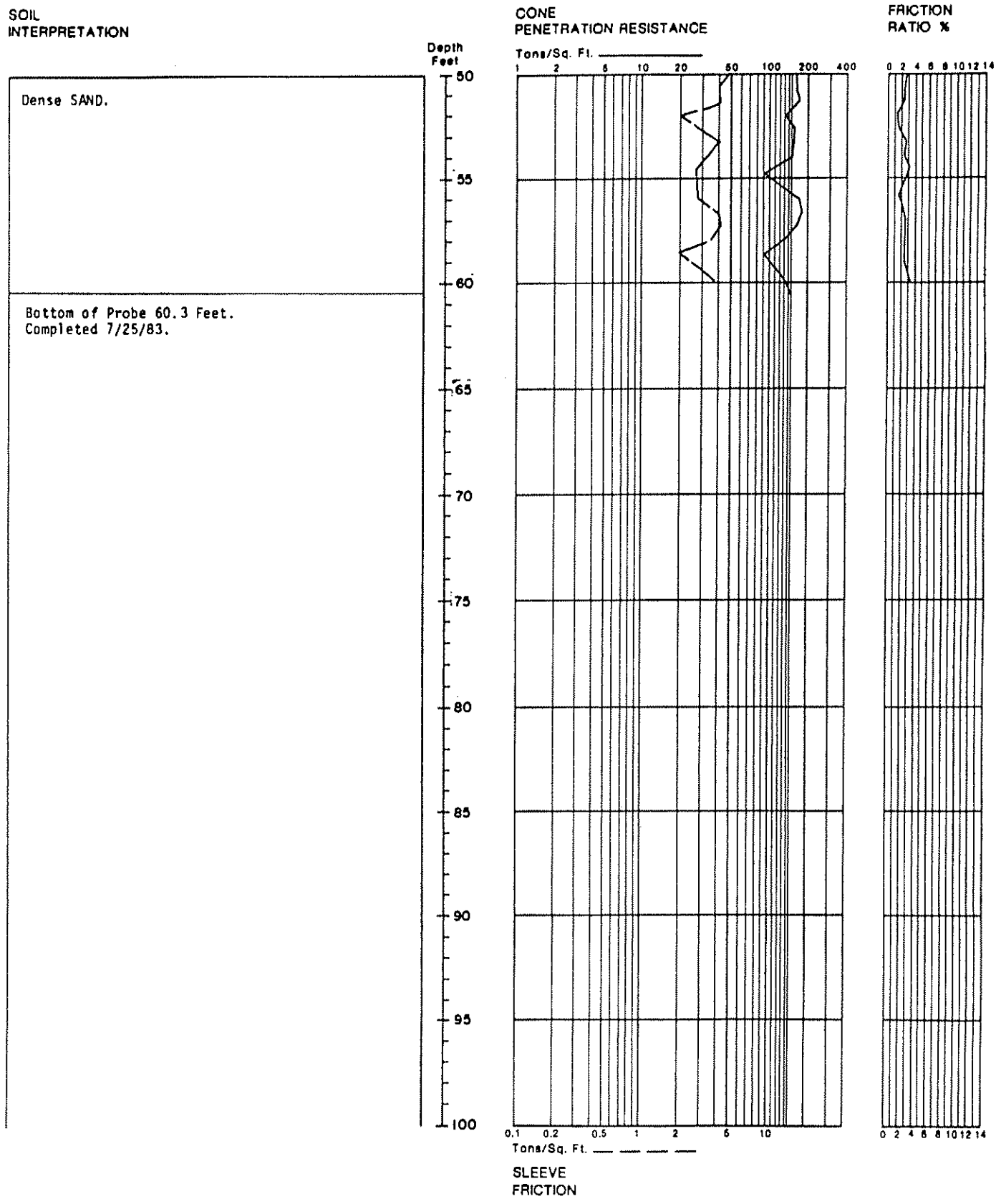
Dense SAND.

- Silty Sand layer.
- Very dense.
- Dense.



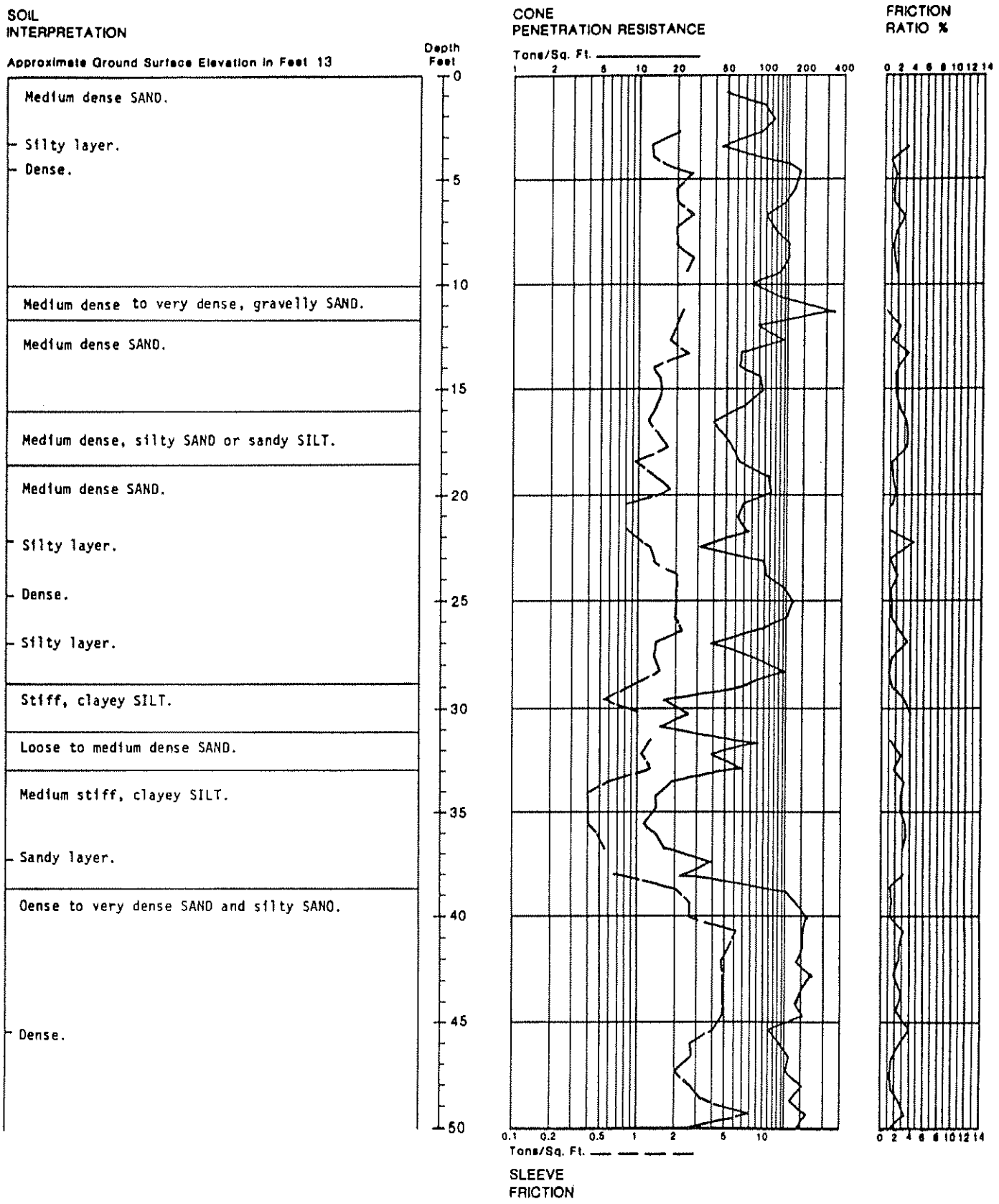
J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-6

Probe Log P-5



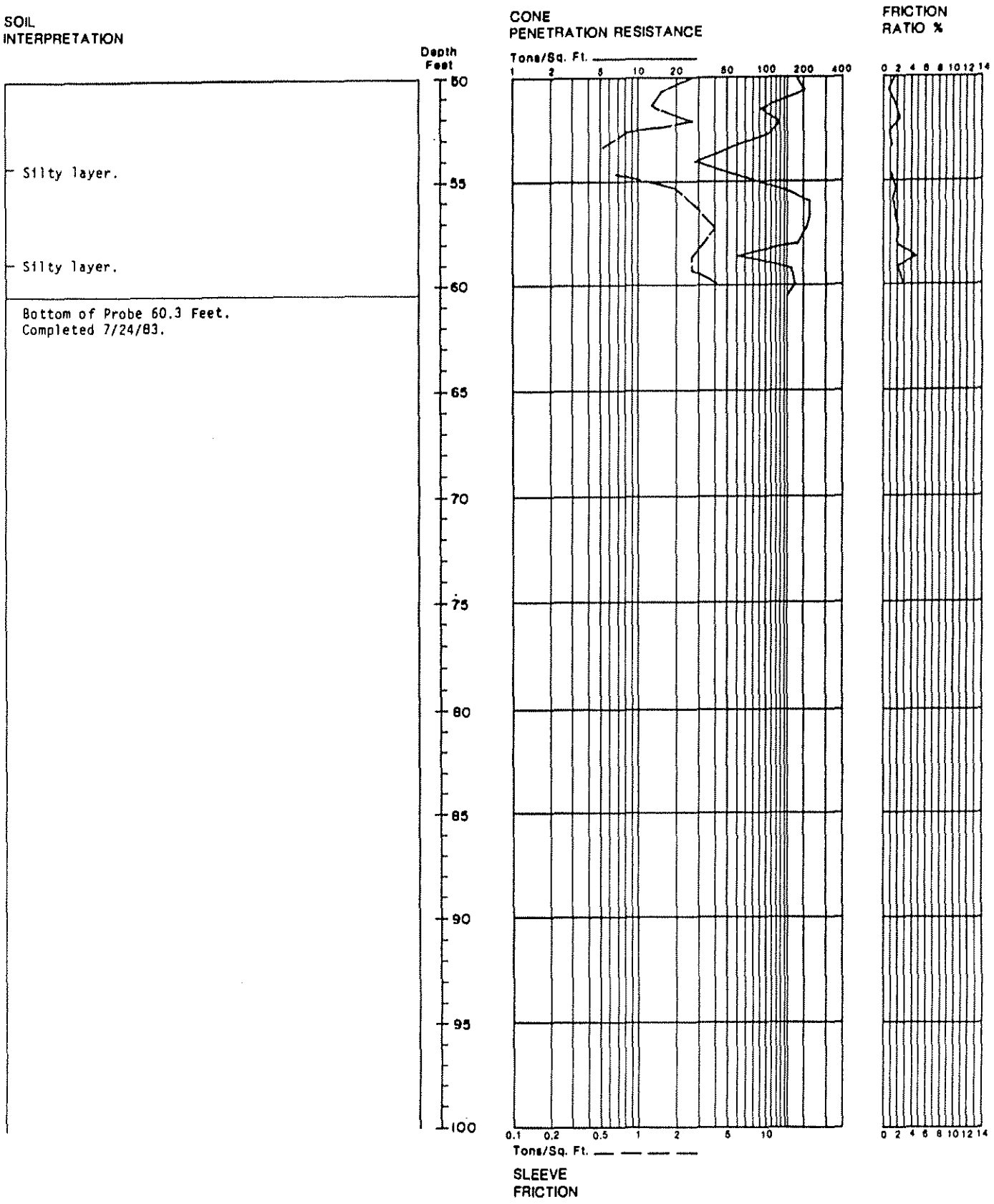
J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 2 of 2 Figure A-6

Probe Log P-6



J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-7

Probe Log P-6



J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 2 of 2 Figure A-7

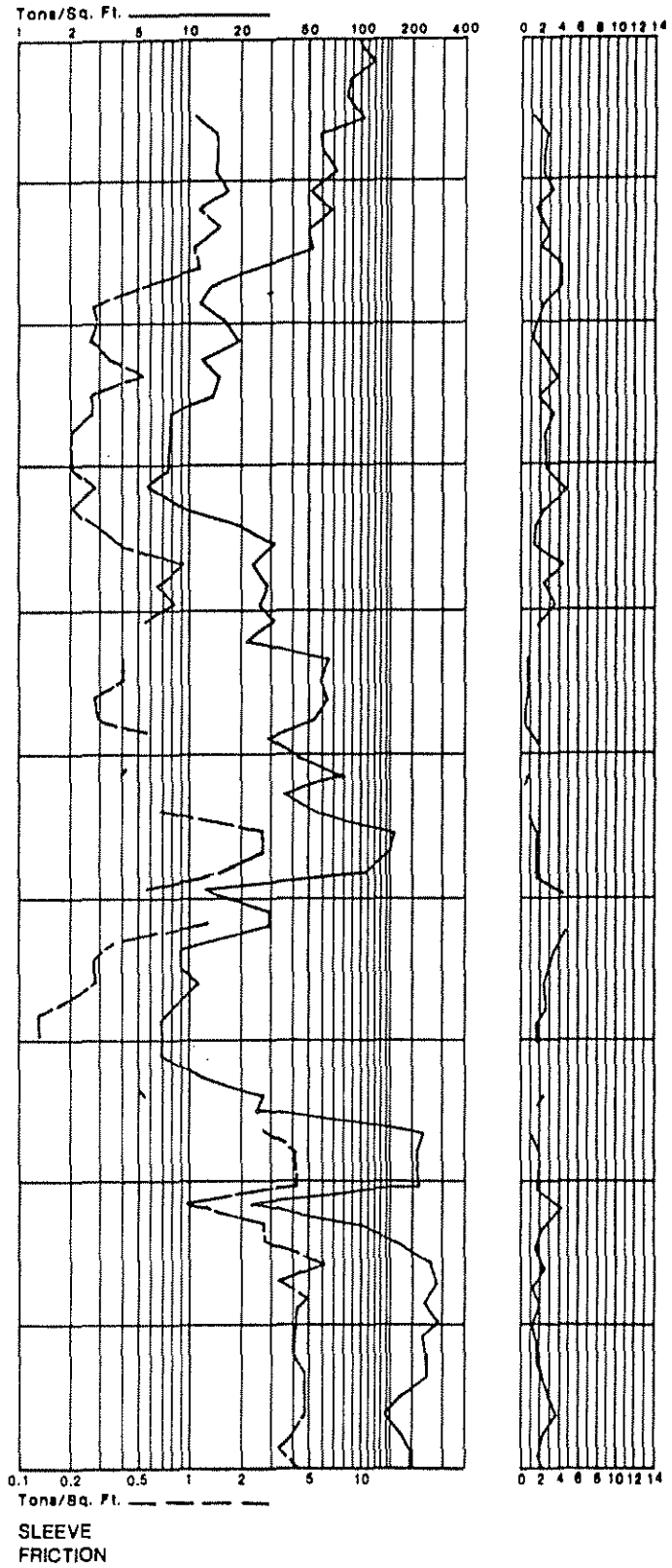
Probe Log P-7

SOIL
INTERPRETATION

Approximate Ground Surface Elevation in Feet 17

Depth Feet

- Medium dense SAND.
- Medium dense, silty SAND
- Medium stiff, clayey SILT and/or sandy SILT.
- Soft to medium stiff.
- Loose, silty SAND and/or sandy SILT.
- Medium dense SAND.
- Loose to medium dense
- Dense.
- Silty layer.
- Loose.
- Soft to medium stiff, clayey SILT and/or sandy SILT.
- Loose SAND.
- Dense to very dense.
- Silty layer
- Very dense.
- Dense.



J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-8

Probe Log P-7

SOIL
INTERPRETATION

Dense SAND.

Very dense.

Dense.

Silty sand layer.

Bottom of Probe 60.3 Feet.
Completed 7/25/83.

Depth
Feet

50
55
60
65
70
75
80
85
90
95
100

CONE
PENETRATION RESISTANCE

Tons/Sq. Ft.
1 2 5 10 20 50 100 200 400

0.1 0.2 0.5 1 2 5 10
Tons/Sq. Ft.

SLEEVE
FRICTION

FRICTION
RATIO %

0 2 4 6 8 10 12 14

0 2 4 6 8 10 12 14

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HART-CROWSER & associates inc.
Sheet 2 of 2 Figure A-8

Boring Log B-1

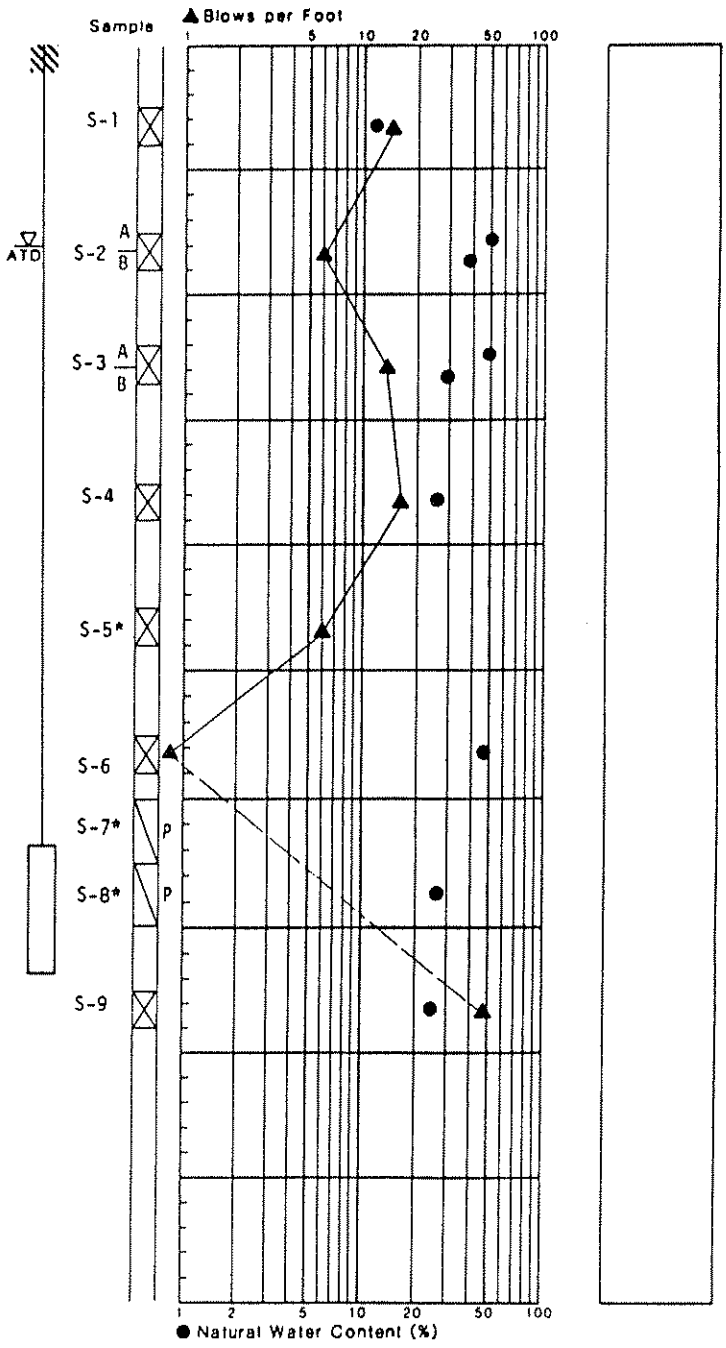
SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 13

Depth Feet	
0	Medium dense, moist, brown, fine to medium SAND. (FILL).
5	Soft, wet to saturated, dark brown, slightly clayey SILT with scattered organics.
10	Loose to medium dense, saturated, dark gray, silty, fine SAND with scattered organics and fine sandy SILT interbeds.
15	Loose to medium dense, saturated, dark gray, fine to medium SAND with scattered root and shell fragments.
20	
25	
30	Very soft, wet to saturated, light gray to brown, slightly fine sandy, clayey SILT with numerous organics.
35	Medium dense to dense, saturated, dark gray to black, fine to medium SAND.
40	Bottom of Boring at 39.0 Feet. Completed 7/20/83.
45	
50	



Groundwater Level

Bentonite Seal
2/4/83
ATD
Water Level (Date) At Time of Drilling
Observation Well Tip or Slotted Section

Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- * No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1 Soil descriptions are interpretive and actual changes may be gradual
2 Water Level, if indicated, is for the date specified and may vary with the time of year

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-9

Boring Log B-2

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 10

Soft to medium stiff, wet to saturated, dark brown to dark gray to black, laminated, fine sandy SILT with organics, and clay lens.

Loose, saturated, black, fine to medium SAND.

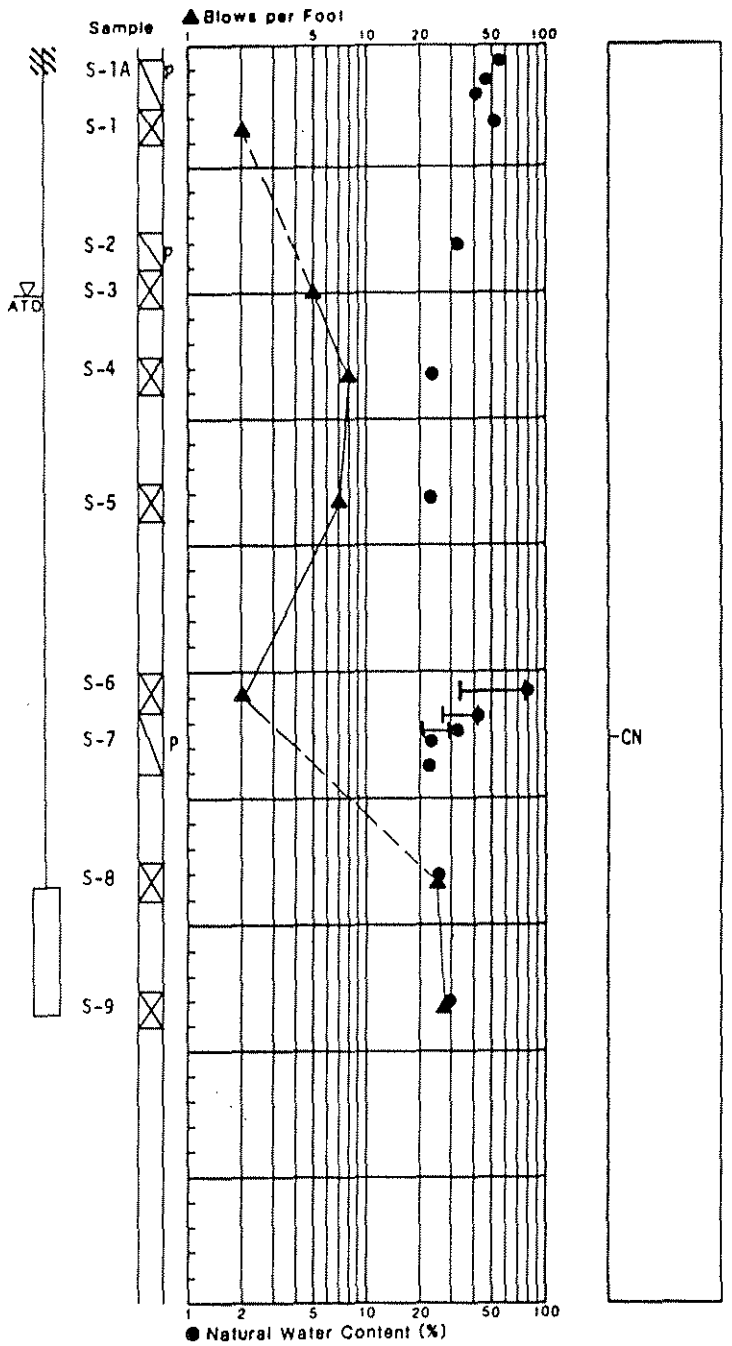
Loose, saturated, black to dark brown, silty, fine to medium SAND with scattered silt lenses, wood fragments and shell fragments.

Very soft, saturated, green-brown, slightly fine sandy SILT with lenses of silty sand to very soft, saturated, clayey SILT.

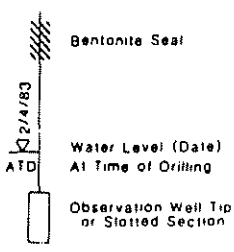
Medium dense, saturated, black, fine to medium SAND.

Medium dense, saturated, black, slightly silty to silty, fine to medium SAND.

Bottom of Boring at 39.0 Feet.
Completed 7/26/83.



Groundwater Level



Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
DU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year

J-1280 August 1983

HART-CROWSER & associates inc.

Figure A-10

Boring Log B-3

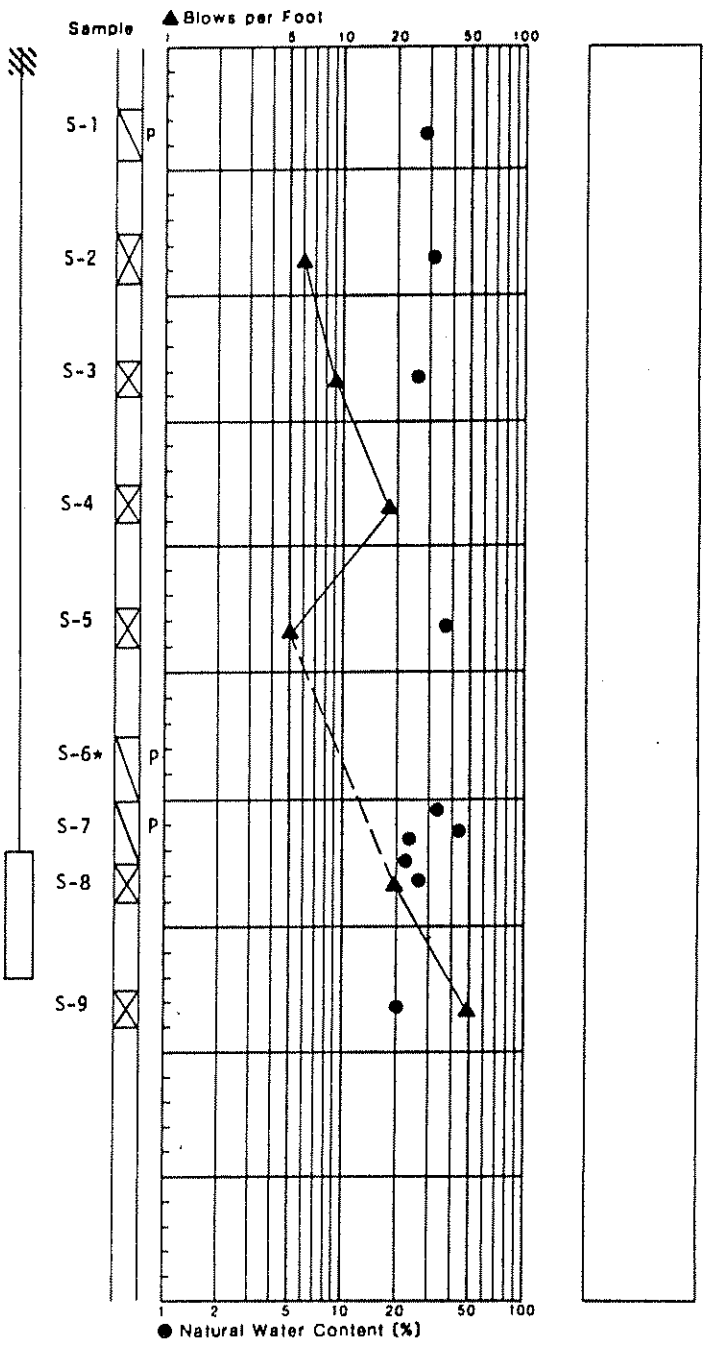
SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

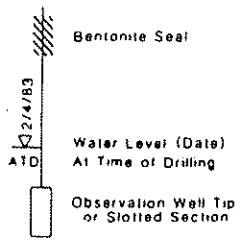
LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 11

Depth Feet	Soil Interpretation
0	Loose, moist, black, very silty, fine SAND with gray silt laminations.
5	
10	Loose, wet to saturated, black, fine to medium SAND.
15	
20	
25	Soft, saturated, green, clayey SILT.
30	Loose, wet, gray to black, very silty, fine to medium SAND.
35	Dense, saturated, black, fine to medium SAND.
40	Bottom of Boring at 39.0 Feet. Completed 7/26/83.
45	
50	



Groundwater Level



Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- ★ No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

J-1280 August 1983

HART-CROWSER & associates inc.

Figure A-11

Boring Log B-4

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 11

Depth Feet	Sample	Soil Interpretation
0		Loose, wet, dark gray, very silty, fine SAND to very fine sandy SILT with scattered root fragments.
5	S-1	Loose to medium dense, saturated, dark gray to black, fine to medium SAND with scattered fine sandy Silt interbeds and root fragments.
10	S-2	
15	S-3	Dense, saturated, dark gray, fine to medium SAND with scattered shell fragments.
20	S-4	Medium dense to dense, wet to saturated, dark gray, slightly silty to silty, fine SAND with scattered shell fragments.
25	S-5	
30	S-6	Dense, saturated, dark gray to black, fine to medium SAND.
35	S-7	
40	S-8	Medium dense, saturated, dark gray, slightly silty to silty, fine SAND with zones of numerous shell fragments and interbeds of fine to medium sand.
45	S-9	Bottom of Boring at 44.0 Feet. Completed 7/20/83.
50		

ATD

▲ Blows per Foot (1, 5, 10, 20, 50, 100)

● Natural Water Content (%) (1, 2, 5, 10, 20, 50, 100)

Groundwater Level

Bentonite Seal

2/14/83 ATD — Water Level (Date) At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- * No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

J-1280 August 1983

HART-CROWSER & associates inc.

Figure A-12

Boring Log B-5

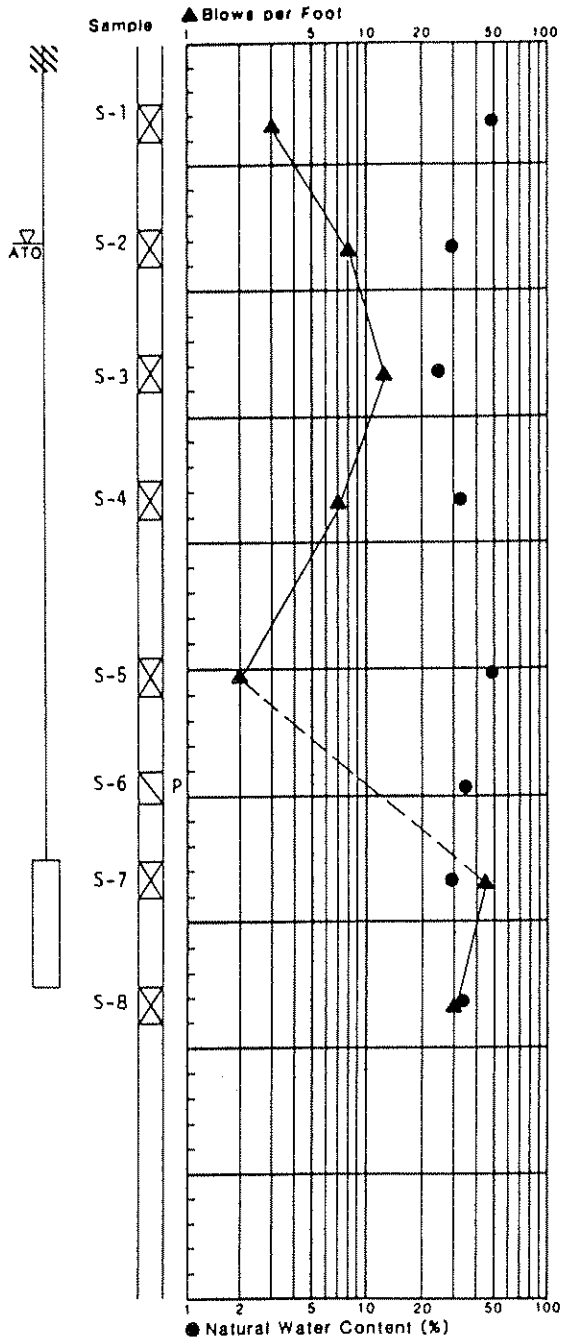
SOIL
INTERPRETATION

STANDARD
PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

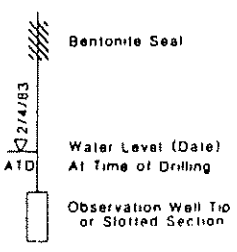
LABORATORY
TESTS

Approximate Ground Surface Elevation in Feet 11

	Depth Feet
Soft, wet to saturated, gray to brown, fine sandy SILT to very silty, fine SAND with scattered root fragments.	0
Loose, wet to saturated, dark gray to black, fine to medium SAND.	5
	10
Medium dense, saturated, dark gray to black, silty, fine to medium SAND with scattered organics.	15
Loose, saturated, dark gray to black, fine to medium SAND.	20
Soft, saturated, gray to brown, clayey SILT.	25
	30
Dense, saturated, dark gray to black, fine to medium SAND.	35
	40
Bottom of Boring at 39.0 Feet. Completed 7/21/83.	45
	50



Groundwater Level



Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- * No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-13

Boring Log B-6

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 12

Loose, wet, black, slightly silty, fine SAND.

Loose to medium dense, saturated, black fine to medium SAND.

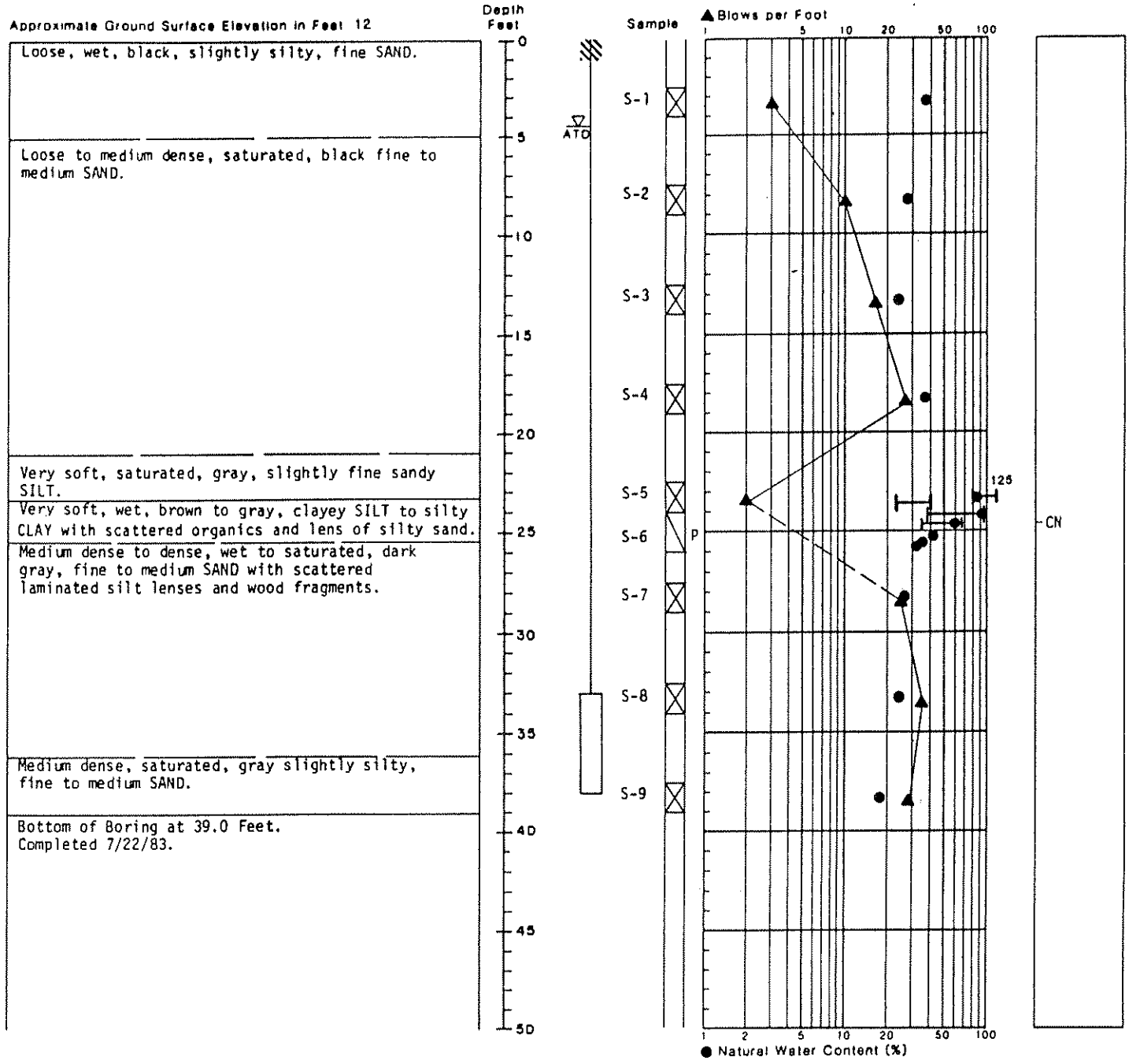
Very soft, saturated, gray, slightly fine sandy SILT.

Very soft, wet, brown to gray, clayey SILT to silty CLAY with scattered organics and lens of silty sand.

Medium dense to dense, wet to saturated, dark gray, fine to medium SAND with scattered laminated silt lenses and wood fragments.

Medium dense, saturated, gray slightly silty, fine to medium SAND.

Bottom of Boring at 39.0 Feet.
Completed 7/22/83.



Groundwater Level

- Bentonite Seal
- 12/4/83 ATO — Water Level (Date) At Time of Drilling
- Observation Well Tip or Slotted Section

Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- * No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis	TUU	Triaxial Unconsolidated Undrained
CN	Consolidation Test	TCU	Triaxial Consolidated Undrained
K	Permeability Test	TCD	Triaxial Consolidated Drained
OS	Direct Shear		
QU	Unconfined Compression, tsf		
TV	Torvane, tsf		
PP	Pocket Penetrometer, tsf		

Water Content (%)

Plastic Limit — Natural — Liquid Limit
Water Content

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-14

Boring Log B-7

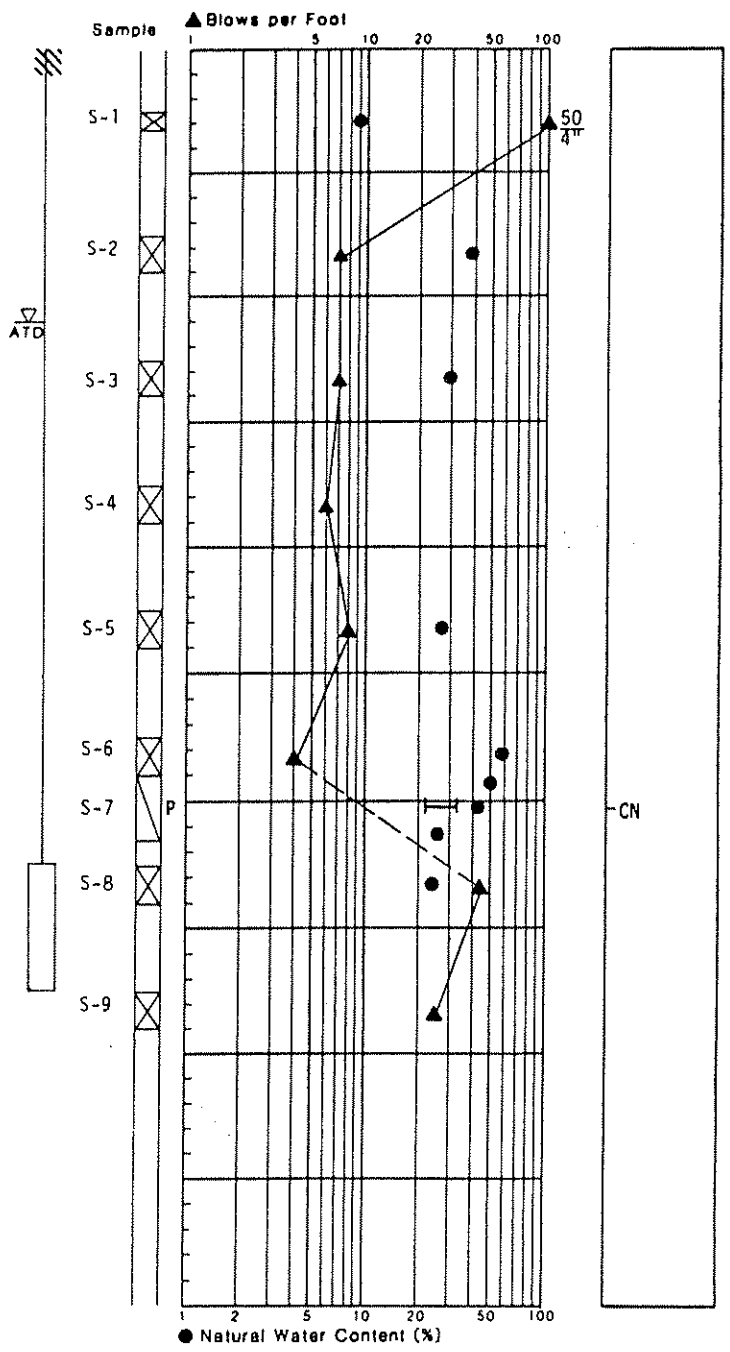
SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 14

Depth Feet	Soil Interpretation
0	Very dense, moist, gray to brown, sandy GRAVEL with abundant wood and concrete debris. (FILL).
5	Loose, wet, dark gray, laminated, very fine sandy SILT.
10	Loose, saturated, dark gray to black, fine to medium SAND.
15	
20	Loose, saturated, dark gray to black, silty fine SAND with scattered shell fragments.
25	Loose, saturated, dark gray to black, fine to medium SAND with numerous shell fragments and scattered zones of silty, fine SAND.
30	Soft, wet to saturated, light gray, clayey SILT, silty CLAY to slightly clayey, fine sandy SILT with scattered root fragments and clay lens.
35	Medium dense to dense, saturated, dark gray to black, fine to medium SAND.
40	Bottom of Boring at 39.0 Feet. Completed 7/21/83.
45	
50	



Groundwater Level

- Bentonite Seal
- 12/4/83 ATD — Water Level (Date) At Time of Drilling
- Observation Well Tip or Slotted Section

Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- ★ No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
OS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year

J-1280 August 1983

HART-CROWSER & associates inc.

Figure A-15

Boring Log B-8

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 17

Depth Feet

Loose to medium dense, damp, gray to brown, fine to medium SAND with scattered gravel and wood fragments (FILL).

Soft, wet, gray, laminated, clayey SILT with scattered root fragments.

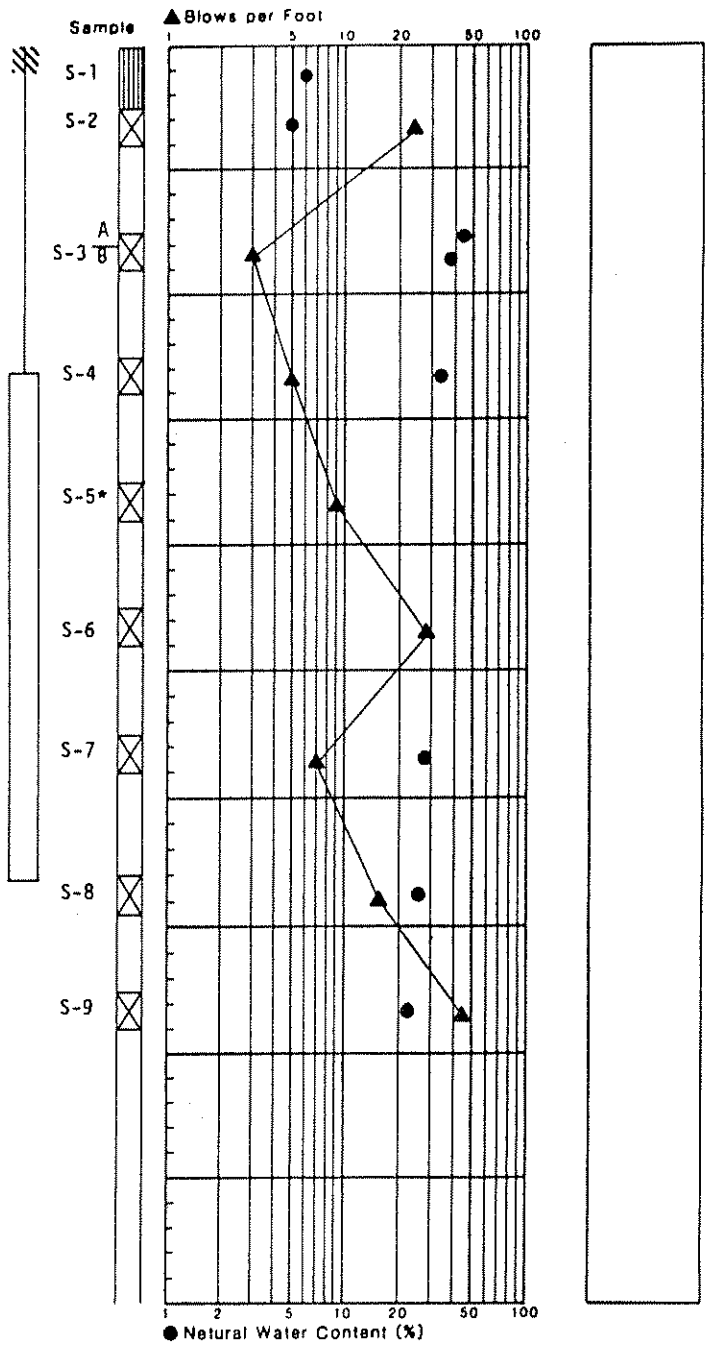
Loose to medium dense, saturated, dark gray to black, fine to medium SAND with scattered silt interbeds and shell fragments.

Loose, saturated, gray to dark gray, silty, fine SAND with a trace of shell fragments.

Medium dense, saturated, gray, silty, fine SAND with scattered silt interbeds.

Dense, saturated, dark gray to black, fine to medium SAND.

Bottom of Boring at 39.0 Feet.
Completed 7/22/83.



Groundwater Level

- Bentonite Seal
- 12/4/83 ATD — Water Level (Date) At Time of Drilling
- Observation Well Tip or Slotted Section

Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- * No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-16

Boring Log B-9

SOIL
INTERPRETATION

STANDARD
PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY
TESTS

Approximate Ground Surface Elevation in Feet 18

Depth
Feet

Medium dense, damp, gray to brown, fine to medium SAND. (FILL).

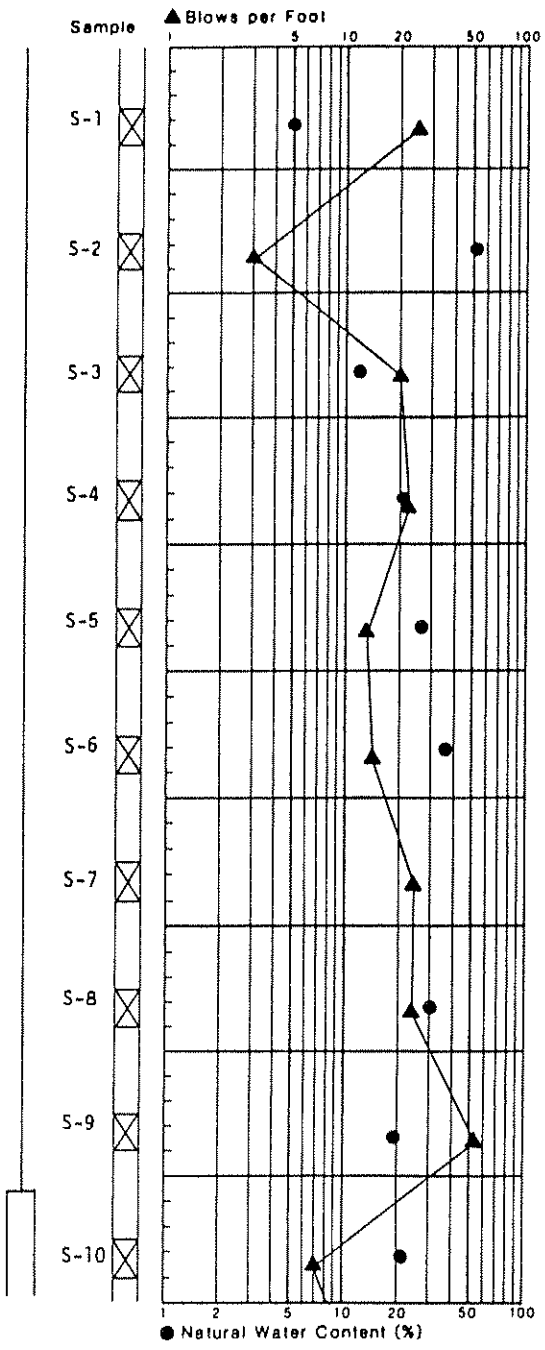
Soft, moist, black, massive SILT. (FILL).

Medium dense, moist to wet, black, fine to medium SAND with scattered gravel and silty sand.

Medium dense, wet, black, silty, fine SAND with thin, gray silt interbeds.

Very dense, wet, black, fine to medium SAND.

Loose, wet to saturated, green-black, silty, fine to medium SAND with scattered shell fragments.



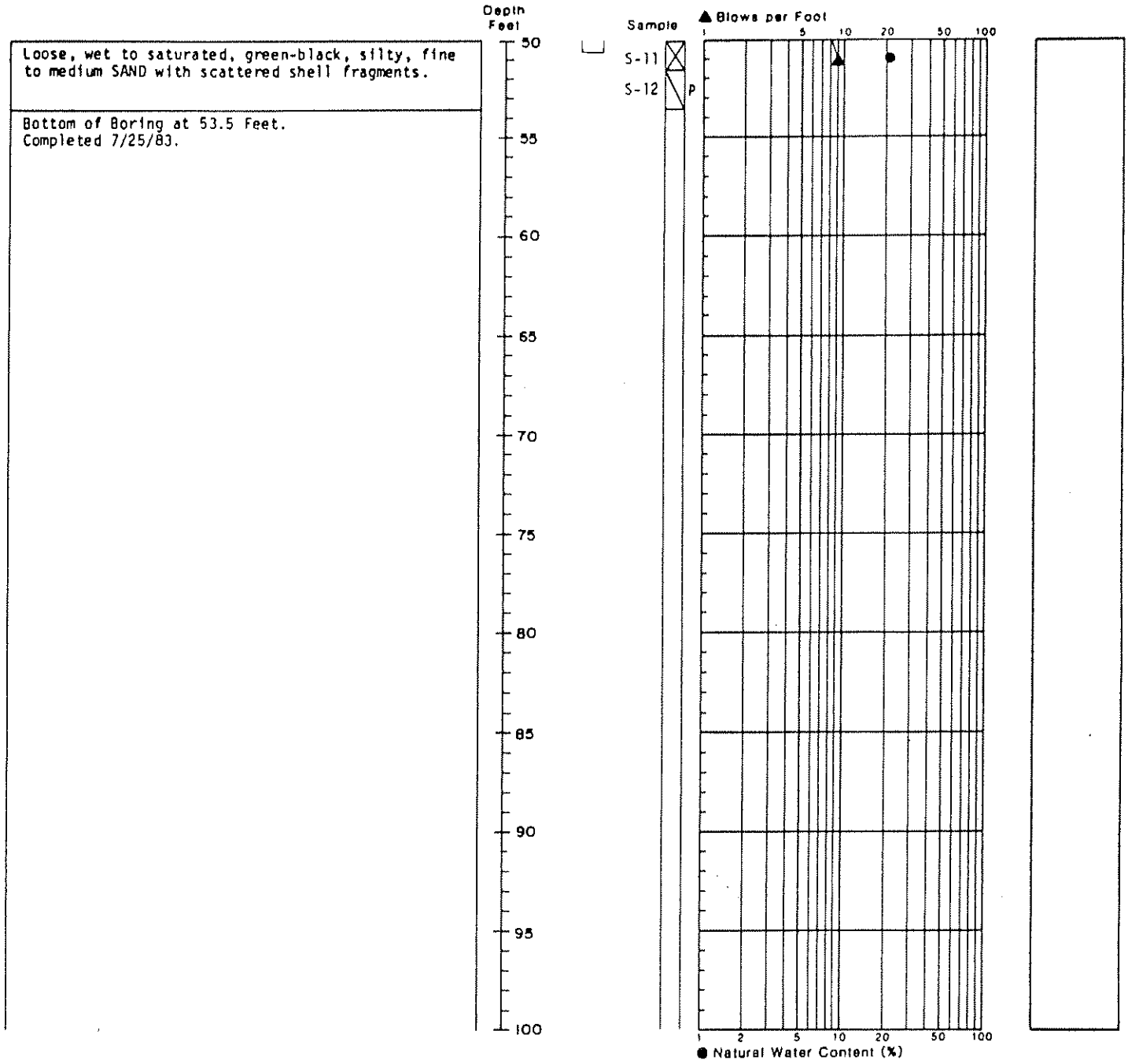
J-1280 August 1983
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-17

Boring Log B-9

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS



Groundwater Level

Bentonite Seal

7/24/83 ATD — Water Level (Date) At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- No Sample Recovery
- P — Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year

J-1280 August 1983

HART-CROWSER & associates inc.

Sheet 2 of 2 Figure A-17

Boring Log B-10

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 18

Depth Feet

Sample

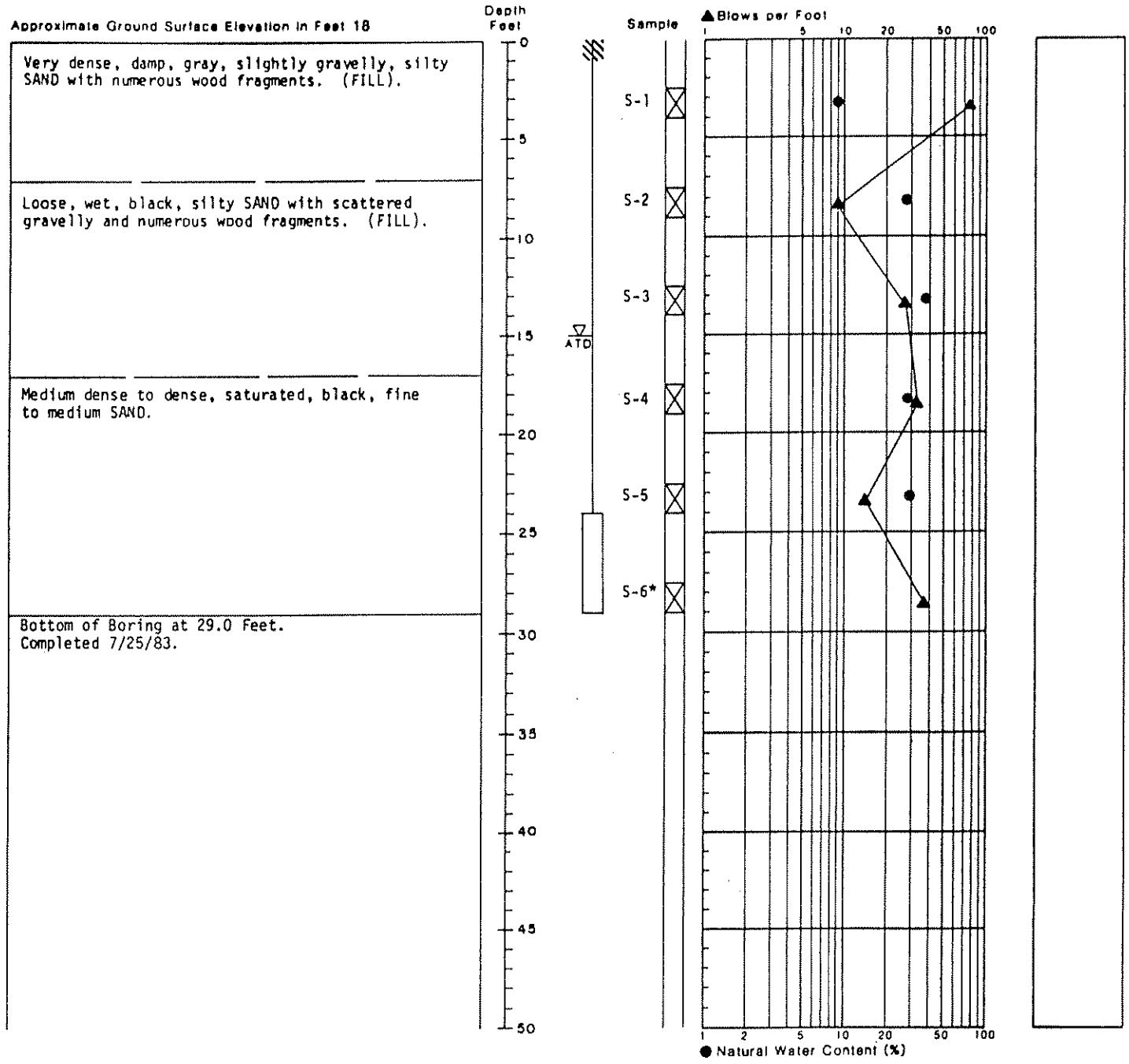
▲Blows per Foot

Very dense, damp, gray, slightly gravelly, silty SAND with numerous wood fragments. (FILL).

Loose, wet, black, silty SAND with scattered gravelly and numerous wood fragments. (FILL).

Medium dense to dense, saturated, black, fine to medium SAND.

Bottom of Boring at 29.0 Feet.
Completed 7/25/83.



Groundwater Level

Bentonite Seal

7/24/83 ATD

Water Level (Date) At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

★ No Sample Recovery

P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

J-1280 August 1983

HART-CROWSER & associates inc.

Figure A-18

Boring Log B-11

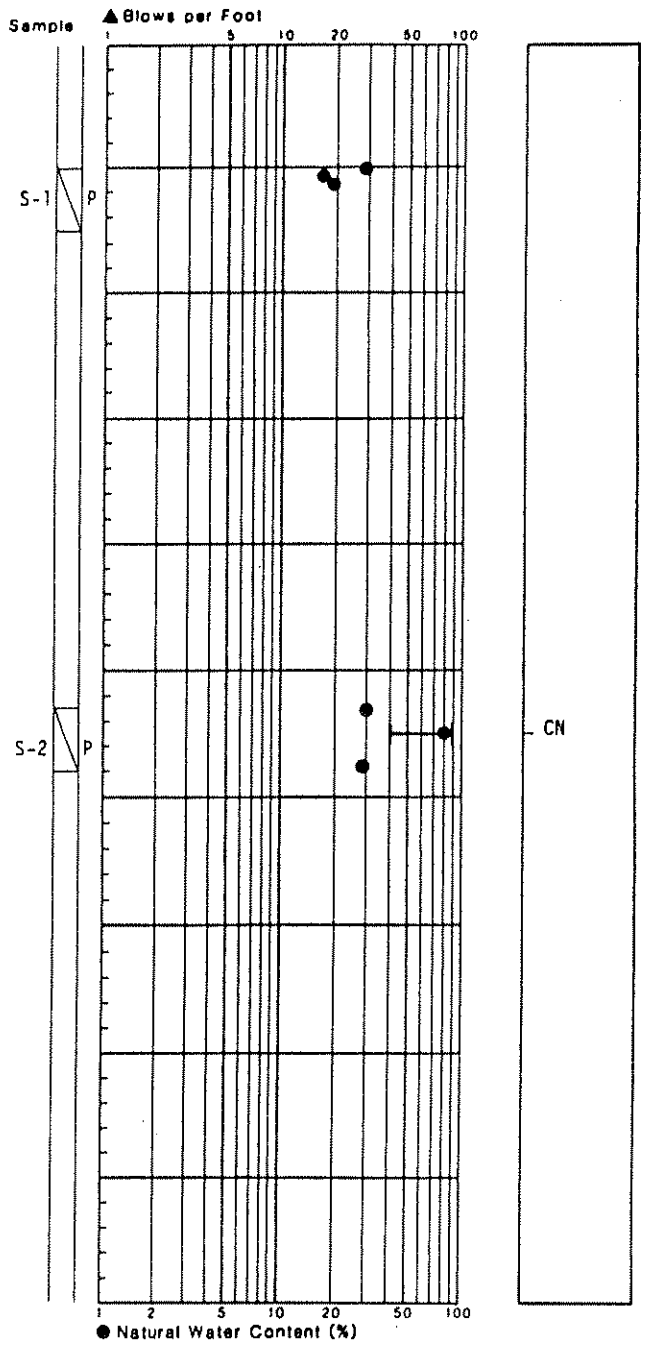
SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

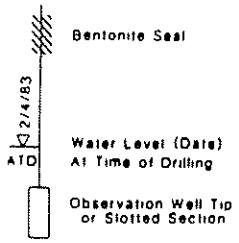
LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 12

Depth Feet	
0	FILL
5	Soft to medium stiff, clayey SILT to medium dense, moist, dark brown, sandy SILT, trace of wood debris, organics
10	Loose SAND
15	Medium stiff to stiff, clayey SILT
20	Loose SAND
25	Soft to medium stiff, moist to wet, dark gray to black to brown clayey SILT to sandy SILT, trace organics, and wood fragments
30	Bottom of Boring at 29.0 Feet. Completed 7/27/83.
35	
40	Note: B-11 was excavated adjacent to P-2 to obtain Shelby Tube samples. Stratigraphy was inferred from P-2 and TP-13 where soil was not sampled.
45	
50	



Groundwater Level



Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- ★ No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

J-1280 October 1983

HART-CROWSER & associates, inc.

Figure A-19

Boring Log B-12

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE

(140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 11

Depth Feet

Soft to medium stiff, moist, tan to brown, clayey SILT, trace of roots, to fine sandy SILT to silty SAND.

Loose to medium dense SAND

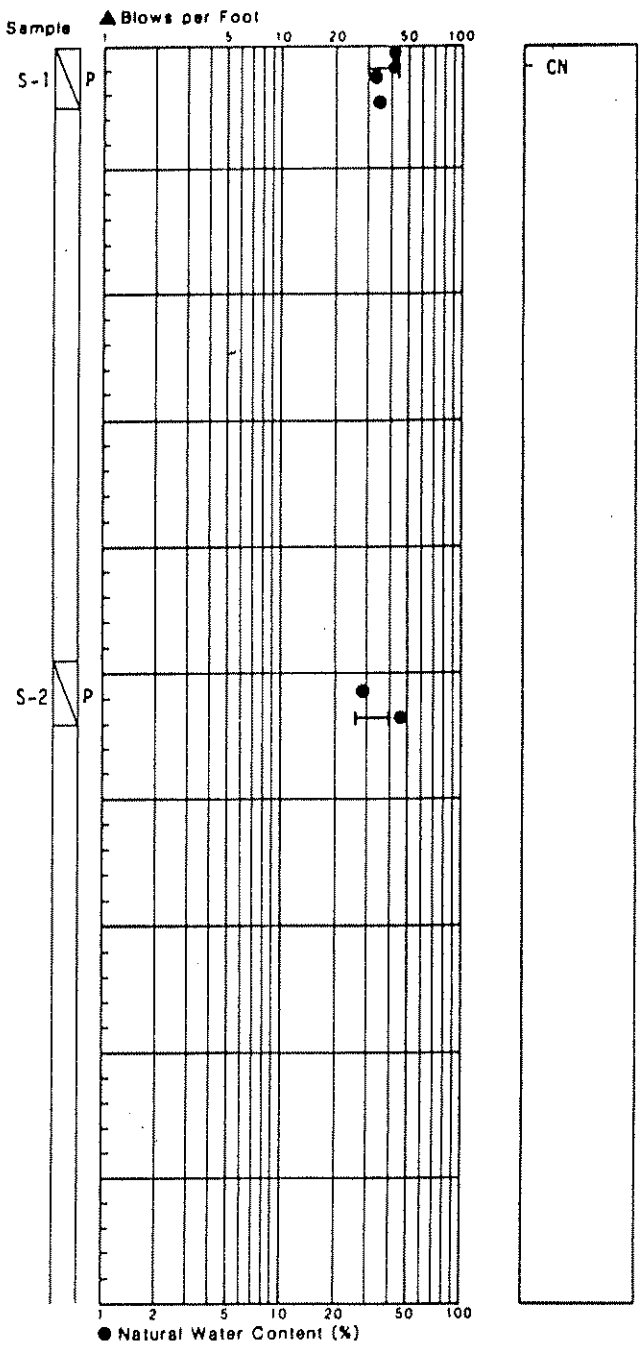
Loose, silty SAND and/or sandy SILT

Loose to medium dense SAND

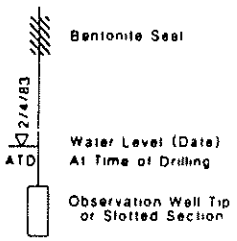
Soft to medium stiff saturated, black to gray, clayey SILT with lens of sand to medium dense, SAND with lens of clayey silt.

Bottom of Boring at 27.0 Feet.
Completed 7/27/83.

Note: B-12 was excavated adjacent to P-5 to obtain Shelby Tube samples. Stratigraphy was inferred from P-5 where soil was not sampled.



Groundwater Level



Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- ★ No Sample Recovery
- P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year

J-1280 October 1983

HART-CROWSER & associates, inc.

Figure A-20

Boring Log B-13

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Approximate Ground Surface Elevation in Feet 10

Depth Feet

Soft to medium stiff, moist, dark brown to gray brown, clsyey SILT to sandy SILT with roots, wood debris, lens of silty clay.

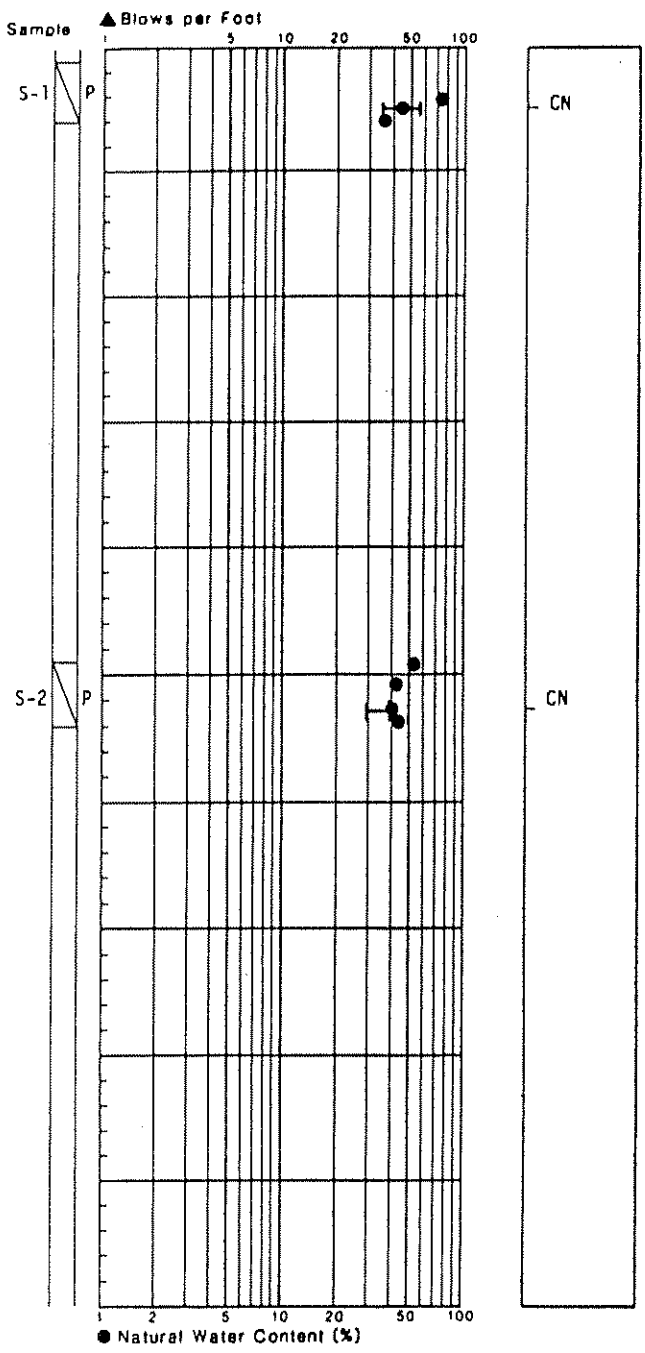
Loose SAND and silty SAND

Loose SAND

Very soft to medium stiff, moist to wet, gray, clayey SILT to sandy SILT with trace of wood and organics.

Bottom of Boring at 27.0 Feet.
Completed 7/27/83.

Note: B-13 was excavated adjacent to P-4 to obtain Shelby Tube samples. Stratigraphy was inferred from P-4 where soil was not sampled.



0 5 10 15 20 25 30 35 40 45 50

Groundwater Level

Bentonite Seal

2/4/83 ATD

Water Level (Date) At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

* No Sample Recovery

P Sampler Pushed Hydraulically, Not Driven

Laboratory Tests

GS	Grain Size Analysis
CN	Consolidation Test
K	Permeability Test
DS	Direct Shear
QU	Unconfined Compression, tsf
TV	Torvane, tsf
PP	Pocket Penetrometer, tsf
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

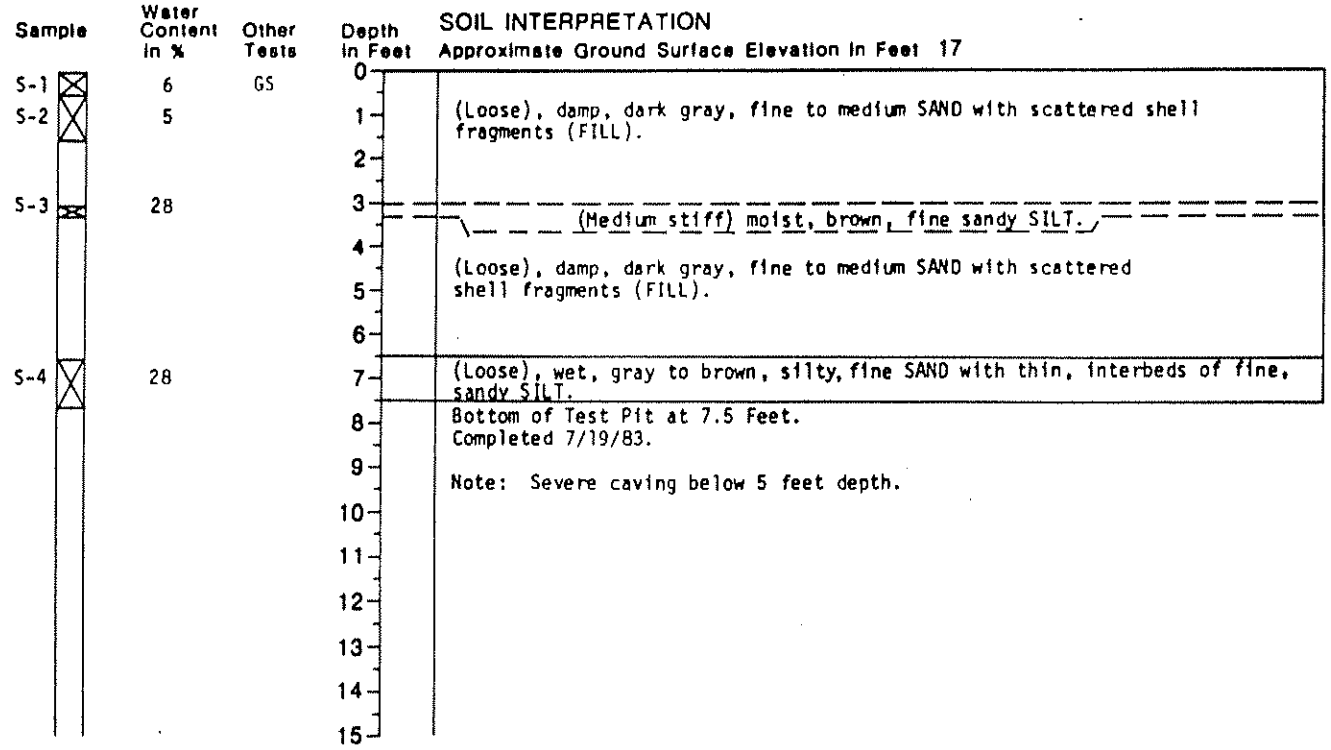
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

J-1280 October 1983

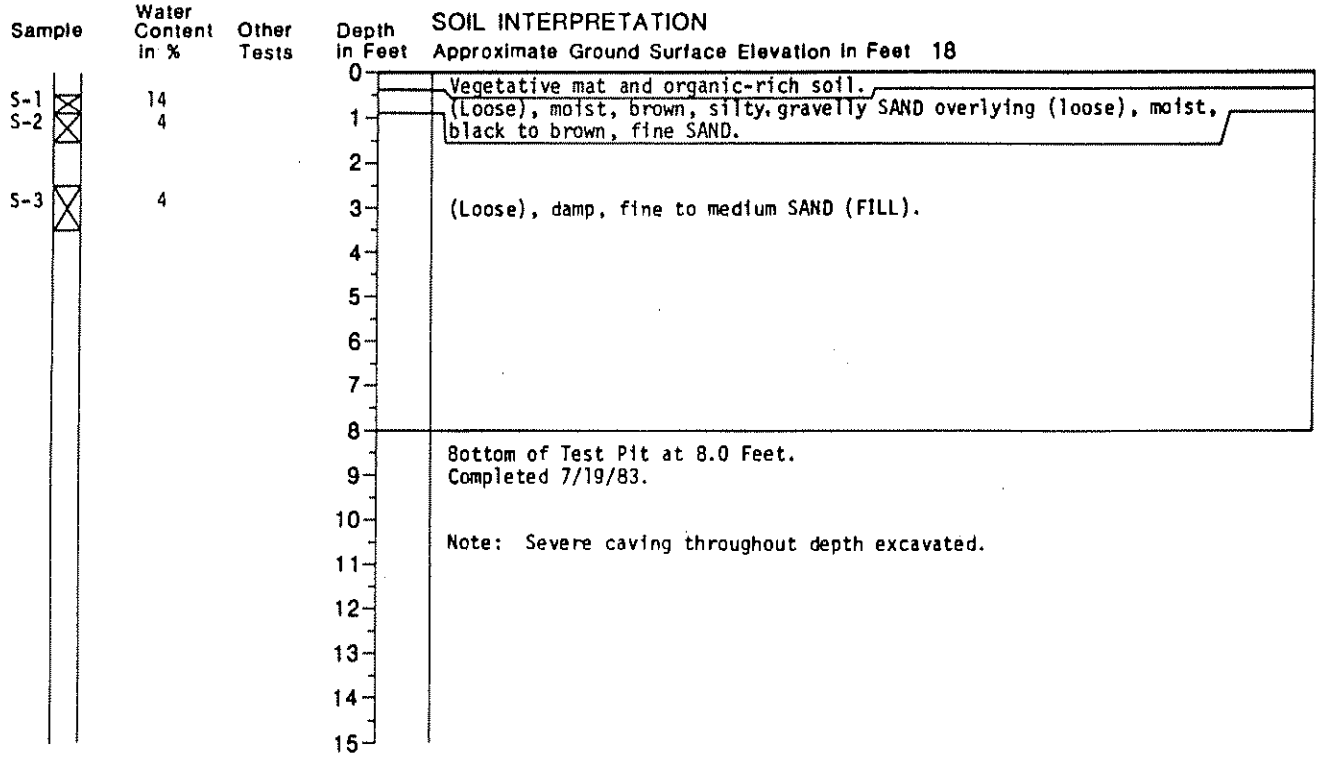
HART-CROWSER & associates, inc.

Figure A-21

Test Pit Log TP-1



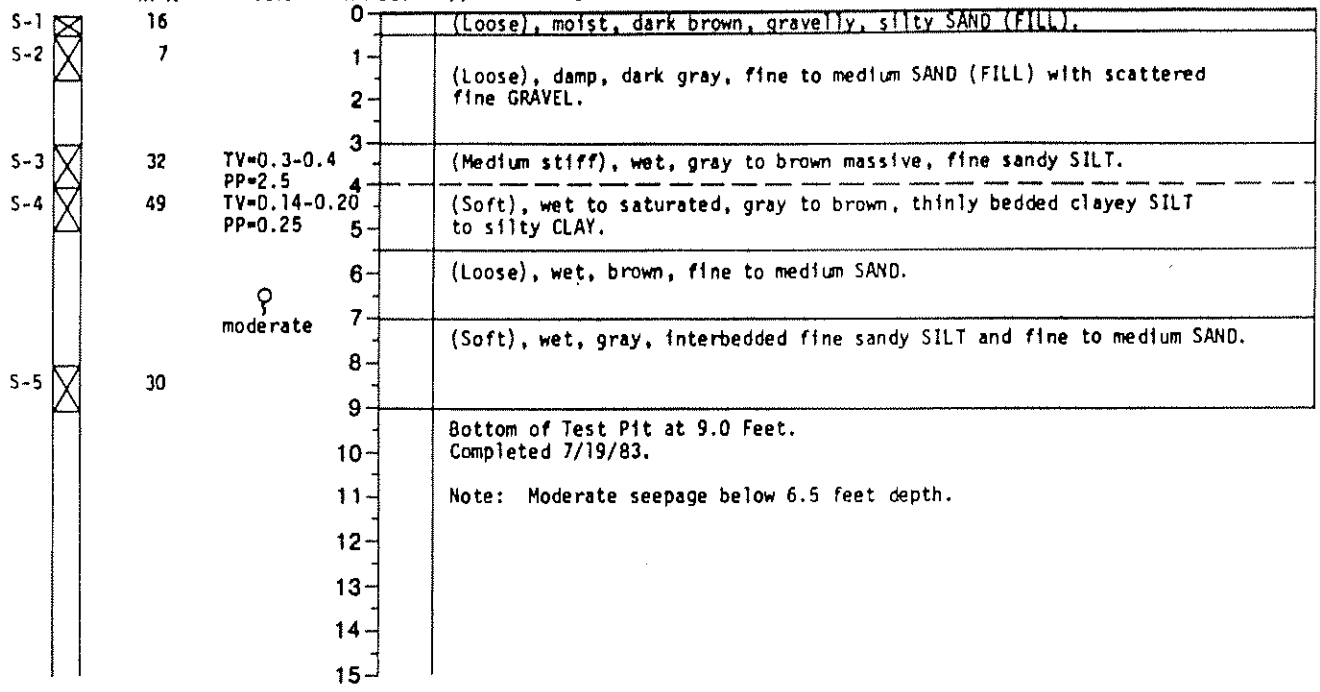
Test Pit Log TP-2



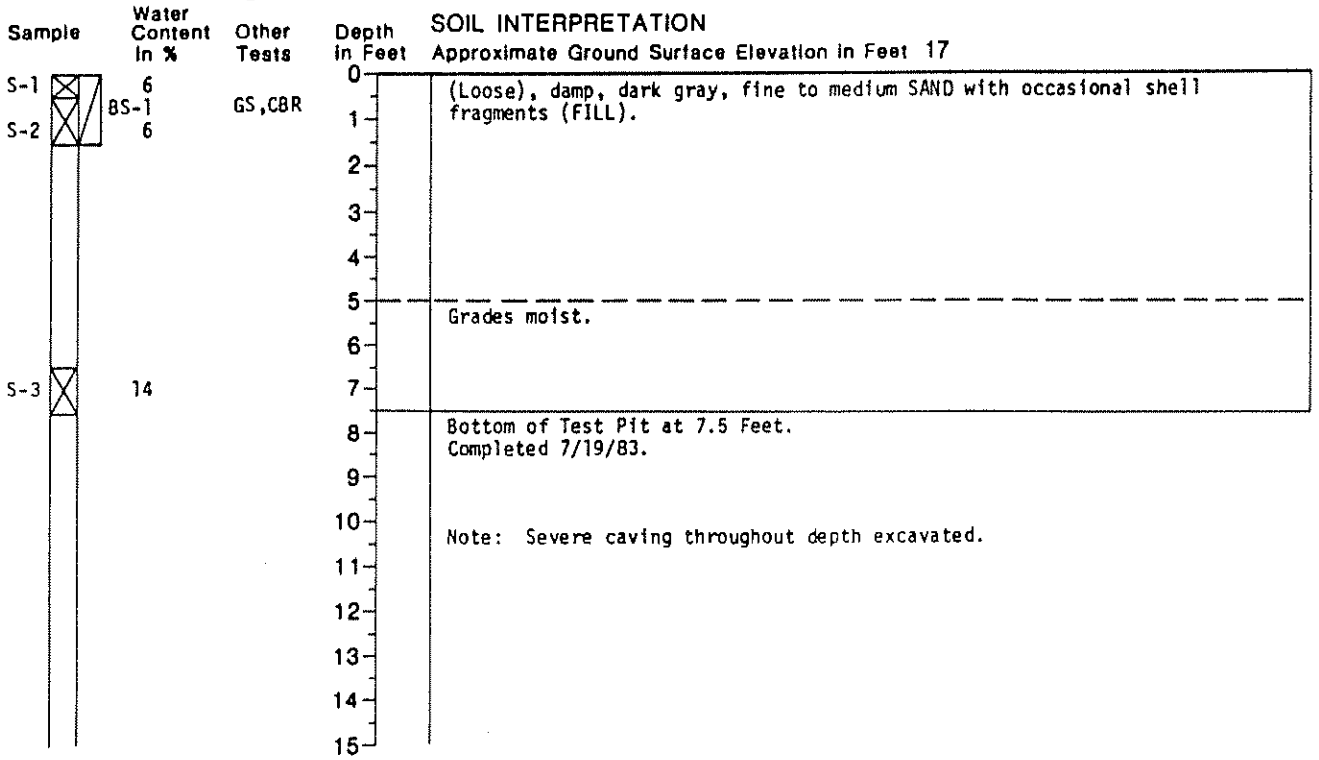
NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-22

Test Pit Log TP-3



Test Pit Log TP-4



NOTES:

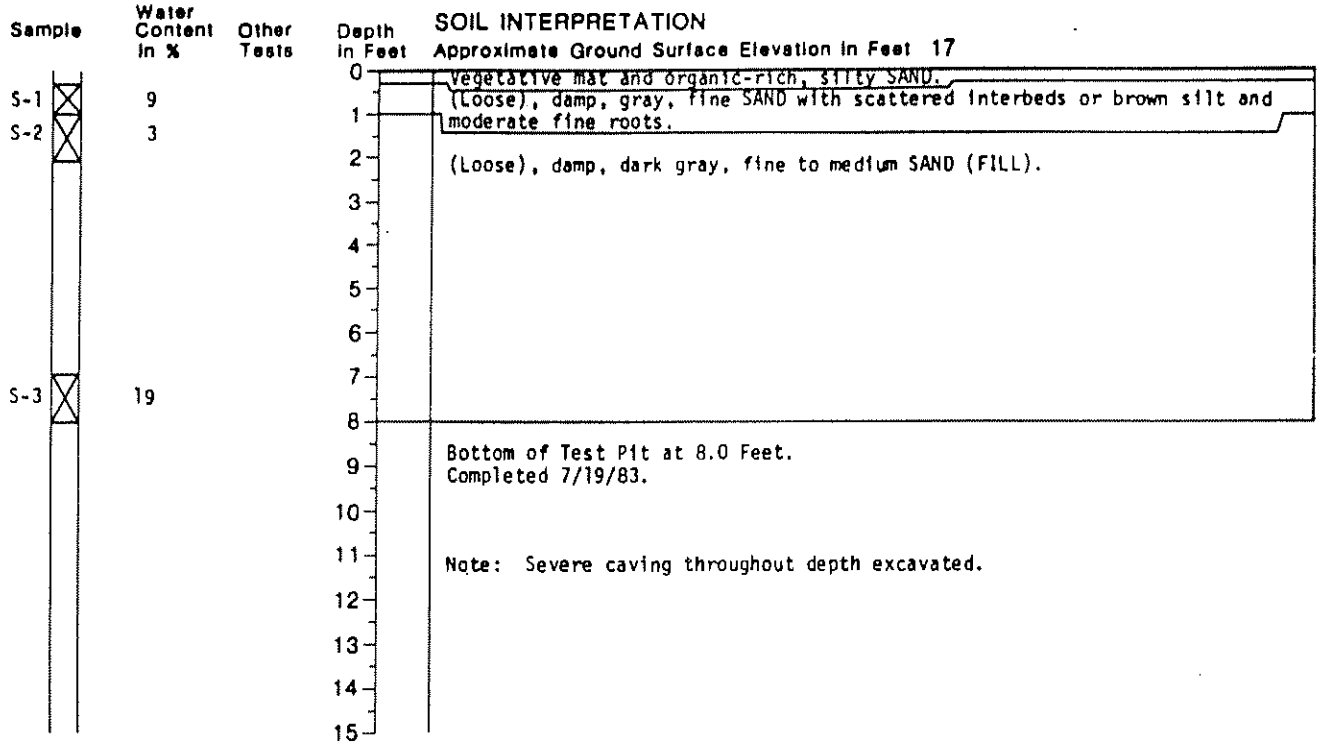
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

J-1280 August 1983

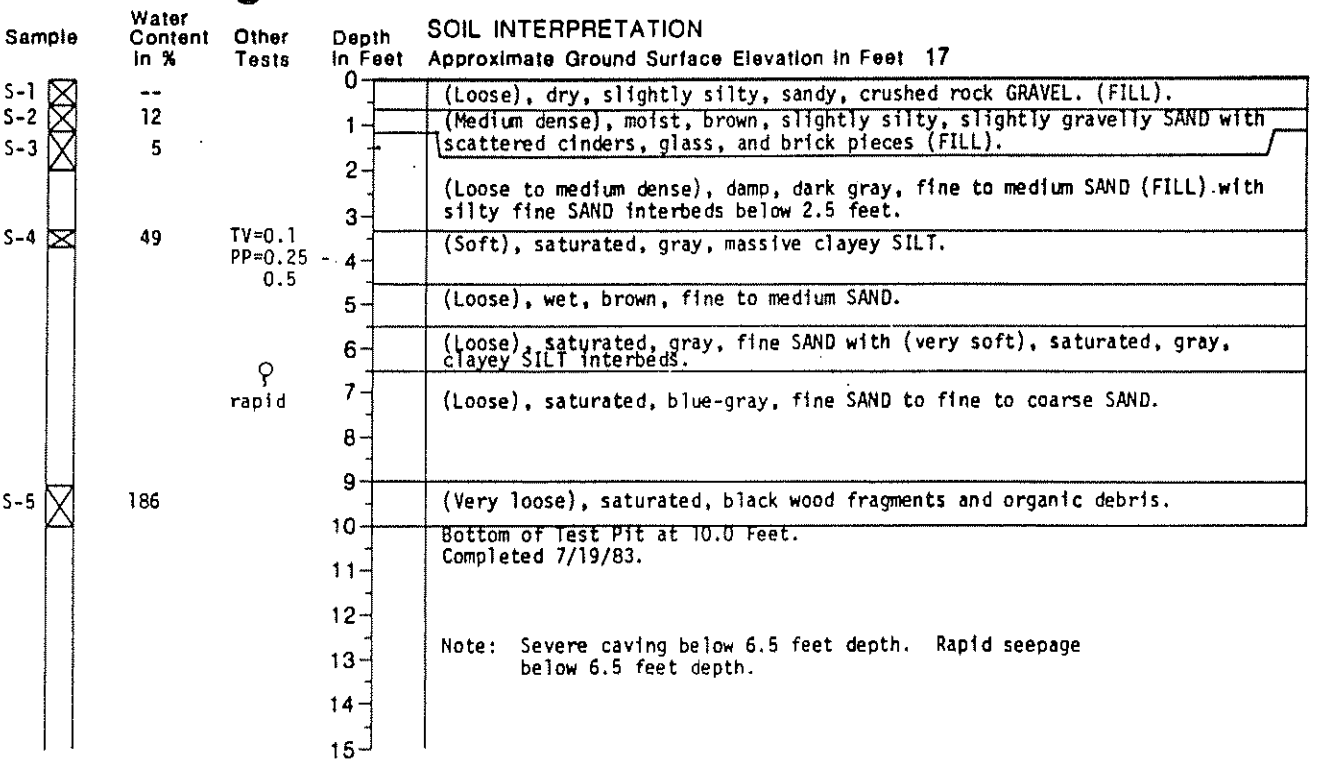
HART-CROWSER & associates inc.

Figure A-23

Test Pit Log TP-5



Test Pit Log TP-6



NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP-7

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 18
S-1	6		0–1	(Loose), damp, dark brown, gravelly, silty SAND (FILL).
S-2	6		1–6	(Loose), damp to moist, dark gray, fine to medium SAND with substantial shell fragments.
S-3	16		6–7	Saturated below 6.0 feet.
			7	Bottom of Test Pit at 7.0 Feet. Completed 7/19/83.
			10	Note: Severe caving throughout depth excavated.

Test Pit Log TP-8

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 18
S-1	9		0–1	(Loose), damp, dark gray, slightly silty, fine to medium SAND (FILL) with scattered shell fragments.
S-2	9		1–9	Grades (medium dense), damp to moist, dark gray, fine to medium SAND (FILL).
S-3	8		9	Bottom of Test Pit at 9.0 Feet. Completed 7/19/83.
			12	Note: Slight caving below 6 feet depth.

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-25

Test Pit Log TP-9

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 18
S-1	4		0–1	(Loose), damp, brown, organic-rich, silty SAND with substantial fine roots.
			1–2	(Loose), damp, dark gray, fine to medium SAND (FILL).
S-2	20		2–4	(Soft to medium stiff), moist, gray to brown, interbedded, fine sandy SILT and fine to medium SAND.
S-3	55	TV=0.1-0.05	4–5	(Very soft), saturated, gray to brown, silty CLAY to clayey SILT.
			5–9	(Medium dense), wet, dark gray, fine to medium SAND.
S-4	138		9–10	(Medium stiff), wet, gray, fine sandy SILT with interbedded fibrous organic material.
			10	Bottom of Test Pit at 9.5 Feet. Completed 7/19/83. Note: Severe caving below 7 feet depth.

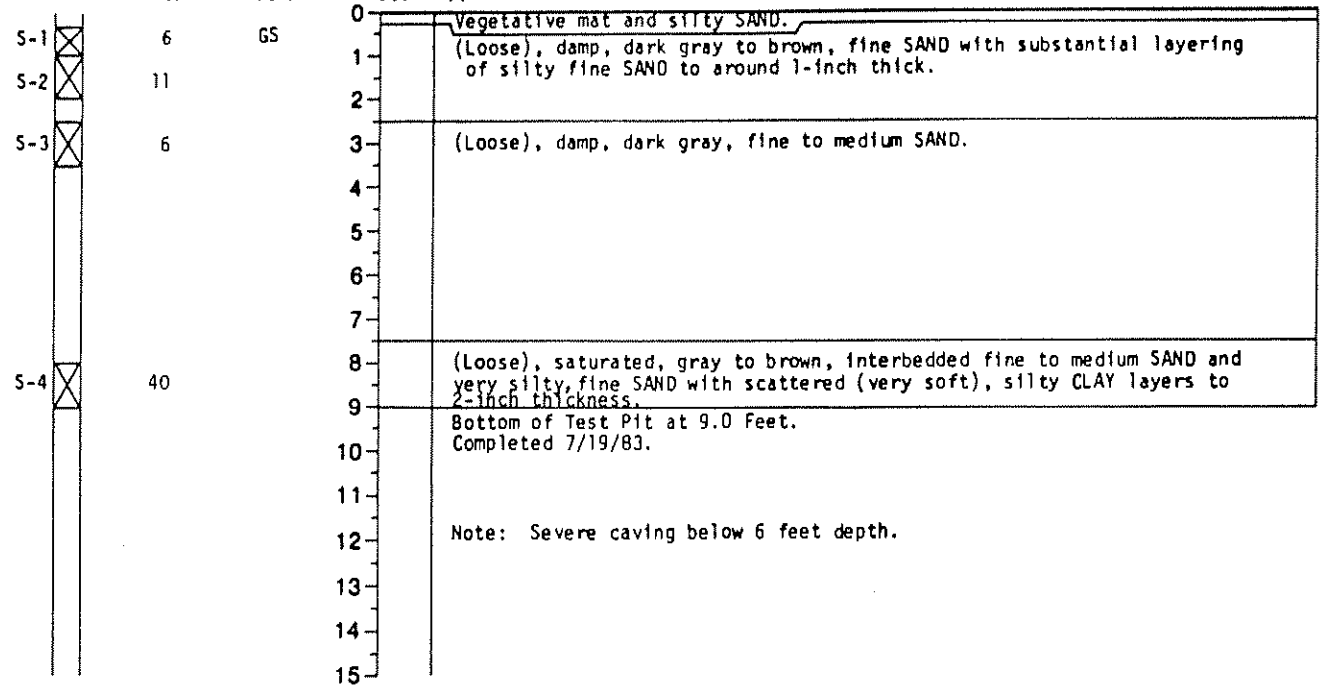
Test Pit Log TP-10

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 18
S-1	-		0–1	(Medium dense), damp, brown, sandy GRAVEL and COBBLES.
S-2	5		1–6	(Loose), damp, dark gray, fine to medium SAND (FILL). With scattered shell fragments below 3 feet.
S-3	19		6–7	Grades to wet.
			7	Bottom of Test Pit at 7.5 Feet. Completed 7/19/83. Note: Slight caving throughout depth excavated.

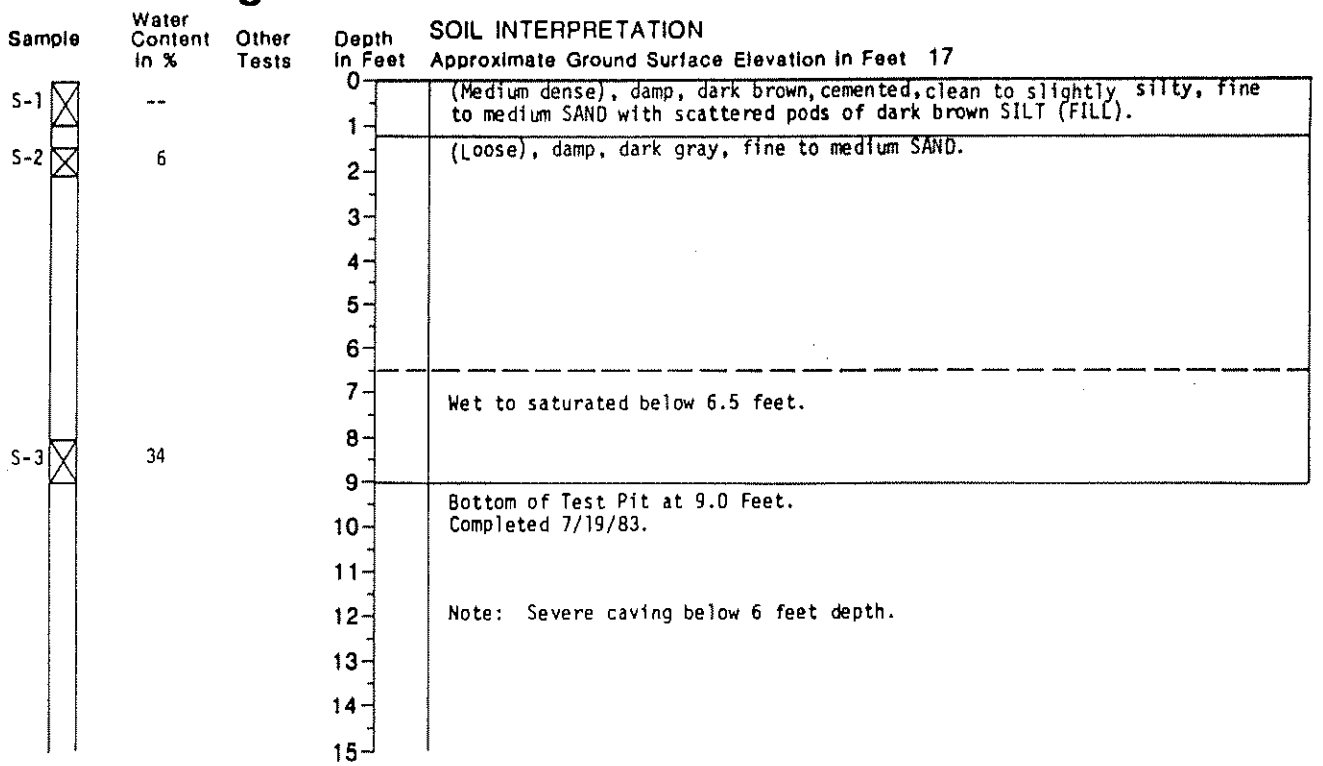
NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-26

Test Pit Log TP-11



Test Pit Log TP-12



NOTES:

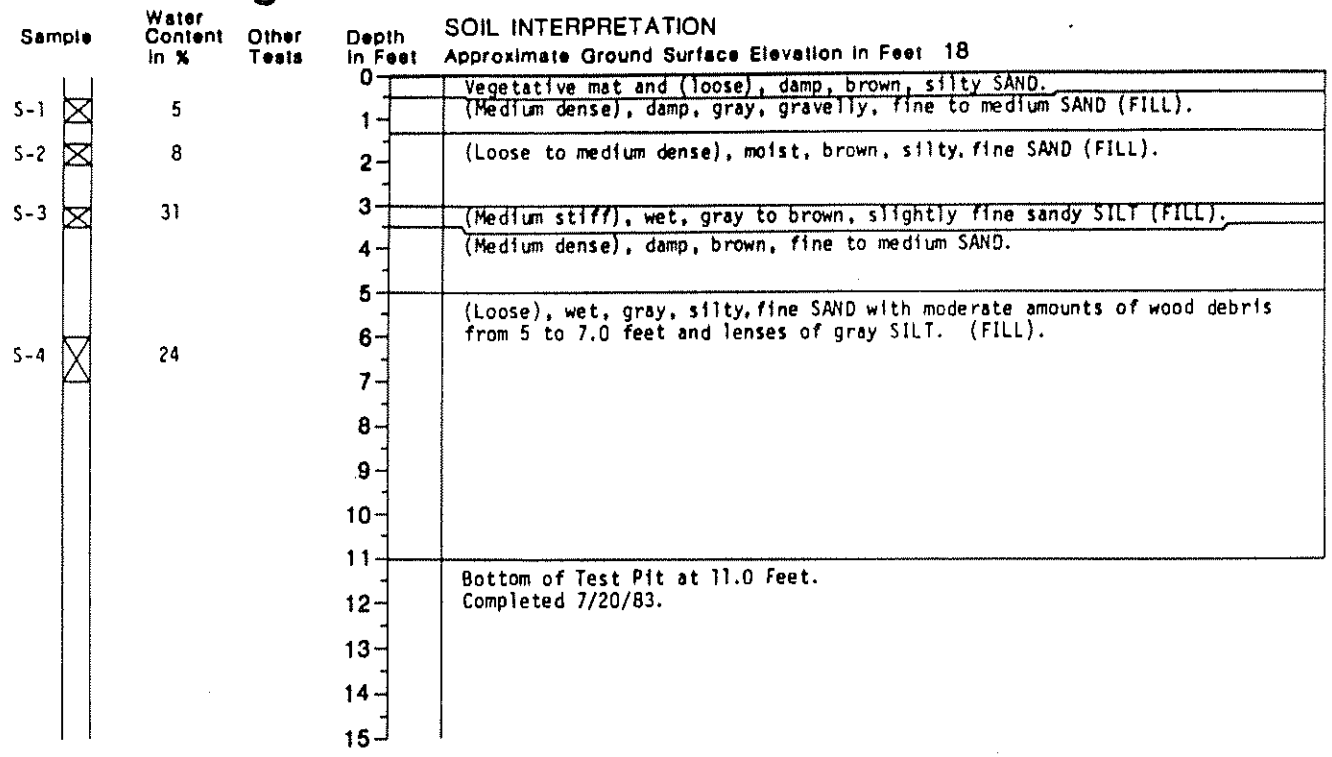
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

J-1280 August 1983

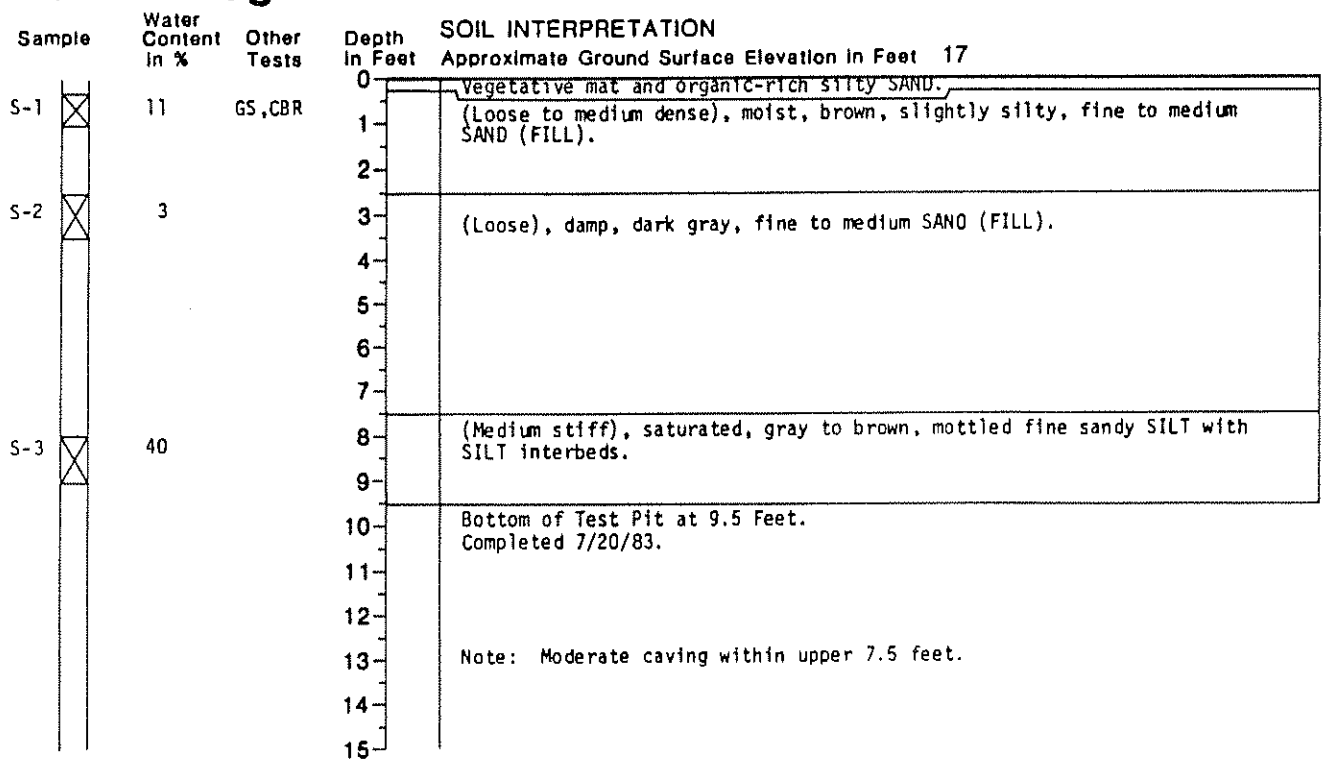
HART-CROWSER & associates inc.

Figure A-27

Test Pit Log TP-13



Test Pit Log TP-14



NOTES:

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

J-1280 August 1983

HART-CROWSER & associates inc.

Figure A-28

Test Pit Log TP- 15

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION
				Approximate Ground Surface Elevation in Feet 17.5
S-1	9		0–1	Vegetative mat and organic-rich, silty SAND. (Loose), damp, brown, fine to medium SAND (FILL).
S-2	18		2–3	(Medium dense), moist, slightly mottled brown to gray, silty, fine to medium SAND with interbeds of (stiff), fine sandy SILT (FILL).
S-3	3		4–7	(Medium dense to loose), damp, dark gray, fine to medium SAND (FILL).
S-4	39		7–10	(Medium stiff), saturated, brown to gray, heavily mottled, fine sandy SILT.
			10	Bottom of Test Pit at 10.0 Feet. Completed 7/20/83.
				Note: Slight caving from 4-7 feet depth.

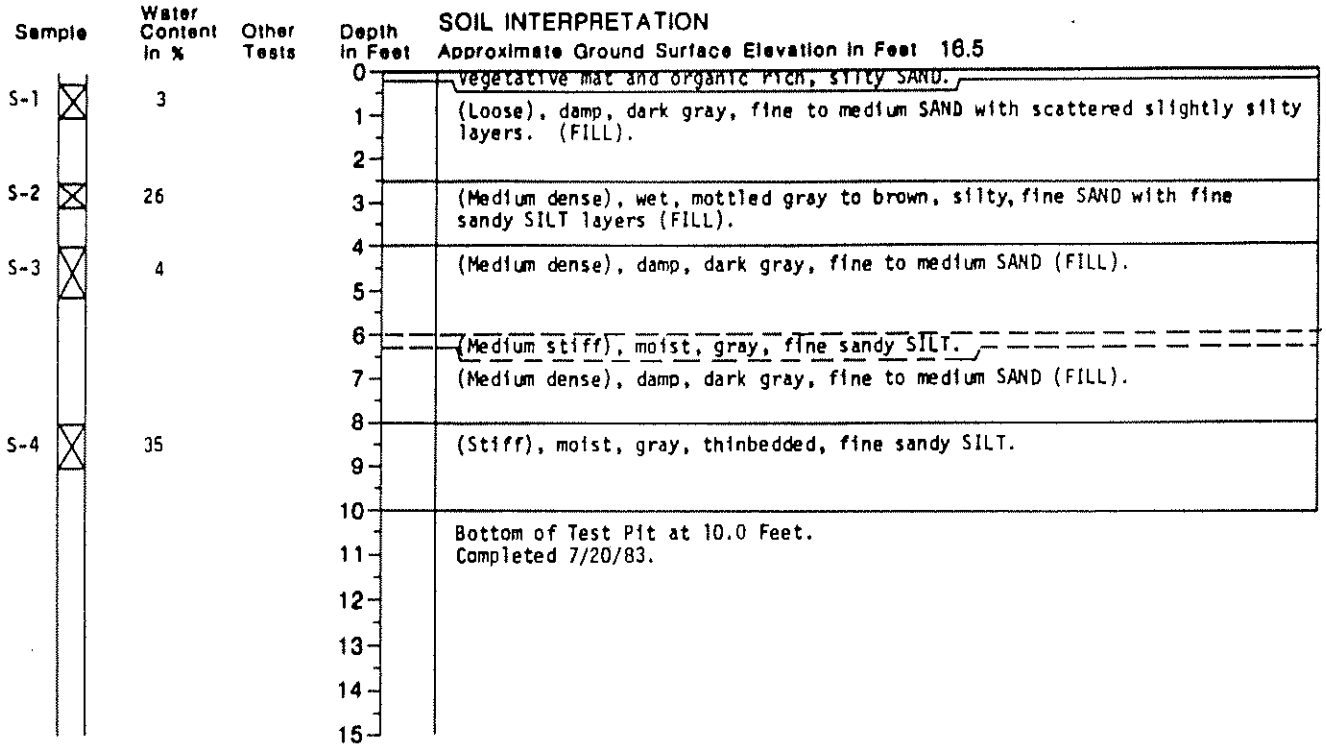
Test Pit Log TP-16

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION
				Approximate Ground Surface Elevation in Feet 17
S-1	7		0–1	Vegetative mat and organic-rich, silty fine SAND. (Loose), damp, brown, fine SAND with substantial fine roots (FILL).
S-2	4		1–4	(Loose to medium dense), damp, brown to dary gray, interbedded silty, fine SAND and fine to medium SAND (FILL).
			4–8	(Loose), damp, dark gray, fine to medium SAND with scattered silty fine SAND interbeds.
S-3	33		8–10	Saturated below 8.0 feet, with scattered organic debris (wood chips).
			10	Bottom of Test Pit at 10.0 Feet. Completed 7/20/83.

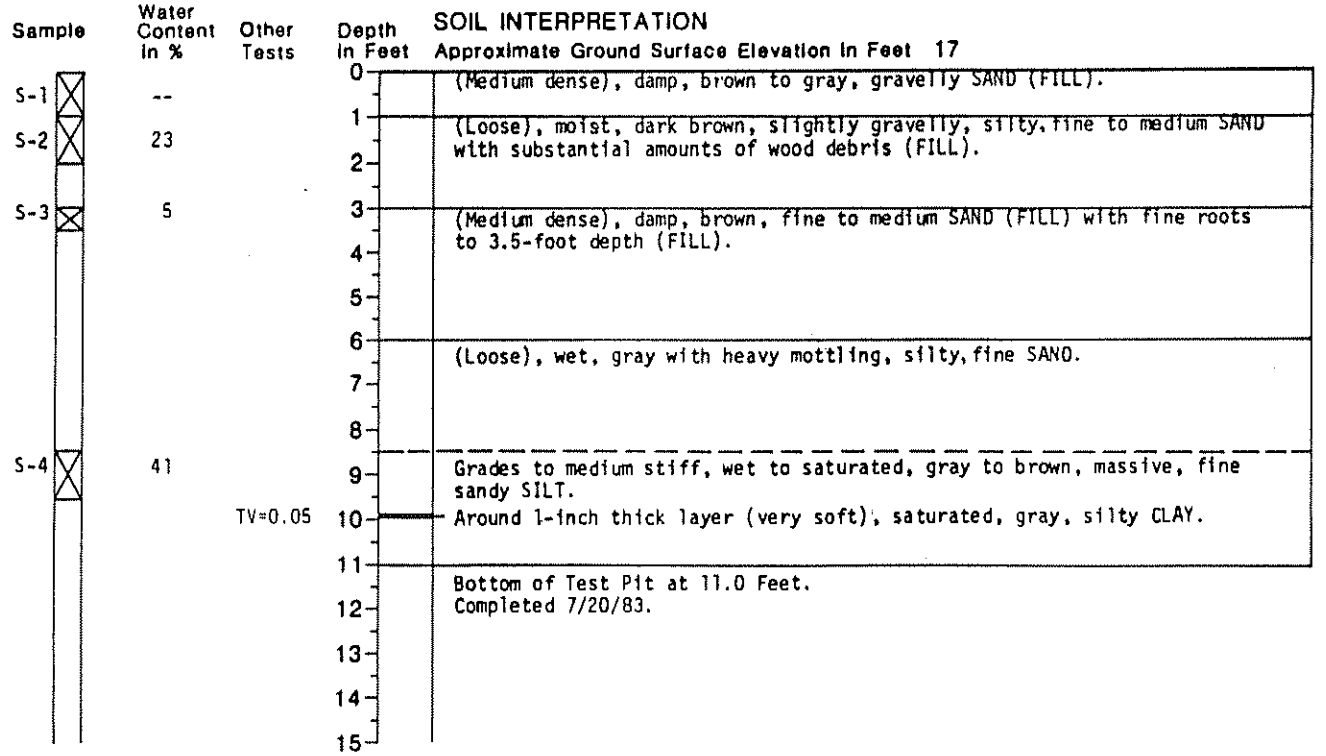
NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-29

Test Pit Log TP-17



Test Pit Log TP-18



NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-30

Test Pit Log TP-19

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 16
S-1	13		0	(Loose), moist, brown, gravelly, silty, fine to medium SAND (FILL).
S-2	4		1	(Loose), damp, dark gray, fine to medium SAND (FILL) with substantial roots to 2 inches diameter to 2.5 foot depth.
			2	
			3	Grades (medium dense)
			4	
			5	
			6	
			7	
S-3	53	TV=0.1	8	(Soft), saturated, gray, laminated SILT with interbeds of clayey SILT.
		▽	9	1 inch thick interbeds of (very soft), silty CLAY below 9 foot depth.
S-4	46	TV=.05	10	
			11	Bottom of Test Pit at 11.0 Feet. Completed 7/20/83.
			12	
			13	Note: Sudden rapid seepage at 10 feet depth. Water level stabilized at 9 feet depth.
			14	
			15	

Test Pit Log TP-20

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 16
S-1	10		0	(Loose), damp, brown to dark gray, fine to medium SAND (FILL) with scattered fine roots from 1 to 2.5 foot depths.
S-2	8		1	
			2	
S-3	14		3	
			4	
			5	
			6	(Soft), wet to saturated, gray to brown, fine sandy SILT with occasional thin layers of (very soft), wet, gray, silty CLAY and strong fuel odor.
			7	
			8	
			9	
S-4	42		10	
			11	Bottom of Test Pit at 10.5 Feet. Completed 7/20/83.
			12	
			13	
			14	
			15	

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

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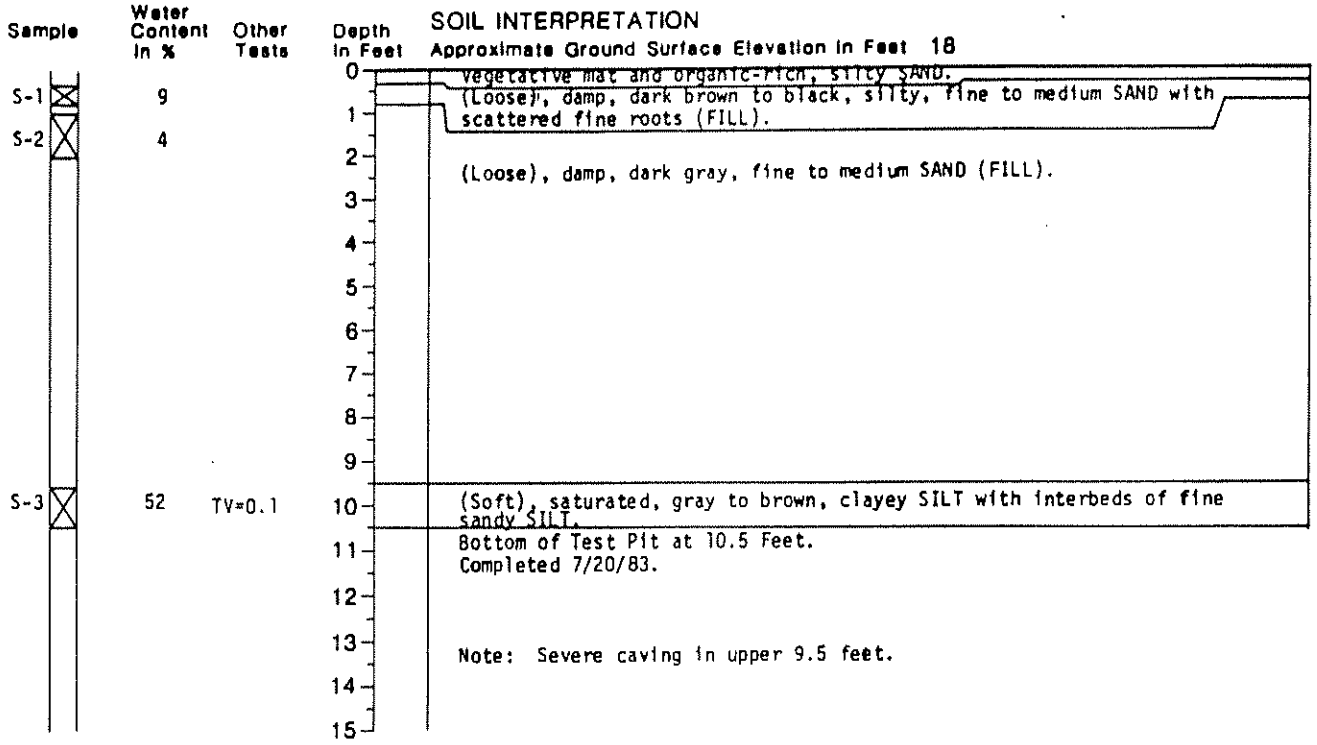
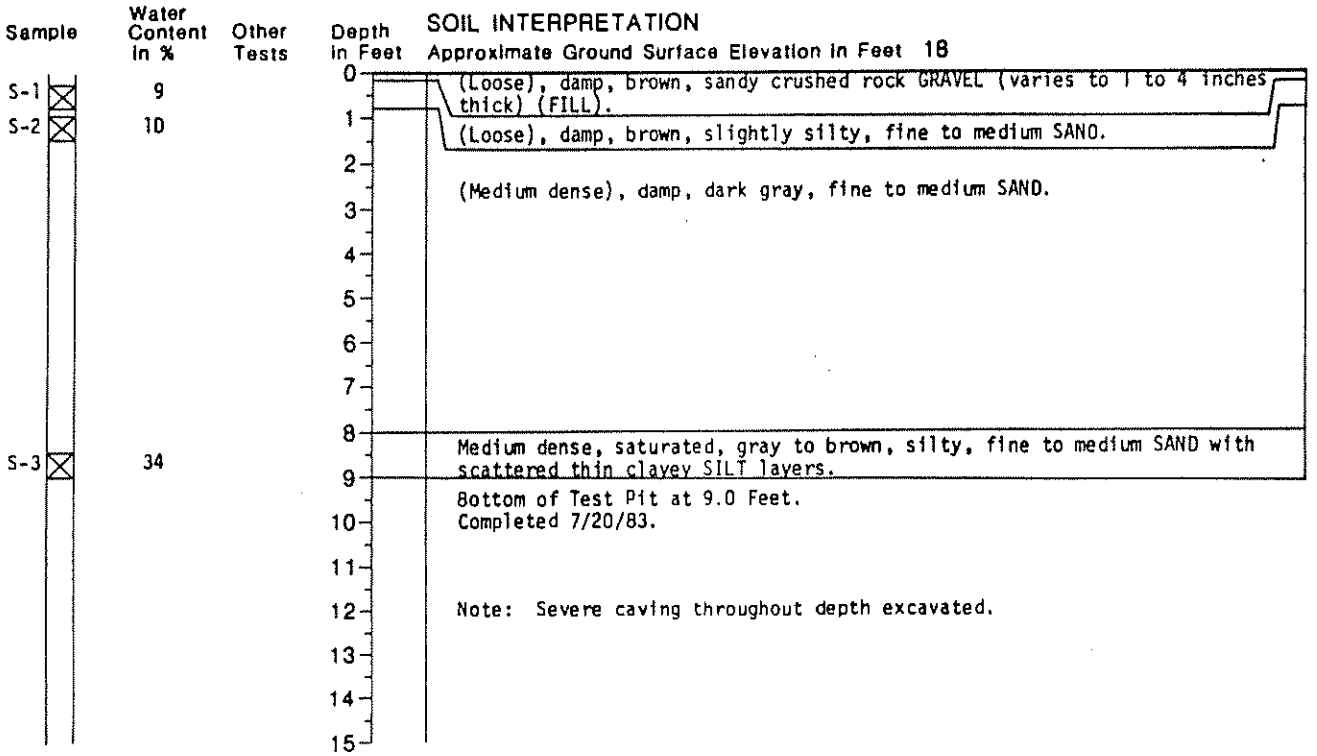
HART-CROWSER & associates inc.
Figure A-31

Test Pit Log TP-21

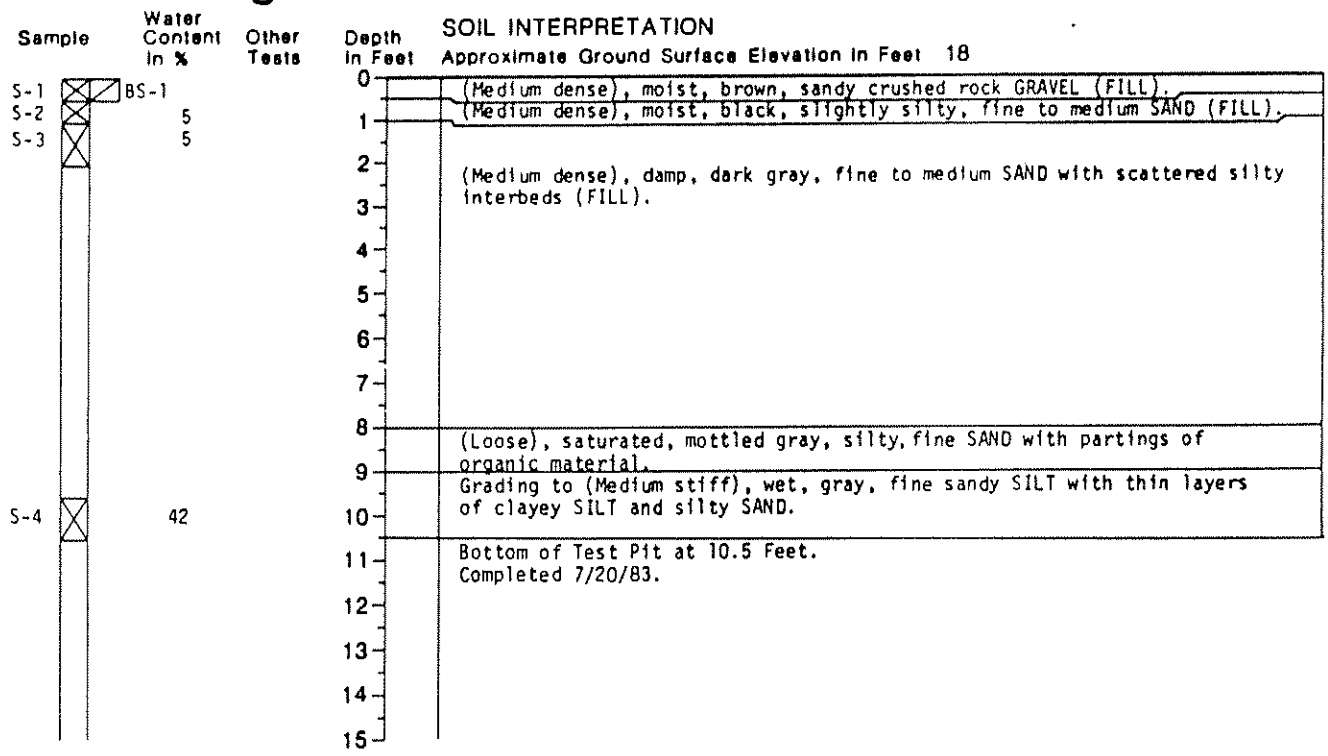


Test Pit Log TP-22

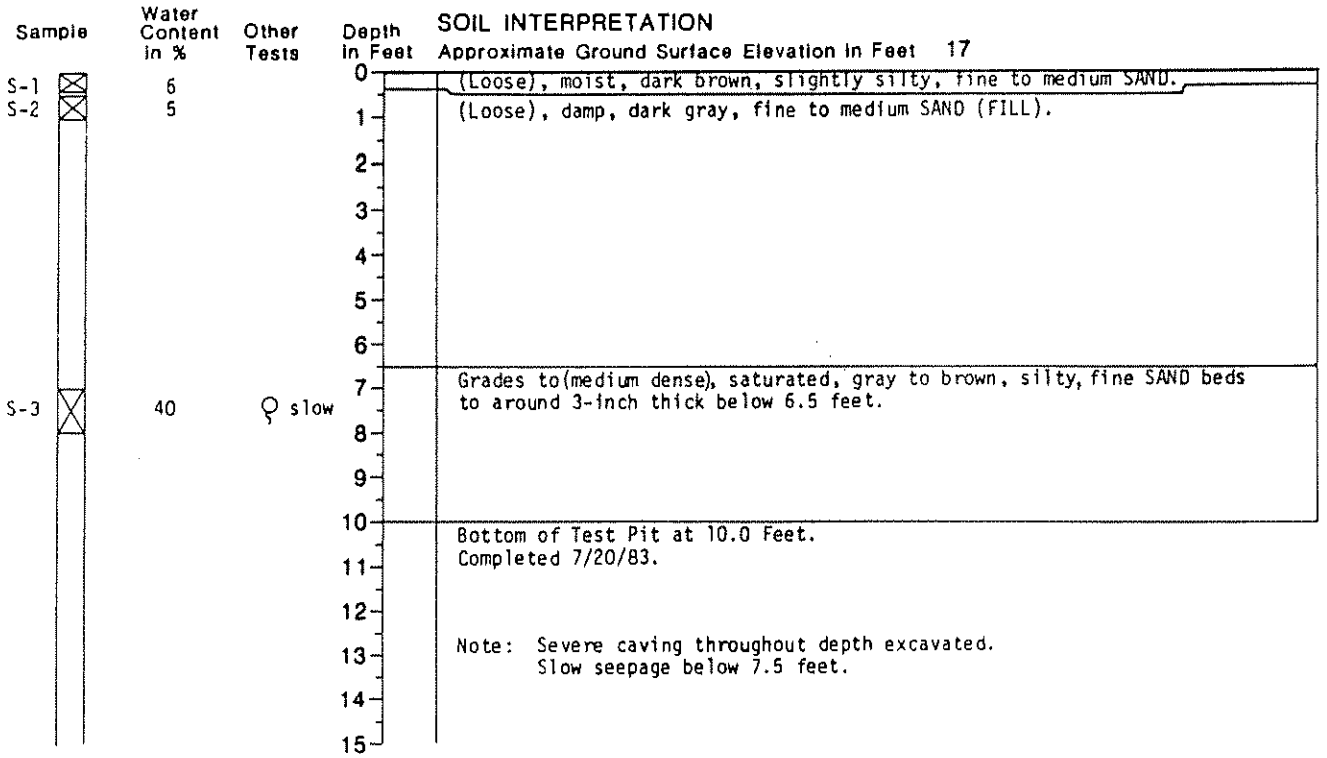


NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP- 23



Test Pit Log TP-24



NOTES:

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP-25

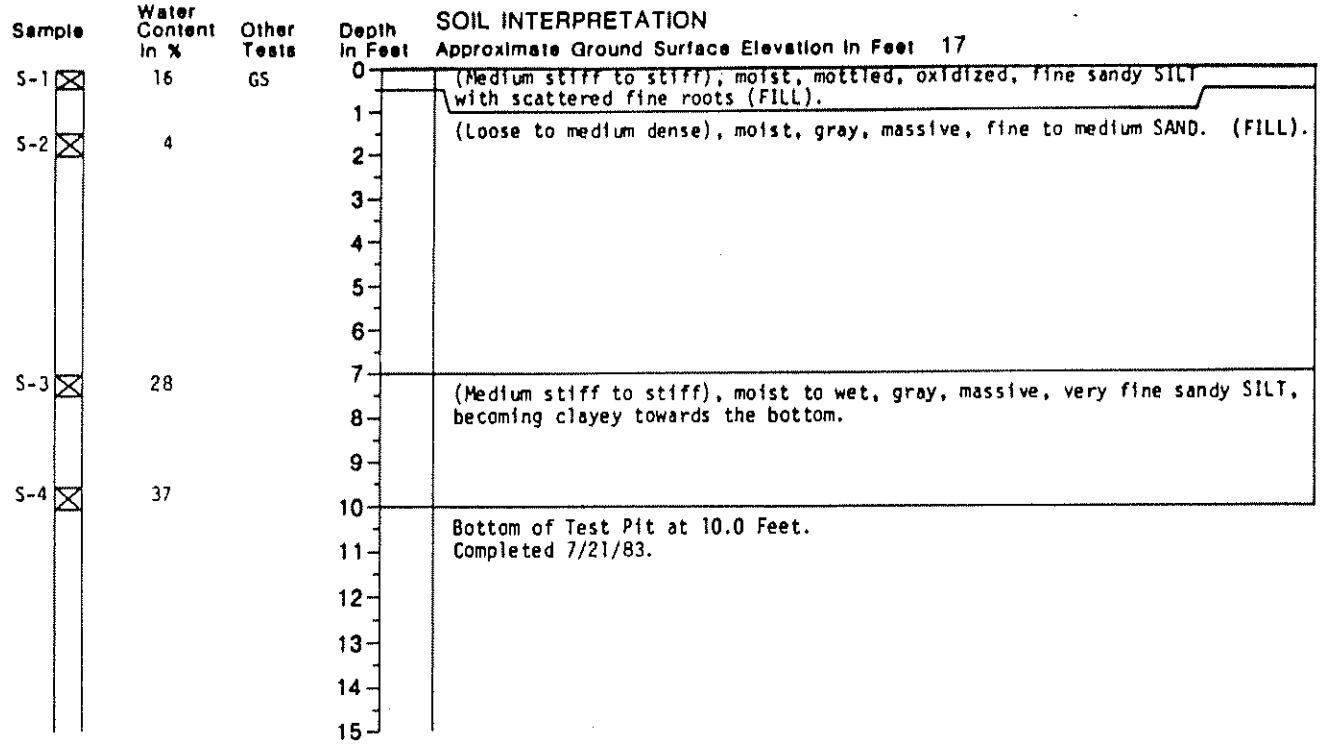
Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 19
S-1	5	GS	0	Vegetative mat and loose, silty SAND.
S-2	8		1	(Medium dense), damp to moist, dark gray, fine to medium SAND with scattered silty interbeds (FILL).
			2	
			3	
			4	
			5	
			6	
			7	
			8	
			9	
			10	Bottom of Test Pit at 9.5 Feet. Completed 7/22/83.
			11	
			12	
			13	
			14	
			15	

Test Pit Log TP-26

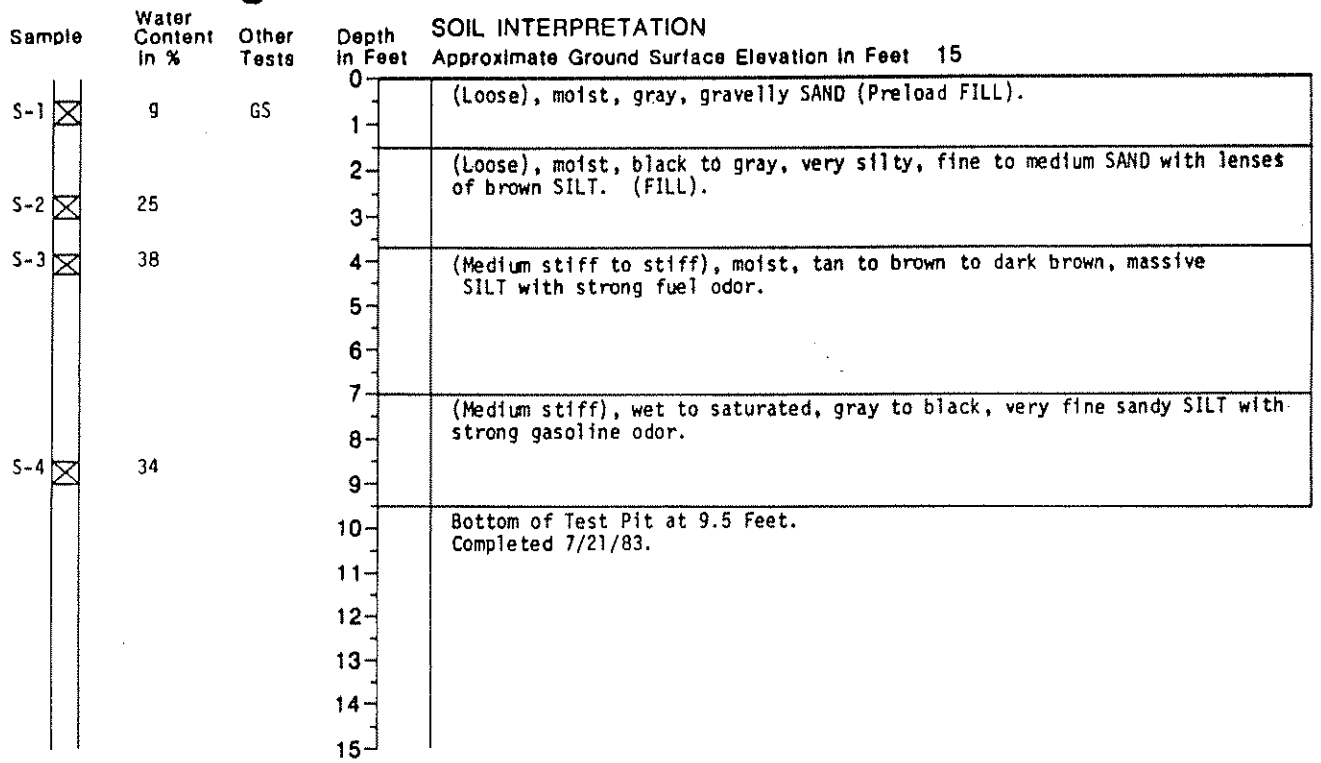
Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 18
S-1	4		0	(Loose), moist, dark gray, fine to medium SAND F(LL).
S-2	29		1	
			2	(Medium stiff), moist, tan SILT (FILL).
S-3	3		3	(Loose to medium dense), moist, dark gray to black, fine to medium SAND. (FILL).
			4	
			5	
			6	
S-4	40		7	
			8	(Soft to medium stiff), moist to wet, gray to brown, laminated to massive, slightly clayey SILT.
			9	Bottom of Test Pit at 8.5 Feet. Completed 7/21/83.
			10	
			11	Note: Severe caving at 8.5 feet depth.
			12	
			13	
			14	
			15	

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP-27



Test Pit Log TP-28



NOTES:

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP-29

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 17
S-1	7		0–1	(Dense), damp to moist, brown, gravelly, fine to medium SAND (Preload FILL).
S-2	21		1–3	(Loose), moist, black, silty, fine SAND with some gravel, brown sand pockets and railroad ties (FILL).
S-3	5		3–7	(Loose), damp to moist, dark gray to black, fine to medium SAND (FILL).
S-4	43		7–10	(Soft to medium stiff), wet to saturated, gray to brown, very fine sandy SILT.
			10	Bottom of Test Pit at 10.0 Feet. Completed 7/21/83.

Test Pit Log TP-30

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 10
S-1	42		0–7	(Medium stiff), moist, massive to laminated, oxidized tan, fine sandy SILT.
		▽	5	
S-2	20	♀	7–9	(Loose to medium dense), wet, dark gray to black, fine to medium SAND.
S-3	43		9–10	(Loose to medium dense), saturated, dark gray to black, silty, fine SAND.
			10	Bottom of Test Pit at 10.0 Feet. Completed 7/21/83.
				Note: Seepage at 7 feet depth. Water level stabilized at 5 feet depth.

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

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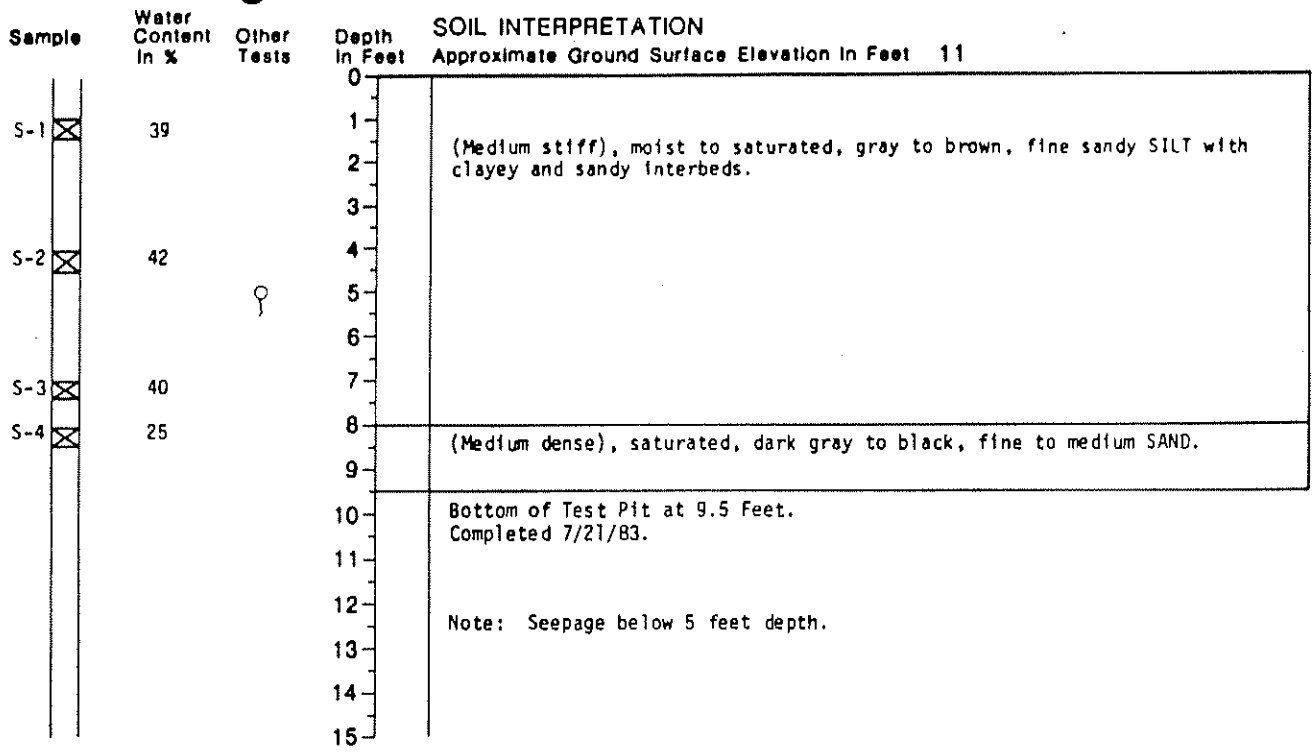
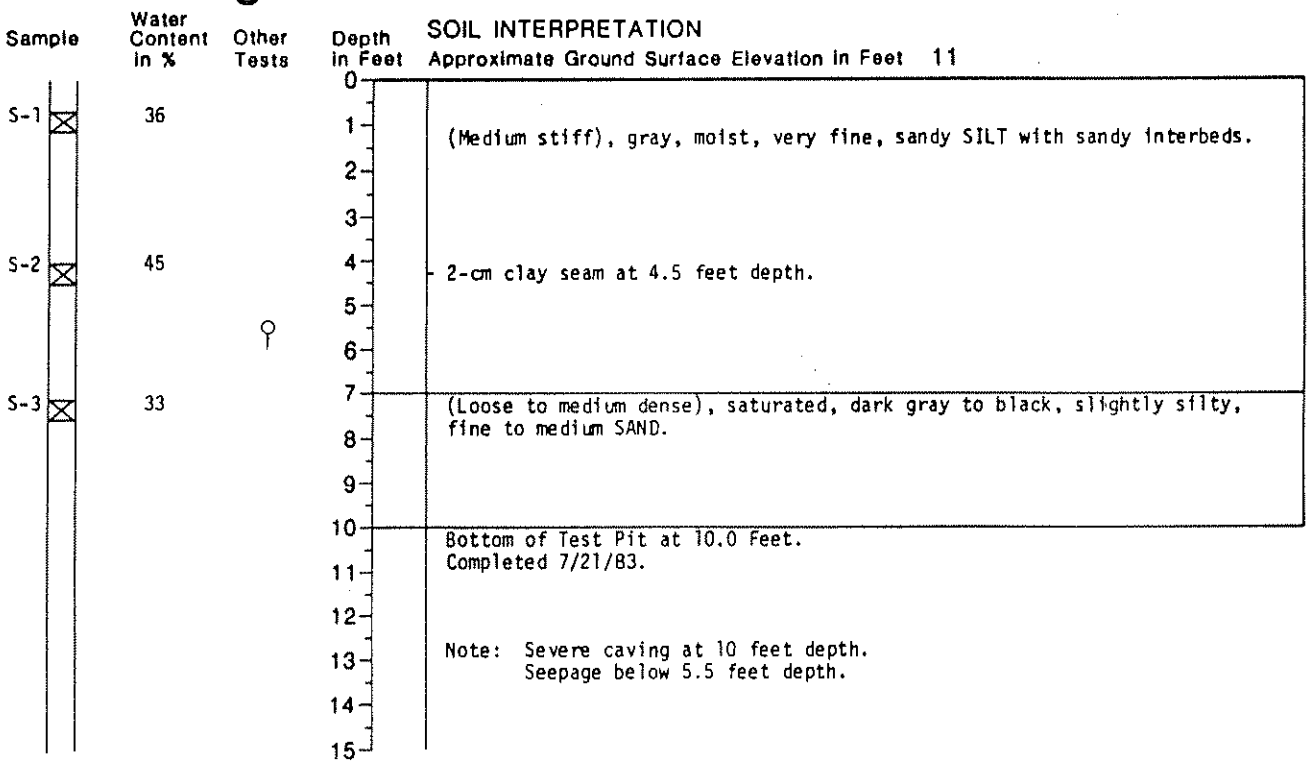
Figure A-36

Test Pit Log TP-31



Test Pit Log TP-32



NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

J-1280 August 1983
HART-CROWSER & associates inc.
Figure A-37

Test Pit Log TP-33

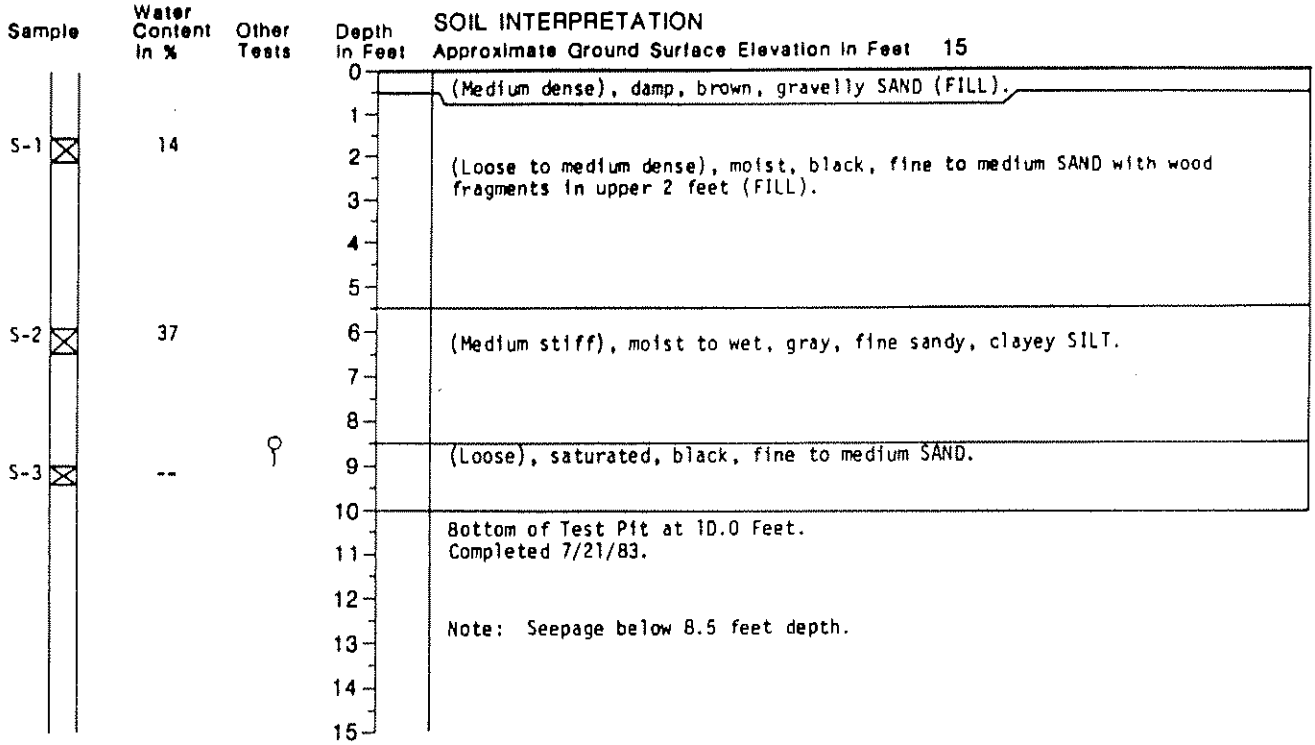
Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 11
S-1	110		0–1	(Loose), moist, balck to dark brown, very silty SAND with abundant wood fragments and metal. (FILL).
S-2	44		1–10	(Medium stiff), moist to saturated, gray, fine sandy SILT. Clay seam (2-cm) at 4.5 feet depth.
S-3	31		10–11	(Medium dense), saturated, dark gray to black, fine to medium SAND.
			11	Bottom of Test Pit at 11.0 Feet. Completed 7/21/83.
				Note: Seepage below 8 feet depth.

Test Pit Log TP-34

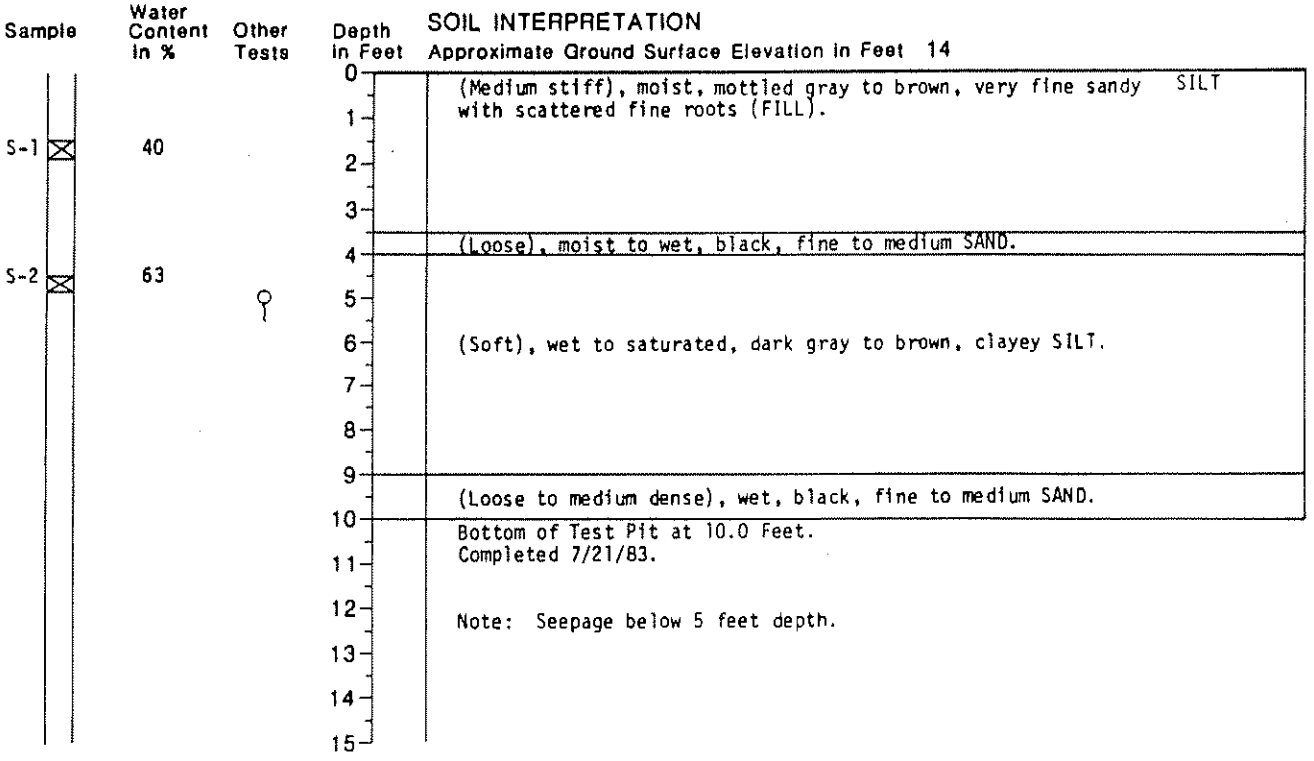
Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 14
S-1	13		0–3	(Medium dense to dense), moist, brown to rusty brown, partly cemented, slightly silty, gravelly SAND with admixed brick and wood fragments. (FILL).
S-2	40		3–5	(Loose to medium dense), moist to wet, gray to black, very silty, fine to medium SAND with scattered gravel and wood. (FILL).
S-3	42		5–8	(Soft), wet to saturated, dark gray to brown, clayey SILT.
S-4	31		8–11	(Loose to medium dense), saturated, black, fine to medium SAND.
			11	Bottom of Test Pit at 11.5 Feet. Completed 7/21/83.
				Note: Seepage below 4.5 feet depth.

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP-35



Test Pit Log TP-36



NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP-37

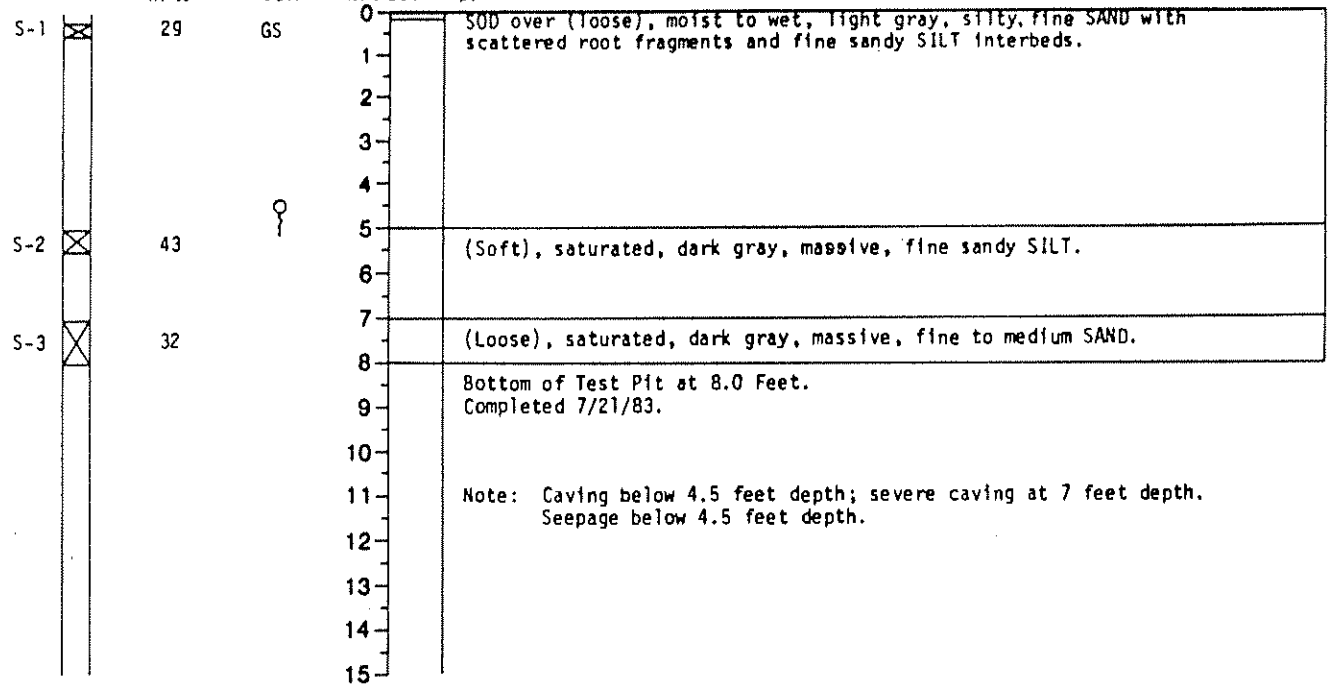
Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 11
S-1	32	PP=1.0 TV=0.1 - 0.15	0	SOD over (soft), moist, grayish-brown mottled, fine sandy SILT with scattered root fragments.
S-2	22		1	
			2	(Loose), wet, gray, silty, fine SAND with scattered root fragments and scattered discontinuous SILT laminations.
		flowing	3	
			4	
			5	
S-3	31		6	(Loose), saturated, dark gray, fine to medium SAND with scattered fine sand interbeds.
			7	Bottom of Test Pit at 7.0 Feet. Completed 7/21/83.
			8	
			9	
			10	Note: Caving below 5 feet depth, severe caving at 7 feet depth. Rapid seepage below 5 feet depth.
			11	
			12	
			13	
			14	
			15	

Test Pit Log TP-38

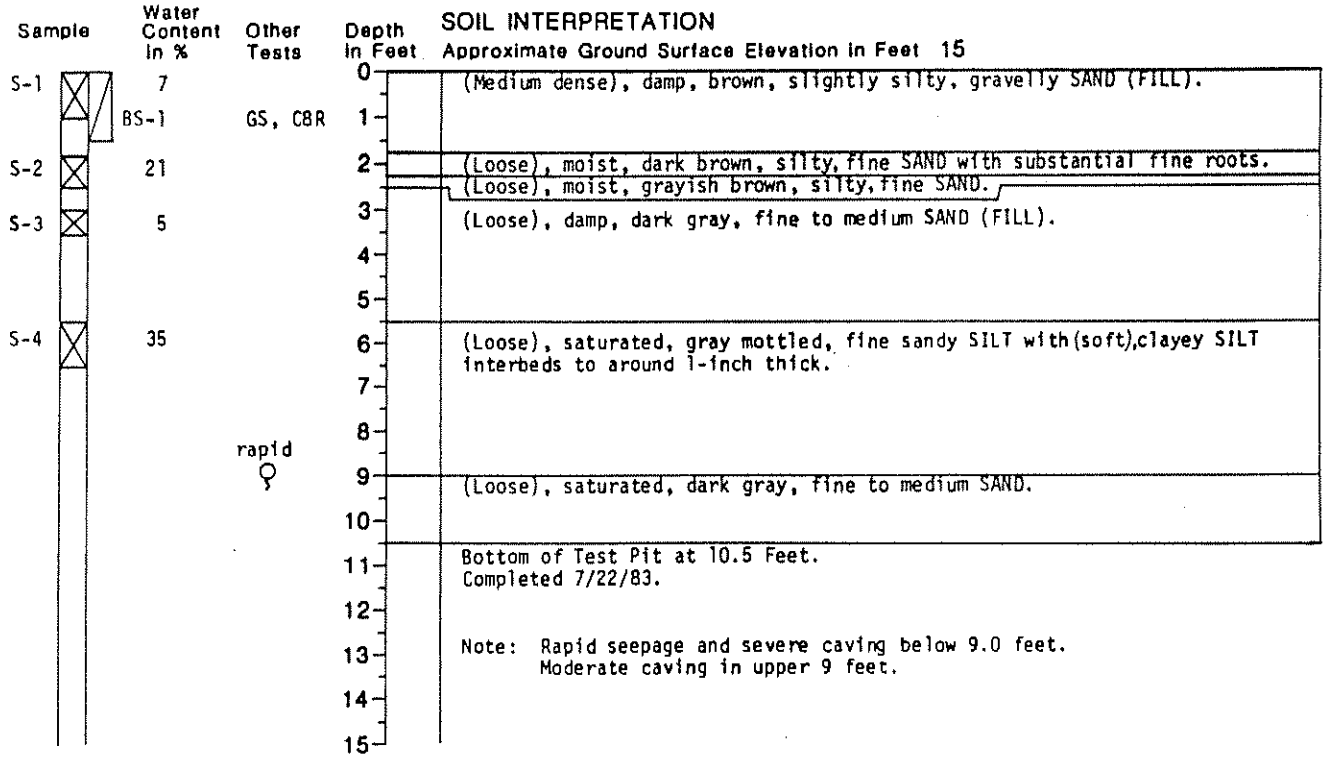
Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 11
S-1	44		0	SOD over (soft), wet, brown, slightly clayey SILT with numerous small roots and organics.
			1	
S-2	50		2	(Loose), wet, brown and gray, fine sandy SILT with numerous wood and root fragments, and discontinuous layers of organics.
			3	
S-3	43	PP=0.4 TV=0	4	(Very loose to loose), wet to saturated, light gray, laminated fine sandy, clayey SILT.
			5	
			6	
S-4	24		7	(Loose), saturated, dark gray, fine to medium SAND with trace wood and shell fragments.
			8	Bottom of Test Pit at 7.0 Feet. Completed 7/21/83.
			9	
			10	Note: Caving below 2 feet depth, severe caving at 6 feet depth. Seepage below 4 feet depth.
			11	
			12	
			13	
			14	
			15	

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP-39



Test Pit Log TP-40



NOTES:

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP-41

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet 16
S-1	5		0	(Loose), damp, dark gray, fine to medium SAND with substantial fine roots in upper 0.3 feet. (FILL).
S-2	5		1	
			2	
			3	
			4	
			5	Bottom of Test Pit at 4.5 Feet. Completed 7/22/83.
			6	
			7	
			8	
			9	
			10	
			11	
			12	
			13	
			14	
			15	

Test Pit Log TP-42

Sample	Water Content in %	Other Tests	Depth in Feet	SOIL INTERPRETATION Approximate Ground Surface Elevation in Feet
			0	(Medium dense), moist, brown, gravelly, silty SAND (FILL).
S-1	24		1	(Medium stiff), moist, brown to gray, slightly clayey, slightly sandy to sandy SILT (FILL).
			2	
S-2	33		3	(Loose), wet, dark brown, organic-rich silty SAND with wood fragments (FILL).
			4	
S-3	20		5	(Medium dense), moist, dark gray, silty to slightly silty, fine to medium SAND (FILL).
			6	(Medium dense), moist, dark gray, fine to medium SAND.
			7	
			8	
			9	
			10	Bottom of Test Pit at 9.5 Feet. Completed 7/22/83.
			11	
			12	Note: Moderate caving below 5.5 feet depth.
			13	
			14	
			15	

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

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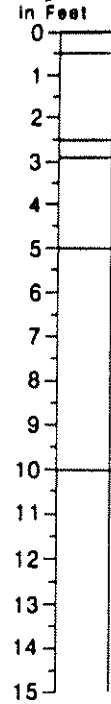
Figure A-42

Test Pit Log TP-43



SOIL INTERPRETATION

Approximate Ground Surface Elevation in Feet

Vegetative mat and organic-rich, silty, fine SAND.

(Medium dense), moist, brown, silty SAND with scattered GRAVEL and fine roots (FILL).

(Loose), moist, black, organic-rich, silty, fine SAND and cinders (FILL).

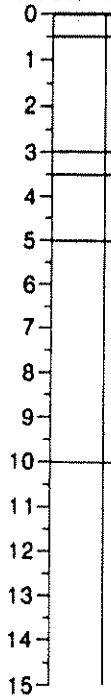
(Medium dense), damp, dark gray, slightly silty, fine SAND.

(Medium dense), moist, fine to medium SAND with strong fuel oil odor.

Bottom of Test Pit at 10.0 Feet.
Completed 7/22/83.

Note: Moderate caving below 5 feet.

Test Pit Log TP-44



SOIL INTERPRETATION

Approximate Ground Surface Elevation in Feet

Vegetative mat and (loose), moist, brown, organic-rich, silty SAND.

(Medium dense), moist, brown, interbedded silty SAND with scattered gravel and (stiff), moist, brown, sandy SILT with scattered fine roots to 1.5 feet depth.

(Loose), moist, dark brown, silty, fine SAND.

(Medium dense), moist, grayish-brown, slightly silty, fine SAND.

(Medium dense), moist, dark gray, fine to medium SAND.

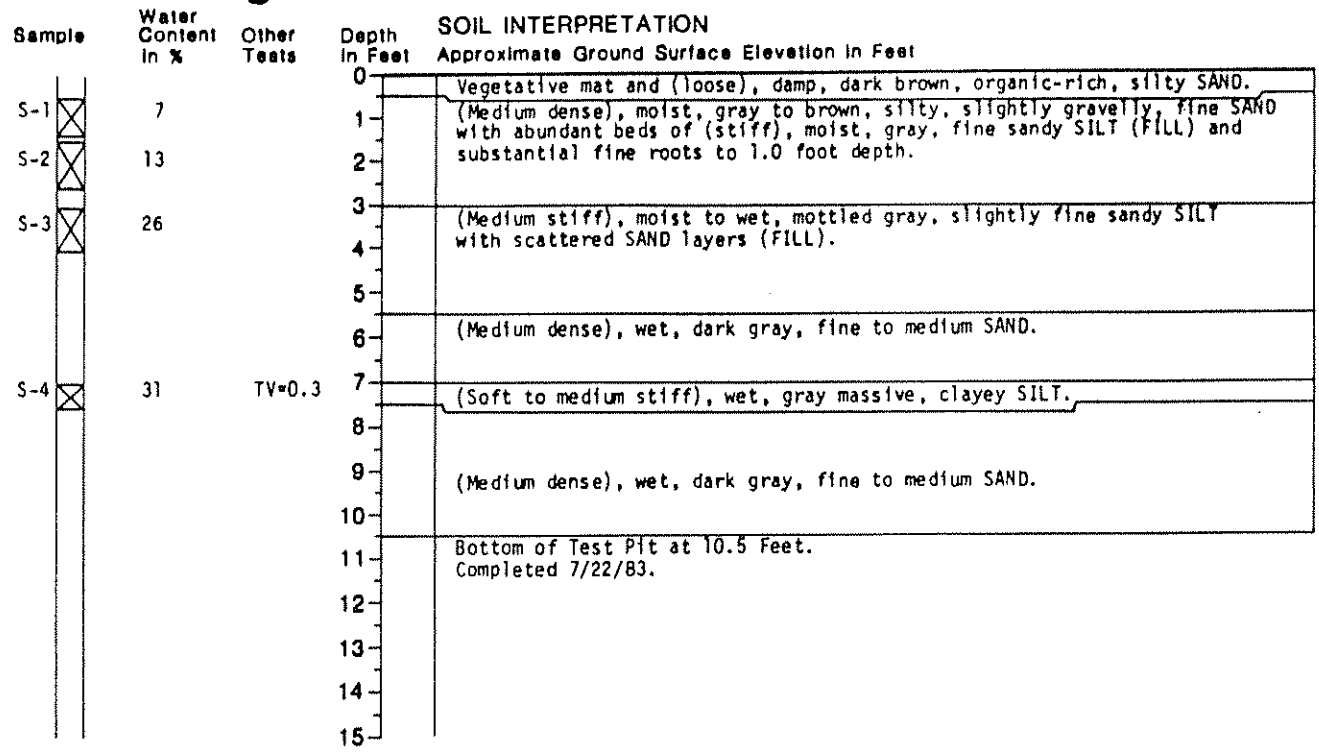
-Wet below 9.0 feet.

Bottom of Test Pit at 10.0 Feet.
Completed 7/22/83.

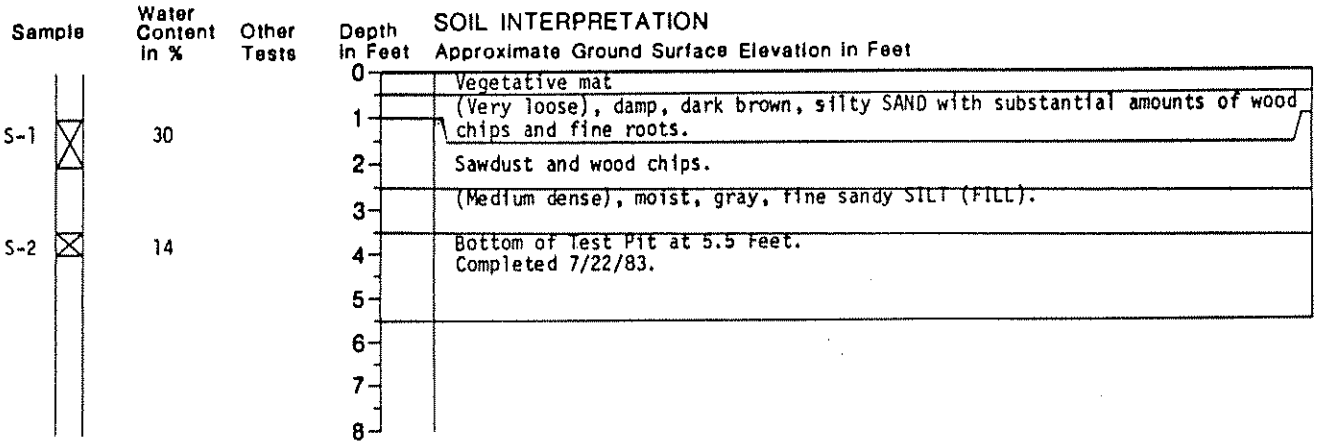
NOTES:

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

Test Pit Log TP-45



Test Pit Log TP-46



S-1 ⊠ Grab Sample Location and Number

BS-1 ⊘ Bag Sample Location and Number

GS Grain Size Classification

CBR California Bearing Ratio

PP Pocket Penetrometer - Approximate Unconfined Compressive Strength in TSF

TV Torvane - Approximate Shear Strength in TSF

Seepage

Water Level

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Groundwater conditions, if indicated, are for the date specified and may vary with the time of year.

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HART-CROWSER & associates inc.
Figure A-44