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1905 NW
Cedar Ridge
Dr

GEOTECHNICAL INVESTIGATION

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2824/4

01-140538RS

MACLEAN SUBDIVISION

WEST HILLS
PORTLAND, OREGON

PREPARED FOR:
HGW INC.

21-07279-00

Ridgeview #2 Lot 43

FEBRUARY, 1994

RZA AGRA, Inc.
Engineering & Environmental Services

AGRA
Earth & Environmental Group

RZA AGRA, Inc.
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February 10, 1994

21-07279-00

HGW, Inc.
121 SW Morrison Street
Portland, OR 97204

Attn: Mr. Bob Hartford

SUBJECT: GEOTECHNICAL INVESTIGATION FOR MCLEAN SUBDIVISION

Dear Bob;

It is our pleasure to present our findings for the geotechnical investigation of the proposed Maclean Subdivision. This site will present challenges similar to those you have encountered at other projects in the area. The findings for this site are presented in the context of the preliminary conceptual plan, which is of course subject to change. However, the bases for the recommendations are discussed in detail, and can be applied to any layout scheme.

Please contact me if you have any questions after you've had a chance to review this report. I would be happy to review a revised conceptual plan at your request.

Respectfully Submitted,

RZA AGRA, Inc.

Miriam G. Liberatore, P.E., Geotechnical Engineer

TABLE OF CONTENTS

1.0 SUMMARY

This report presents the findings of a geotechnical investigation for a new residential subdivision in the West Hills of Portland. The investigation was based on a preliminary conceptual layout of the lots and streets, which may be subject to change. However, the bases for our recommendations are presented in detail and may be applied to other layouts with our review. The subject site is geotechnically suitable for the proposed subdivision, subject to the recommendations and modifications provided in this report. Key design items are summarized below and are discussed in greater detail in the following sections of this report.

- The near-surface, native soils consist of clayey silt and silty clay with varying amounts of fine sand, scattered coarse sand, and pebbles. The fine-grained material is underlain by weathered volcanic bedrock. The bedrock was encountered at depths ranging from 23 feet to more than 40 feet.

- The bedrock elevation is expected to be irregular. Rock excavation techniques could be necessary over limited areas where the excavation depths (including sewer installations) exceed about 20 feet. Blasting is not expected to be necessary.

- Groundwater was encountered in one boring at a depth of 31.5 feet, though it was not determined whether this was static groundwater or perched. Evidence of perched groundwater, common in this area, was observed at various elevations. Seeps are likely to be encountered in excavations. Ditching, grading, and a small pump will probably suffice to control water from springs encountered during construction. Wet soils and wet or soft subgrades requiring overexcavation are likely to be encountered. Constructed drains beneath fills or in cutslopes may be necessary.

- Most of the native clayey silt could be used in engineered fills if compaction specifications can be met, depending on clay content, moisture, and on grading and handling techniques. The suitability of materials with comparatively high clay content or moisture will probably require the judgment of a geotechnical consultant. Soil moisture contents greater than optimum are common throughout the year. Most of the usable excavated soils will probably require drying before they can be compacted. Recommended compaction levels are 95% (ASTM D-1557) for granular materials (gravel and sand), and 92% (ASTM D-1557) for clayey silt.

- The maximum recommended embankment slopes for this project are 2H:1V. Fill construction should be in accordance with the techniques presented in the report. The maximum cut slope angle will depend on field conditions and the height of the cut. A guideline of 2H:1V over a maximum height of 10 feet is provided for permanent cuts. Temporary cuts less than 10 feet in height may be cut at 1H:1V. Fresh slopes should be protected from erosion by applying a layer of crushed rock or by another approved erosion control method.

The above summary is intended for introductory and reference use only. A complete reading of this report is necessary for a thorough understanding of the conditions and limitations affecting the use of this information. Designs should be based on the complete recommendations provided in this report.

2.0 INTRODUCTION

2.1 General Project Description

This report presents the preliminary results of our geotechnical exploration for a proposed residential subdivision in the Portland West Hills. The project involves development of approximately 112 single-family residential lots with common open spaces on a 61.4 acre parcel near the intersection of Skyline Boulevard and Cornell Road. The land is currently undeveloped.

2.2 Purpose and Scope

The purpose of our study was to establish the general surface and subsurface geotechnical conditions in the proposed subdivision on which our conclusions and recommendations for design and construction would be based, including a review of the preliminary lot and street layout for the subdivision. The investigation and findings are based on the preliminary layout shown in Plate 1. The scope of work as described in our proposal (P-93-266) included a review of geologic literature and past soils reports in the vicinity conducted for HGW; surficial reconnaissance; subsurface exploration; and geotechnical engineering analyses. Laboratory testing beyond basic confirmation of soil properties was proposed on an as-needed basis, in the event that the soil or groundwater conditions varied significantly from those encountered in past investigations in the vicinity for this client. The conditions encountered were in fact very similar to those other investigations; therefore only basic tests were performed to confirm the field classifications. The recommendations in this report are intended for general development of streets and utilities. Recommendations specific to building on individual lots were beyond the scope of this report.

This report has been prepared for the exclusive use of HGW, Inc., and their clients and agents, for specific application to this project in accordance with generally accepted geotechnical engineering practice. Written authorization to proceed with this study was granted by Bob Hartford of HGW, Inc.

3.0 SITE DESCRIPTION

Plate 1 shows the project area and preliminary lot and street layout, with the approximate locations of our subsurface explorations shown. The project covers 61.4 acres. The area is divided topographically into three regions by a broad ridge and main draw. The ridge crosses the property from a curve in Skyline Boulevard and continuing southwest to the western boundary at the end of Hazeltine Road. North of this ridge, the slopes are steep and incised with minor draws. South of this ridge to the top of the main draw, most of the middle third of the property slopes moderately toward the main draw. The east end of this section is steeply sloped at the head of the main draw, and along the two minor draws in the vicinity of borings B-4, B-5, and B-6. The lower third of the property is again steeply sloping on both sides of the main draw. Minor slumping was observed on the slope along the south edge of the property, in the vicinity of the proposed Lot 107. Slope stability is addressed in Section 7.7.

The draws all originate suddenly, transitioning very quickly from swales to steep-sided channels. Many narrow, shallow rills are evident even in well vegetated areas, where runoff concentrates on its way to the draws. These rills appear to indicate a tendency for rapid runoff and high erodibility of native soils.

4.0 EXPLORATION

Seven borings were drilled on December 16 and 22, 1993, to establish soil and rock conditions in the proposed subdivision. The borings were used to define depths to bedrock and groundwater, classify the soils, examine the type and quality of bedrock, and establish the presence or absence of undesirable soil or groundwater conditions which would affect the proposed development. The drilling was accomplished with a trailer-mounted drill rig towed by a dozer and operated by licensed drillers subcontracted by us. The borings were drilled to depths ranging from 23.6 feet to 41.5 feet.

The drilling was conducted under the observation of an experienced geotechnical engineer from our office who logged the borings, classified the soils in the field, and noted other significant drilling and subsurface conditions. Boring logs are included in Appendix A of this report.

5.0 PROJECT SOIL CONDITIONS

The soils encountered in this exploration were very similar across the site and are similar to soils encountered in adjacent developments. The soil profile described as follows is a composite interpreted from all the borings conducted during our exploration. Some units were absent from the various borings.

TOPSOIL AND DUFF. The site is covered with an organic duff layer. Beneath this layer is a thin topsoil consisting of brown, clayey silt with minor organics and roots. The combined thickness of the duff and topsoil layer ranges from about four to eight inches, and may approach one foot in hollows.

PORTLAND HILLS SILT. Virtually the entire site is covered with a thick layer of stiff to very stiff, brown, fine sandy clayey silt and silty clay. Trace amounts of coarse sand and pebbles are present in the silty matrix at various elevations. The relative proportions of silt, clay, and fine sand varies transitionally, so that the silty clay and clayey silt grade into one another without distinguishable contacts. Groundwater tends to move within the sandier portions and perch above those with greater clay contents to create wet zones and zones of relatively dry material. Wet zones tend to be softer than drier zones. The thickness of the Portland Hills silt varies considerably, but may be estimated at 20 to 50 feet in this vicinity. The less clayey brown silt would be suitable for fills if the moisture can be controlled. Field moisture contents are generally well above the optimum moisture content for fill compaction. The higher the clay content, the more difficult the material is to dry to a workable state, and therefore the less suitable the material would be for fills.

GRAY, SILTY CLAY. Underlying the brown Portland Hills silt in portions of the site is a layer of stiff to very stiff, gray, silty clay with fine sand. This material was encountered in one boring (B-6). It is similar in character to the brown, silty clay but contains a greater proportion of clay. Moisture tends to perch above this layer. The gray clay is not suitable for use in fills because the clay content would render it difficult to dry and compact. The thickness of this layer was observed to exceed 15 feet in boring B-6.

WEATHERED VOLCANIC BEDROCK. Weathered volcanic bedrock was observed beneath the Portland Hills silt in three borings (B-3, B-4, B-7). This material varied in the degree of weathering from completely weathered (B-3, B-4) to abruptly hard (B-7). The depth to this layer was observed to vary from 23 to 30 feet in the borings and its thickness was observed at about 15 feet. The completely decomposed material reworks to a sticky, sandy clay which could be excavated normally to the depth of more competent rock. The reworked, decomposed rock would not be suitable for use in fills because of its poor workability. Hard rock was encountered only in B-7 and could impact sewer construction. A supplemental report under separate cover will describe further exploration to determine the extent of the rock.

GROUNDWATER. Evidence of perched groundwater was observed throughout the depth of the soil materials on the site, indicated by variations in soil coloring, moisture content, and soil consistency. Water was observed on the tip of a sample from the bottom of one boring (31.5 feet in B-2), but it was not directly determined whether that was static groundwater or a zone of perched water. Borings drilled to lower elevations did not encounter water, implying that the moisture was due to perched water.

6.0 PRELIMINARY LAYOUT REVIEW

Our work on this project included a review of the preliminary lot and street layout as depicted in a preliminary concept drawing provided by HGW, Inc. and included as Plate 1. We concur with the preliminary layout which concentrates the lot placement in the middle third of the property because the slopes are more moderate here than in any other portion of the project area. Fills are planned in many of the draws in the project area. Recommendations for fills in draws are included in Section 7.4.1. Current plans call for phased construction. Phased construction is desirable because it allows greater control over the extent of exposed soil at any given time, an important consideration when working erodible soils such as these.

7.0 GEOTECHNICAL RECOMMENDATIONS

7.1 Site Preparation

7.1.1 General Site Preparation - Prior to beginning construction, those areas in which construction will occur should be cleared of vegetation. Before earthwork is begun, the work area should be stripped of topsoil and root mats to firm, inorganic soil, and the strippings reserved for landscaping or spread thinly in non-structural areas of the site. Strippings may be placed up to 12 inches thick on finished lots. It may be possible to place excess strippings in sliver fills adjacent to structural fills. The success of this disposal method depends in large part on the proportion of soil to organic matter and on the moisture content of the blend. Strippings can be difficult to place and compact adequately. Sliver fills constructed of strippings may require remedial work after the first winter to repair shallow slumps. Exposed strippings usually require the same erosion protection as other soils. If strippings are to be disposed of in sliver fills, we should be contacted to assist in location of the fills, assessment of the soil-organics blend, and placement method.

If the long-range weather is hot and dry and excavated soils are to be used as fill, large areas may be stripped at once to facilitate surface drying. However, if the weather is rainy, damp, or changeable, only the immediate work area should be stripped to avoid leaving large, un-worked areas exposed to rain and runoff. We anticipate that stripping depths will be on the order of six to eight inches in most locations. Because the site was heavily vegetated, the combined depth of the duff layer and topsoil could exceed eight inches in places.

7.1.2 Preparing Embankment or Pavement Subgrades - It is anticipated that most subgrades will be areas which have been cut or filled. Comparatively few subgrades will be located at existing grade. Subgrades at or within one foot of existing grade are subject to cyclic freezing and thawing which tends to loosen surface soils. We recommend that these shallow subgrades, or any other subgrade which has been exposed to freezing and thawing after preparation and before paving, be further prepared to assure good performance. In warm, dry weather, subgrades may be scarified to a depth of six inches, aerated or dried to within 2% of the optimum moisture content as determined by ASTM D-1557, and recompacted with a moderately heavy, static sheepsfoot or combination roller. Under wet conditions, scarification and drying will not be possible and it will be necessary to follow the wet weather recommendations detailed in Section 7.1.3.

Subgrades in areas cut more than one foot to grade can be used as-is, if the excavation leaves a smooth, firm, undisturbed surface which does not yield excessively under proof rolling (proof rolling is addressed in Section 7.1.4). If excessively wet or soft subgrade areas are identified during excavation or proof rolling, they should be overexcavated and replaced with compacted granular material. Excessively wet or soft subgrades are identified by rutting, tearing, or other disturbance by equipment, or by excessive yielding during proof rolling as determined by an experienced geotechnical engineer or technician.

Subgrades on adequately compacted fills should not require further preparation if the proof-rolling is acceptable and if the period between fill completion and paving is brief. If prolonged exposure between fill completion and paving results in cyclic freezing and thawing, softening by exposure to moisture, or damage by construction equipment, the subgrades should be prepared as for shallow subgrades and proof rolled again.

It is important to note that groundwater in this vicinity has a tendency to perch at multiple elevations in the silt. Excessively soft or wet areas would very likely be encountered within the proposed cut, fill, and pavement areas. The depth of overexcavation required in these vicinities can vary from a few inches to more than two feet and the areas of overexcavation can be extensive. Overexcavated areas should be backfilled with imported granular material. Excavated soils suitable for reuse as fills are likely to be well over the optimum moisture content at any time of year. Prolonged warm, dry weather and large areas for spreading and mixing are necessary to dry the soils sufficiently to meet compaction requirements.

7.1.3 Wet Weather Subgrade Preparation - If weather or soil moisture conditions are such that the site cannot be worked without causing severe rutting to the work areas, it will be necessary to install a granular working blanket to support construction equipment and provide a firm base on which to construct fills. A working blanket consists of bank run gravel or pit run quarry rock, with a maximum size of six inches and no more than 5% by weight passing a No. 200 sieve. We recommend that we be consulted to approve the material before installation.

The working blanket should be installed on a stripped subgrade in a single lift, by trucks end-dumping off an advancing pad of the granular material. It should be possible to strip the work areas on this project at almost any time of year with the careful operation of rubber-tired or track-mounted equipment. However, if even track-mounted equipment cannot operate without damaging the subgrade, stripping may have to be accomplished simultaneously with placement of the working blanket, using a large trackhoe or similar equipment working from the edge of the granular fill. After installation, the working blanket should be compacted by a minimum of four passes with a moderately heavy, static, steel drum or grid roller.

Normally the design, installation and maintenance of a granular working blanket is made the responsibility of the contractor. Our experience indicates that a working blanket about 12 inches thick usually will provide adequate support for construction equipment, depending on the gradation and angularity of the material. If the working blanket is placed on a very soft, disturbed subgrade or is subjected to frequent heavy construction traffic, a thicker blanket may be necessary. Approved geotextiles can sometimes be substituted for up to five inches of working blanket. If used, filter fabrics should be of a non-degradable type with sufficient strength to resist punching by the aggregate and sufficient permeability to readily pass water without ponding. Many of the commonly used woven construction fabrics do not have the permeability necessary for placement beneath a working blanket. We can provide sample specifications for geotextiles on request.

7.1.4 Proofrolling - Prior to fill or base rock placement, the subgrade or granular working blanket should be proof-rolled with a fully-loaded, 10 to 12 yard dump truck or other suitable heavy equipment. Any areas that pump, weave, or appear otherwise soft and muddy should be overexcavated and backfilled with compacted granular fill. If significant traffic has been routed across the proposed alignment, or if an extended period of time lapses between initial proof-rolling and fill or base rock placement, we recommend that those areas of the site be similarly proof rolled again. This is particularly important if a subgrade has been exposed to heavy rains or freezing and thawing.

7.2 Embankments

This section contains recommendations for the construction of earth embankments. All embankments required for the project should be constructed on subgrades prepared in accordance with the recommendations given in Section 8.1.

7.2.1 Embankment Materials - Fills installed in dry weather on firm subgrades may be constructed of almost any well-graded blend of silt, sand, and gravel which can be compacted to the specified density. The material should be free of organics and clayey lumps. The native clayey silt would be suitable for fill construction or for blending if adequate moisture control can be obtained. The clay content of the soil varies considerably; some materials may be too clayey to use as fill because they cannot be dried or because they dry in clods which do not break down under compaction. These materials are generally distinguishable in the field by a geotechnical consultant. Materials which are extraordinarily difficult to dry, or which dry in hard clods which do not break down with discing and turning, are probably unsuitable for use in compacted fills and should be reviewed by a geotechnical consultant before use.

Past experience on large grading projects in this vicinity indicates that the moisture content of the excavated materials is likely to vary widely between approximately 20% and 40%, with the highest moisture occurring in seepage zones. Large drying areas and repeated discing and turning will be necessary in order to dry the material sufficiently to place as controlled fill. In prolonged damp or rainy weather, it can be impossible to dry the native silt sufficiently to allow placement as fill, and it may be necessary to alter the construction schedule or to import fill. Lime treatment can be used to dry the soil, but it is very expensive.

In order to achieve adequate compaction during wet weather or in areas where adequate moisture control is not possible, fills should consist of well-graded granular soils (sand or sand and gravel) with a maximum particle size of six inches and not more than 5% material by weight passing the No. 200 sieve. It is possible to chemically dry the soils, but the cost may be prohibitive on large projects.

7.2.2 Embankment Construction - Embankments should be installed on a subgrade that has been prepared in accordance with the recommendations provided in Section 7.1. Fills should be installed in horizontal lifts not exceeding eight inches uncompacted thickness, and should be compacted to at least 92% of the maximum dry density (ASTM D-1557). We anticipate that most fills will be constructed of the native silty materials. If predominantly granular soils are used, the density requirement should be increased to 95%.

Fills constructed midway on slopes steeper than 5H:1V should be installed using keys and benches, as shown in Plate 2. Fills on slopes steeper than 3H:1V which do not toe out on ground 5H:1V or flatter require individual design of keys and benches. We should be contacted in these cases. Fills on slopes are addressed again in Section 7.7. Fills in draws are also addressed in Section 7.4.1.

Finished fill slopes should be achieved by placing and compacting material beyond the intended fill limits and then excavating back to the design limits at the desired slope, or by other methods that will result in a dense, compacted slope face. Predominantly silty fills should not be sloped steeper than 2H:1V.

The native silt is very erodible. Fresh slope faces should be protected from erosion as soon as practicable by applying a layer of crushed rock or graded rock rubble, heavy mulch, fast-growing vegetation, or other approved erosion control material.

7.2.3 Settlement Beneath Embankments - The weight of a new embankment can result in settlement of the soil within and/or beneath the embankment, even if the fill itself is well compacted. The amount of settlement produced depends on the soil depth and type beneath the embankment, the moisture conditions, and on the dimensions of the new fill. The amount of settlement likely to occur beneath embankments on this project will probably be negligible because the soils on this site are relatively incompressible. Furthermore, our experience indicates that settlement occurs rapidly in these soils, usually within the embankment construction period.

7.3 Cuts

In general, permanent cuts up to 10 feet high in the native silt should be sloped no steeper than 2H:1V. Permanent cuts higher than 10 feet should be individually reviewed on the final grading plan. Temporary cuts should conform with OSHA standards, but should not exceed 1:1 for a maximum height of 10 feet. All fresh slopes, whether temporary or permanent, will require erosion protection. It should be noted that it is often necessary to modify cut slope angles in the field based on the soil conditions at the time of construction. Of particular importance is the presence of perched water, which can have a pronounced impact on the stability of cut slopes. Perched water conditions fluctuate with the seasons and with precipitation. We recommend that we be retained to observe cut slopes as they are excavated to determine whether modifications in the slope angle are necessary. Seeps and springs in cut slopes are addressed in the following section.

7.4 Drainage, Dewatering, and Shoring

7.4.1 Seeps, Springs, and Draws - Groundwater was encountered in one boring at a depth of 31.5 feet and it is not clear whether this was static groundwater or a zone of perched water. As mentioned elsewhere, we have not yet reviewed a grading plan but preliminary expectations are that cuts would not exceed 30 feet in depth. Therefore we consider it unlikely that static groundwater will be encountered in cuts. However, it is probable that seeps and springs will be encountered in cut slopes during construction because of the tendency for groundwater to perch at many elevations throughout the depth of the silt.

Cut slopes encountering seepage may require flatter angles or may require drains. Drains are normally constructed by excavating back into the slope a short distance and installing a perforated pipe in an envelope of clean, compacted drain rock. The details of individual drains are designed on a case-by-case basis as needed. We should be consulted to review the cut slopes if seeps in soil are encountered, to determine whether adjustments in slope angle or drainage are necessary. Failure to appropriately treat seeps in cuts can result in excessive erosion and cut slope failures.

Fills in the heads of draws usually require special attention to drainage. We recommend construction of a drainage base layer beneath all fills in draws. The drainage base layer may consist of a layer of free-draining, relatively well-graded granular material. A woven or nonwoven geotextile should be placed between the fill subgrade and the granular material. If the overlying fill is fine-grained, then a layer of geotextile should be used to separate these materials as well.

7.4.2 Utility Trenches and Excavations - All temporary excavations should be adequately sloped or shored. Because of the variations in soil conditions, it is not possible to provide recommended "safe" slopes, and final decisions are usually based on field conditions at the time of construction.

The following recommendations are included as a guideline for installation of utilities. Trenches less than three feet in depth and in which no workers are present may be sloped at any convenient angle. Any trenches greater than three feet in depth or in which workers are present should be sloped or shored in accordance with OSHA requirements. Flatter slopes may be required in areas of perched groundwater or if caving occurs.

We do not anticipate that extensive dewatering operations will be necessary on this project. It may be necessary to control springs by routing the flow via ditching or grading, and/or with the use of a sump and pump. Utility excavations may likewise require pumping after storms or if heavy springs are encountered.

Excavation shoring and dewatering systems are normally designed and provided by the contractor. Unless special circumstances arise, the choice of excavation and dewatering equipment is normally left up to the contractor.

7.5 Erosion Protection

Rip-rap, dense vegetation, or other approved slope protection measures should be used to protect embankments, ditches, and culvert outlets from erosion. Vegetation would probably not be suitable at culvert outlets or other locations where runoff is concentrated. Dense, fast growing vegetation can be effective in protecting slope faces. Erosion control during the construction phase should be monitored on a regular basis and following heavy rains, and maintained as needed.

7.6 Retaining Structures

We are not aware of plans for retaining structures at this stage of the project plan. We have included general retaining structure recommendations for this project in the event that retaining structures are added. These recommendations are intended for application to walls less than 12 feet high and not subjected to heavy loads within a designated setback.

7.6.1 Soil Design Characteristics - The following soil characteristics may be used for wall design. They assume that the wall backfill will be a free-draining, granular material composed of sand and gravel with less than 5% by weight passing a No. 200 sieve. Wall drainage is assumed sufficient to prevent the buildup of hydrostatic pressure behind the wall. The value for base friction assumes a clean aggregate base course on a clayey silt subgrade. Lateral earth pressures are presented in a separate subsection below.

Backfill Angle of Internal Friction:	28°
Backfill Cohesion:	0 psf
Moist Unit Weight for Sand and Gravel: (assuming light compaction and 15% moisture)	125 pcf
Moist Unit Weight for Clayey Silt:	115 pcf
Base Friction Coefficient:	0.35
Bearing Capacity:	2,000 psf

With the exception of the bearing capacity, no factor of safety is included in these values. The bearing capacity includes a factor of safety of 3. It is critical that designers understand the assumptions inherent in these values before using them in design. Please contact us if additional clarification of these assumptions is needed, or if design values for other soil characteristics are required.

7.6.2 No Load Zone Setback - The lateral earth pressures provided in the subsection below do not include any effect of external loading. Foundations, roads, parking lots, and any other sources of applied load should be located outside a zone that extends back from the base of the wall at a 1H:1V slope as shown in Plate 3.

7.6.3 Lateral Earth Pressures - The lateral earth pressures presented in this subsection represent our best estimates of actual pressures that may develop. They do not contain a factor of safety. These pressures are assumed to act horizontally (normal to the wall), based on the assumption that friction between the wall and backfill will be prevented. This is the case for walls with drainage membranes or impervious wall coatings, or for walls constructed of reinforced fills. Please contact us for further assistance if it is desired to include friction between the wall face and the backfill.

Restrained Walls - Restrained walls are walls which are prevented from rotating during backfilling. These are typically walls which are anchored or tied back, walls which make sharp bends, short walls with fixed ends, walls restrained at the top, or gravity structures. We recommend that restrained walls be designed for the equivalent unit weights shown below.

Backfill Slope (Horizontal:Vertical)	Design Equivalent Unit Weight For Retaining Structures(PCF)
Level	45
3H:1V	65
2H:1V	105
>2H:1V	Not Recommended

Non-Restrained Walls - Non-restrained walls are not restrained at the top or ends and are free to rotate about their base during backfilling. If the movement is sufficient, the soil will assume its "active" state and the wall pressures will be reduced. The lateral movement at the top necessary to mobilize this state may be up to one-half percent of the wall height. Most cantilever retaining walls fall into this category. We recommend that non-restrained walls be designed for the equivalent unit weights shown below.

Backfill Slope (Horizontal:Vertical)	Design Equivalent Unit Weight For Retaining Structures(PCF)
Level	35
3H:1V	55
2H:1V	95
>2H:1V	Not Recommended

7.6.4 Retaining Wall Backfill and Drainage - Good drainage is critical to good wall performance. The backfill behind retaining walls should consist of free-draining granular material containing no more than 5% by weight material passing the No. 200 sieve. The use of material with a higher fines content could cause hydrostatic pressures to develop behind the wall, increasing the wall pressures beyond the design values. The backfill should be lightly compacted with hand operated equipment just enough to minimize fill settlement behind the wall, approximately 90% of the maximum dry density (ASTM D-1557). Overcompaction can greatly increase the lateral soil pressures on the wall beyond the design values. Heavy machinery of any sort should not be operated within five feet of the wall.

All retaining walls require drainage through or away from the face in order to prevent the buildup of hydrostatic pressures behind the wall. We recommend that walls be drained either by weep holes or by a perforated pipe subdrain installed in a properly graded filter material or wrapped in a filter fabric. Weep hole spacing will depend on the backfill material. We can be consulted for spacing recommendations if a weep hole drainage system is planned. Plate 4 shows typical retaining wall subdrain details. All drains should be sloped to drain by gravity to a storm sewer or other positive outlet. Surface water from sources behind the wall should never be routed into the retaining wall backfill or its subdrain.

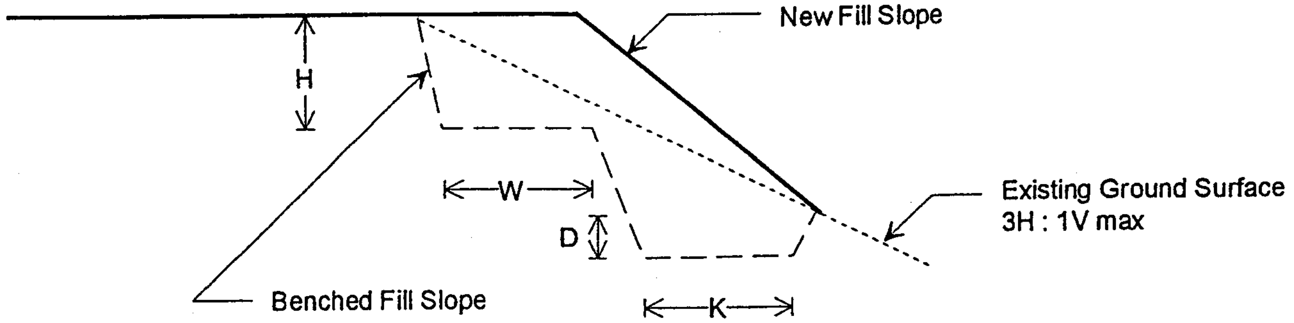
7.7 Slope Stability

A common soil condition in this area is creep, or gradual surface movement. Creep generally occurs in the upper four to five feet of the soil profile. The effect of creep is to increase lateral soil pressures on retaining walls and foundation walls. As mentioned earlier, lot-specific recommendations are beyond the scope of this report. Individual lot owners are encouraged to seek the advice from a geotechnical consultant when designing foundation elements and retaining walls.

A small slump was observed in the proposed Lot 107. Slumps in this material are usually the result of oversteepening by erosion and high pore water pressures in the soil. This and any other areas containing slumps will require individual attention. They can generally be treated by removing the failed mass, grading, installing a subsurface drainage system, and replacing the material as compacted fill. The project as proposed in Plate 1 is not expected to adversely impact the stability of this or other slopes in the project area.

8.0 FUTURE GEOTECHNICAL SERVICES

The preliminary recommendations contained in this report are based on information gathered during the course of our work and on information provided by HGW, Inc. Our work was based on a preliminary project layout provided us by HGW. This preliminary layout may change. We recommend that we be permitted to review the revised lot and street layout so that we may determine whether our recommendations have been applied to the modified layout. Similarly, we ask that we be provided an opportunity to review the grading plan when it becomes available, as well as the final project plans and specifications in due time. This will allow us to determine whether any change in concept may have affected the validity of our recommendations, and whether our recommendations have been correctly interpreted.



H = 4' Maximum
W = 2' Minimum
D = 2' Minimum
K = 15' Minimum

PLATE 2

RZA AGRA, Inc.
ENGINEERING & ENVIRONMENTAL SERVICES

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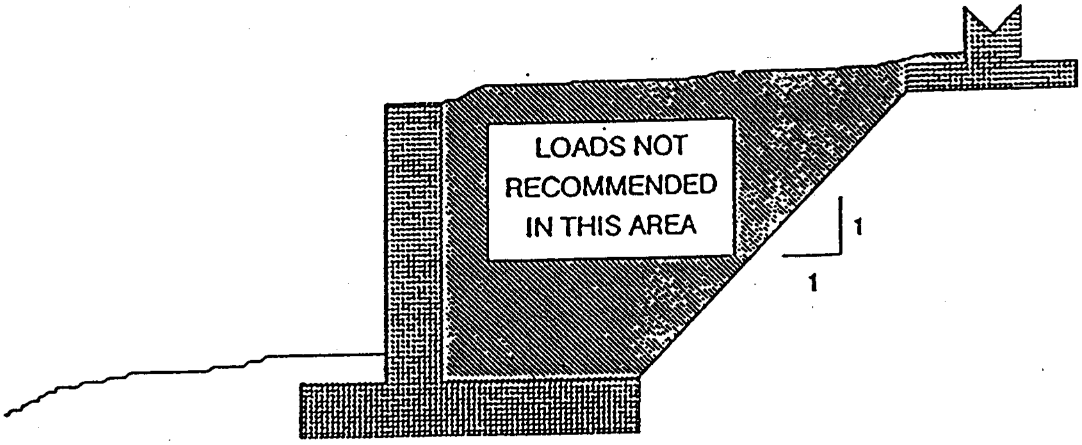
Phone (503) 639-3400 Fax (503) 620-7892

W.O. 21-7279-00
DESIGN M.L.
DRAWN RMS
DATE 1/6/94
SCALE

BENCHED FILL SLOPE
MACLEAN SUBDIVISION
PORTLAND, OREGON

FILE #: 7279FILL.DRW



"NO LOAD ZONE" BEHIND RETAINING WALLS

PLATE 3

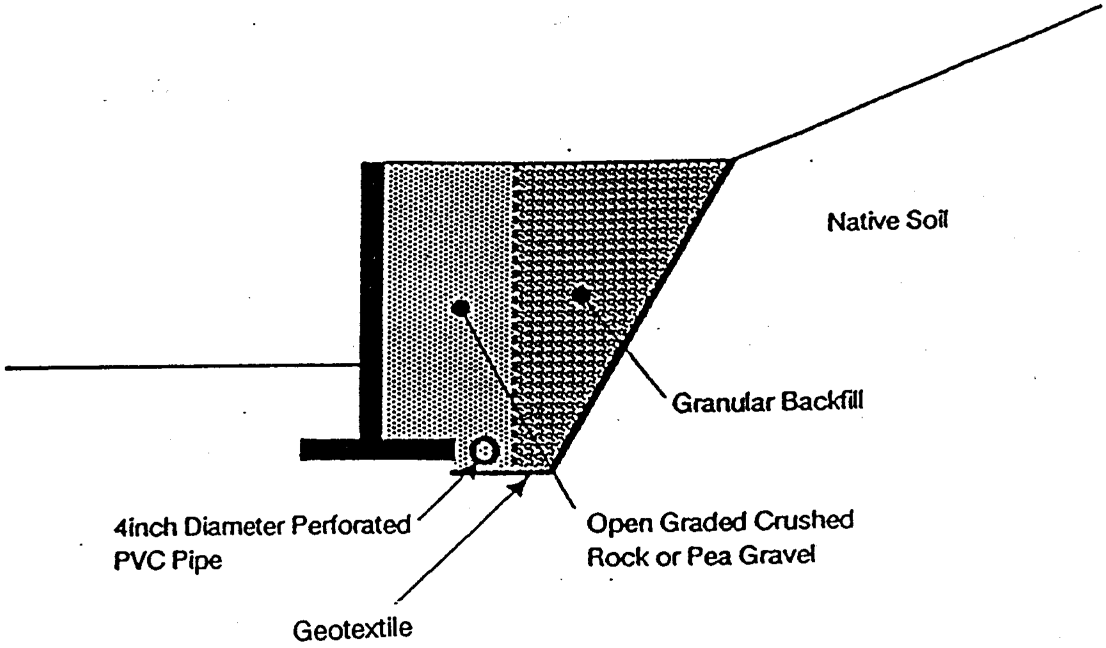
RZA AGRA
ENGINEERING & ENVIRONMENTAL SERVICES

7477 S.W. Tech Center Dr.
Portland, Oregon 97223-8024
Phone (503) 639-3400 Fax (503) 620-7892

W.O. ________
DESIGN ________
DRAWN ________
DATE ________
SCALE ________

RETAINING WALL SETBACK
MACLEAN SUBDIVISION
PORTLAND, OREGON

INTERNAL USE ONLY - FILE NAME:



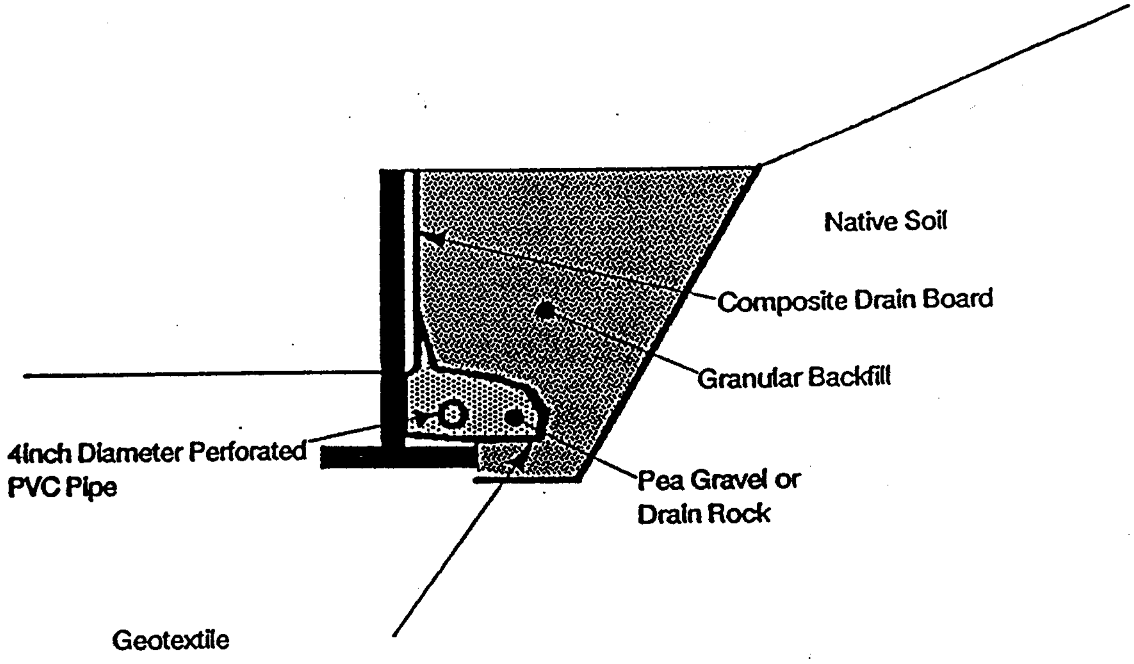


PLATE 4

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W.O. ____________
DESIGN ____________
DRAWN ____________
DATE ____________
SCALE ____________

RETAINING WALL DRAINAGE
MACLEAN SUBDIVISION
PORTLAND, OREGON

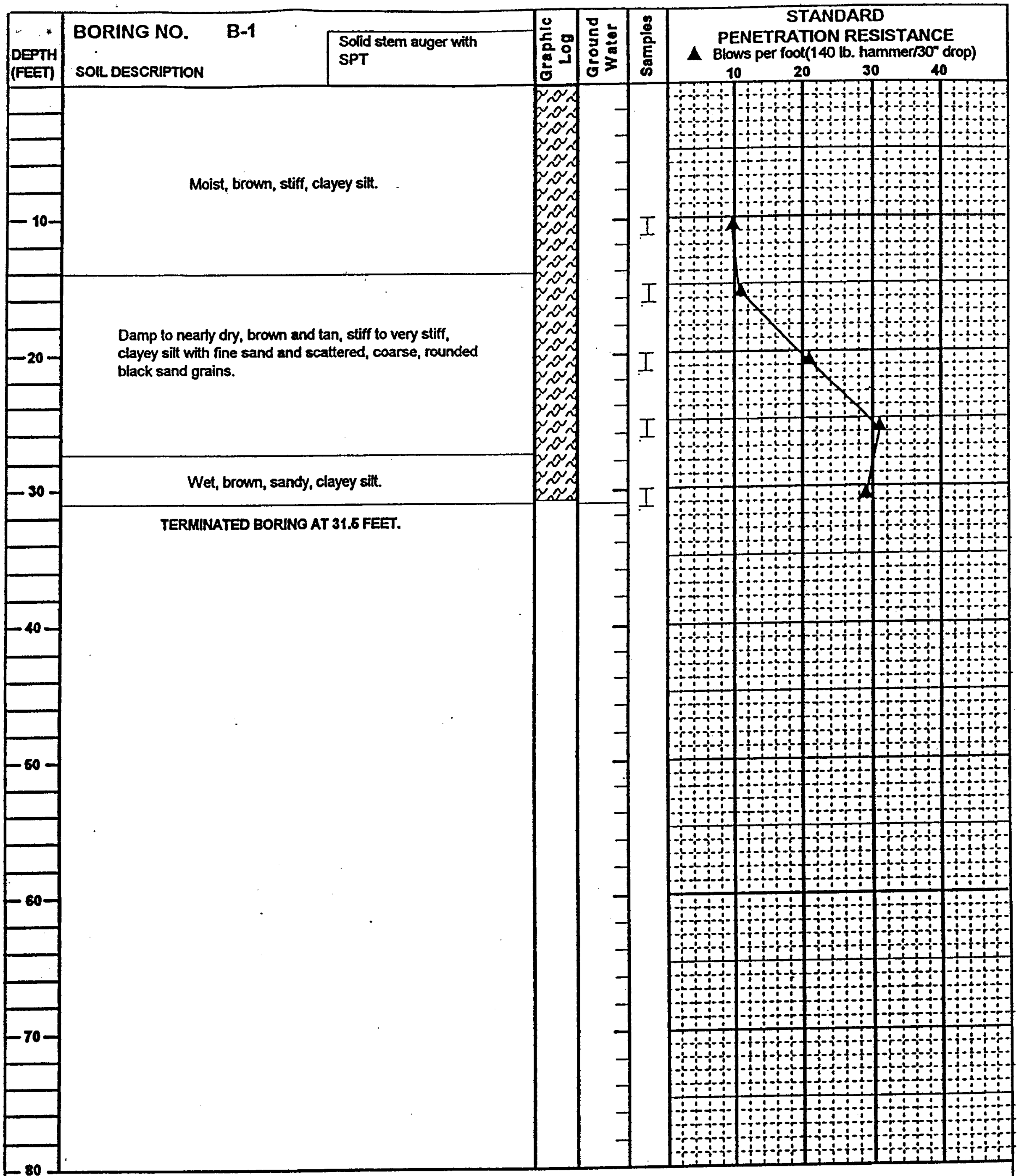
INTERNAL USE ONLY - FILE NAME:

Appendix A

Boring Logs

BORING NO. B-1

Solid stem auger with SPT



Moist, brown, stiff, clayey silt.

Damp to nearly dry, brown and tan, stiff to very stiff, clayey silt with fine sand and scattered, coarse, rounded black sand grains.

Wet, brown, sandy, clayey silt.

TERMINATED BORING AT 31.5 FEET.

LEGEND

I	2.0" O.D. split spoon sampler	P	Sampler pushed
II	3.0" O.D. undisturbed sampler	●	% moisture content
☒	3.0" I.D. Universal sampler	*	Sample not recovered
▢	3.0" I.D. Ring sampler	▽	Water level fluctuation
G	Grab sample interval	▽	Static water level
L(C)	Laboratory/chemical analysis	ǀ	Piezometer tip

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BORING NO. B-2

Solid stem auger with SPT

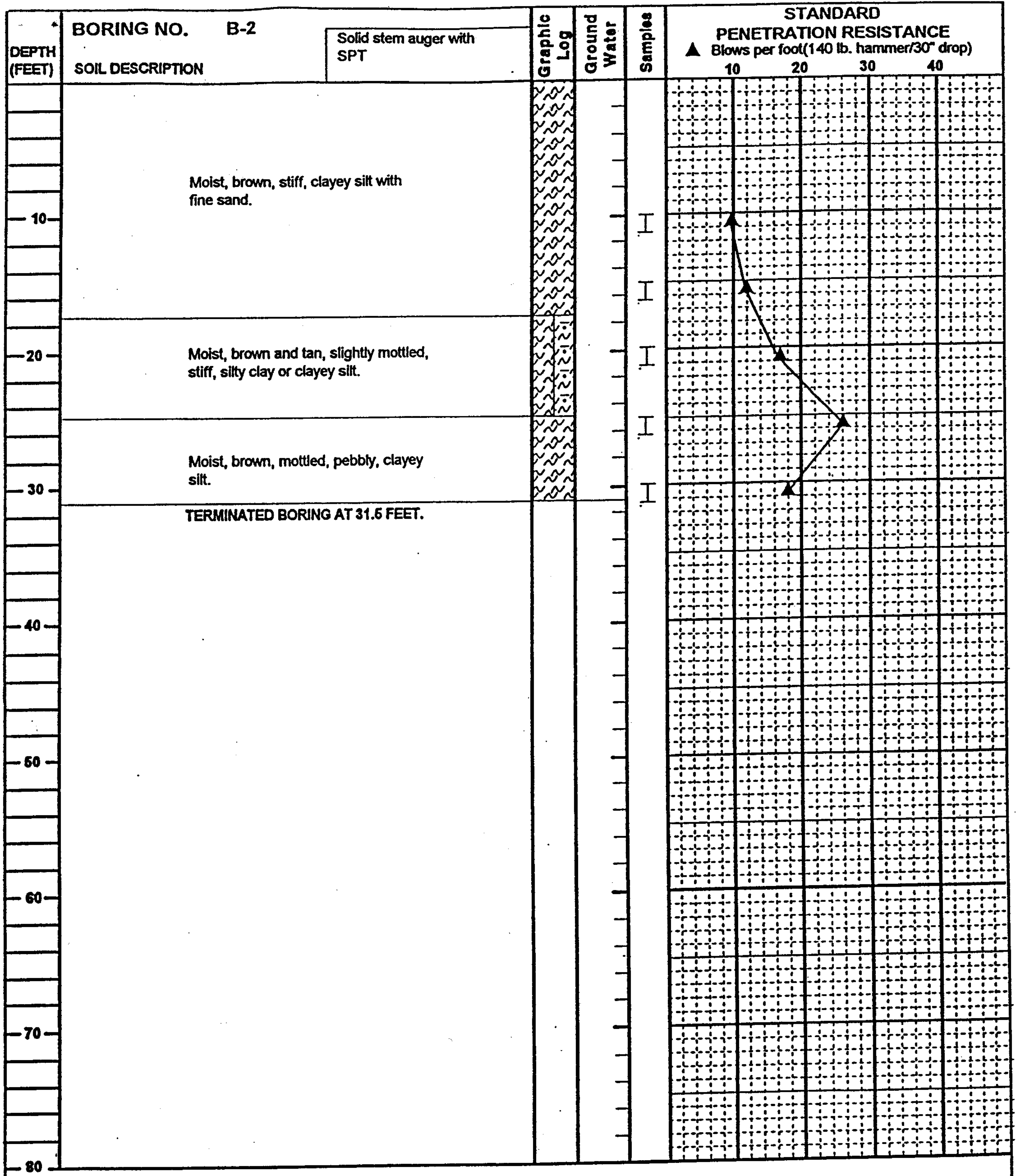
DEPTH (FEET) **SOIL DESCRIPTION**

Moist, brown, stiff, clayey silt with fine sand.

Moist, brown and tan, slightly mottled, stiff, silty clay or clayey silt.

Moist, brown, mottled, pebbly, clayey silt.

TERMINATED BORING AT 31.5 FEET.



LEGEND

I	2.0" O.D. split spoon sampler	P	Sampler pushed
II	3.0" O.D. undisturbed sampler	●	% moisture content
☒	3.0" I.D. Universal sampler	*	Sample not recovered
▢	3.0" I.D. Ring sampler	▽	Water level fluctuation
G	Grab sample interval	▽	Static water level
L(C)	Laboratory/chemical analysis	ǀ	Piezometer tip

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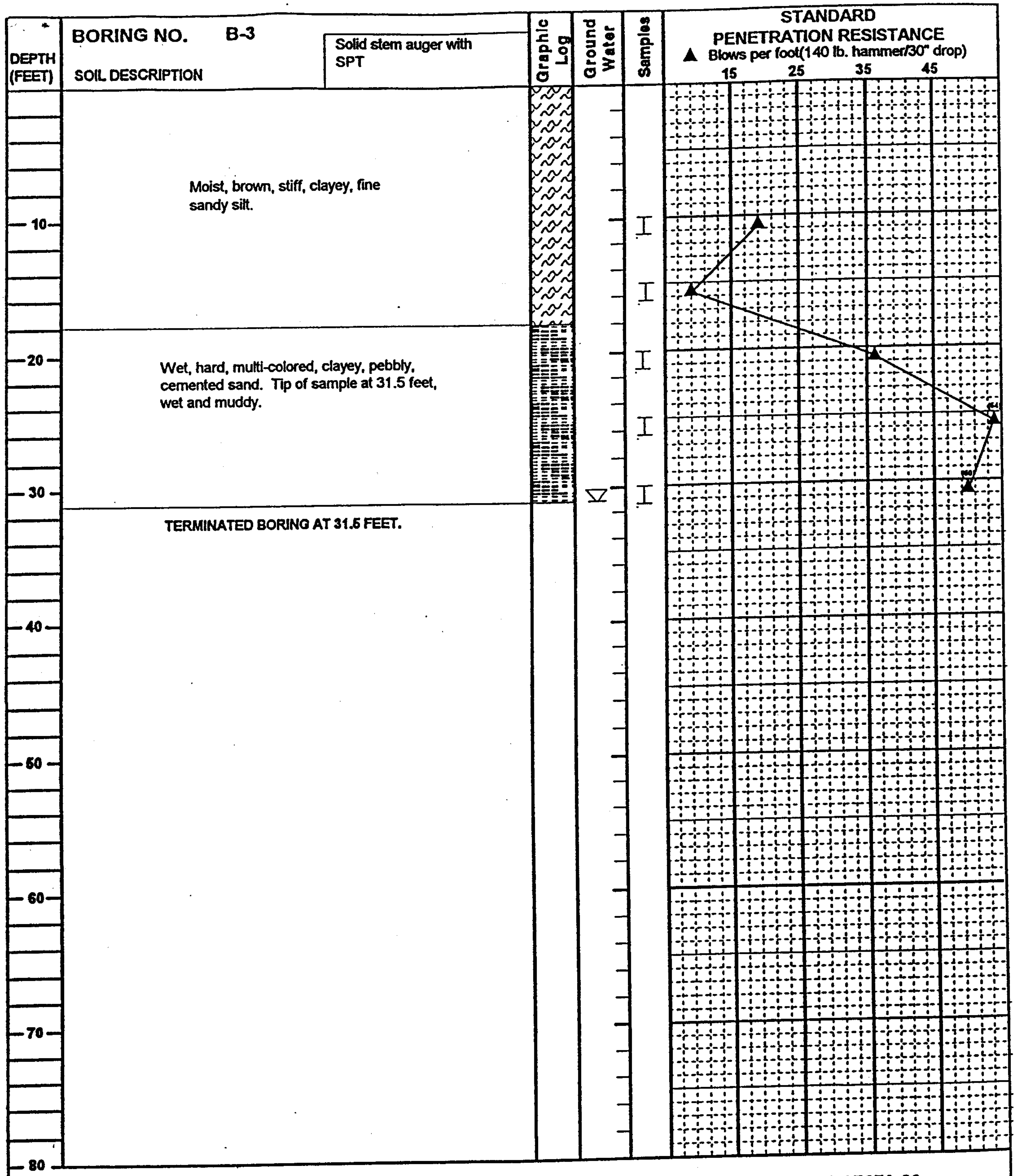
BORING NO. B-3

Solid stem auger with SPT



Moist, brown, stiff, clayey, fine sandy silt.

Wet, hard, multi-colored, clayey, pebbly, cemented sand. Tip of sample at 31.5 feet, wet and muddy.

TERMINATED BORING AT 31.5 FEET.

LEGEND

I	2.0" O.D. split spoon sampler	P	Sampler pushed
II	3.0" O.D. undisturbed sampler	●	% moisture content
☒	3.0" I.D. Universal sampler	*	Sample not recovered
▢	3.0" I.D. Ring sampler	∵	Water level fluctuation
·G	Grab sample interval	▽	Static water level
L(C)	Laboratory/chemical analysis	ǀ	Piezometer tip

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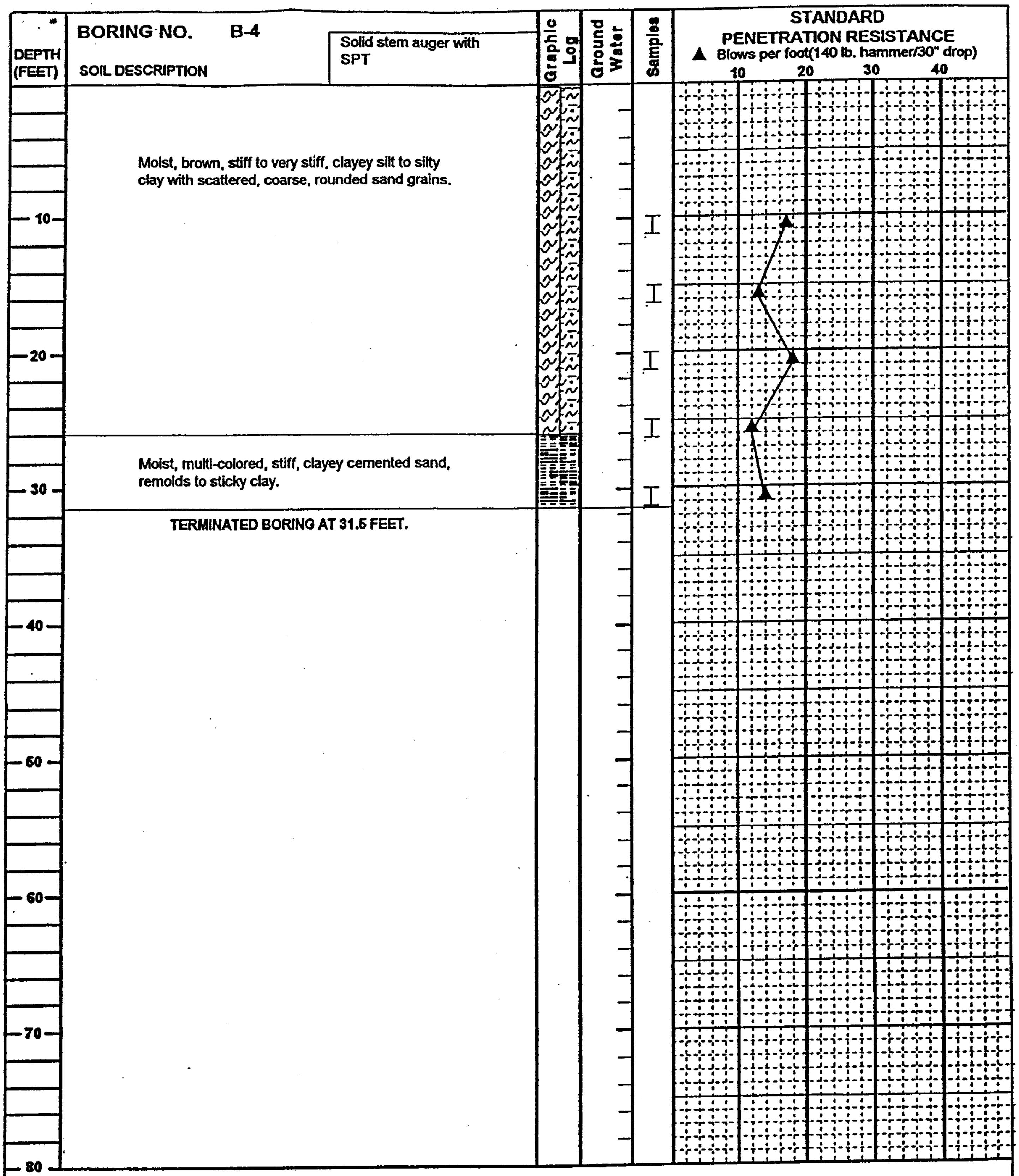
BORING NO. B-4

Solid stem auger with SPT



Moist, brown, stiff to very stiff, clayey silt to silty clay with scattered, coarse, rounded sand grains.

Moist, multi-colored, stiff, clayey cemented sand, remolds to sticky clay.

TERMINATED BORING AT 31.5 FEET.

LEGEND

I	2.0" O.D. split spoon sampler	P	Sampler pushed
II	3.0" O.D. undisturbed sampler	●	% moisture content
☒	3.0" I.D. Universal sampler	•	Sample not recovered
▢	3.0" I.D. Ring sampler	∇	Water level fluctuation
G	Grab sample interval	∇	Static water level
L(C)	Laboratory/chemical analysis	¡	Piezometer tip

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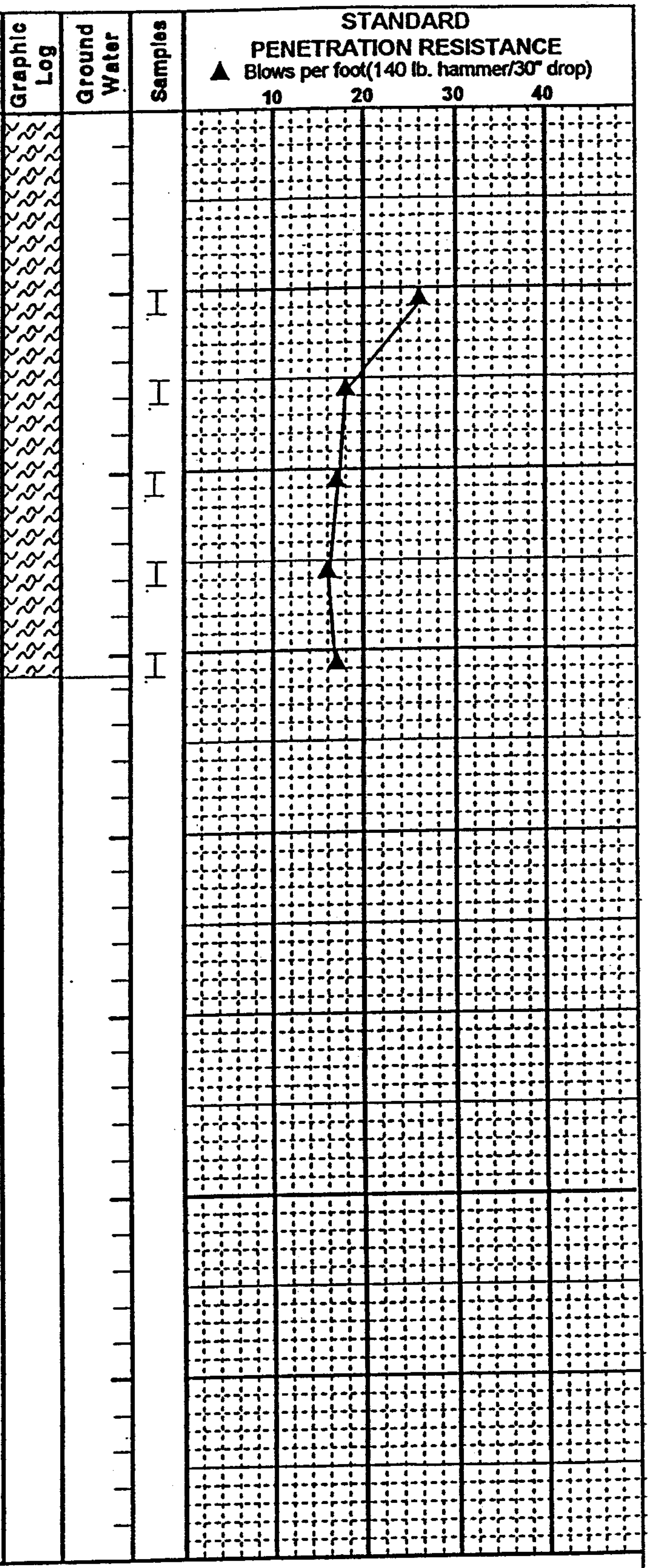
BORING NO. B-5

Solid stem auger with SPT

DEPTH (FEET)	SOIL DESCRIPTION
	Damp, light-brown, hard, clayey silt with fine sand.
	Moist, brown, stiff to very stiff, clayey silt with coarse, rounded sand grains below 20 feet.
10	Moisture increasing with depth to wet, clayey silt.
20	
30	
	TERMINATED BORING AT 31.5 FEET.
40	
50	
60	
70	
80	



LEGEND

I	2.0" O.D. split spoon sampler	P	Sampler pushed
II	3.0" O.D. undisturbed sampler	●	% moisture content
☒	3.0" I.D. Universal sampler	•	Sample not recovered
☐	3.0" I.D. Ring sampler	▽	Water level fluctuation
G	Grab sample interval	▽	Static water level
L(C)	Laboratory/chemical analysis	ǀ	Piezometer tip

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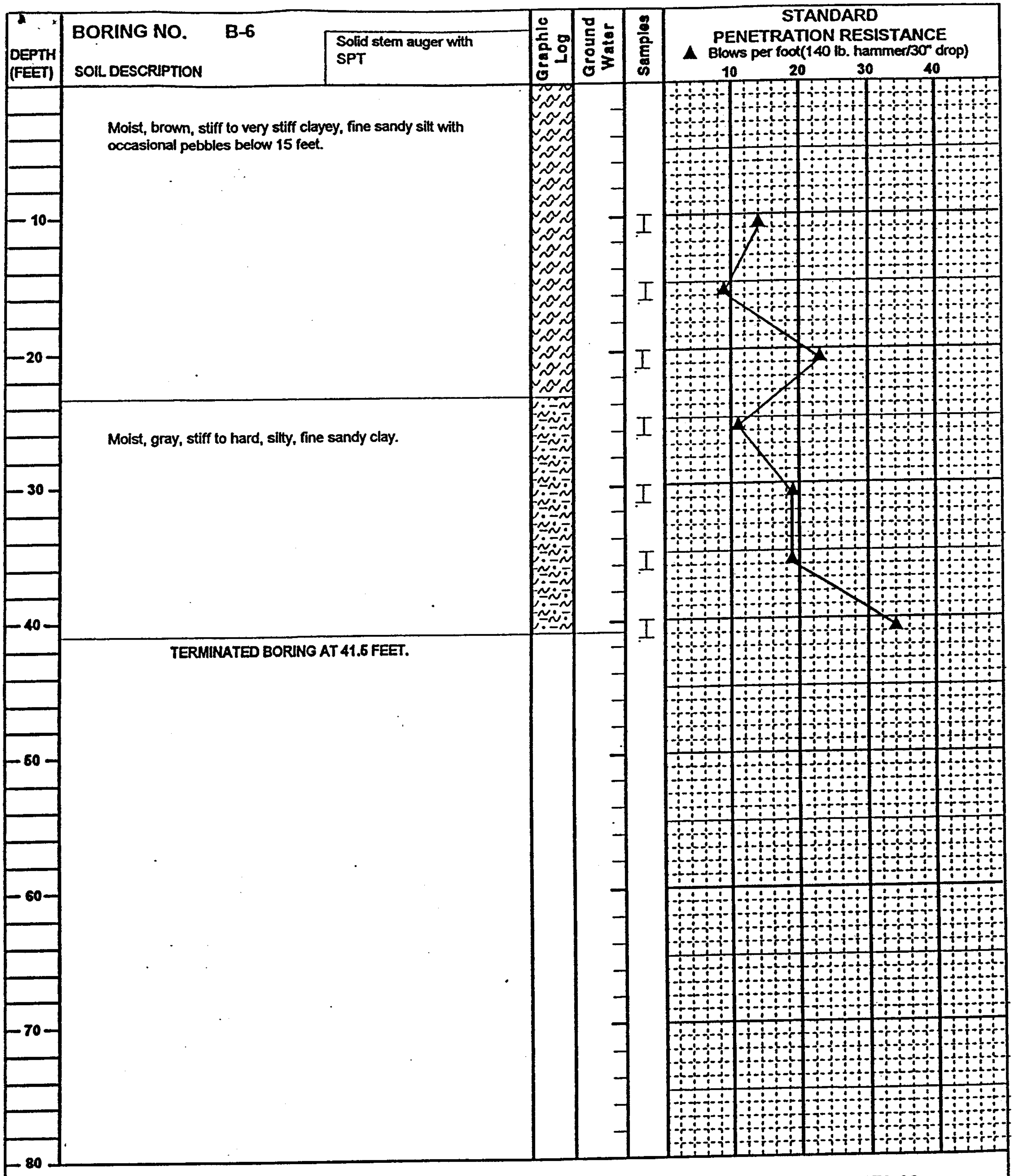
BORING NO. B-6

Solid stem auger with SPT



Moist, brown, stiff to very stiff clayey, fine sandy silt with occasional pebbles below 15 feet.

Moist, gray, stiff to hard, silty, fine sandy clay.

TERMINATED BORING AT 41.5 FEET.

LEGEND

I	2.0" O.D. split spoon sampler	P	Sampler pushed
II	3.0" O.D. undisturbed sampler	●	% moisture content
☒	3.0" I.D. Universal sampler	*	Sample not recovered
▢	3.0" I.D. Ring sampler	▽	Water level fluctuation
G	Grab sample interval	▽	Static water level
L(C)	Laboratory/chemical analysis	ǀ	Piezometer tip

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BORING NO. B-7

Solid stem auger with SPT

DEPTH (FEET) **SOIL DESCRIPTION**

Damp to moist, light brown to brown, very stiff to stiff, clayey silt.

Weathered bedrock at 23 feet. Auger refusal at 23' - 8". Attempted SPT - refusal, no recovery.

TERMINATED BORING AT 23.6 FEET.

10

20

30

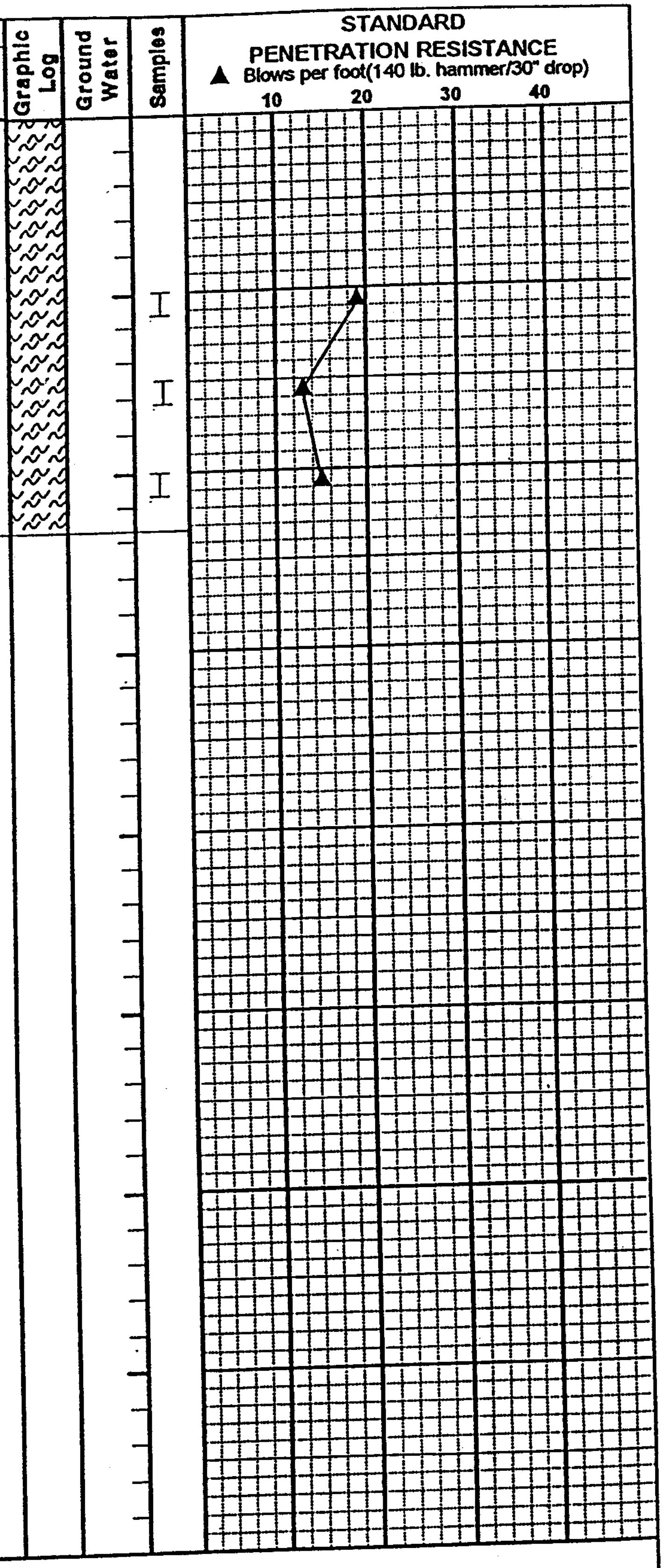
40

50

60

70

80



LEGEND

I	2.0" O.D. split spoon sampler
II	3.0" O.D. undisturbed sampler
☒	3.0" I.D. Universal sampler
☐	3.0" I.D. Ring sampler
G	Grab sample interval
L(C)	Laboratory/chemical analysis
P	Sampler pushed
●	% moisture content
*	Sample not recovered
▽	Water level fluctuation
▽	Static water level
ǀ	Piezometer tip

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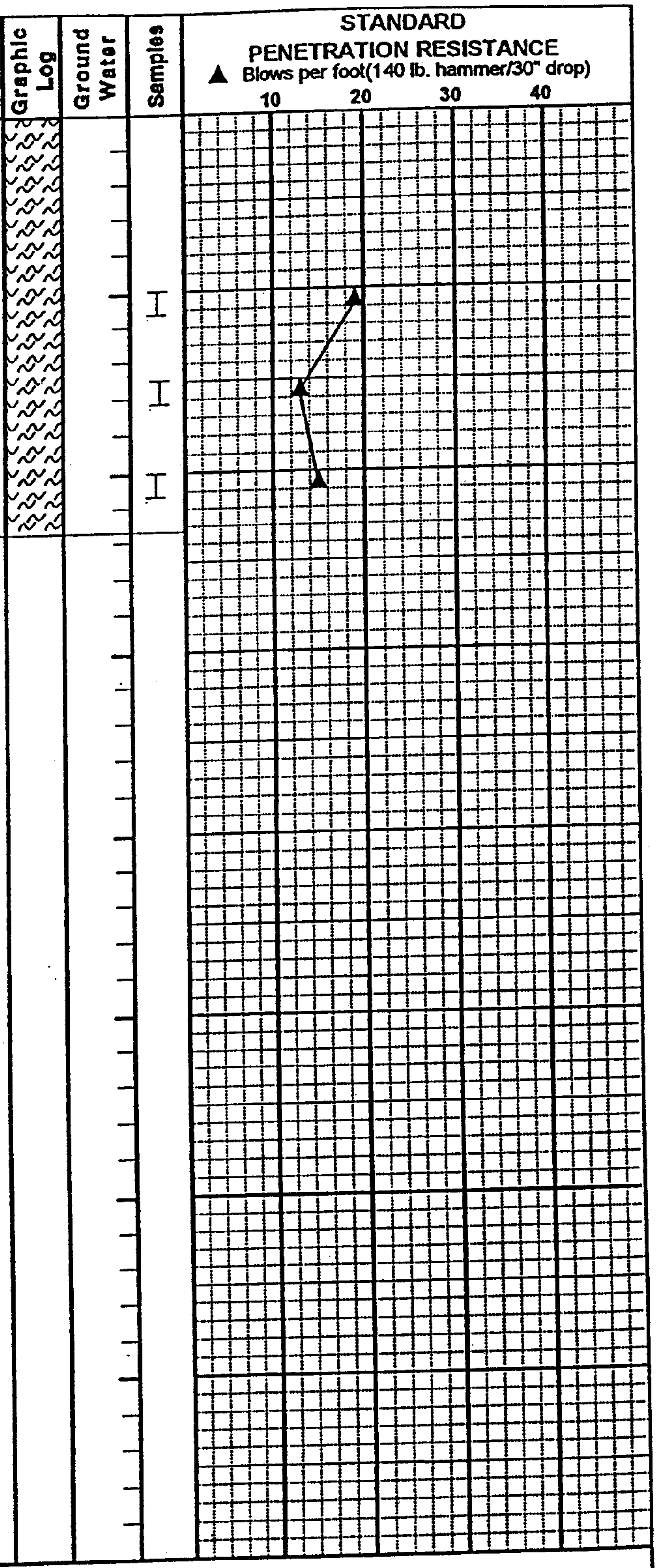
BORING NO. B-7

Solid stem auger with SPT

DEPTH (FEET)	SOIL DESCRIPTION
	Damp to moist, light brown to brown, very stiff to stiff, clayey silt.
10	
20	Weathered bedrock at 23 feet. Auger refusal at 23' - 8". Attempted SPT - refusal, no recovery.
	TERMINATED BORING AT 23.6 FEET.
30	
40	
50	
60	
70	
80	



LEGEND

I	2.0" O.D. split spoon sampler
II	3.0" O.D. undisturbed sampler
☒	3.0" I.D. Universal sampler
▢	3.0" I.D. Ring sampler
G	Grab sample interval
L(C)	Laboratory/chemical analysis
P	Sampler pushed
●	% moisture content
*	Sample not recovered
▽	Water level fluctuation
▽	Static water level
|	Piezometer tip

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PLATE 1

21-07279-00

MACLEAN SUBDIVISION
PORTLAND, OREGON

Base map provided by Otak Incorporated Architects,

Boring locations shown are approximate