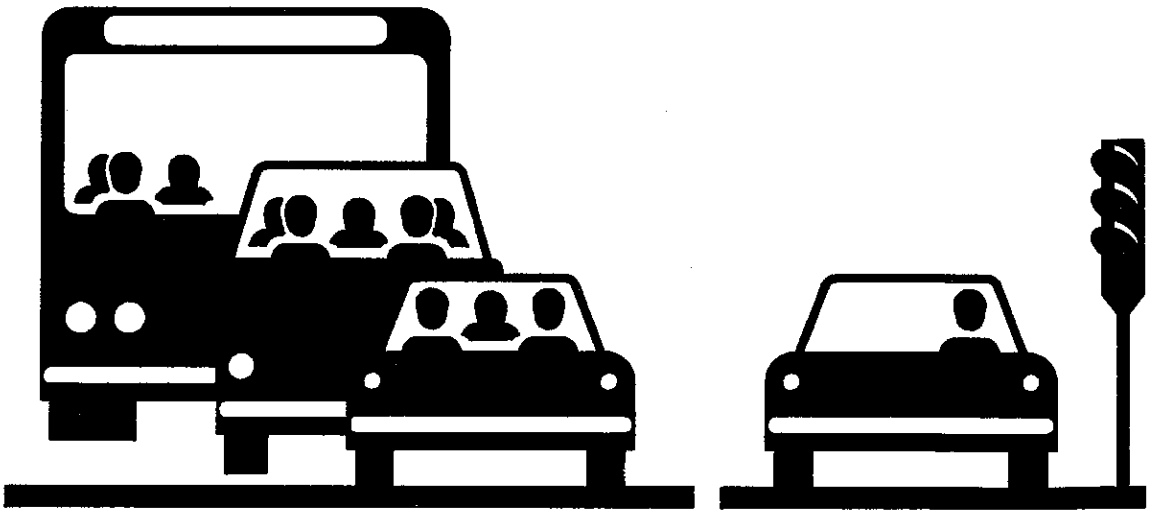
SR-167

15TH STREET S.W. TO SOUTH GRADY WAY

Soils Report



- HOV Improvements
- Ramp Metering
- Surveillance, Control, and Driver Information

Washington State Department of Transportation

HONG WEST & ASSOCIATES
geotechnical consultants

HONG WEST & ASSOCIATES

• Geotechnical Engineering • Hydrogeology • Materials Testing • Construction Inspection •

HWA File No. 91101
March 18, 1992

Alpha Engineering Group, Incorporated
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Attention: Mr. Thomas E. Murawski, P.E.
Project Manager

Subject: GEOTECHNICAL INVESTIGATION
State Route 167
15th Street SW to South Grady Way
South King County, Washington

Dear Mr. Murawski:

We are pleased to present the following *Geotechnical Investigation* which has been prepared for the 12.5 mile portion of SR-167 included in this study. Although highly variable conditions were encountered in the investigation, soil materials consisting of embankment fill overlying sand, silt and some organic alluvium and lake bed deposits were typical.

The primary geotechnical constraints to the planned highway and ramp improvements are soft, compressible organic silt and peat deposits encountered in certain locations. In addition, construction of retaining walls will be necessary in areas where the proposed improvements are adjacent to right-of-way boundaries, wetlands areas, and existing structures.

The results of our investigation, with pertinent recommendations for site development, are presented in the report which follows. Included in the report are the following:

- details of the pavement survey, subsurface investigation and laboratory testing performed,
- plan and profile figures showing subsurface conditions along the SR-167 alignment, and at various ramp locations,
- recommendations for site preparation and earthwork,

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- pavement design recommendations,
- settlement and slope stability considerations,
- evaluation of various retaining wall types for use at specific locations as currently planned, and
- other geotechnical considerations as considered appropriate.

The opportunity of providing geotechnical engineering services on this significant project is appreciated. Should you have any questions or require additional information, please advise.

Sincerely,

HONG WEST & ASSOCIATES

William J. Neely, P.E.
Chief Geotechnical Engineer

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Senior Geotechnical Engineer

ST:SLH:WJN(sr-167f1.doc)

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GEOTECHNICAL INVESTIGATION
STATE ROUTE 167
15TH STREET SW TO SOUTH GRADY WAY
SOUTH KING COUNTY, WASHINGTON

March 18, 1992
HWA Project Number 91101

Prepared For:

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

c/o ALPHA ENGINEERING GROUP, INCORPORATED
16040 Christensen Road, Suite 305
Seattle, Washington 98188-2929

Attention: Mr.. Thomas E. Murawski, P.E.
Project Manager

1.0 INTRODUCTION

final design

In accordance with your request, Hong West & Associates (HWA) has completed a geotechnical investigation for the subject portion of State Route 167. The purpose of the investigation was to evaluate surface and subsurface conditions at the site and, based on the conditions encountered, to provide recommendations pertaining to geotechnical aspects of the proposed highway improvements.

1.1 PROJECT DESCRIPTION

The project alignment consists of a 12.5 mile segment of State Route 167 (SR-167), from 15th Street SW in Auburn (Station LM 491+00) to South Grady Way in Renton (Station EE 1005+00), Washington, as shown on the Vicinity Map, Figure 1. Proposed improvements for this segment of SR-167 include constructing High Occupancy Vehicle (HOV) lanes in both the southbound and northbound directions. It is our understanding that current plans are to improve the existing median area as additional travel lanes, and to convert existing outside lanes to designated HOV lanes. In addition, on ramps and off ramps at various interchanges along the alignment will be widened, as part of this project.

It should be noted that northbound HOV lanes between South 180th Street and the SR-405 Interchange in Renton have recently been completed, and are therefore not within the scope of this project. Southbound HOV lanes along this portion of the alignment are yet to be constructed, and are included in this geotechnical investigation.

Both cut and fill operations will be required at the various ramp locations. Proposed cut and fill slopes are planned at inclinations of 2:1 (horizontal:vertical) or flatter. Retaining walls are to be constructed at locations where right-of-way is limited, or embankment construction would encroach into wetlands or other sensitive areas.

1.2 AUTHORIZATION

A proposal for performance of this geotechnical investigation was submitted by HWA on May 15, 1991. Authorization to proceed was received in a subcontract agreement signed by Mr. Prakash V. Limaye, President of Alpha Engineering Group, Incorporated, dated September 9, 1991.

1.3 SCOPE OF WORK

As outlined in the proposal dated May 15, 1991, the scope of this geotechnical investigation includes the following:

a. gather and examine readily available geotechnical and geological information for the project alignment;

b. plan and conduct on-site investigations to provide additional geotechnical information, including site reconnaissance, coring of the existing pavements, exploratory borings in the median area, and borings or backhoe test pits at locations set forth in a Washington State Department of Transportation (WSDOT) Intra-Department Communication dated February 28, 1991;

c. conduct necessary laboratory testing on selected soil samples to determine pertinent engineering properties; and

d. prepare this report summarizing conditions observed during the field investigation, laboratory test results, and results of our engineering analysis/evaluation. In addition, recommendations for site preparation and earthwork, retaining walls, and pavement design are presented.

Please note that the subsurface investigation and laboratory testing were performed to evaluate physical characteristics only; evaluation of potential environmental impacts of the proposed improvements, or the potential presence of hazardous materials, were not within the scope of this study.

2.0 BACKGROUND

State Route 167 was previously identified as Primary State Highway (PSH) 5. Upgrading PSH-5 to its present traffic capacity, and the proposed improvements which are the subject of this report, are part of an overall plan to service the anticipated future development of the valley south of Renton. Following completion of a final design report in 1968, construction of what is now the Valley Freeway, or SR-167, took place under several different contracts until completion in 1987. In 1989, construction of the northbound HOV lanes between South 180th Street and SR-405 was completed under Contract No. 3390.

Since initial construction, the freeway alignment has been resurfaced under 10 or more different contracts to bring the pavement to its current thickness and condition. The existing data from the Washington State Pavement Management System suggest that the current design pavement thicknesses and sections are as shown in Figures 2 and 3.

Construction of the freeway included embankment fills varying from roughly 3 to 35 feet in height. Much of the alignment was constructed over soft subsoil and high groundwater conditions. Fill was placed to preload and/or surcharge the foundation soils prior to construction of the highway embankments. Approaches to bridge foundations were overexcavated and backfilled with gravel borrow to reduce the potential for differential settlement at bridge abutments.

3.0 PROJECT SITE CONDITIONS

3.1 SURFACE CONDITIONS

The project alignment is located within Green River Valley between Auburn and Renton, in southern King County, Washington (see Figure 1). The valley, which is approximately one mile wide and relatively flat, is flanked by hillsides on the east and west throughout the alignment.

Land use bordering the subject portion of SR-167 is primarily agricultural, with open pasture/farmland and a few single-family residences. Within the cities of Kent and Renton land use adjacent to SR-167 is primarily commercial/industrial, particularly along the western side of the highway.

Hydrophytic vegetation, standing water or other conditions indicative of shallow groundwater conditions were observed in several locations adjacent to the toe of the existing highway embankment. Standing water and/or streams crossing beneath the highway through culverts were observed in some of these areas.

4.0 EXPLORATION PROGRAM

4.1 PAVEMENT SURVEY

On September 19, 1991, HWA personnel conducted a reconnaissance of pavement conditions along the existing travel lanes and ramps included in the scope of this study. Results of the pavement survey, based on visual observations, are discussed below.

4.1.1 Travel Lanes

In general, the travel lane pavement appeared to be in moderate to good condition, with some evidence of normal wear and aging. Typically, the pavement showed some wheel rutting of varying extent; rutting at the outside lanes, both in the southbound and northbound directions, appeared to be more severe than the inside lanes. Longitudinal cracking was observed at various locations along the alignment, mostly at the locations where rutting was observed to be most severe.

Poor pavement conditions were observed at the following locations:

Stations LM 615+50 to LM 617+50 (Approx.)
Northbound Lanes

An overlay has been placed recently in this area, encompassing approximately 200 linear feet of the travel lanes. The location of the overlay coincides with a box culvert crossing beneath the roadway; it appears that the overlay may have been necessitated by settlement of the highway embankment.

Stations LM 688 to LM 693 (Approx.)
Southbound and Northbound Lanes

Travel lanes in this area appear to have been recently overlaid, again, possibly due to settlement of the highway embankment. A box culvert (Mill Creek) is located beneath the highway at approximately Station LM 691. On the southbound lanes, the overlaid section appears to be thicker due to a "dip" in the pavement at the location in line with the box culvert; on the northbound lanes, a transverse crack was observed, also in line with the culvert.

Stations LM 722 to LM 760 (Approx.)
Northbound, Outside Lane Only

Approximately 70 percent of this section, located between the South 277th Street Interchange and Green River, appears recently overlaid

and/or repaired. Although some repair work was also observed on the inside lane, most of the patching/repair work appears to be concentrated on the outside lane. In some areas, it appears that the pavement has been overlaid at least twice recently.

Stations LM 728 to LM 732 (Approx.)
Southbound Lanes

Some patching/overlay was observed along this section, primarily within the outside lane. Severe longitudinal alligator cracking was also observed in this area.

Stations LM 908 to LM 912 (Approx.)
Northbound Lanes

The pavement within the outside lane was observed to have zones of moderate to severe alligator cracking.

4.1.2 Ramps

The pavement conditions observed at different ramps varied widely; each ramp is described individually below:

SR-18 Interchange

NW Ramp - Based on field observations during the performance of our subsurface exploration program, the pavement on this ramp was overlaid in August and September of 1991.

ES Ramp - Some rutting within the wheel tracks was observed, however, no significant cracking was observed at the time of our visit. Overall, the pavement appears in good condition. Placement of an overlay is considered a viable means for upgrading the pavement on this ramp.

WN Ramp - From the ramp entrance to approximately Station WN 12, closely spaced alligator cracks were observed within the right wheel track. From approximately Station WN 12 to the bridge abutment, some longitudinal and alligator cracks were also observed. It is our opinion that, in areas where the pavement is severely cracked, removal and replacement will likely be necessary.

Differential settlement has occurred between the WN Ramp embankment and the bridge abutment at the overpass above SR-18. It appears that

some patching has been done to level the "bump". The observed conditions may be a result of settlement of foundation soils and/or lateral movement of the embankment.

EN Ramp - The pavement appears to have been recently overlaid. No rutting or cracking was observed in the pavement.

15th Street NW Interchange

AL2 Ramp - Extensive longitudinal cracks were observed along both wheel tracks; the leftmost of these extends almost the entire length of the ramp. Overall, the pavement is in good condition. Use of an overlay is considered a viable means for upgrading the existing pavement.

DR2 Ramp - Some minor cracks and rutting were observed, however, the pavement is in good condition overall.

South 277th Street Interchange

AL1 Ramp - The pavement appears recently overlaid. Some minor, longitudinal cracks at the left wheel track in southernmost part of the ramp, and some cracks at the right shoulder were observed. No rutting was observed. Overall the pavement appears in good condition.

DR1 Ramp - Longitudinal cracks were observed along the entire ramp, and some alligator cracks were observed toward the south side of the ramp. It is our opinion that use of an overlay will be a viable alternative, provided a levelling course and geosynthetic, such as Petrotac™ or equivalent, is used. Overall, the pavement appears to be in moderate to poor condition.

SR-516 Interchange

AL2 Ramp - No significant rutting or cracking was observed. The pavement appears in good condition.

DR2 Ramp - Longitudinal cracking was observed, extending nearly the entire length of the ramp. Some minor alligator cracks were also observed. Use of an overlay is anticipated to be feasible for this ramp.

84th Avenue South Interchange

AL3 Ramp - No significant rutting or cracking was observed. The pavement appears recently overlaid, in good condition.

DR1 Ramp - No significant rutting or cracking was observed; overall, the pavement appears in good condition.

South 212th Street Interchange

EW-S Ramp - No significant rutting or cracking was observed; overall, the pavement appears in good condition.

WE-N Ramp - As at the EW-S Ramp, no significant rutting or cracking was observed. Overall, the pavement appeared in good condition.

South 180th Street Interchange

AL2 Ramp - Observations indicate that the pavement at this ramp is in poor condition. Closely spaced alligator cracks were observed along the entire ramp. It is probable that use of an overlay is not a viable alternative; the existing pavement should probably be removed and new pavement constructed.

DL2 Ramp - Some rutting and longitudinal cracking were observed. Overall, the pavement appeared in moderately good condition and use of an overlay is considered a viable alternative for rehabilitation. Edges of the existing pavement appeared irregular and the asphalt concrete ravelling from the edge. Pavement edge support in this area should be improved.

DR2 Ramp - The pavement on this ramp appears to have been overlaid recently. No rutting or cracking was observed at the time of our visit.

SR-405 Interchange

AR2 Ramp - The pavement along this ramp has been recently overlaid with approximately 1.5 inch of asphalt concrete, and appeared in good condition.

BL2 Ramp - Along this ramp, the pavement appears recently overlaid and in good condition. A 6-inch diameter corrugated pipe exists at approximately Station BL2 78, transverse to the ramp at shallow depth. Settlement of the pipe backfill on the order of 3 inches was observed.

4.2 SUBSURFACE EXPLORATION PROGRAM

4.2.1 Hand-Excavated Borings

Borings were excavated using hand tools to investigate subsurface conditions in the median area, during the time period August 15 to 29, 1991. Logs of the hand-excavated borings, designated with the prefix "HB", are presented in Appendix A.

Both a post-hole digger and a portable split-spoon sampler were used in this phase of the investigation. Split spoon samples were obtained only in native soil deposits, since this equipment is not suitable for use in gravelly soil.

The portable split-spoon sampler was driven using a 40-pound hammer mounted on a lightweight frame. Soil samples were retrieved from borings by driving the split spoon with the hammer, dropped 24 inches each strike. The number of blows required to drive the sampler 12 inches was recorded. "Blowcounts" thus obtained are shown on the appropriate boring logs, and were used as an index of the soil density/consistency. It should be noted that this is a non-standard penetration test. The "blowcounts" obtained from the portable split-spoon sampler are not the same as blowcounts obtained using the Standard Penetration Test (SPT), as described below.

A Troxler nuclear moisture/density gauge (Model No. 3411B) was used to determine the in-place density and moisture content of fill material in the median area. The test results are shown on the respective hand boring logs.

4.2.2 Backhoe Test Pits

Backhoe test pits were excavated during August 28 to September 6, 1991, at accessible locations where ramp widening is proposed. Tire mounted backhoe equipment was used. Logs of the backhoe test pits, designated with the prefix "TP", are presented in Appendix B.

The backhoe test pit excavations were observed, and subsurface soil conditions examined and classified in the field by HWA personnel. Soil samples obtained from the test pits were sealed in air tight containers, and transported to the laboratory.

Relatively undisturbed soil samples of soft soils, when present, were retrieved using Shelby tubes. These samples were used to determine shear strength and compressibility of the in-place soils, as described below. As a supplement to the laboratory tests, a "torvane" was also used to determine the shear strength of the fine grained soils. The test results are shown on appropriate test pit logs.

4.2.3 Exploratory Borings

Five exploratory borings were drilled on September 10 and 11, 1991, using a truck-mounted rig equipped with 6-inch diameter continuous flight hollow stem augers. Logs of the borings, which ranged from approximately 40 to 50 feet deep, are presented in Appendix C.

Soil samples were taken at 2.5 and 5 foot intervals in the borings by driving a 2-inch outside diameter split spoon 18 inches into relatively undisturbed soils with a 140 pound hammer dropping 30 inches per stroke. The number of blows required to drive each 6- inch interval was recorded; number of blows for the last 12 inches of penetration constitute a Standard Penetration Test (SPT) "blowcount" or N-value, which is used as an indicator of soil density/consistency.

Where soft, fine grained soils were encountered, relatively undisturbed soil samples were obtained by pushing Shelby tubes into the strata. The Shelby tube samples were used in our laboratory testing program for determining engineering properties of in-place soils, as discussed below.

The samples obtained from the borings were logged, sealed in air tight containers and returned to HWA's laboratory for further analysis.

4.2.4 Pavement Coring

Pavement coring was performed in 5 locations, at selected intervals along the highway travel lanes. The purpose of the coring program was to obtain a general indication of existing pavement section thicknesses in comparison with design pavement sections as indicated in WSDOT records. Definitive verification of pavement section thicknesses over the entire alignment was beyond the scope of this study.

The design thicknesses of pavement sections along the highway alignment, based on the WSDOT records reviewed, are shown on Figures 2 and 3. Pavement section thicknesses measured at the locations cored are also shown on the figures. Results of the coring indicate that pavement sections are generally consistent with the WSDOT records, at the locations tested. Care should be exercised in extrapolation of the coring program test results; pavement section thicknesses may vary markedly over a relatively short distance.

4.3 LABORATORY TESTING

Laboratory testing was performed on selected soil samples, in accordance with ASTM or other generally-accepted standards. The testing program included moisture content, grain size analyses, Atterberg Limits, direct shear and consolidation tests. Laboratory test results, with the exception of moisture content tests, are presented in Appendix D,

and are summarized in Table D-1. The moisture content test results are plotted on the appropriate boring or test pit logs.

A limited program of pH and minimum resistivity testing was performed, to provide a preliminary evaluation of corrosion potential of on-site soils in contact with culverts or other metal improvements. Results of the pH and minimum resistivity testing are presented in *Corrosion Potential*, Section 6.8.

5.0 SUBSURFACE CONDITIONS

Subsurface conditions are discussed in Sections 5.1 and 5.2. General geology of the project area, and the predominant geologic units encountered, are discussed in Section 5.1. Subsurface conditions in the median area and at the various ramps included in this study are discussed in Sections 5.2.1 and 5.2.2, respectively. Descriptions provided are based on results of the subsurface exploration program, review of available boring logs from previous phases of highway improvement (see References), and available literature including geologic maps developed by Mullineaux (1965).

5.1 GENERAL GEOLOGIC CONDITIONS

Geologic units in the Green River Valley consist primarily of post-glacial sand and silt deposits. These alluvial sediments are a result of Holocene drainage of the flanking higher land, or were deposited during the seasonal flooding of Green, Cedar and White Rivers. Organic soils and peat deposits, which represent former bogs and lakes of the flat-bottomed river valley, are also found in isolated areas along the alignment.

5.1.1 Embankment Fill

Embankment fill placed during highway construction is the most recent soil unit. These materials were placed at various times during the previous phases of construction, and consist predominantly of silty sand, sand and gravel. Maximum thickness of fill is on the order of 30 feet, at several ramp locations.

5.1.2 Alluvium

The majority of the highway alignment is underlain by alluvial deposits. The alluvium consists primarily of sand, silt and clay deposited by Green River and White River, and contains isolated gravel and peat lenses. Thickness of the alluvium may range from 10 feet to more than 75 feet. The alluvial soils in the vicinity of the SR-167/SR-405 Interchange were deposited by Cedar River, and consist predominantly of sand and gravel interbedded with thin lenses of silt, clay, and peat.

5.1.3 Lacustrine Deposit/Peat

Lacustrine/peat deposits are mapped by Mullineaux, from the Kent/Renton city limit north to approximately SW 19th Street. This unit "*contains minor amounts of silt and clay, chiefly as basal beds, and a thin, widespread layer of volcanic ash.*" Thickness of the lacustrine deposits is highly variable, and may range from 3 to perhaps 20 feet or more.

5.2 SOIL STRATIGRAPHY/DISTRIBUTION

Subsurface conditions at various locations along the project alignment are discussed in general terms in the report sections which follow. Generalized subsurface profiles along the SR-167 alignment are presented on Figures 4 through 49, attached. Subsurface conditions in the ramp areas are shown on Cross Section A-A' through S-S', Figures 50 through 65. Please note that borings or test pits performed at a particular ramp location may or may not be shown on the individual cross sections, depending on the distance of the exploration from the cross section location. For more detailed soil and geologic information, refer to the individual boring and test pit logs in Appendices A through C. Symbols used on the profiles and cross sections are consistent those on the boring and test pit logs (see *Legend of Symbols Appearing on the Soil Logs,* Appendix A).

5.2.1 Highway Median Area

The median area is typically underlain by embankment fill materials, with maximum thickness on the order of 30 feet at some interchanges. Away from the interchanges, fill thickness varies from 2 to 15 feet, but is generally on the order of 5 feet. Based on the hand borings in the median area, the fill material consists primarily of medium dense to dense, silty or gravelly sand and sandy gravel. In some areas, sand and silt fill were also encountered. Fill soils were not encountered between Stations L 965 to L 995, and Stations L 1048 to L 1068.

The highway segments from Stations L 965 to L 995 and Stations L 1048 to L 1068 were constructed by cutting into previously existing hill slopes. It appears that little or no fill exists within these areas. Based on the borings conducted in this area prior to the construction of the highway, the soil conditions in these sections were primarily silty, clayey, gravelly sand. Often, these soils were classified as till.

Below the embankment fill, where present, materials encountered in the hand borings consisted primarily of loose to medium dense, sandy silt and silty sand with gravel and silt/clay, and a few interbeds of soft silt and peat.

In the area south of Station L 724 and north of Station L 998, except in the cut area, the extent of soft, compressible materials appeared more significant than between

Stations L 724 and L 998. In the area south of Station L 724, the soft material was generally on the order of 2 to 5 feet, and locally might be as thick as 10 feet. North of Station L 998, a relatively extensive deposit of "fibrous peat" was encountered; thickness of the peat is likely on the order of 5 to 10 feet.

Groundwater was encountered at relatively shallow depths along the alignment. For more specific data on groundwater levels, refer to the boring and test pit logs, as well as the profile and cross section drawings.

5.2.2 Ramps

Subsurface conditions encountered during the field exploration, or interpreted from available information and previous geotechnical studies, are described below. Conditions at each ramp location are discussed separately.

SR-18 Interchange

NW Ramp - Three test pits (TP-14, 15, 16) were conducted in the NW ramp approach area, in the vicinity of the West Main Street overpass. Approximately 6 to 7 feet of fill overlying alluvial sand were encountered in the test pits. The fill material was predominantly loose to dense sand, gravel and silty sand. Organic sandy silt was encountered in TP-14.

Soft, dark brown, organic, sandy silt and sod was observed between the embankment fill and underlying alluvium. This material is probably old topsoil which blanketed the area prior to placement of the existing fill. Thickness of the old topsoil appeared on the order of 12 inches.

The lowermost soil unit encountered in TP-15 and TP-16 was a medium dense, gray to dark gray, silty, fine to medium sand, interpreted as an alluvial deposit. Test pit TP-14 did not penetrate through the fill material.

Groundwater seepage was observed in test pit TP-16, just below the old topsoil at a depth of approximately 6 feet. No seepage was encountered in the other two test pits.

ES Ramp - Subsurface conditions at this ramp are shown on Cross Section A-A', Figure 50. Two test pits (TP-17, 18) and two borings (BH-2, 3) were excavated within this ramp area. Embankment fill was encountered to a depth of approximately 25 feet and 20 feet, respectively, in borings BH-2 and BH-3. The test pits did not extend through the embankment fill, therefore the fill thickness at the test pit

locations is not known. The fill materials were primarily silty sand with some gravel, and possibly cobbles. Some organic debris was also observed.

Below the embankment fill, a unit of loose to very dense, dark gray, silty sand with silt laminae was encountered. Some organic debris and sawdust were encountered in boring BH-2 at a depth of approximately 40 feet.

Groundwater was encountered at 13 and 15 feet below ground surface in borings BH-2 and BH-3, respectively.

EN Ramp - Subsurface conditions in the area of this ramp are shown on Cross Section B-B', Figure 51. An exploratory boring (BH-1) was conducted from the top of this ramp embankment, at approximately Station EN 31+50. The embankment fill at this location, approximately 22 feet thick, consisted primarily of dense, brown and gray, silty/clayey sand, gravel, and possibly cobbles. Below the embankment fill was a layer of medium stiff, dark brown, fibrous peat, on the order of 5 feet thick.

Based on the results of probing conducted by WSDOT (Project No. L-3598, 1971) along the EN ramp, thickness of soft peat/organic silt in the area near the toe of the embankment is on the order of 5 feet from Station EN 20 to EN 30, and 1 to 3 feet north of Station EN 30.

Beneath the peat, a unit of dense to very dense, gray, interbedded, silty, fine to medium sand and silty, fine to coarse sand with gravel was encountered.

Groundwater was encountered at a depth of approximately 25 feet in the boring, which was near the bottom of the peat layer.

WN Ramp - Two test pits (TP-19, 20) were excavated at the toe of the ramp. Approximately 2 to 4 feet of medium dense, silty sand and gravel and silty sand fill were encountered at the surface. Below the fill was a layer of old topsoil approximately 1.5 feet thick (see Figure 52).

Beneath the old topsoil was a 2 to 3 foot thick layer of gray, loose silty sand (in TP-19) and soft, gray, plastic silt (in TP-20) over a 3 foot layer of soft, dark brown peat. Below the peat was a unit of loose to medium dense, gray, fine to medium sand with some silt. Some organic fragments were also found in the sand layers.

Probing conducted by WSDOT (Project No. L-3598, 1971) showed that the soft material was on the order of 5 feet thick in this area. This is consistent with the soil conditions observed in TP-19 and TP-20.

Groundwater was encountered just below the peat layer, which was at a depth of 10.5 and 8.5 feet, respectively, in test pits TP-19 and TP-20.

15th Street NW Interchange

AL2 Ramp - Two test pits (TP-12, 13) were conducted at this location. Approximately 5.5 and 3.5 feet of embankment fill material were found in TP-12 and TP-13, respectively (see Cross Section E-E', Figure 53). The fill material varied from loose to medium dense, brown, silty sand to dense, gray, sand and gravel with some cobbles.

Soft to medium stiff, gray and brown, slightly plastic to non-plastic, silt and sandy silt was found below the fill. This was the lowermost layer encountered in TP-12; in TP-13, the soft silt layer was approximately 2.5 feet thick. Below the silt in TP-13, loose to medium dense, fine to medium sand with some silt was encountered.

Groundwater seepage was encountered in this unit at a depth of 6 feet. Sloughing of test pit walls occurred below the groundwater level.

DR2 Ramp - Two test pits (TP-21, 22) were excavated near the toe of the ramp embankment (see Cross Section F-F', Figure 54). The uppermost 2 feet in TP-21 was a loose to medium dense, silty sand fill; in TP-22, the top 1.5 feet was a unit of soft, brown, sandy silt with some organic matter which was interpreted as topsoil.

Below the topsoil and fill was a 2.5 foot layer of soft, gray, fine sandy silt and silty sand with traces to some organic matter.

The lowermost unit encountered in both test pits was a unit of loose to medium dense, dark gray, fine to medium sand with some silt. Groundwater was found within this dark gray sand layer at depths of approximately 6.5 and 4 feet, respectively, in TP-21 and TP-22.

South 277th Street Interchange

AL1 Ramp - A single test pit (TP-11) was conducted at this ramp. Subsurface conditions extrapolated from the test pit are shown on Cross Section G-G', Figure 55. Approximately 13 feet of embankment fill were encountered, consisting of loose to medium dense, brown, gravelly

sand in the upper 5 feet; and graded to a medium dense, gray, sandy gravel with some silt, and layers of gravelly sand below 5 feet.

Below the embankment fill was a 12 inch thick layer of medium dense, fine sandy silt, with some organic debris. This layer was interpreted as old topsoil.

The lowermost unit encountered was a medium dense, gray silt with some fine sand and some medium sand laminae.

DR1 Ramp - Three test pits (TP-23, 24, 25) were excavated near the toe of the embankment. Subsurface conditions encountered in the area of the DR1 ramp are shown on Cross Sections H-H' and I-I', Figure 56. A 2 foot layer of topsoil was encountered near the surface in TP-23. In TP-24 and TP-25, fill material on the order of 1 to 4 feet thick was found. Consistency of the fill ranged from loose, brown, silty sand and gravel in TP-24 to dense, brown and gray, sand and gravel in TP-25.

Below the fill and topsoil was a layer of soft to medium stiff, gray, slightly plastic silt with traces of organic matter, and interbeds of gray and dark gray sand. This unit ranged from 2.5 feet thick in TP-24 to 5 feet in TP-23.

The lowermost unit encountered in the test pits was a medium dense, dark gray, silty, fine to medium sand.

Groundwater was encountered in TP-24 and TP-25 at a depth of 8 feet.

SR-516 Interchange

AL2 Ramp - Two test pits (TP-8, 9) were excavated near the toe of the ramp. A layer of loose to medium dense, brown and gray, sand and gravel fill was found in TP-8 and TP-9, to depths of approximately 2.5 and 1 foot, respectively (see Cross Section J-J', Figure 57).

The fill was observed to be underlain by a medium dense, brown and gray, fine sandy silt, approximately 5.5 feet thick in TP-8, and 8 feet thick in TP-9.

In TP-8, below the brown and gray sandy silt, a 6 foot layer of medium dense, gray, fine sand with silt was encountered. This unit was not observed in TP-9.

The lowermost unit found in both test pits was a medium stiff, gray silt and sandy silt.

Groundwater was not encountered during the test pit excavation.

DR2 Ramp - Three test pits (TP-26, 27, 28) were excavated near the toe of the embankment, and an exploratory boring (BH-4) was drilled from the top of the embankment. Cross Section K-K', Figure 58, depicts subsurface conditions encountered. Embankment fill was encountered in all test pits and borings; the thickness ranged from 1.5 feet in TP-27 to 7 feet in TP-26, and 28 feet in BH-4. The fill was brown and gray, sandy gravel and gravelly sand with traces of organic matter, and possibly some cobbles.

Below the fill, a layer of soft to stiff, gray and brown mottled, plastic silt with thin sand interbeds was encountered. The thickness of the silt layer was on the order on 11 feet in both BH-4 and TP-27, and approximately 3 to 4 feet in TP-28.

The lowermost unit encountered at this ramp was a medium dense to dense, dark gray, fine to medium sand with some silt.

Groundwater was encountered at a depth of 41 feet in BH-4, approximately 1 foot lower than the bottom of the silt layer. Although soils appeared wet, no groundwater was encountered in the test pits.

84th Avenue South Interchange

AL3 Ramp - Two test pits (TP-6, 7) and a boring (BH-5) were excavated near the toe of the ramp embankment. At the test pit and boring locations, the embankment fill ranged from 3 to 7 feet thick. The fill material was a loose, brown and gray, silty, sometimes gravelly sand with organic debris. Below the fill a layer of old topsoil was found in test pits TP-6 and TP-7, approximately 3 and 1 feet thick, respectively (see Cross Section L-L', Figure 59).

Below the fill and topsoil was a unit of loose to medium dense, dark gray, silty, fine to medium sand. The materials were observed to be dense below 35 feet in BH-5.

Groundwater was encountered at a relatively shallow depth; 6 feet below ground surface in TP-7, and 8 feet in both TP-6 and BH-5.

DR1 Ramp - Subsurface conditions in the area of ramp DR1 are shown on Cross Section M-M', Figure 60. One test pit (TP-29) was excavated near the toe of the embankment. It appeared that the area east of the toe was blanketed by approximately 1 foot of topsoil, consisting of brown, silty fine sand.

Below the topsoil, interbedded silty fine sand, silt, sandy silt, and peat were encountered. The silty sand and sandy silt were gray in color, wet, and loose to medium dense. The silt layer was the lowermost unit encountered; this material was observed to be soft, and plastic.

The peat layer, encountered between 6.5 and 12 feet below ground surface, appeared loose and saturated. Groundwater seepage was encountered in this layer at a depth of 6.5 feet.

Logs of exploratory borings performed by others (Shannon & Wilson, 1968; WSDOT Project No. L-6669, 1982) in the vicinity of DR1 ramp show similar soil conditions except that the peat layer was not encountered. Although the exact extent of the observed peat layer is not known, it appears that the deposit is relatively localized, based on the previous investigations. Additional subsurface exploration would be required to delineate the extent of the peat.

South 212th Street Interchange

No test pits or borings were excavated by HWA at this interchange. The subsurface soil conditions at the WE-N ramp, shown on Cross Sections N-N' and O-O', Figure 61, are based on seven borings (H-10 to H-16) conducted by WSDOT (Project No. L-6913, 1982). Cross Section P-P', Figure 62, shows subsurface conditions at the EW-S ramp, based on four borings (H-17 to H-20) conducted as part of the above-referenced study.

WE-N Ramp - Records of the three borings (H-10, 11, 12) conducted near the east end of the ramp loop indicate soil conditions of interbedded soft to medium stiff, sandy silt and clayey silt. Medium dense to dense, silty, sandy gravel was found at depths of 6 to 10 feet.

From the mid-section to the west end of loop, medium dense, brown silt to silty, sandy gravel, gravelly sand and cobbles was encountered in the borings.

EW-S Ramp - Records of the four borings conducted along the ramp show relatively uniform soil conditions. Near the south end of the ramp

(TP-17), the upper 12 feet of soil consisted of interbedded, saturated, loose, dark gray, silty, fine sand and sandy silt. Below 12 feet, the soil graded to a medium dense to dense, silty to slightly silty fine sand with traces of organic material.

The soil conditions observed in other borings were similar, with varying thicknesses of silt interbeds.

South 180th Street Interchange

AL2 Ramp - Test pits TP-4 and TP-5 were conducted near the south end of the ramp, near the South 180th Street overpass. Soils in the test pits were primarily loose to dense, brown and gray, fine to medium sand with various amounts of silt (see Cross Section R-R', Figure 64). Groundwater seepage was encountered in the test pits at depths of approximately 3.5 feet and 5.5 feet, respectively. Sloughing occurred on the sides of test pit TP-4 while backfilling.

Embankment fill materials were not encountered in these test pits.

DL2 Ramp - Subsurface conditions described for this ramp are based on a single test pit (TP-3). Approximately 4 feet of very stiff, brownish gray, sandy silt were found in the test pit. Organic matter was observed throughout this soil unit, interpreted as fill material.

Underlying the fill material, a 3 foot thick layer of soft, dark brown, organic, plastic silt, interbedded with fine sand and blue, gray silt was encountered. Below the silt was an approximately 1.5 foot thick layer of medium stiff, brown to mottled, sandy silt, within which water seepage was observed. The lowermost soil type encountered was a unit of medium dense, gray, silty sand with a trace of shale.

DR2 Ramp - Borings or test pits were not conducted by HWA at this location. WSDOT performed a boring at the northwest corner of the South 180th Street/DR2 Ramp intersection in 1982 (Project No. L-7408) for a traffic signal project. The soil conditions were described as hard, mottled, slightly gravelly silt and silty, slightly gravelly fine to medium sand (see Cross Section Q-Q', Figure 63).

The soil conditions HWA observed at the site, on an exposed slope on the right side of the DR2 ramp and in the construction excavation near the Valley Medical Center, were consistent with the description of the boring log.

Field conditions observed and the boring log did not indicate the presence of groundwater.

SR-405 Interchange

BL2 Ramp - Subsurface exploration was not conducted by HWA at this location. The subsurface conditions described herein are based on six hand borings (HH-134 to HH-139) conducted by WSDOT in 1983 along the ramp (Project No. L-6166). These hand borings were conducted to depths of 3 to 8 feet.

The soil conditions described in these boring logs were predominantly medium dense, brown, silty, sandy, fine to coarse gravel and (imported) sandstone. This material was the lowermost unit encountered, classified as embankment fill.

AR2 Ramp - Two test pits (TP-1, TP-2) were excavated near the toe of the ramp. Approximately 4 feet of fill were found in both test pits. In TP-1, the fill material consisted of loose, brown to gray with reddish mottling, silty sand; in TP-2, the fill was an unit of very soft, brown to gray, clayey silt (see Cross Section S-S', Figure 65).

Below the fill, a 3 to 4 foot thick layer of very soft, plastic, blue/gray silt with some organic matter was encountered.

Beneath the plastic silt, a unit of loose, gray, fine to coarse sand was observed. Gravel content varied from a trace to gravelly. Groundwater was encountered within this unit, at depths of 8.5 and 7 feet, respectively, in TP-1 and TP-2.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations relative to the proposed improvements are presented below. The recommendations of this section are based on the subsurface conditions encountered during the field investigation, laboratory testing, and review of available geologic literature and previous geotechnical reports. Prior to final design and construction, additional studies may be necessary at specific locations, to verify the recommendations of this report and to provide more specific geotechnical design parameters. The locations where additional study is considered necessary are discussed below.

6.1 SITE PREPARATION AND REMEDIAL GRADING

It is recommended that all vegetation, roots, and any softened material be removed within the footprint of the proposed widening. Based on the surficial conditions observed during our field operation, it is our opinion that the required stripping within the median area is minimal, on the order of perhaps 6 inches in most areas.

6.2 EARTHWORK

6.2.1 Subgrade Preparation

Site preparation should begin with removal of structures, asphalt, concrete, deleterious matter and vegetation. All debris and organic material should be exported off-site. Concrete and asphalt fragments less than 18 inches in maximum dimension may be placed in deeper portions of the embankment fill. Sufficient soil should be provided around the individual fragments so that nesting and void formation do not result.

Loose surficial materials such as topsoil, slopewash and undocumented fill should be removed completely to firm natural material and replaced with properly-compacted fill. Where fill is to be placed adjacent to existing roadway embankments, this should be performed in accordance with Section 2-03.3(14) of the WSDOT Standard Specifications. Depth and width of individual benches should be such that the new compacted fill is founded on relatively dense, undisturbed embankment fill.

Soft or loose materials, or materials disturbed during the excavation process, should be removed to appropriate bearing materials prior to placing compacted fill. Such areas should be dealt with as discussed in Section 2-03.3(14) of the WSDOT Standard Specifications.

A working surface should be constructed if the subgrade is found to be unstable and will not support construction traffic. Initially, the unstable subgrade should be overexcavated 12 inches and covered with a layer of geotextile. The geotextile used should be nonwoven, using materials and placement methods consistent with the WSDOT's General Special Provision for Construction Geotextile. Placement of the geotextile and construction of the working surface should be observed by the geotechnical consultant.

6.2.2 Materials

Material used as roadway fill should consist of granular soils. Such fill materials should be less than 1-1/4 inches in maximum dimension, with less than 7 percent passing the U.S. Standard No. 200 sieve (WSDOT 9-03.14). As allowed in the Standard Specifications, the maximum sieve size may be increased if it is

determined that larger size aggregate will be satisfactory for the specified embankment construction.

Subsequent to fill placement as required to achieve grade, and subgrade preparation as recommended above, base course materials should be placed, conforming to WSDOT requirements for 1-1/4 or 5/8 inch crushed surfacing top course (CSTC, WSDOT 9-03.9(3)). Asphalt treated base (ATB) and Class B asphaltic concrete paving (ACP) should then be placed, in conformance with WSDOT specifications WSDOT 9-03.6(2) and 9-03.8(6), respectively, as recommended in Section 6.3.

6.2.3 Compaction Criteria

Roadway fill soils should be compacted in accordance with WSDOT Standard Specifications, Section 2-03.3(14)C, Method B. Under this specification for compacting earth embankments, minimum relative compaction of 95 percent, and maximum loose lift thickness of 4 inches, are recommended for the upper 2 feet of fill. Fill placed below the top 2 feet shall be compacted to 90 percent relative compaction, and loose lift thicknesses shall not exceed 8 inches in depth.

Relative compaction should be determined based on maximum dry density, using WSDOT Test Method No. 609. The 95 percent relative compaction criterion also applies to base and surfacing materials, and retaining wall backfill.

The procedure to achieve proper density of a compacted fill depends on the size and type of compacting equipment, the number of passes, thickness of the layer being compacted, and certain soil properties. When size of the excavation restricts the use of heavy equipment, smaller equipment can be used, but the soil must be placed in thin enough layers to achieve the required relative compaction.

Generally, loosely compacted soils are a result of poor construction technique or improper moisture content. Soils with a high percentage of silt or clay are particularly susceptible to becoming too wet, and coarse-grained materials easily become too dry, for proper compaction. Silty or clayey soils with a moisture content too high for adequate compaction should be dried as necessary, or moisture conditioned by mixing with drier materials, or other methods. Sprinkling is sometimes required to wet a coarse-grained soil to near optimum moisture content before compaction.

If possible, preparation of areas to receive fill, fill placement, and pavement subgrade preparation should be performed during dry weather conditions. Compaction should take place immediately after subgrade preparation, and the newly prepared areas should be protected against soil saturation from precipitation. If protective measures are not provided, and the subgrade soils become saturated and spongy due to rain and/or construction traffic, the required compaction may not be achieved. In such an

event, soft soils should be removed from the area. Imported sand and gravel, with less than 3 percent passing the U.S. Standard No. 200 sieve, should be placed to bring the affected area to proposed grade.

6.2.4 Trench Backfill

Utility trench (including culvert) backfill soils should meet the materials specifications, and be compacted in accordance with the relative density criteria presented above. Bedding materials and thicknesses provided should be suitable for the utility system and materials installed, and in accordance with any applicable manufacturers' recommendations. Mechanical compaction is recommended; ponding or jetting should be avoided, especially in areas supporting structural loads or beneath concrete slabs-on-grade, pavements, or other improvements.

6.3 PAVEMENT DESIGN RECOMMENDATIONS

6.3.1 New HOV Lanes

The proposed improvements include construction of new travel lanes within the existing highway median, and converting the existing outside lanes to HOV lanes. Pavement design recommendations for the new travel lanes are presented below. For a discussion of settlement potential of embankment fill placed within the highway median, refer to Section 6.4.3.

For design purposes, 1990 traffic information supplied by Alpha Engineering Group, Incorporated, was utilized. The information included Average Daily Traffic (ADT) counts and percentage of truck traffic. From this we assumed a truck mix of axle-types typical to interstate traffic as described by the Asphalt Institute MS-1 manual. We assumed a 4 percent compounded annual growth rate, and a 10 year design period. We applied Equivalent Wheel Load Factors (EWLF) used by WSDOT for the estimation of the Traffic Index (TI) and 0.25 EAL per axle (Equivalent 18-kip Axle Load) for estimation of the Design EAL for the pavement.

Utilizing these parameters we compared the WSDOT design manual methodology and the current AASHTO design guide to arrive at the following recommended pavement sections for the new travel lanes:

Table 1. Recommended Pavement Section
New Travel Lanes in Existing Median

Materials	Thickness (feet)	WSDOT Specifications
Class B, ACP	0.35	WSDOT 9-03.8
ATB	0.55	WSDOT 9-03.6
CSTC	0.40	WSDOT 9-03.9(3)
Gravel Borrow	As Required; 3' Minimum Assumed	WSDOT 9-03.14
Class B*, ACP overlay	0.12 to 0.25 (future)	WSDOT 9-03.8

* Because of high truck volumes along this route, a Class A overlay is recommended in truck lanes, to combat rutting.

It should be noted that the pavement sections recommended herein are based on the assumption that at least 3 feet of granular compacted fill exists or will be placed beneath pavement section materials as part of the planned embankment construction. Based on a review of project plans, it appears that in general, the fill for the new travel lanes and ramp widening areas will be sufficient to provide the 3 feet of granular compacted fill. Revisions to the pavement section recommendations may be necessary, in areas where depth of granular compacted fill is less than 3 feet, to reflect the actual subgrade conditions.

6.3.2 Ramps

The ramp locations considered within this scope of work are listed in Table 2 below. Proposed ramp improvements consist of widening the existing embankments and pavement in order to accommodate the HOV lanes on the ramps. For the purposes of developing pavement section recommendations for the ramps, traffic information supplied by Alpha Engineering Group, Incorporated, and the assumptions described in the section above were utilized. Based upon these parameters we arrived at the estimated Design EAL and Traffic Index for each ramp as listed below.

Table 2. Traffic Information at Ramp Locations

Ramp	1990 ADT	Percent Trucks	T.I. (est.)	EAL x 10^6 (est.)
SR 18 NW	11,548	6	6.0	4.12
SR 18 ES	3,375	6	5.5	1.21
SR 18 WN	10,962	10	6.2	6.58
SR 18 EN	7,110	6	5.8	2.56
15th NW AL2	5,084	8.5	5.8	2.59
15th NW DR2	6,705	7.7	5.9	3.08
S 277th AL1	3,120	6.7	5.5	1.25
S 277th DR1	5,845	5.4	5.7	1.93
SR 516 AL2	10,990	6.9	6.0	4.61
SR 516 DR2	4,660	8.8	5.8	2.47
84th AL3	6,550	15.4	6.2	6.06
84th DR1	11,530	3.5	5.8	2.42
S 212th EW-S	7,510	7.7	5.9	3.45
S 212th WE-N	7,625	5.8	6.0	2.67
S 180th AL2	8,855	10.5	6.1	5.58
S 180th DL2	12,410	9.9	6.3	7.32
S 180th DR2	11,290	4.3	5.9	2.93
SR 405 AR2	15,580	7.6	6.2	7.17
SR 405 BL2	22,800	4.0	6.1	5.47

Embankment fill placed as part of the proposed improvements will result in consolidation of underlying compressible alluvium or lacustrine deposits. This consolidation and concomitant settlement at the ground surface is anticipated to be significant, particularly in cases where large amounts of fill are to be placed in areas underlain by soft silt and/or peat. The resulting settlement is anticipated to occur primarily beneath the portion of the ramp embankment which is widened, potentially resulting in differential settlement between the existing and new pavement sections.

By grading and placing the embankment fill well ahead of paving operations, the magnitude of post-construction settlement can be reduced. However, due to the

variable and uncertain subsoil conditions, some differential settlement may still occur after paving. Therefore, it is suggested that the design section for the ramps include a subsequent overlay after differential settlement has occurred.

Assuming an R-value of 60 for the compacted embankment fill, and utilizing the WSDOT design guide, we arrived at the pavement section listed below. This section is at least as stringent as the recommended minimum in the WSDOT Design Manual.

Table 3. Recommended Pavement Section
Ramps on Granular Embankment Fill

Layer	Thickness (feet)	WSDOT Specifications
Class B, ACP	0.35	WSDOT 9-03.8
ATB or ACB	0.35	WSDOT9-03.6
CSTC	0.40	WSDOT 9-03.9(3)
Embankment Fill	as required; 3' Minimum Assumed	WSDOT 9-03.14
Class B, ACP overlay	0.15 (future)	WSDOT 9-03.8

The ramp near the South 180th Street overcrossing (AL2) was constructed over medium dense native sands. The existing pavement was observed to be severely deteriorated and is in need of replacement. We recommend the pavement section presented below for the ramps constructed over these native sands.

Table 4. Recommended Pavement Section
South 180th Street Interchange, AL2 Ramp

Layer	Thickness (feet)	WSDOT Specification
Class B, ACP	0.35	WSDOT 9-03.8
ATB or Class E, ACP	0.50	9-03.6 or 9-03.8
CSTC	0.40	WSDOT 9-03.9(3)
Gravel Base	0.60	WSDOT 9-03.10

6.3.3 Future Studies

The pavement recommendations presented herein are based on the assumptions stated, and are for the proposed improvements within the median area and selected ramps only. The scope of work for this project did not include non-destructive pavement evaluation of the ramps or main highway. Since WSDOT has adopted a mechanistic approach for the rehabilitation and design of pavement structures,

additional studies would be necessary to provide design parameters necessary for such an analysis.

During the subsurface investigation phase of the project we noted some of the surface conditions indicating pavement distress such as rutting, alligator or fatigue cracking, and longitudinal cracking. Our observations of such areas are noted below in Table 5.

Table 5. Summary of Observed Pavement Conditions at Ramps

Ramp	Rutting	Fatigue Cracking	Longitudinal Cracking	Comments
SR 18 NW				recently overlaid
SR 18 ES	some			good condition
SR 18 WN		severe	severe	repair needed*
SR 18 EN				recently overlaid
15th NW AL2			extensive	further evaluation*
15th NW DR2	minor	minor		further evaluation*
S 277th AL1		minor	minor	recently overlaid*
S 277th DR1		some	extensive	renovation needed*
SR 516 AL2				good condition
SR 516 DR2		minor	extensive	further evaluation*
84th AL3				recently overlaid
84th DR1				good condition
S 212th EW-S				good condition
S 212th WE-N				good condition
S 180th AL2		severe		replacement needed*
S 180th DL2	some		some	fair condition*
S 180th DR2				recently overlaid
SR 405 AR2				recently overlaid
SR 405 BL2				recently overlaid; localized repair needed

It is our opinion that removal and replacement of the existing pavement at some locations would be advisable. Other ramps may benefit from patching, use of an overlay, or sealing and an overlay. The actual design of the overlays would require additional coring and non-destructive testing of the pavement in the subject areas.

It is recommended that additional testing be conducted in the following areas to determine subgrade modulus values, thicknesses of the existing pavement, extent of fatigue cracking, and the recommended pavement rehabilitation. These areas are marked with an asterisk (*) in Table 5 above.

SR 18 Interchange, WN ramp
15th Street NW Interchange, AL2 and DR2 ramps
South 277th Street Interchange, AL1 and DR1 ramps
SR 516 Interchange, DR2 ramp
South 180th Street Interchange, AL2 and DL2 ramps

In addition, indications of pavement distress were observed along the main highway travel lanes at the following locations (refer to Section 4.1.1 for additional details):

Station LM 615+50 to LM 617+50 Northbound lanes
Station LM 688 to LM 693 Northbound and southbound lanes
Station LM 722 to LM 760 Northbound outside lane
Station LM 728 to LM 732 Southbound lanes
Station LM 908 to LM 912 Northbound outside lane

Additional investigation of these areas may also be advisable, to assist in determining appropriate rehabilitation measures.

6.4 EARTH EMBANKMENTS

Widening of earth embankments will require additional fill on the existing embankments, or cut into the adjacent slopes. In some areas, particularly where right-of-way is restrictive, retaining walls may be used. Sections 6.4.1 and 6.4.2 address the general geotechnical considerations of embankment widening at ramp locations where additional fill is required.

Additional discussion is presented for specific ramp areas. The discussions appear in various report sections below, depending on whether that particular ramp widening will involve embankment construction only, use of retaining walls, or cut slopes. For reference, a summary of the ramps included in this study, and the report section in which particular ramps are discussed, is presented in Table 6, below.

Table 6. Summary of Report Sections for Discussion of Embankment/Wall Considerations at Ramps

Interchange	Ramp	Report Section	Page Number
SR-18	ES	6.4.3	30
	WN	6.4.3	30
	NW	6.4.3	30
	EN	6.5.2	35
15th NW	AL2	6.4.3	31
	DR2	6.4.3	31
S. 277th	AL1	6.4.3	31
	DR1	6.5.2	35
SR-516	AL2	6.5.2	35
	DR2	6.5.2	36
84th Ave.	AL3	6.5.2	37
	DR1	6.5.2	38
S. 212th	EW-S	6.4.3	31
	WE-N	6.4.3	32
S. 180th	DR2	6.6	40
	AL2	6.6	40
	DL2	6.4.3	32
SR-405	AR2	6.5.2	39
	BL2	6.4.3	33

6.4.1 Settlement Considerations

Soft, compressible soil layers were encountered during the subsurface investigation, beneath most of the ramp locations. Such compressible soil layers beneath the existing embankments have been consolidated under the weight of the existing fill for years, and primary settlement is therefore essentially complete. The additional embankment fill will cause additional settlement, primarily at the outside edge of the ramps beneath the areas of additional fill. The resulting differential settlement between the existing embankment and new embankment addition could be detrimental, and may result in longitudinal cracking or other pavement distress, particularly near the edges of the widened portions of the embankments.

It is our understanding that preloading and surcharging of the foundation soils were applied during the initial construction of the highway, and during the construction of the northbound HOV lane between South 180th Street and SR-405. It is our opinion

that the preloading technique is a viable alternative for reducing differential settlement between the existing and new pavement sections. Where considered necessary, recommendations relative to preloading are presented below, for specific locations. Overexcavation and replacement may be a viable alternative for mitigating potential settlement at some locations. The specific locations are indicated in the following report section.

Consideration should be given to scheduling grading and paving operations such that there is time for a significant percentage of the primary settlement to occur prior to pavement construction. On the basis of our analyses and experience with similar soil types, a 2 to 4 month time period will typically be sufficient for this purpose. Where preloading is recommended, estimated time for essential completion of primary settlement is discussed below, for the specific locations. Monitoring of settlements should be performed at all locations where preloading is recommended, to establish a trend of settlement and to verify that sufficient settlement has occurred prior to paving.

should vs. must

6.4.2 Slope Stability Considerations

The proposed fill slopes constructed at inclinations of 2:1 (horizontal:vertical) or flatter are anticipated to have adequate factors of safety when considering overall (gross) stability. However, a potential exists for slope instability to occur along the contact between the existing and new embankment fill, particularly for relatively high slopes. To minimize the potential for slope instability, the new embankment addition should be keyed and benched into the existing embankment, as per WSDOT Standard Specifications Section 2-03.3(14).

6.4.3 Site Specific Considerations

Discussed below are considerations related to embankment construction, within the existing median area, and at the specific ramps designated. In addition to those discussed below, recommendations in Sections 6.4.1 and 6.4.2 also apply.

Existing Median Area

We understand that additional travel lanes will be constructed within the existing median, and the outside lanes converted to HOV lanes. Results of this investigation, coupled with previous geotechnical exploration, reveal that much of the alignment is underlain by soft organic silts and alluvial sands with some peat. This is particularly the case in the areas south of Station L 724, and north of Station L 998. These soils have experienced some consolidation due to the initial construction of the Valley Freeway; the roadway has been in existence sufficiently long that primary settlement due to the existing embankment load is complete. Areas within the median have not been subjected to the same long term

loading as have the areas underlying the existing roadway, and are likely to consolidate upon addition of fill. This may result in differential settlement between the new and the existing roadway. Some settlement of the existing roadway is also quite likely.

Excepting the bridge abutment approaches, the majority of the median consists of 5 to 10 feet of compacted fill overlying the soft silty soils. Because of the presence of existing embankment fill, removal and replacement of the underlying compressible soils is not considered feasible. The compacted material should be left in place, with the exception of subgrade preparation as recommended previously. However, if the differential settlement described in the previous paragraph occurs, some periodic maintenance of the pavement may be necessary.

It may be advisable to design the new travel lanes within the existing medians initially utilizing a shorter design life, and allowing for subsequent overlays after settlement due to the additional fill is essentially complete. Precise estimates of settlement magnitude and time for completion of the settlement are difficult to determine, particularly without additional geotechnical exploration and laboratory testing.

SR-18 Interchange

ES Ramp - The existing fill material is approximately 30 feet thick near the bridge abutment. We estimate that the additional fill material required for the proposed widening will be on the order of 5 feet in height (see Figure 50). It is our opinion that the potential settlement due to the additional fill material will not be significant.

WN Ramp - The existing ramp embankment is approximately 30 feet in height. However, the slope at the maximum embankment height is 3:1 or less. By steepening the new embankment to 2:1 inclination, the fill required is anticipated to be less than 5 feet in height (see Figure 52). It is our understanding that the underlying soft compressible soils have been removed, or were preloaded during the construction of the ramp. Therefore, it is our opinion that the potential settlement resulting from the additional fill will not be significant.

NW Ramp - The proposed expansion extends along both sides of the existing ramp, which will require placement of additional embankment fill on each side. Organic silt and peat were encountered within test pits excavated near the toe of the eastern embankment slope. However, the amount of additional fill will be minimal, probably on the order of 2

feet. Therefore, in our opinion, settlement due to placement of the additional fill will not be significant.

15th Street NW Interchange

AL2 Ramp - The existing embankment at this ramp location is up to approximately 20 feet in height, and at an inclination slightly flatter than 2:1 (horizontal:vertical). By steepening the new embankment addition to 2:1, it appears that less than 5 feet of additional fill would be required (see Figure 53). The load resulting from the additional fill is relatively small; consequently, preloading is not considered necessary.

DR2 Ramp - It appears that an additional 5 feet of fill material will be required in the vicinity of the 15th Street SW intersection, where the embankment is approximately 25 feet high and at 2:1 inclination (see Figure 54). The required amount of fill will be less toward the north approaching the northbound SR-167 travel lanes, as the height of the ramp becomes lower, and the slope less steep.

With an additional 5 feet of fill material, estimated primary settlement is on the order of 1 to 1.5 inches. Estimated time for essential completion of the primary settlement is approximately 5 to 6 weeks. It is probable that this magnitude of settlement would be tolerable, and preloading is not recommended at this location.

South 277th Street Interchange

AL1 Ramp - The proposed widening at this ramp location appears to be on the order of 10 feet. The slope of the existing ramp is at an inclination slightly less than 2:1 (horizontal:vertical). If the widening follows the same slope, a retaining structure may be required near the toe where Mill Creek is located. The need for such a wall might be eliminated by steepening the proposed slope to 2:1 (see Figure 55). It is probable that settlement resulting from the additional fill materials at this ramp location would be minimal.

South 212th Street Interchange

EW-S Ramp - Subsurface conditions in the area of this ramp are shown on Cross Section P-P', Figure 62. Additional fill material will be required along the west side of the ramp, to facilitate the planned approximately 10 feet of widening. The inclination of the slope face may remain the same as the existing embankment slope, or be steepened to 2:1 (horizontal:vertical).

A creek passes beneath the ramp at approximately Station EW-S 41+30, where a bridge is located. It is our understanding that the bridge deck will be widened as well. We anticipate that additional foundation elements will be required for the widened bridge deck at the creek crossing; pile foundations are likely to be necessary. Significant differential settlement between the bridge abutment and the new embankment addition may occur, unless preloading of the foundation soil is performed to reduce the potential for differential settlement, as discussed below.

Based on the available subsurface information, approximately 1 to 1.5 inches of primary settlement are estimated at the location of the bridge. Estimated time for essential completion of the primary settlement is 4 to 5 weeks. Preloading is recommended for the bridge approach fills. After placement of embankment fills, a period of approximately 4 weeks should be allowed prior to placement of pavement section materials.

WE-N Ramp - At this ramp, both cut and fill operations will be required to facilitate the proposed widening of approximately 10 feet (see Figure 61).

From Station WE-N 43+30 to 47+00, where cut operations are anticipated, we recommend that the proposed cut slope be designed no steeper than 2:1 (horizontal:vertical), which is slightly steeper than the existing slope.

From Station WE-N 40 to 43+30, additional fill will be required. By grading the new embankment at 2:1, we estimate that the additional fill required will be on the order of 5 feet thick. Based on available information from previous exploration, estimated primary settlement resulting from the additional fill is on the order of 1 to 1.5 inches. Estimated time for essential completion of the primary settlement is approximately 5 to 6 weeks. It is our opinion that this magnitude of settlement would be tolerable to the new pavement section; preloading is not considered necessary at this location.

South 180th Street Interchange

DL2 Ramp - This ramp is located in an area which is nearly level, and a limited amount of fill or cut will be required.

BL2 Ramp - Widening of the pavement will be toward the inside of loop, which is nearly level. Again, a limited amount of cut or fill is anticipated.

6.5 RETAINING WALLS

6.5.1 Selection of Retaining Wall Types

Retaining walls will be necessary at several locations along the widened ramp embankments. Various retaining wall systems are available, which may be suitable for use on the project. Selection of the retaining wall type for each location will depend on subsurface conditions, proximity of adjacent structures or other facilities, and anticipated settlement. Three different types of retaining walls are discussed herein; each have advantages and disadvantages for particular applications, which are also discussed. The types of retaining wall systems included in the discussion below are conventional concrete retaining walls, reinforced soil walls (Keystone or other proprietary systems), and soldier pile or other "specialty" walls.

The principal disadvantage of conventional concrete retaining walls is relatively low tolerance to differential settlement. For this project, without densification or a deep foundation system, concrete retaining walls would probably not be the best retaining wall type at most ramp locations. Concrete retaining walls may be feasible in areas of minor anticipated settlement, or if constructed on pile foundation systems.

A reinforced soil wall consists of facing elements, and alternating layers of backfill soil and reinforcing elements. Reinforcing elements that are commonly used include steel strips and various geosynthetic products such as geogrid sheets. The vertical spacing of the reinforcing elements is typically on the order of 1 to 3 feet, depending on the reinforcing material specified and other parameters. Design of such a wall system must be based on site-specific conditions and geotechnical parameters. Pre-cast concrete members (panels or blocks), such as Keystone or other proprietary systems, are widely used as facing elements. For walls over 10 feet in height, the reinforced soil wall is especially beneficial because of relatively low cost, and ability to tolerate relatively large differential settlements.

The base width of the reinforced soil mass behind a reinforced soil wall must be sufficient to accommodate the full length of the geogrid or other reinforcing material. This length is typically on the order of 70 to 80 percent of the wall height, again depending on site-specific conditions and the specific design used. At locations where right-of-way is limited, it may be necessary to overexcavate into the existing embankment slope to allow placement of the geogrid or other reinforcing material. If this is the case, temporary stability of the oversteepened embankment slope should be

evaluated. In extreme cases of right-of-way limitation, use of reinforced soil walls may be impractical. In such cases, a soldier pile or other "specialty" wall system may be the best choice.

Soldier pile or other "specialty" walls are typically high-cost, and hence would be recommended only where space restrictions or proximity to existing structures rendered use of other wall systems impractical or uneconomical. For a soldier pile wall more than 12 to 15 feet in height, it is probable that one or more levels of tiebacks may be necessary. In cases where the wall is to retain additional embankment fill, conventional drilled tiebacks may be difficult to construct. Instead, piles or deadman anchor blocks might be more practical. As with wall systems discussed previously, design of soldier pile or other "specialty" walls must be done on a site-specific basis, following design-level geotechnical studies.

6.5.2 Site Specific Retaining Wall Considerations

Following are brief descriptions relative to selection of retaining wall types at individual ramps for which retaining walls are planned, as indicated on available preliminary design plan drawings.

Site specific retaining wall recommendations are presented below. These recommendations are considered "conceptual", based on available information from previous subsurface investigations and other sources. Because additional geotechnical data may reveal subsurface conditions which vary from those assumed herein, site-specific investigations may result in the need to revise the recommendations presented below, or to re-evaluate the particular wall system suggested for use at a specific ramp location.

In addition to further characterization of subsurface conditions and determination of appropriate design parameters, PS&E-level geotechnical studies for the retaining walls should address such topics as overall (or "gross") stability of the retained earth, the potential impact of soft alluvial sediments on slope stability or retaining wall bearing capacity, and the potential effect of seismic loading or soil liquefaction on the walls.

Prior to construction of a concrete or reinforced soil retaining wall, soft surficial soils should be removed beneath the wall footing. If passive earth pressure is to be used in design, removals should be performed in front of the wall, a distance equal to 10 feet or the depth of overexcavation, whichever is greater. Materials removed should be replaced with granular embankment fill, in accordance with previous recommendations. Existing fill slopes behind the retaining walls should be "benched" prior to fill placement, per WSDOT Standard Specifications Section 2-03.3(14).

SR-18 Interchange

EN Ramp - A wall on the order of 5 feet in height, approximately from Station EN 29 to EN 30+50, may be required on the east side of this ramp to facilitate the proposed 15-foot wide extension. Based on the HWA borings and other geotechnical data reviewed, compressible/soft, organic soils as thick as 5 feet can be expected near the toe of the ramp (see Figure 51). Hydrophytic vegetation and other indications of "wetlands" conditions were observed in this location.

In our opinion, either a conventional concrete retaining wall or a reinforced soil wall may be the used in this location, provided that the surficial soft/compressible soil layers are removed, and replaced with borrow sand and gravel. This approach would have the additional benefit of minimizing the potential of differential settlement between the existing embankment and the new addition.

Groundwater could impose some difficulty during stripping of soft soil and compaction of borrow fill. Dewatering and/or subgrade stabilization using geotextile may be necessary to facilitate the removal; evaluation of such should be performed prior to construction.

South 277th Interchange

Wall 1

DR1 Ramp - A retaining wall is planned to be constructed, from approximately Station DR1 19+80 to Station LM 725, to accommodate embankment widening of up to 20 feet to the east (see Figure 56). We estimate that the wall will be on the order of 5 to 10 feet in height.

The two test pits (TP-24, TP-25) conducted in the vicinity of the proposed retaining wall location showed that the underlying soils are primarily medium stiff to stiff silt. Differential settlement of the foundation can be expected, and could result in cracking of a concrete retaining wall. Therefore, it is probable that use of a reinforced soil type retaining structure would be most advantageous at this location.

SR-516 Interchange

Wall 2

AL2 Ramp - A retaining wall is currently planned at this ramp between Station AL2 95+50 and Station LM 790+50. We anticipate the retaining wall to be on the order of 5 feet because of very mild topographic relief (see Figure 57).

A concrete cantilever retaining wall may be suitable at this location. However, the potential exists for differential settlement and cracking of such a wall. If a conventional concrete wall is utilized, consideration should be given to "segmenting" or providing joints at periodic locations along the length of the structure. A reinforced soil retaining wall may be more advantageous at this location, because of that system's greater tolerance of differential settlement.

Oversteepening of the existing embankment ramp may be required, particularly in the vicinity of Station AL2 92+50 to 93+50, to provide adequate space for construction of the wall. For preliminary planning purposes, temporary slopes should be assumed no steeper than 1.5:1 (horizontal:vertical). Constructing and maintaining safe temporary excavations is the responsibility of the contractor.

DR2 Ramp - The ramp ascends from SR-516 toward the north, and the embankment height increases to approximately 25 feet as it approaches the SR-167 northbound lanes. An embankment widening of approximately 25 feet toward the east will necessitate a retaining structure because of right-of-way constraints (see Figure 58).

Wall 3

We anticipate the wall height to be on the order of 10 to 15 feet, depending on the configuration of the backslope behind the retaining wall. A reinforced soil retaining structure is recommended for use at this location. Removal of the soft to medium stiff sandy silt and replacement with properly-compacted gravel fill, and construction of a conventional concrete retaining wall, might be considered as an alternative. A significant dewatering effort would probably be required to accomplish the necessary removal of unsuitable materials and replacement with compacted fill.

overexcavation as an option - doesn't state a depth estimate...

Where is the estimated GWT? Symbol on bori is below this level.

Estimated potential settlement at this ramp, given the retaining wall configuration shown on Figure 58, is on the order of 8 to 10 inches. Estimated time for essential completion of primary settlement is 5 to 6 weeks. It is considered probable that a properly-designed and constructed reinforced soil wall could tolerate this magnitude of settlement. To minimize differential settlement and resulting damage to the new pavement section, it is recommended that preloading be performed. Embankment fill placed behind the retaining wall should be allowed to settle for approximately 5 weeks prior to placement of pavement section materials. As at all locations where preloading is recommended, settlement monitoring should be performed to verify the trend of settlement and to determine that the desired percentage of primary settlement is complete prior to paving.

This is reduced fro the previous 12"

Preloading is recommended.

recommends settlement monitoring - no specific recommendations, however.

Preliminary slope stability analysis was performed, based on the wall geometry shown on Figure 58. The computer program PCSTABL5M, and shear strength parameters based on SPT N-values coupled with experience with similar soil and geologic conditions, were utilized in the analysis. For deep-seated circular surfaces, passing through the underlying soft to medium stiff sandy silt layer, factors of safety in excess of 1.5 were calculated. Based on these results, staged construction is not considered necessary for placement of embankment fill.

have them submit calculations
- was this a reinforced earth wall?
- was it an undrained unconsolidated analysis?
- where was the footing place & what size was it?

Design of a reinforced soil retaining wall should be performed after a site-specific geotechnical study, to provide data sufficient for design of the wall to accommodate the anticipated settlement. In addition, instrumentation may be necessary during and after construction to verify wall performance. Additional slope stability analyses should be performed in conjunction with PS&E for this retaining wall, based on the final wall height and location, which had not been determined precisely at the time of this study.

This should be accomplished at this time - in this report.
- what type of instrumentation?
- If the wall is not performing - what remedial options are available?
- Final wall design may be appropriate, however, further investigation should not be warranted - - -

84th Avenue South Interchange

AL3 Ramp - A retaining wall is planned at this ramp, from Station AL3 89+30 to LM 892+50, to facilitate approximately 25 feet of embankment widening to the west (see Figure 59). A retaining wall is not planned in the area north of Station AL3 89+30 due to availability of right-of-way and relatively low embankment height. An existing drainage ditch exists along the toe of slope, near the area of the proposed retaining wall.

It appears that a retaining wall as high as 25 feet may be needed at the maximum height of the existing embankment. We recommend that either a soldier pile or reinforced soil wall be used at this location, as discussed below.

If a reinforced soil wall is used, oversteepening of the existing embankment ramp may be required, particularly between Stations AL3 88+50 and L 886, to provide adequate space for construction of the wall. For preliminary planning purposes, temporary slopes should be assumed no steeper than 1.5:1 (horizontal:vertical). Construction and maintenance of safe temporary excavation slopes is the responsibility of the contractor. Alternatively, a temporary retaining structure may be installed to allow removal of embankment fill at the toe; however, this

would significantly reduce the economic advantage of selecting the reinforced soil wall.

For the reinforced soil wall alternative, the existence of the drainage ditch along the toe of the slope would be a consideration. The ditch would need to be realigned, and positive drainage maintained. Keystone or other types of facing units could be utilized as lining for one side of the ditch bank; the wall should be founded well below the bottom of the ditch and any anticipated scour zone. Overexcavation below the bottom of the existing ditch would likely be necessary, and dewatering may also be required. Other alternatives might include rerouting the drainage ditch well away from the retaining wall, if possible, or routing the ditch through a culvert in the area of the proposed retaining wall.

Should a soldier pile wall be selected for use in this location, the soldier piles would likely need to be installed by pre-drilling holes in the ground to facilitate placement of the piles. Because of shallow groundwater table and likelihood of caving in the holes, we anticipate that casing would be required. It is probable that, for wall sections 10 to 25 feet in height, one or more levels of tiebacks may be necessary.

Since the upper row of tiebacks would extend through the zone of planned additional fill, installation of conventional drilled tiebacks could be difficult. It is our view that use of deadman anchor blocks or drilled shaft anchors may be a more feasible alternative. The drilled shafts could be installed from the top of the existing ramp embankment, using the same drill rig used for installation of the soldier piles.

DR1 Ramp - It is our understanding that a retaining structure is planned at this ramp, from Station L 883+50 to DR1 89+50. Retaining wall design and construction at this location will be impacted by the presence of soft compressible soils, and the close proximity of existing structures to the east (see Figure 60). The limited subsurface data available indicate the presence of discontinuous layers of peat, very soft to soft silt, and silty sand.

Based on subsurface conditions observed in test pit TP-29, which showed peat deposits and soft silt, placement of additional fill for widening of the embankment could result in primary settlement on the order of 18 to 24 inches, both to the new embankment fill and the existing embankment. Estimated time for essential completion of primary settlement is 9 to 11 weeks. In addition, foundations of the existing buildings located east of the ramp may be distressed as a result of the ramp widening, unless precautionary measures are taken.

Foundation types of the existing buildings mentioned above should be identified prior to finalizing the design. If these buildings were constructed on deep foundations, the potential impact of constructing the new ramp addition and retaining structure would be reduced. Additional study will be required, to evaluate the potential impact of the proposed improvements on the existing structures, and to devise appropriate mitigation measures, if necessary. The extent of the peat deposit should also be determined through additional subsurface investigation.

The potential impact of settlement on the new pavement section could be mitigated through removal and replacement of the peat layer. This would require shoring to protect both the buildings and to prevent instability of the existing embankment, a relatively costly alternative. In the event that complete removal of compressible materials is not feasible, preloading should be performed prior to constructing the pavement. Estimated preloading time is approximately 9 weeks.

Because of the potential for large differential settlements, and the necessity of protecting the adjacent structures, it is probable that a soldier pile or sheet pile wall will be the most feasible alternative wall system at this location. One principal advantage of using a sheet pile wall is that it can isolate the effects of potential settlement of the ramp from the buildings. A soldier pile wall can accomplish the same objective with some overexcavation at the west side of the wall to allow placing lagging below the existing ground surface. However, dewatering would likely be required to accomplish this.

SR-405 Interchange

AR2 Ramp - A retaining wall is currently planned along the west side of the ramp, from approximately Station AR2 81+50 to AR2 84+80, to facilitate the proposed embankment widening of approximately 10 feet. Anticipated wall height is less than 10 feet (see Figure 65).

Based on the limited subsurface data available, a reinforced soil type retaining structure is recommended for this location. A layer of soft silt was found in test pits TP-1 and TP-2, however, over-excavation of this layer is probably not necessary. Assuming the silt layer is left in place, estimated settlement is on the order of 4 to 5 inches, which is considered tolerable for a reinforced soil retaining wall. Estimated time for essential completion of primary settlement is 2 to 3 weeks. This time period is relatively short compared to similar walls at other ramp locations, primarily because of the presence of thinly interbedded silts

and sands. A relatively short drainage path was assumed to model this condition. Preloading is recommended at this location prior to paving, for an estimated 2 weeks.

6.6 CUT SLOPES

Cut slopes of significant height are currently planned at two locations. Considerations relative to cut slope construction are addressed below.

180th Street Interchange

DR2 Ramp: It is our understanding that the subject ramp will be widened approximately 15 feet to the east, where there is an existing cut slope on the order of 5 to 10 feet in height, at approximate inclination of 2:1 (see Cross Section Q-Q', Figure 63). The proposed widening will require excavation into the existing cut slope, which appears to be in a stable configuration. No indications of instability or sloughing were observed at the time of our reconnaissance.

Cut slopes should be constructed at inclinations no steeper than 2:1 (horizontal:vertical). The soil conditions at the subject slope are highly susceptible to erosion. Some measures, such as covering the slope with visqueen and hydroseeding, should be taken to minimize the potential for surficial erosion, particularly during construction.

AL2 Ramp: Widening on the order of 40 feet along the west side of the ramp is planned. Excavation into an existing slope, which is approximately 15 feet high at approximately 2:1 (horizontal:vertical), will be required to facilitate the proposed widening (see Figure 64).

The South 180th Street overpass crosses over the AL2 ramp in the area of the proposed cut slope. The west bridge abutment is in close proximity to the edge of the roadway widening area, as currently proposed. This may impose adverse effects on the bridge abutment, depending on the type and depth of its foundation. To limit the potential for undermining the existing abutment foundation, it is likely that a soldier pile wall with one or more rows of tiebacks may be necessary. Design of the wall should be based on a site-specific geotechnical study. If the existing abutment is supported on a spread foundation, lateral earth pressure imposed on the wall by the abutment foundation should be included in wall design.

Sufficiently away from the bridge abutment, the existing slope may be open graded to no steeper than 2:1 (horizontal:vertical).

6.7 DRAINAGE

Adequate drainage provisions are imperative. Under no circumstances should water be allowed to pond adjacent to paved areas. The site should be graded and maintained such that surface drainage is directed away from the tops of slopes into swales or other controlled drainage devices. All pavement drainage should be directed into conduits which carry runoff into the storm drain system or other appropriate outlet.

Landscaping planters immediately adjacent to paved areas are not recommended due to the potential for surface or irrigation water to infiltrate the pavement's subgrade and base course. It is suggested that either subdrains, which collect excess irrigation water and transmit it to drainage structures, or impervious, above-grade planter boxes be used. In addition, where landscaping is planned adjacent to the pavement, it is recommended that consideration be given to providing a cutoff wall along the edge of the pavement that extends at least 6 inches below the subgrade soil.

Where embankments are to be widened, the existing discharge pipes connecting to the catch basins should also be extended outside the widened section. Without extending the existing discharge pipe, the base of the embankment can be saturated during the wet season, and may result in instability. We also recommend that rip-rap be placed at the discharge point to minimize the potential of erosion.

Where encountered at locations of culvert or drain pipe extension, soft, unsuitable soils should be removed and replaced with compacted, clean, borrow materials. If such excavations extend below the groundwater level, dewatering may be required. Design and implementation of any dewatering system should be performed by the contractor.

6.8 CORROSION POTENTIAL

A limited program of pH and resistivity testing was performed using ASTM Test Method G57-78, results of which are shown on Table 7, below. This information may be utilized as a preliminary indication of the corrosion potential of on-site soils in contact with culverts or other metal improvements associated with the roadway project.

Table 7. Results of pH and Resistivity Tests

Boring or Test Pit	Sample Depth (feet)	pH	Resistivity (ohm-cm)	Estimated Yrs. to Perforation, 18-gauge C.M.P.
TP-8	8.5	6	15,510	25
TP-13	8	6	5,780	19
TP-23	9	6	31,200	30
TP-28	4	6	5,320	19
BH-4	42.5	6	18,220	26

In general, pH and resistivity testing indicated a low to moderate potential for corrosion. Estimated years to perforation for 18-gauge metal culverts are shown on Figure 6. These estimates average 24 years in the range 19 to 30 years, and are based on the *California Method for Estimating Service Life of Metal Culverts* (1972), Test Method No. 643-6, California State Department of Transportation. With this method, estimated time to perforation can be determined for culverts having various wall thicknesses, by applying appropriate correction factors.

6.9 SOIL LIQUEFACTION POTENTIAL

Soil liquefaction is generally limited to granular soils located below the water table that are in a relatively loose, unconsolidated condition at the time of a large nearby earthquake. Although a detailed evaluation of soil liquefaction potential was not within the scope of this study, conditions considered susceptible to soil liquefaction were noted at several locations. Liquefaction within loose sand or silty sand deposits could result in bearing capacity failure and excessive movements of earth embankments and retaining walls.

The potential risk to the proposed improvements due to seismic loading or soil liquefaction should be evaluated prior to final design. If the potential risk is considered unacceptable, ground improvement techniques may be necessary to densify and/or provide sufficient soil drainage to reduce the risk to an acceptable level.

6.10 BRIDGE APPROACH EMBANKMENT CONSIDERATIONS

Subsurface evaluation and analysis of bridge foundations associated with the proposed highway improvements are being provided by others; these considerations are not addressed in detail herein. However, embankment construction may have a potential impact on existing and future bridge foundations, as discussed below.

Embankment fill placed in conjunction with the roadway widening is anticipated to induce settlement of the underlying alluvium and lacustrine deposits, as discussed previously. Depending on the magnitude of settlement and proximity of bridge foundation elements, such settlement could potentially induce downdrag loading on nearby pile foundations. In addition, if bridge wing walls or abutments are founded on conventional spread footings, embankment construction may induce settlement of such shallow foundations.

The potential impact of embankment loading on bridge foundations should be addressed and mitigation measures recommended where necessary. Scheduling of construction such that embankment placement occurs several months in advance of bridge foundation construction may be advisable. This would allow the majority of settlement to occur prior to pile driving, thus reducing or eliminating the applied downdrag load

for the newly-constructed foundations. Additional evaluation related to this issue should be performed in conjunction with bridge foundation design.

Based on our field observations, the existing bridges have not been provided with approach slabs. Consequently, construction of approach slabs for the areas of bridge widening would be incongruous, and is not recommended.

7.0 LIMITATIONS

This geotechnical investigation was planned and conducted in accordance with generally accepted engineering standards practiced presently within this geographic area. Experience has shown that geotechnical investigations performed by these standards reveal with reasonable regularity soils that are representative of subsurface conditions throughout a site. The analyses and recommendations contained in this report are made on the assumption that the soil conditions encountered in borings and test pits are representative of actual conditions throughout the subject site. However, experience has also proven that subsoils can vary quite radically over small distances. Inconsistent conditions can occur between borings and not be detected by a geotechnical study. If, during construction, subsurface conditions are encountered which are different from those anticipated based on the results of this investigation, HWA should be notified so that we can review these variances and reconsider our recommendations wherever necessary.

Unexpected conditions such as those described in the previous paragraph frequently require an additional capital expenditure in order to attain a properly constructed project. Therefore, some contingency funds should be made available to cover these potential extra costs.

This report is prepared for the exclusive use of the owner's design engineers for specific application on this project in accordance with generally accepted soils and foundation engineering practice. No warranty, expressed or implied, is made. In addition, geotechnical observation and testing is recommended during the construction phases to verify that the recommendations presented herein are incorporated in the constructed work.

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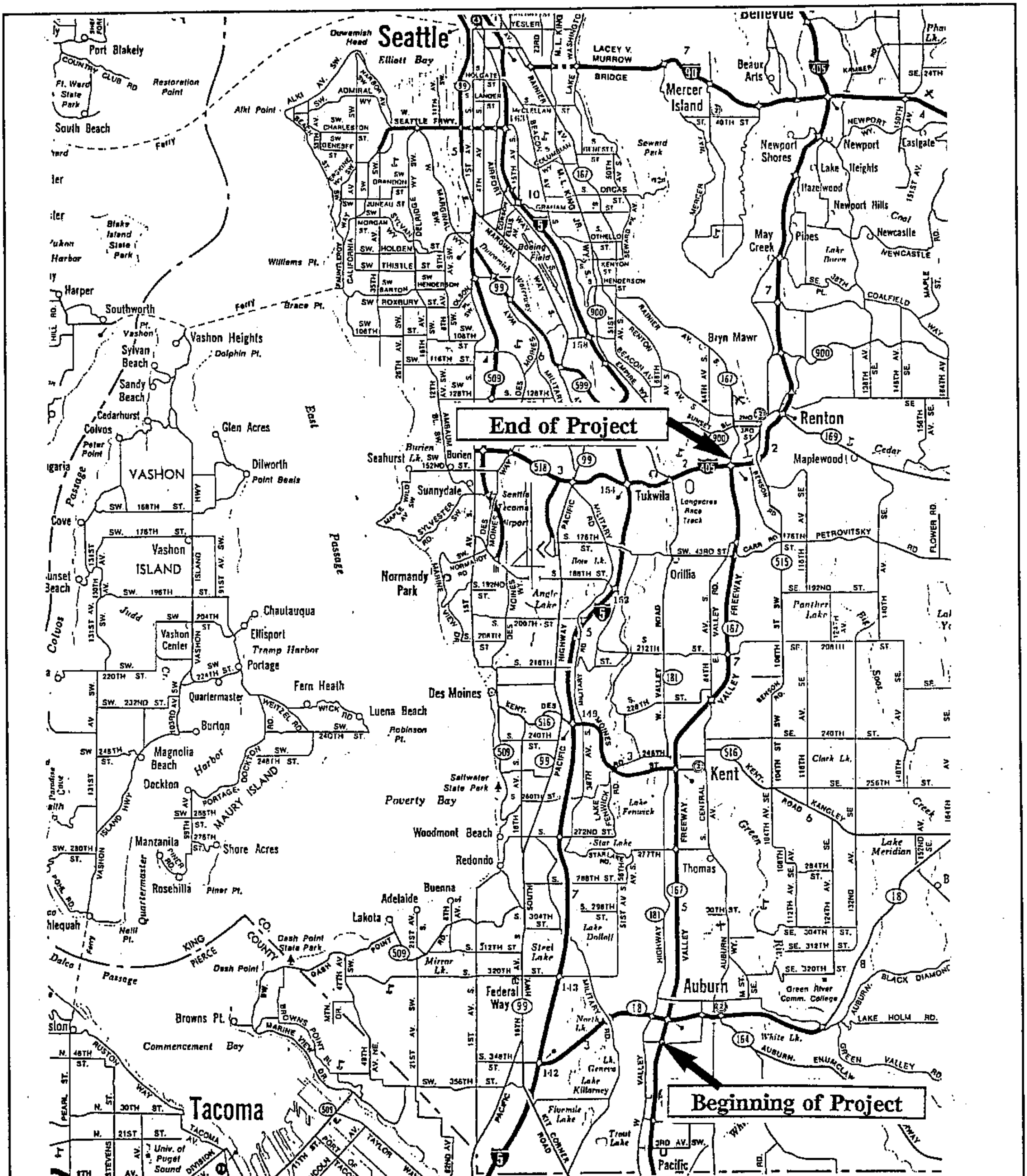
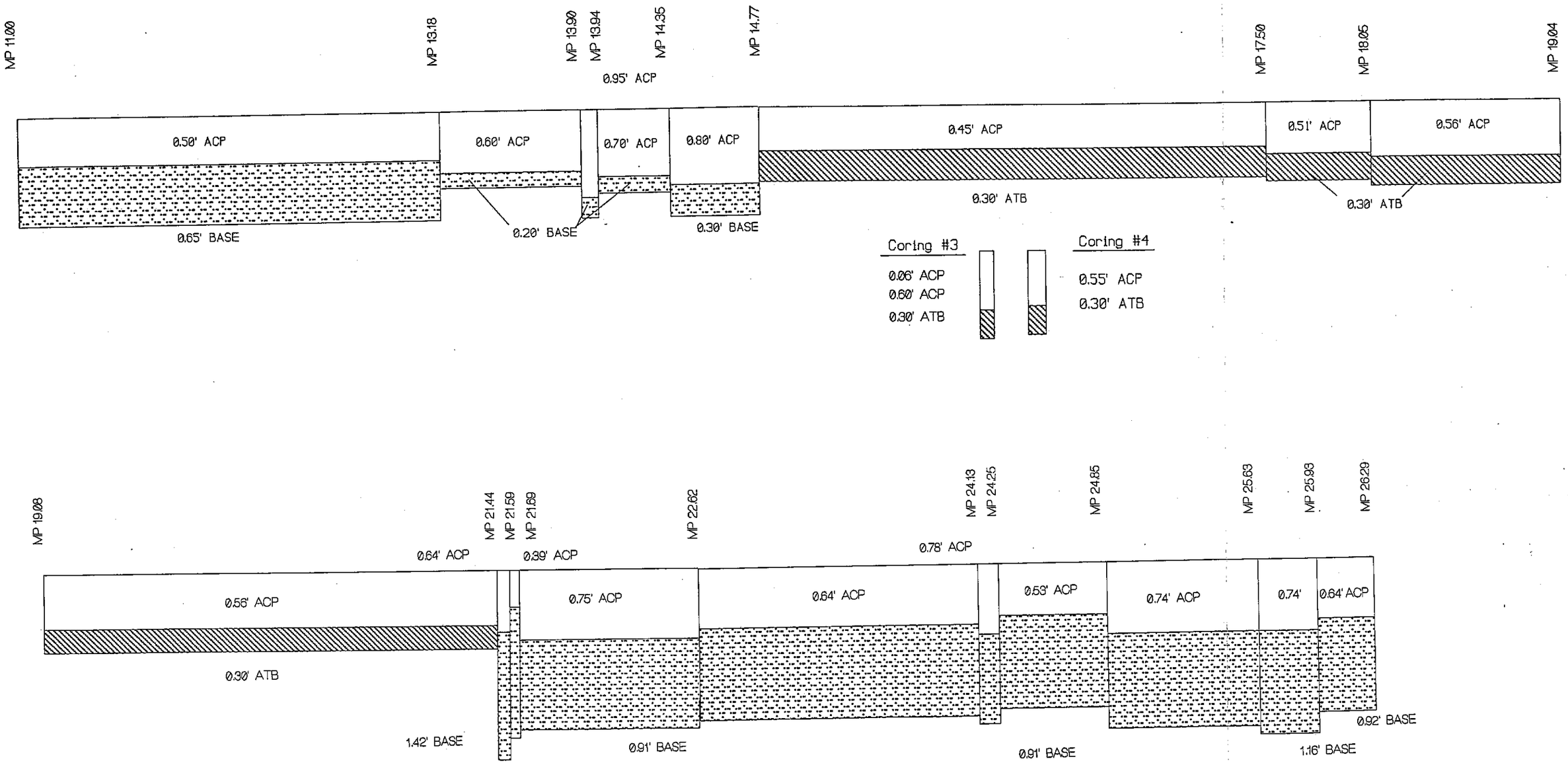


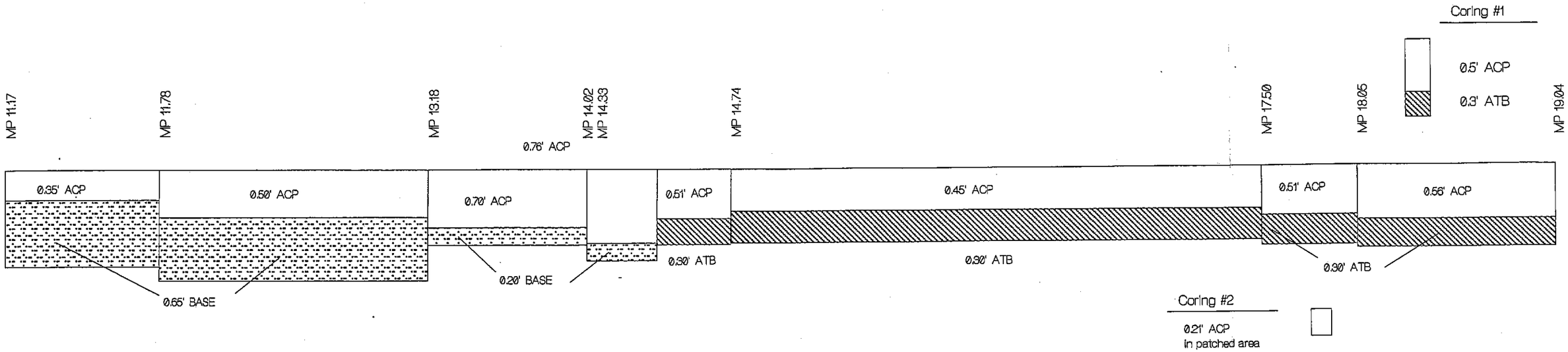
VICINITY MAP
SR-167: 15TH STREET SW TO SOUTH GRADY WAY
AUBURN TO RENTON, WASHINGTON

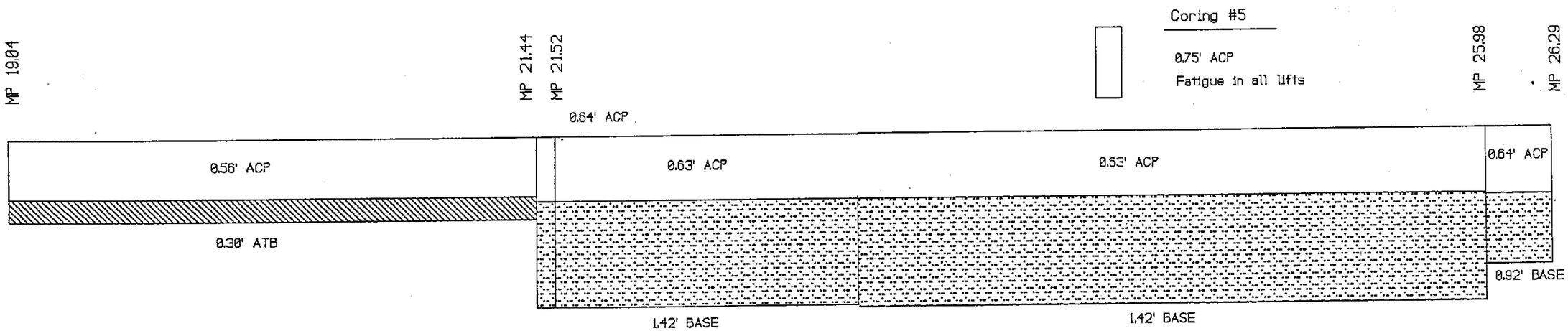
FIGURE 1



Note: Information derived from WSPMS data and may vary from actual conditions in the field

Hong West & Associates Geotechnical Consultants PO Box 536, Lynnwood, WA 98046	AS BUILT PAVEMENT SECTIONS NORTHBOUND LANES	Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES	DRAWING NO. FIGURE NUMBER 2



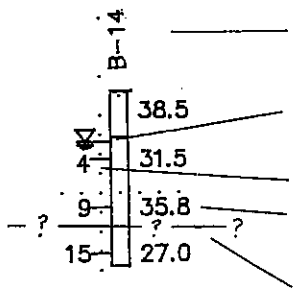


Note: Information derived from WSPMS data and may vary from actual conditions in the field

Hong West & Associates Geotechnical Consultants PO Box 536, Lynnwood, WA 98046	AS BUILT PAVEMENT SECTIONS SOUTHBOUND LANES	Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES	DRAWING NO. FIGURE NUMBER 3

LEGEND TO SYMBOLS FOR PLAN AND PROFILE DRAWINGS

BH	HWA boring location
HB	HWA hand boring location
TP	HWA test pit location
	WSDOT boring location
B	Shannon and Wilson boring location 1968



Boring designation

Water table at time of drilling

Left side: SPT values (blows/ft)

Right side: moisture content

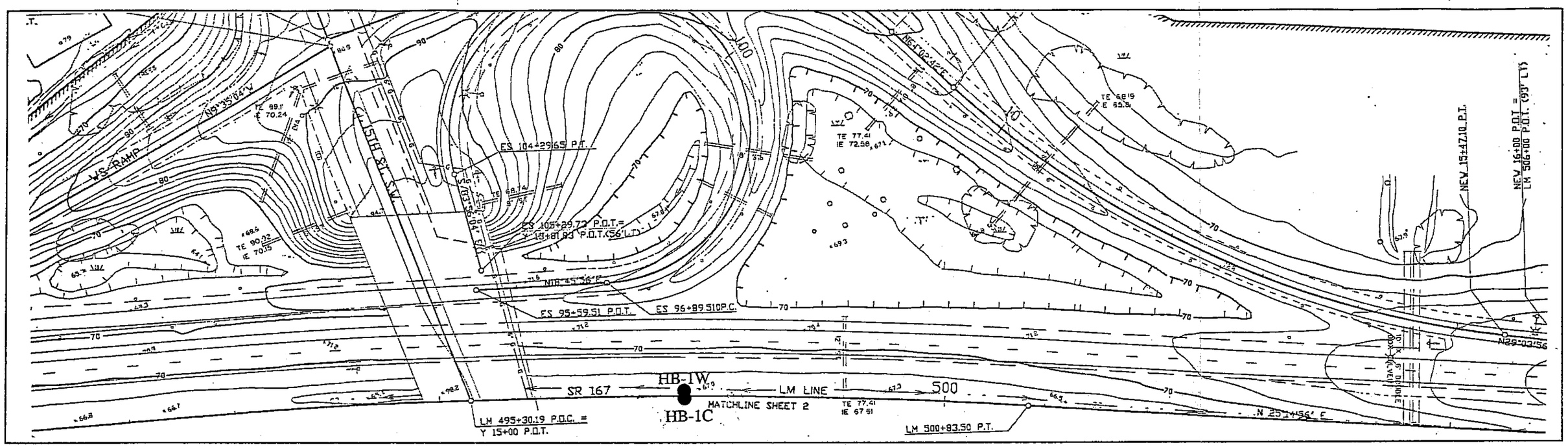
Approximate delineation of geologic soil unit

Notes:

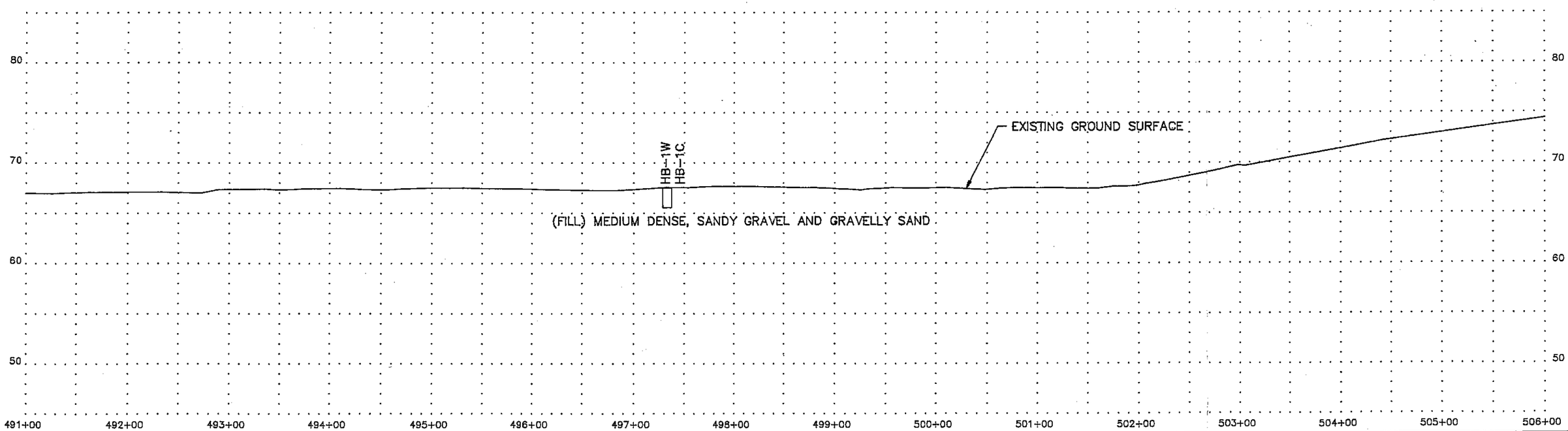
1. Elevations based upon WSDOT National Geodetic Vertical Datum (NGVD) and base maps provided by Alpha Engineering Group.

2. Profiles have a 10:1 vertical exaggeration in scale unless indicated otherwise.

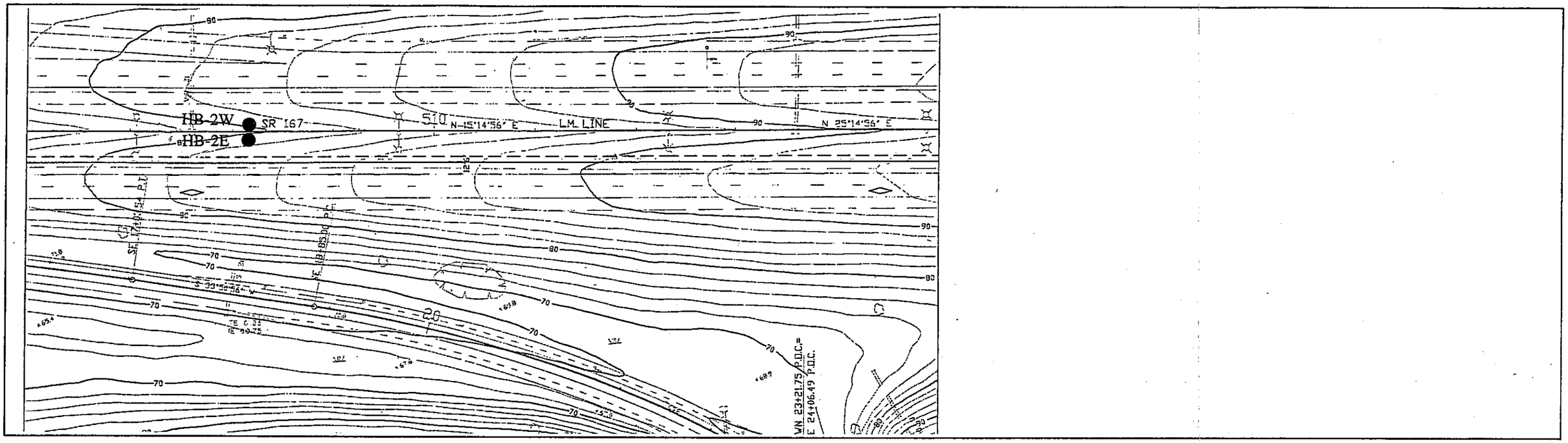
3. Interpretations of geologic units are based upon our field work, research, and boring logs. Actual conditions may vary from simplified representations shown on the plan and profile sheets.



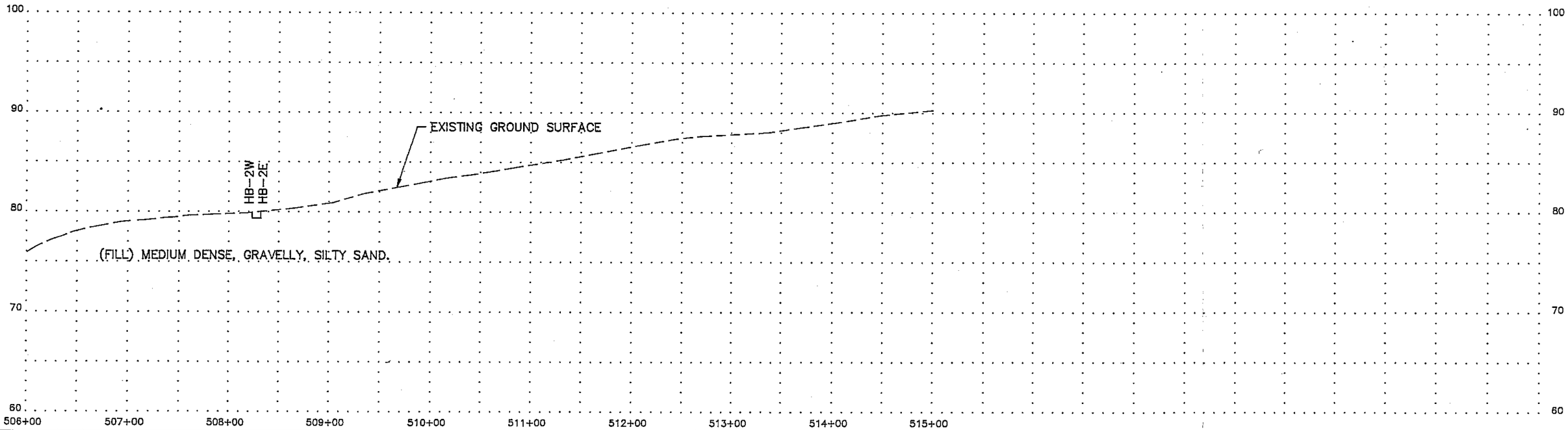
SCALE: HORIZ. 1"=100' VERT. 1"=10'



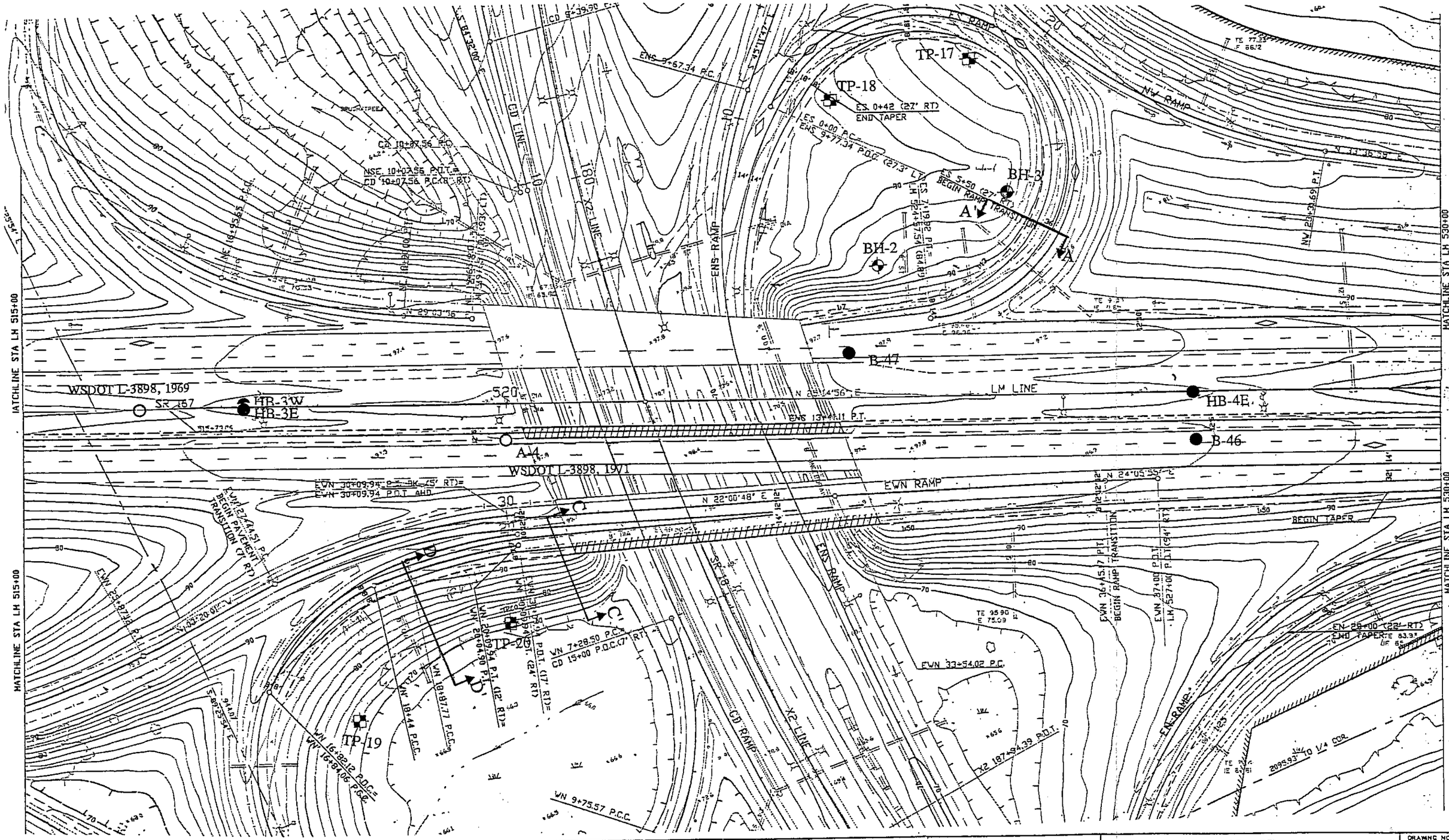
Hong West & Associates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES STA 491+00 TO STA 506+00	DRAWING NO. 1, 2 FIGURE NUMBER 4



SCALE: HORIZ. 1"=100' VERT. 1"=10'



Hong West & Associates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES STA 506+00 TO STA 515+00	DRAWING NO. 3 FIGURE NUMBER 5



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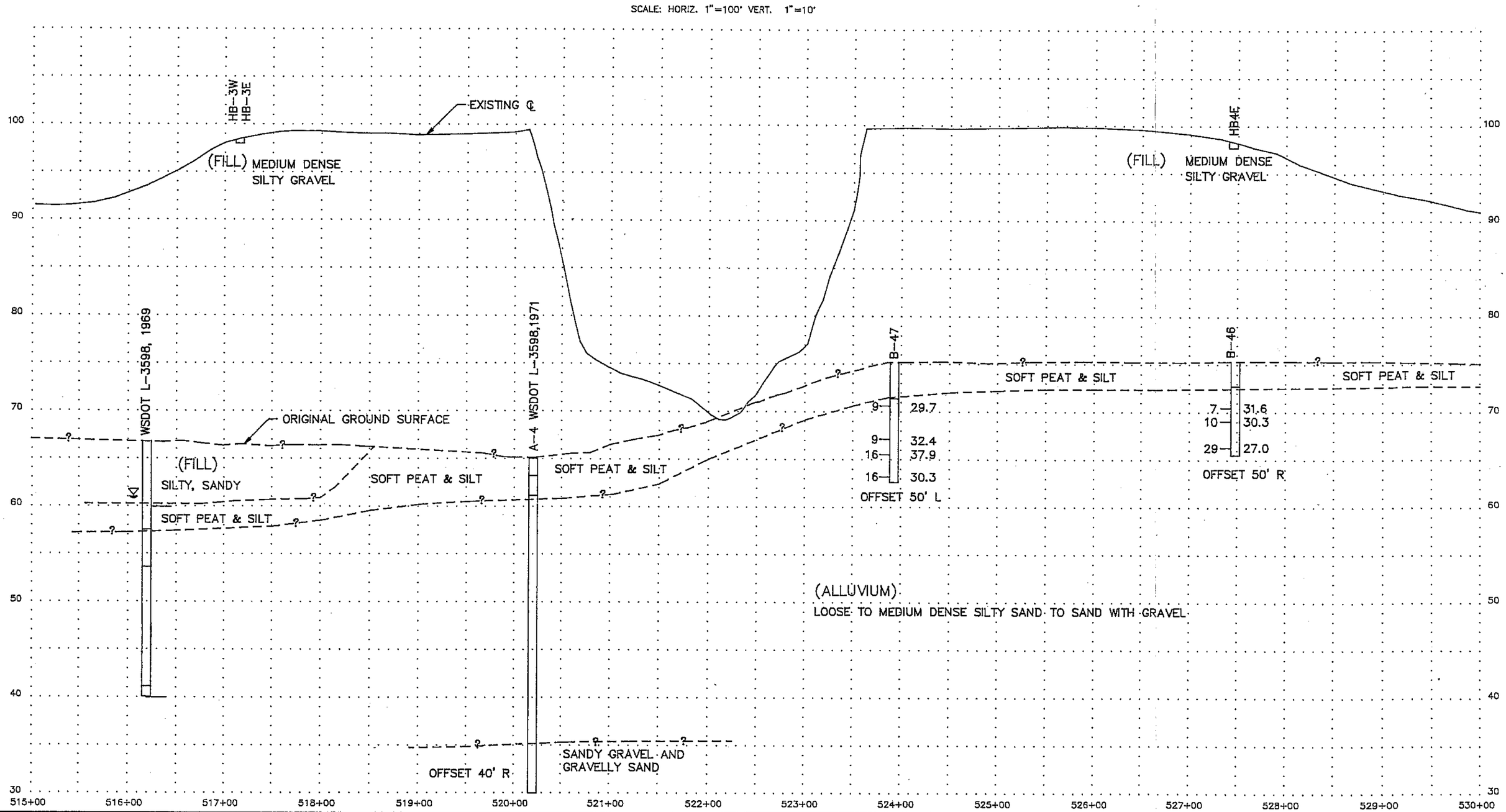
Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 515+00 TO STA 530+00

DRAWING NO. 4

FIGURE NUMBER 6A



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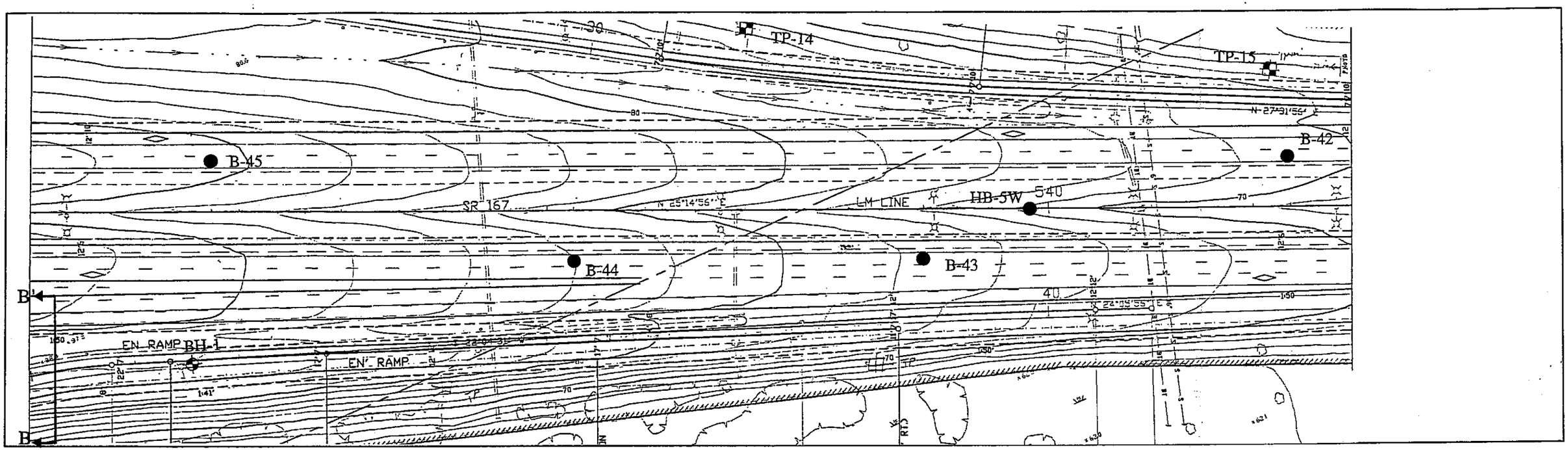
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

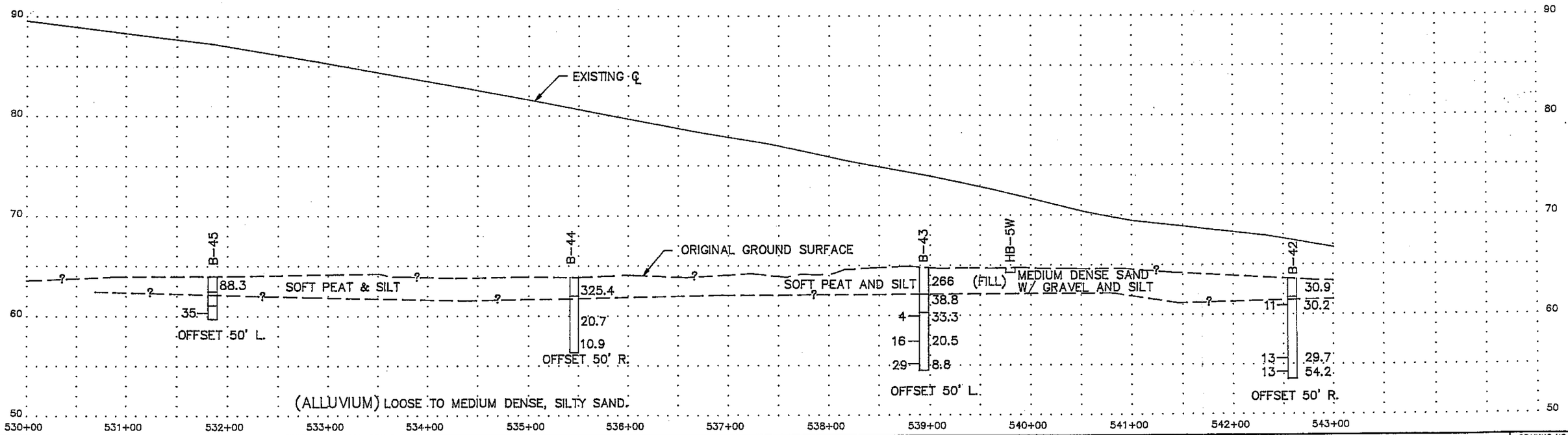
STA 515+00 TO STA 530+00

DRAWING NO. 4/5

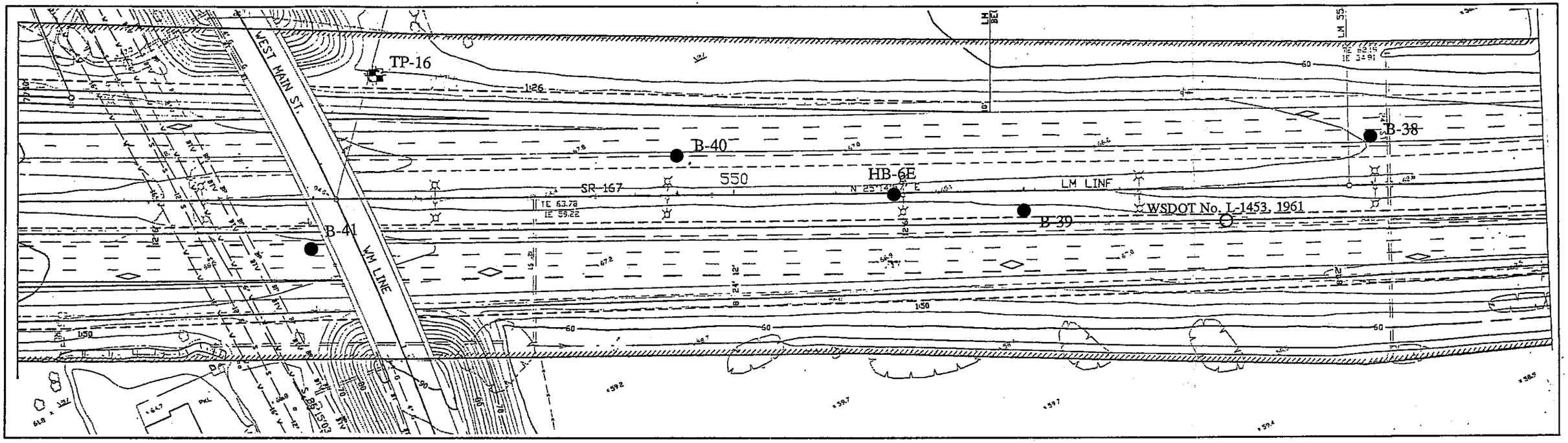
FIGURE NUMBER 6B



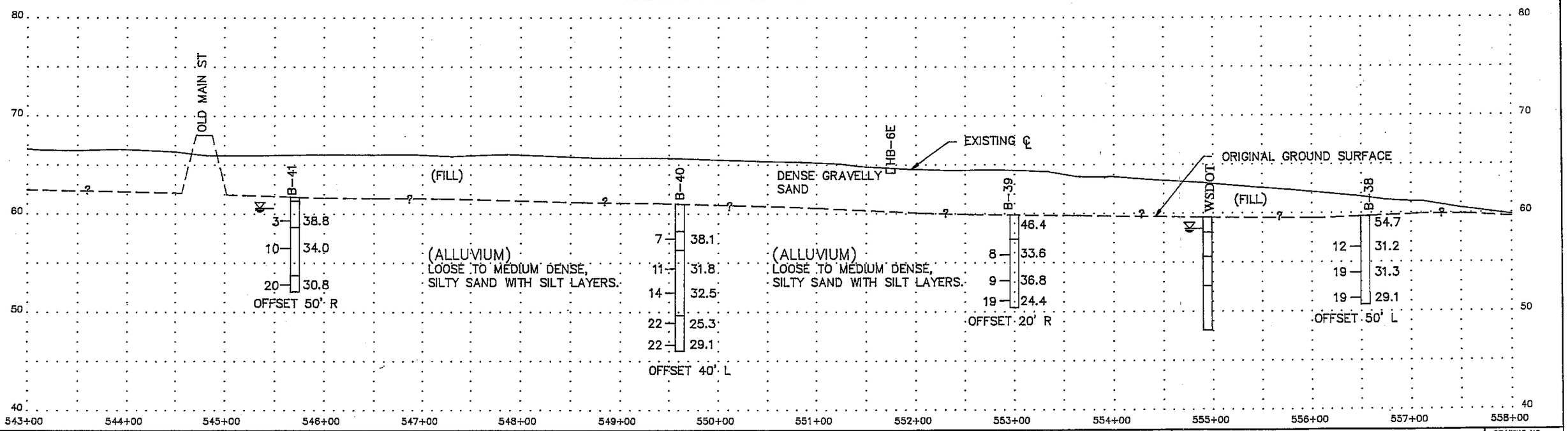
SCALE: HORIZ. 1"=100' VERT. 1"=10'



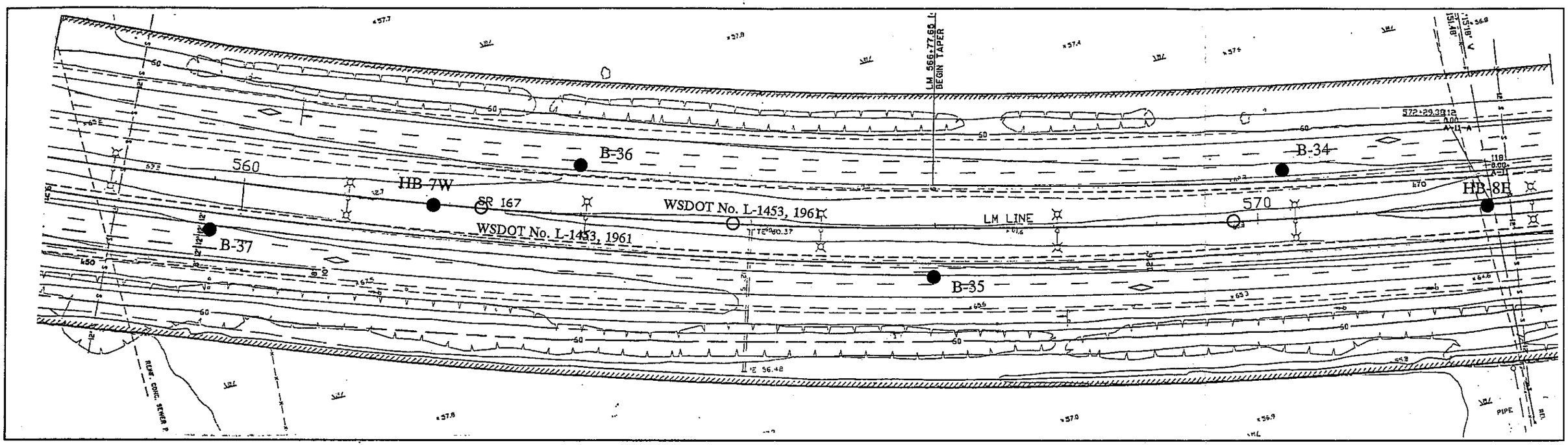
Hong **W**est & **A**ssociates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046	Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES STA 530+00 TO STA 543+00	DRAWING NO. 6 FIGURE NUMBER 7



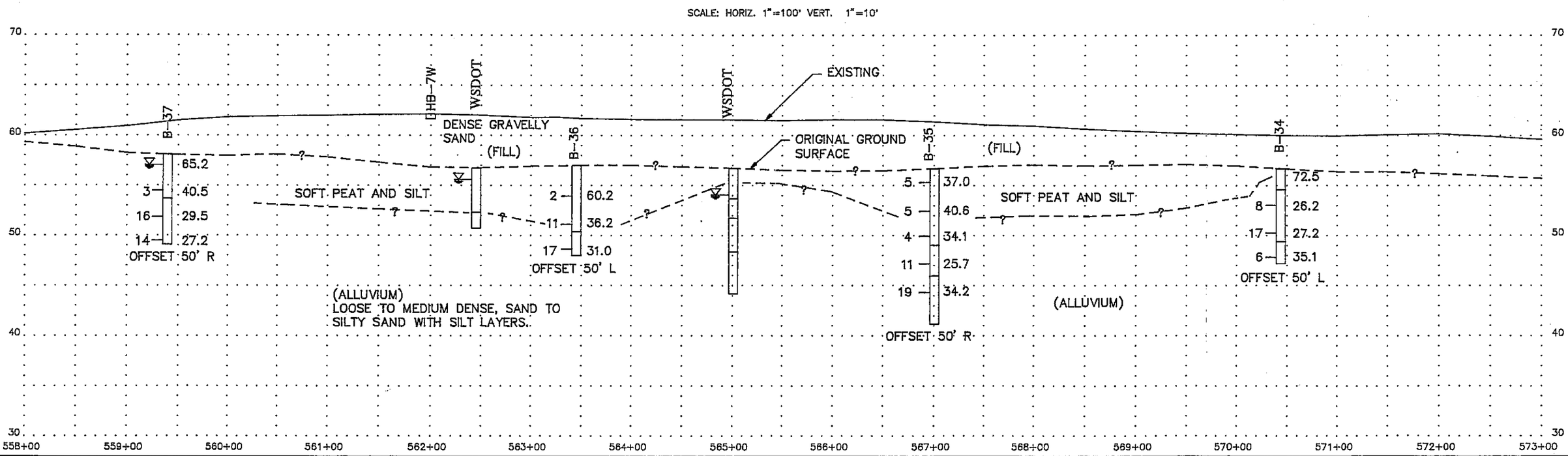
SCALE: HORIZ. 1"=100' VERT. 1"=10'



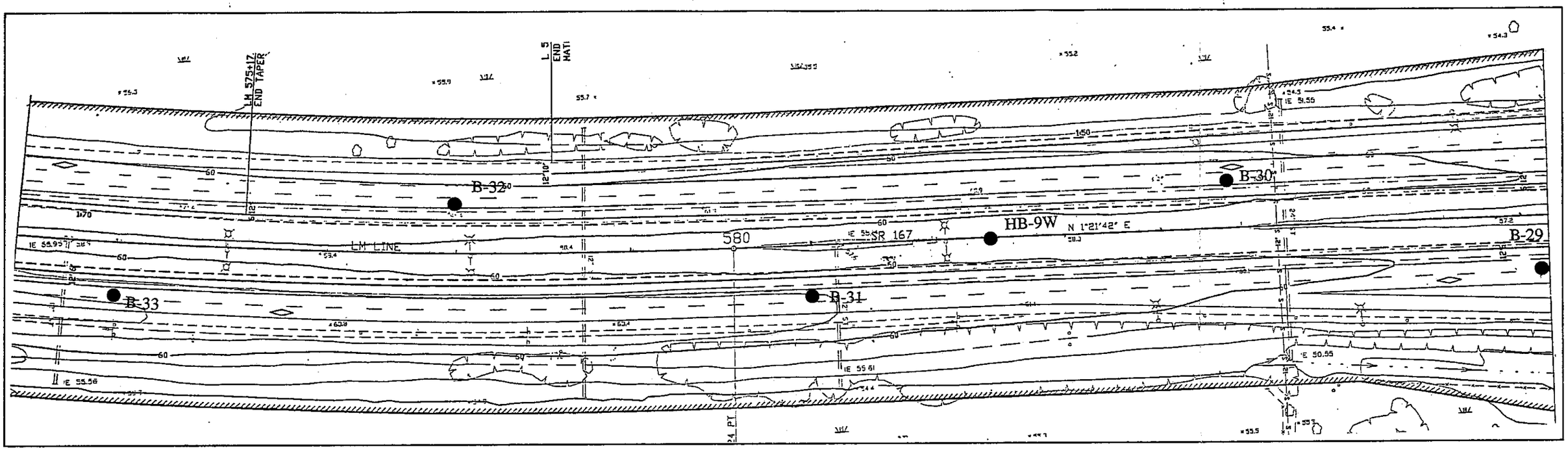
Hong **W**est & **A**ssociates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046	Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HDV LANES STA 543+00 TO STA 558+00	DRAWING NO. 7 FIGURE NUMBER 8



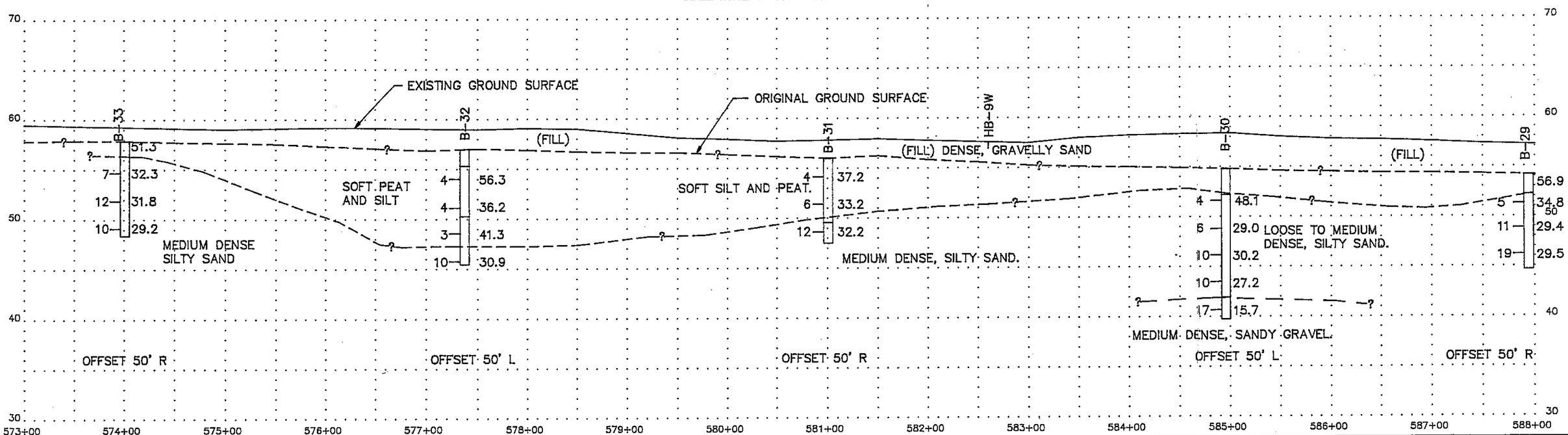
SCALE: HORIZ. 1"=100' VERT. 1"=10'



Hong **W**est & **A**ssociates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES STA 558+00 TO STA 573+00	DRAWING NO. 8 FIGURE NUMBER 9



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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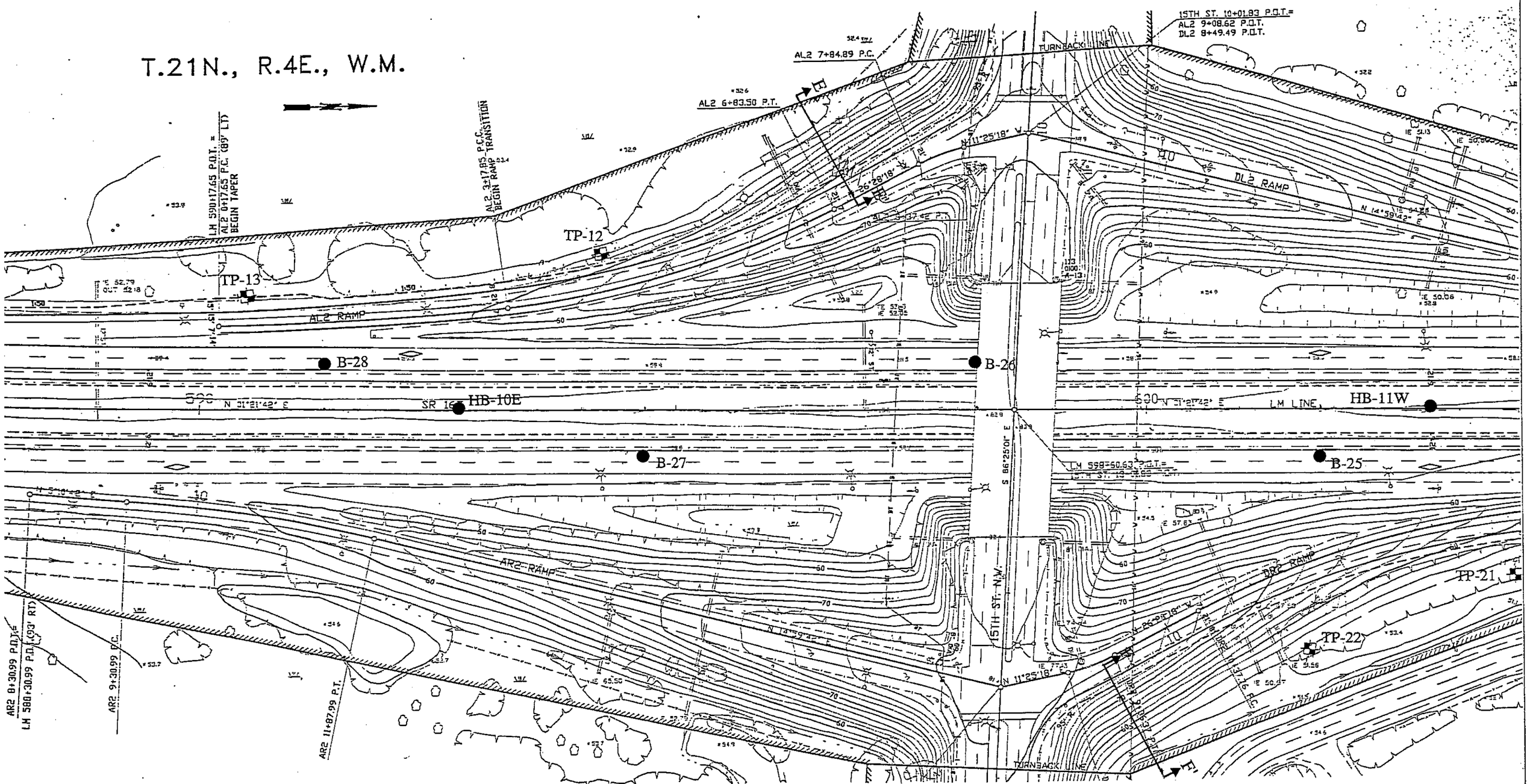
			STA 573+00 TO STA 588+00	FIGURE NUMBER 10



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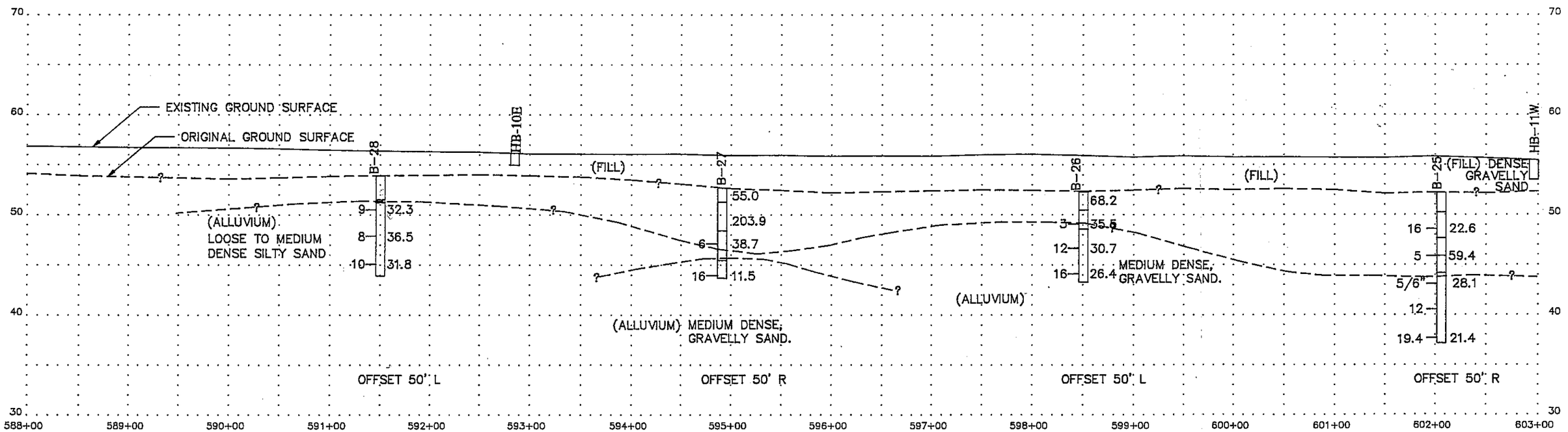
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 588+00 TO STA 604+00

DRAWING NO.
10

FIGURE NUMBER
11A

SCALE: HORIZ. 1"=100' VERT. 1"=10'



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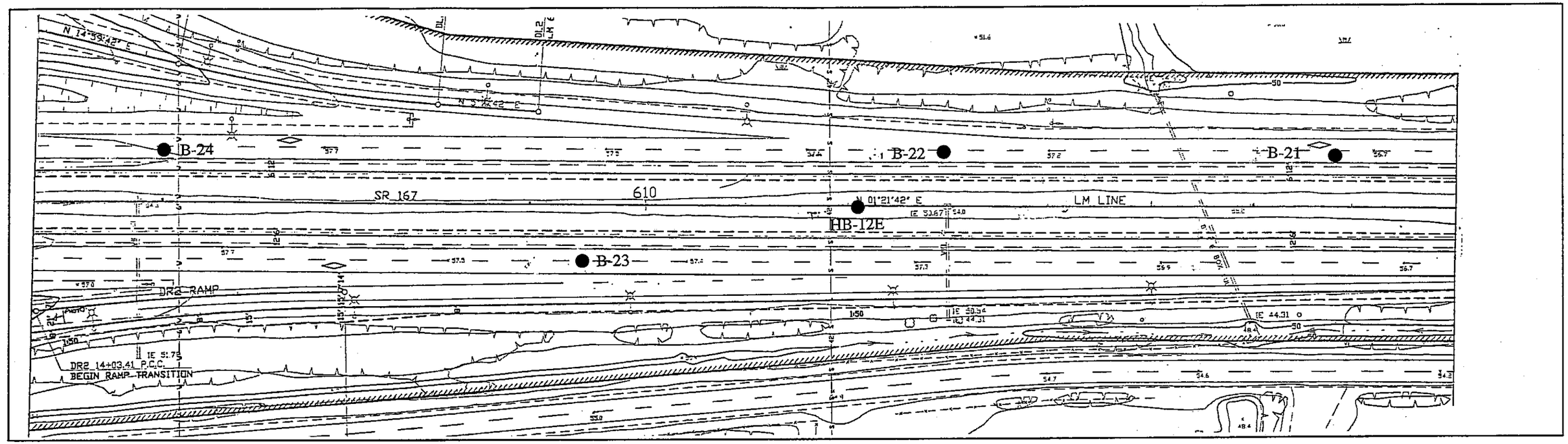
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

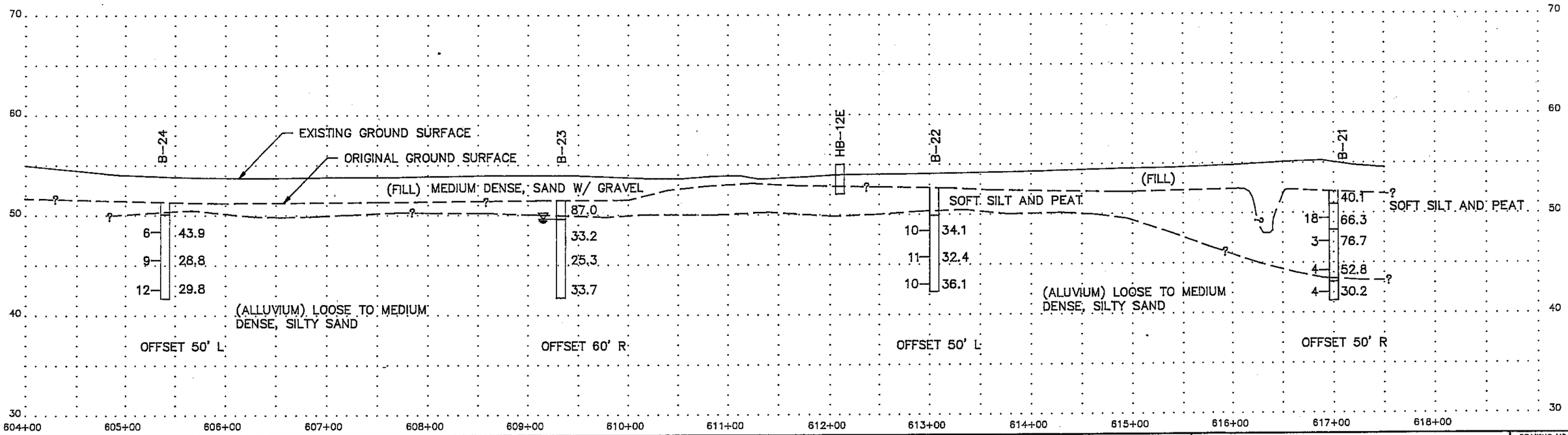
STA 588+00 TO STA 603+00

DRAWING NO.
10

FIGURE NUMBER
11B



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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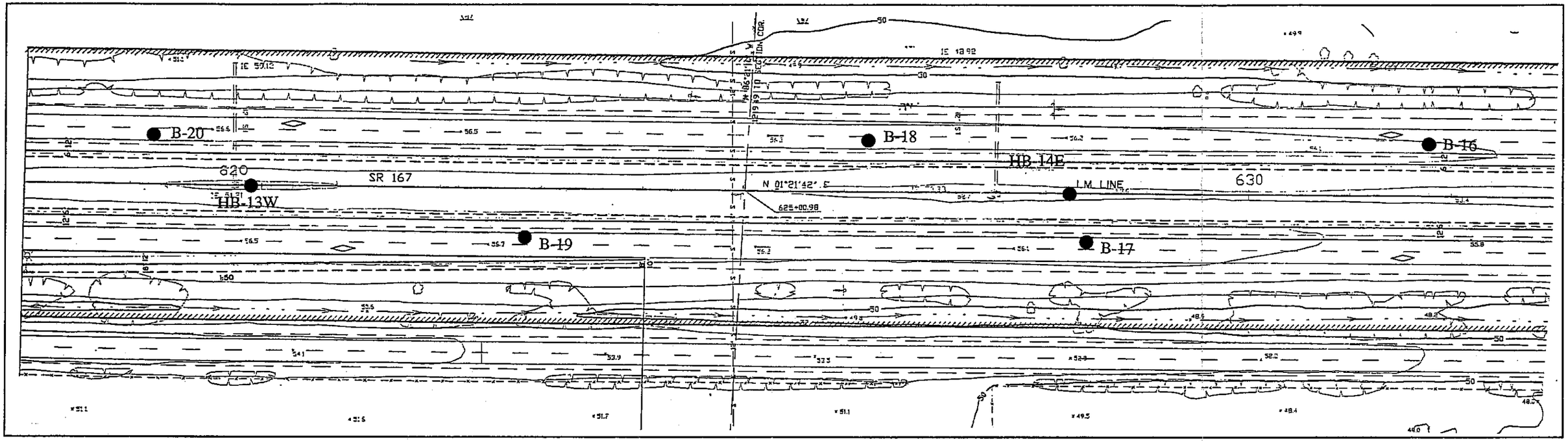
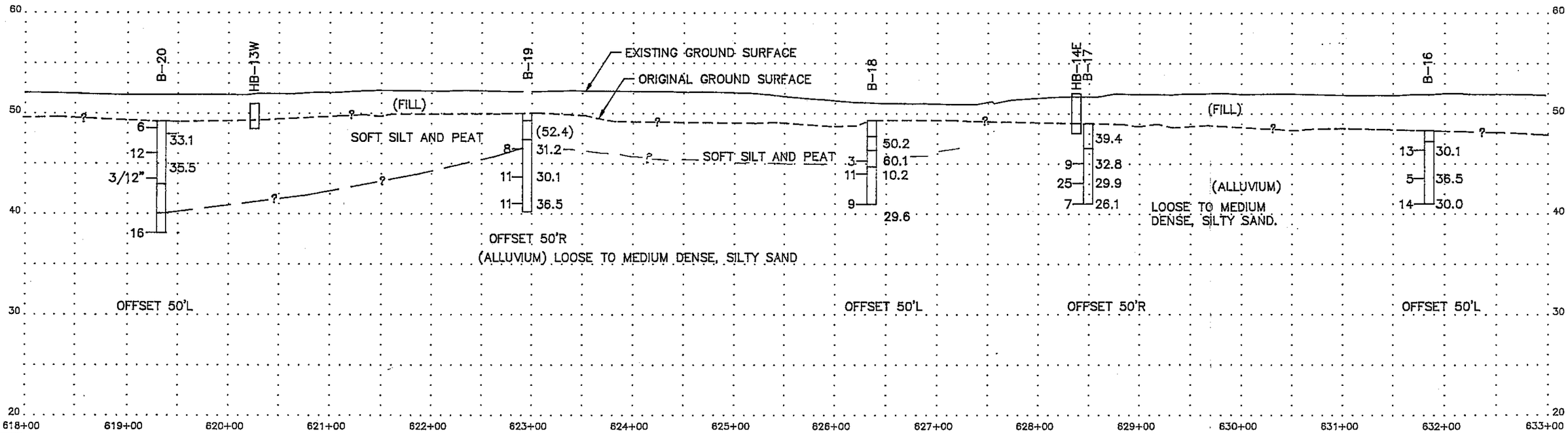


SCALE: HORIZ. 1"=100' VERT. 1"=10'



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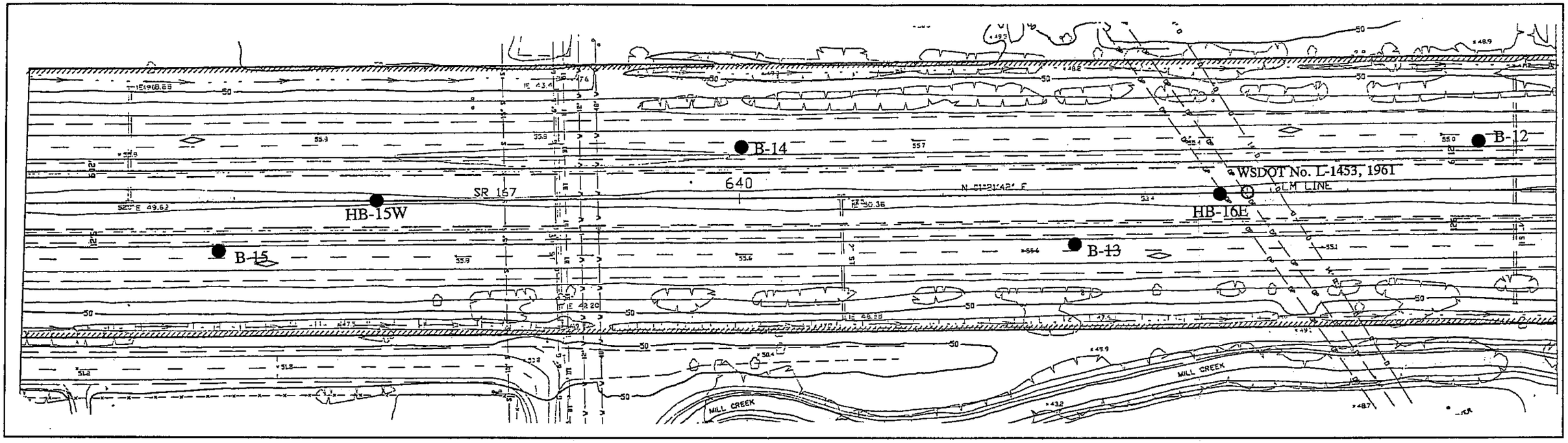

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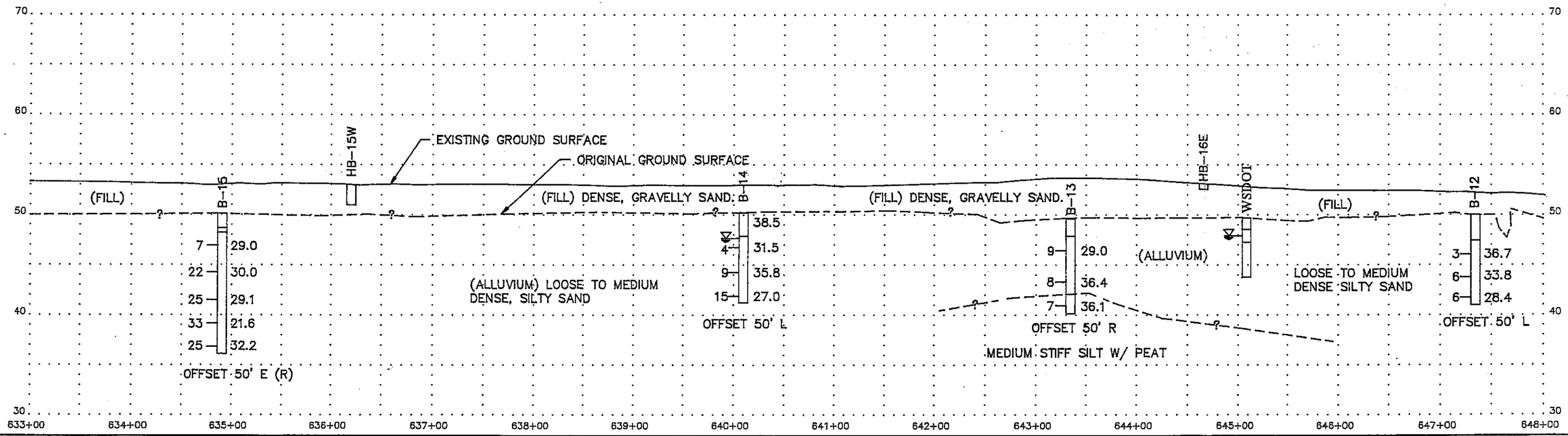

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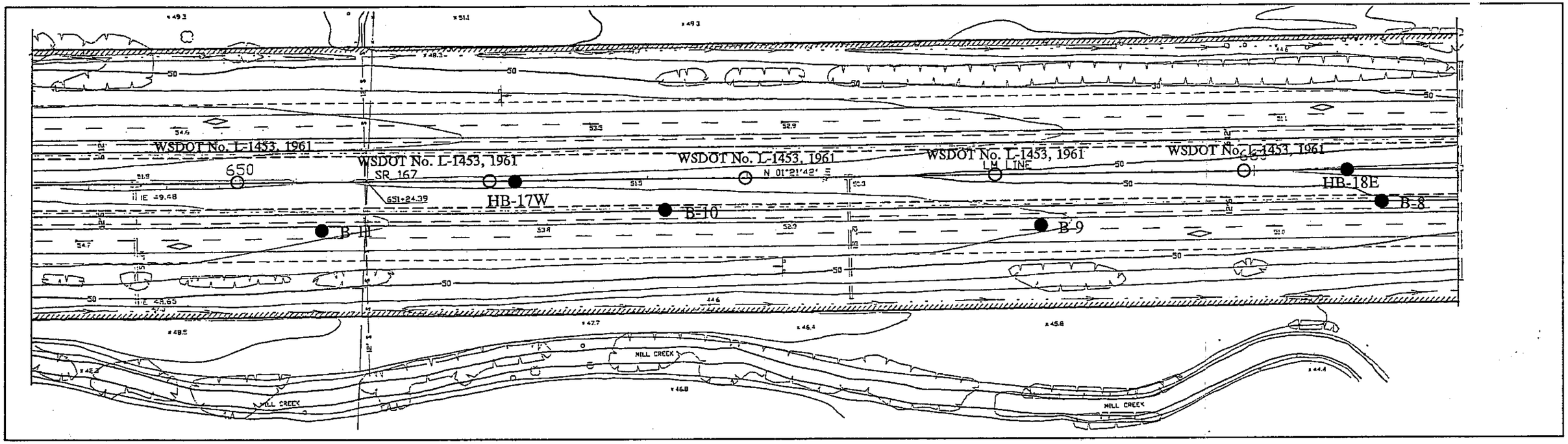
Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

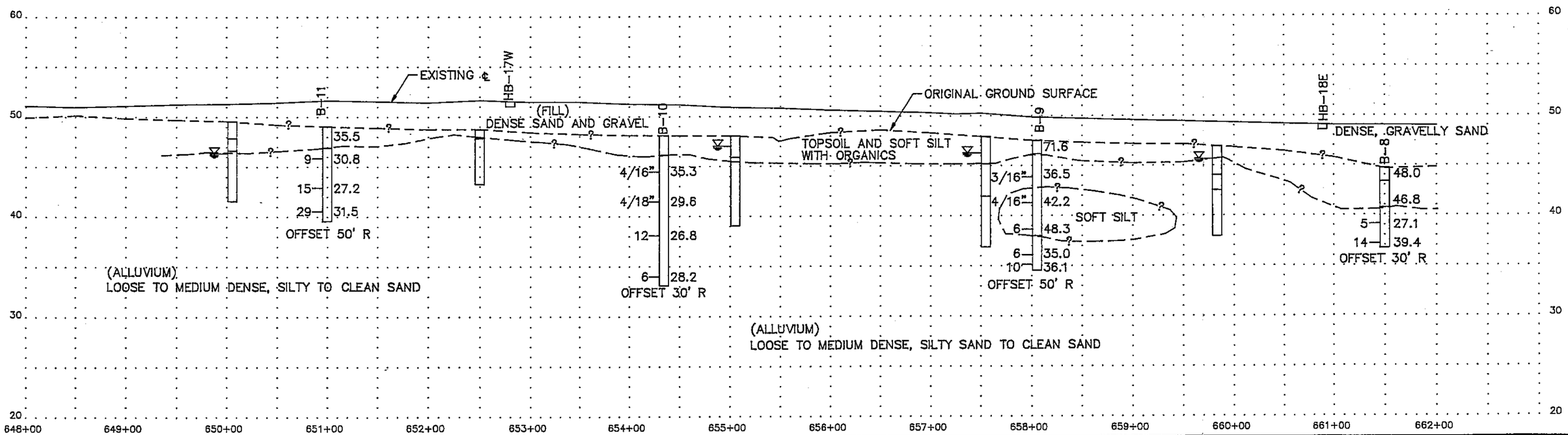
STA 633+00 TO STA 648+00

DRAWING NO. 13

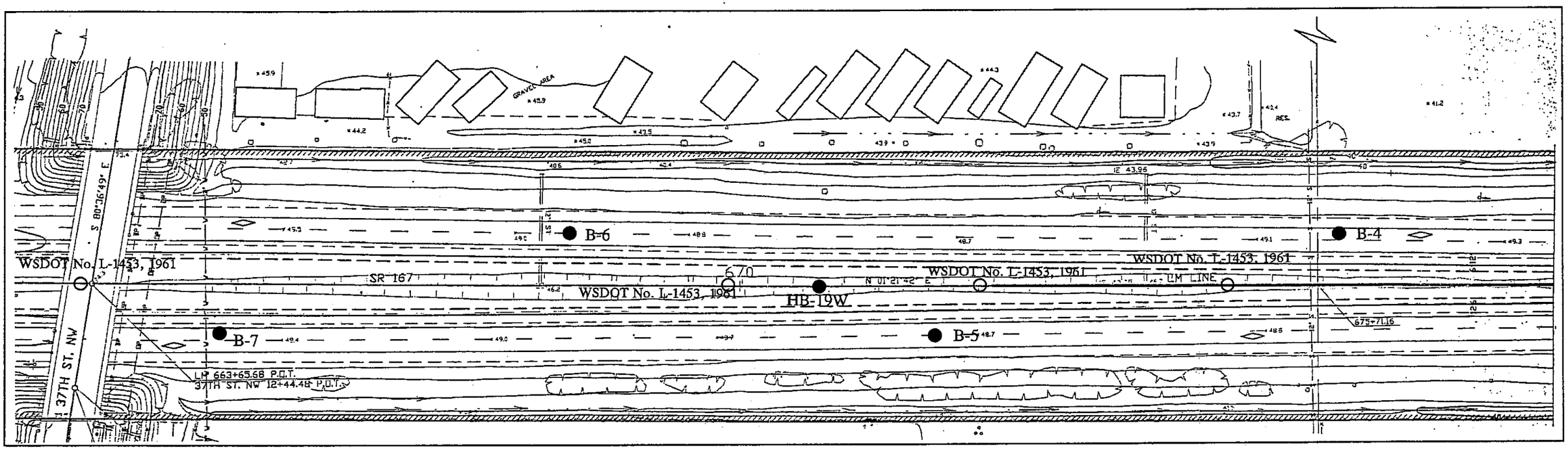
FIGURE NUMBER 14



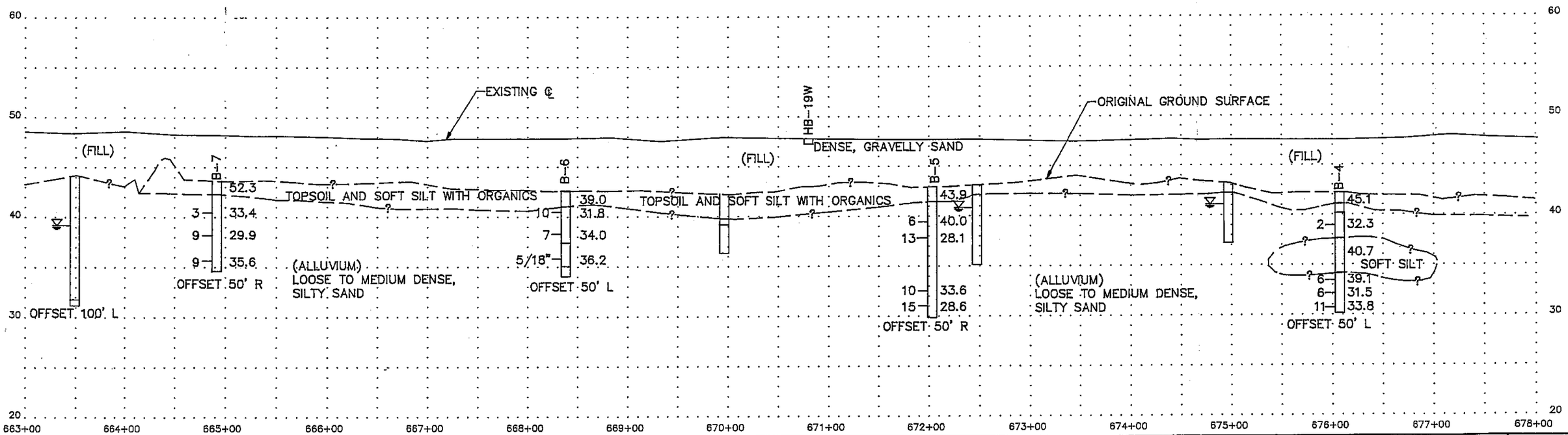
SCALE: HORIZ. 1"=100' VERT. 1"=10'



Hong West & Associates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES STA 648+00 TO STA 662+00
			DRAWING NO. 14 FIGURE NUMBER 15



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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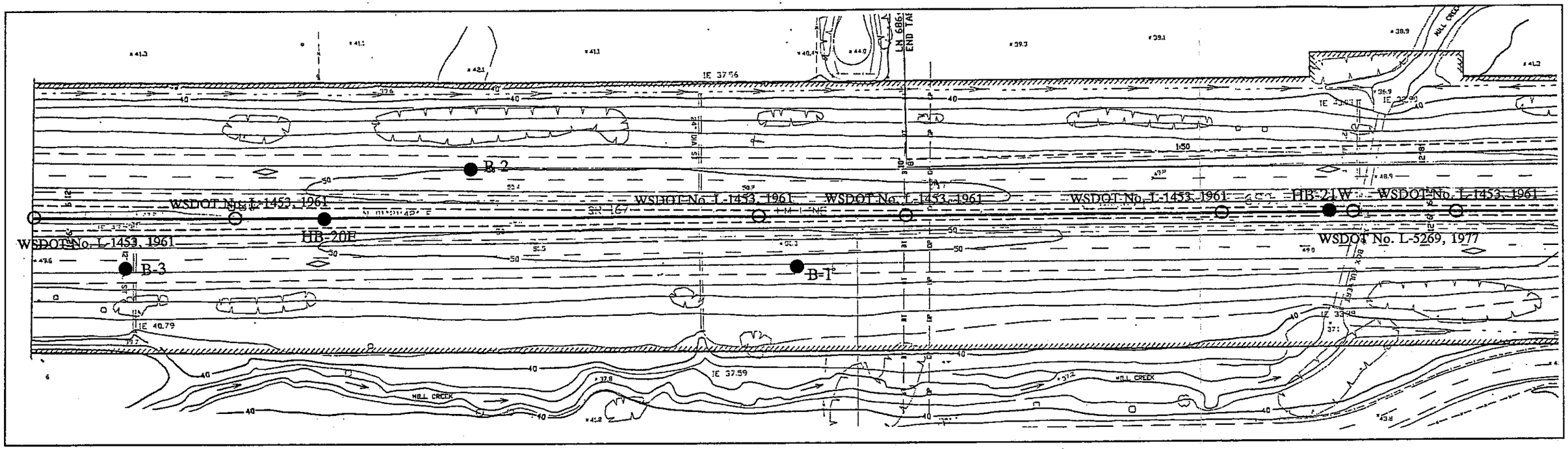

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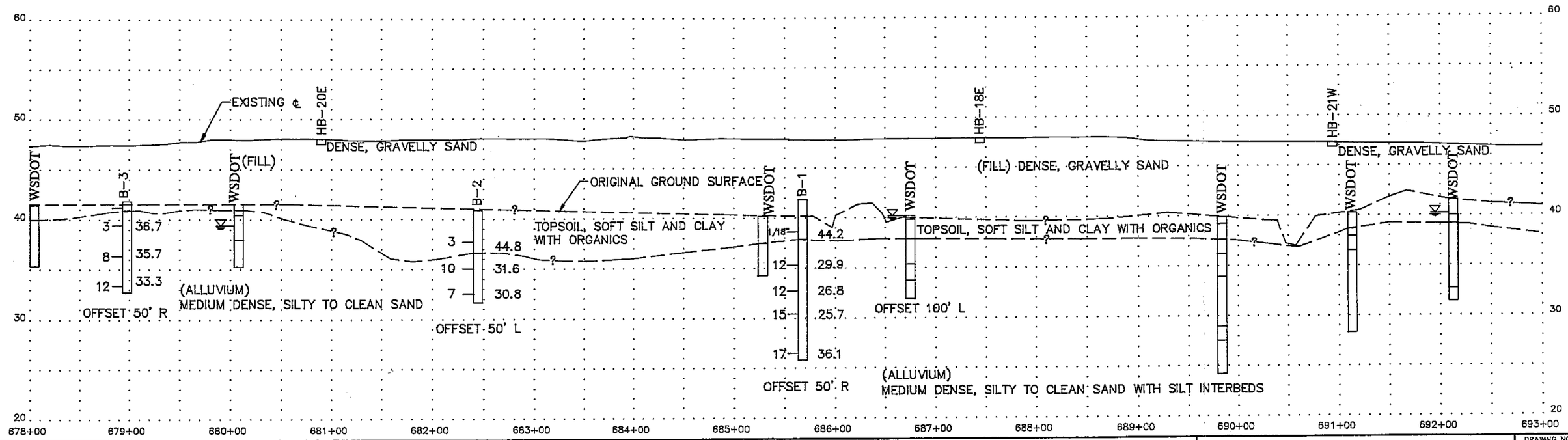

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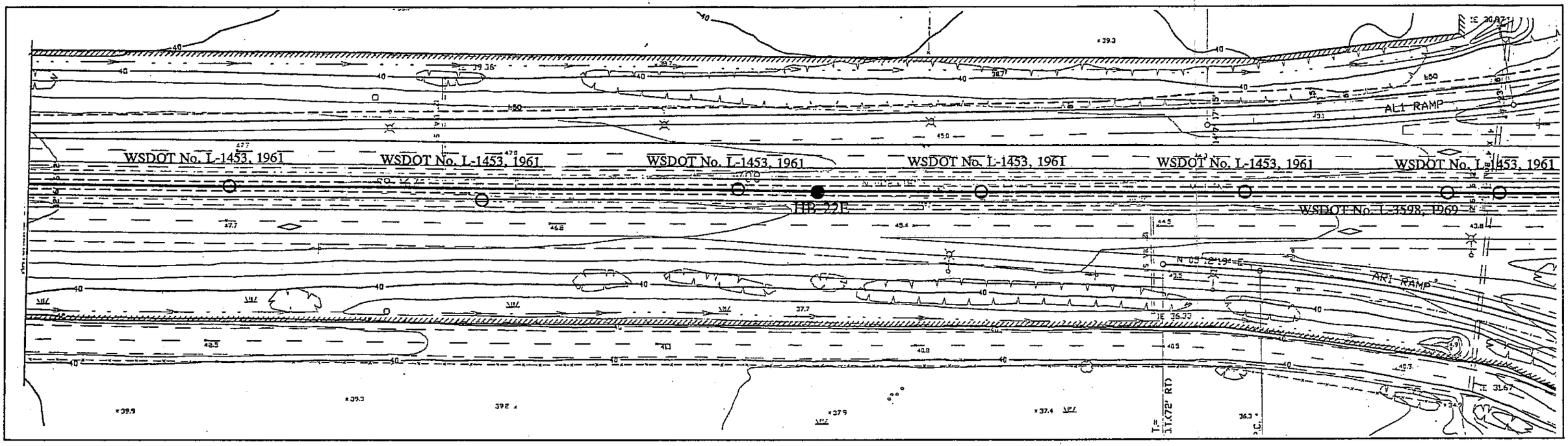
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 678+00 TO STA 693+00

DRAWING NO. 16

FIGURE NUMBER 17



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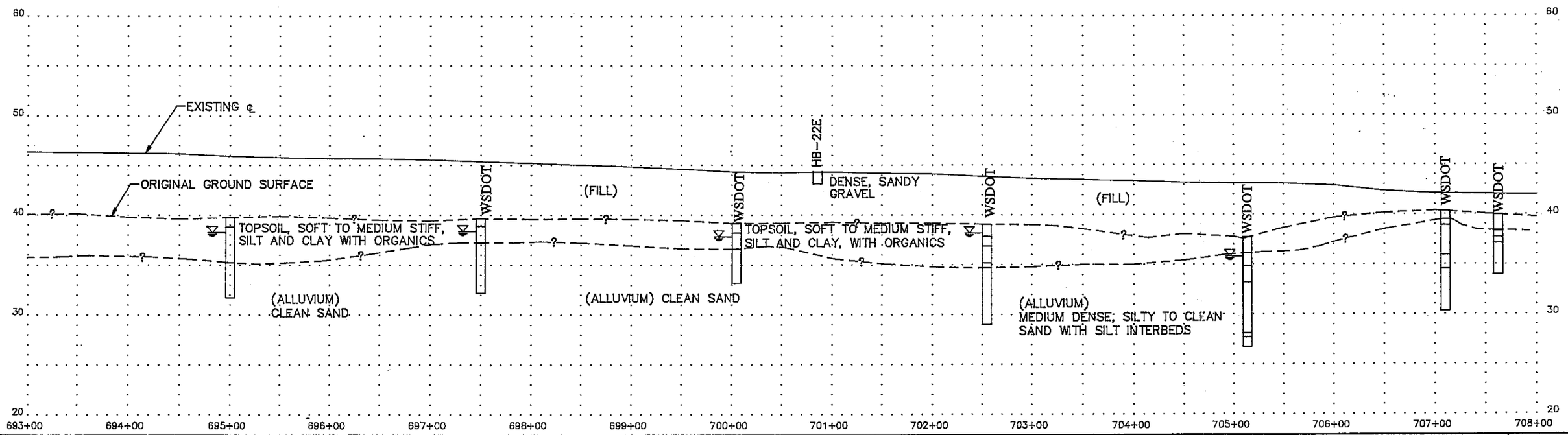

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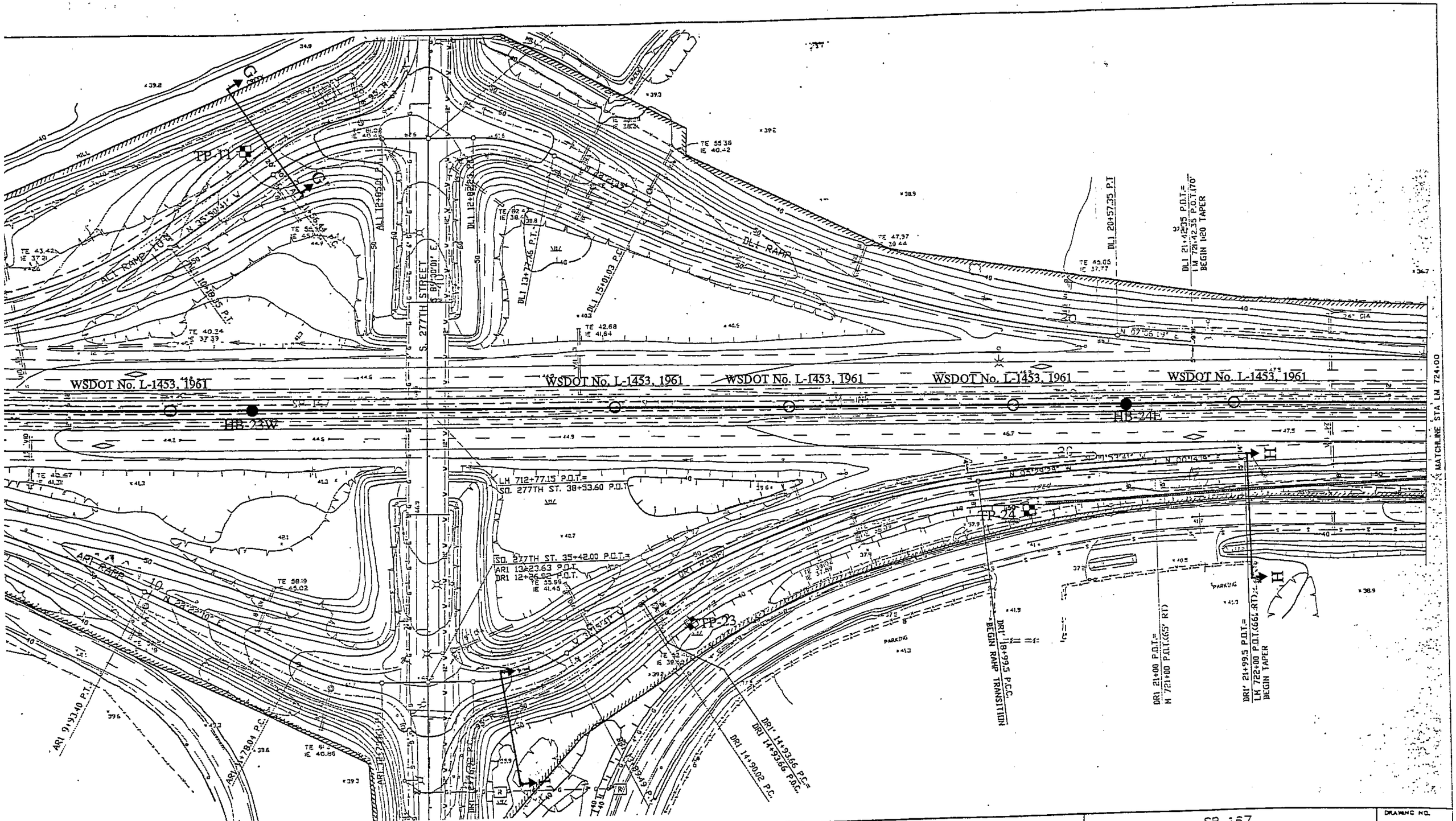

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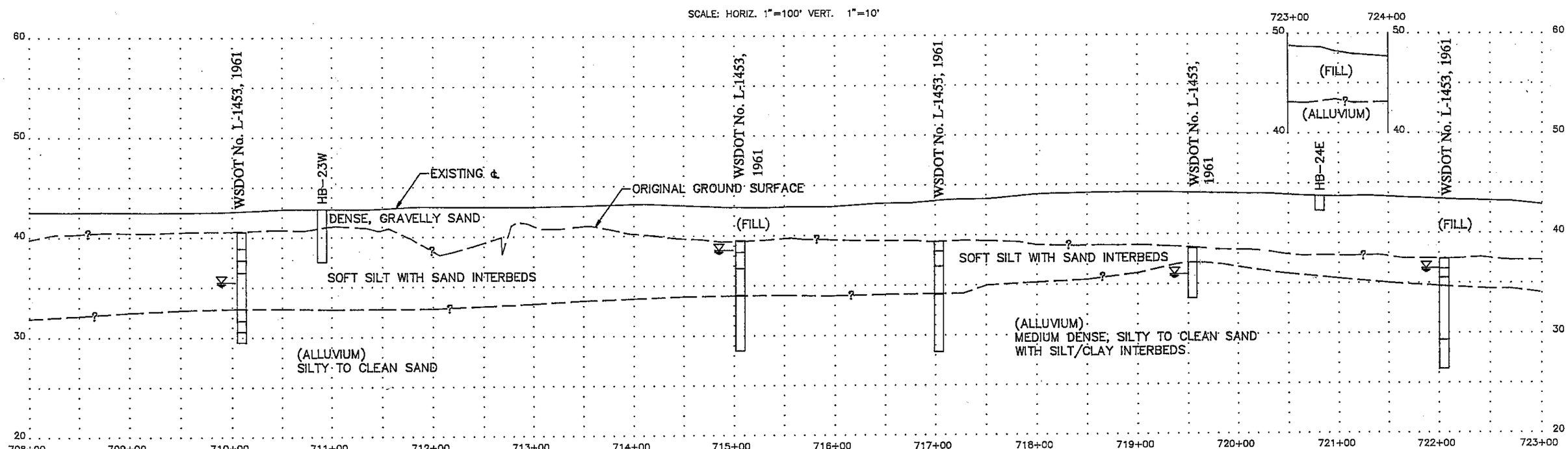
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 708+00 TO STA 724+00

DRAWING NO. 18

FIGURE NUMBER 19A



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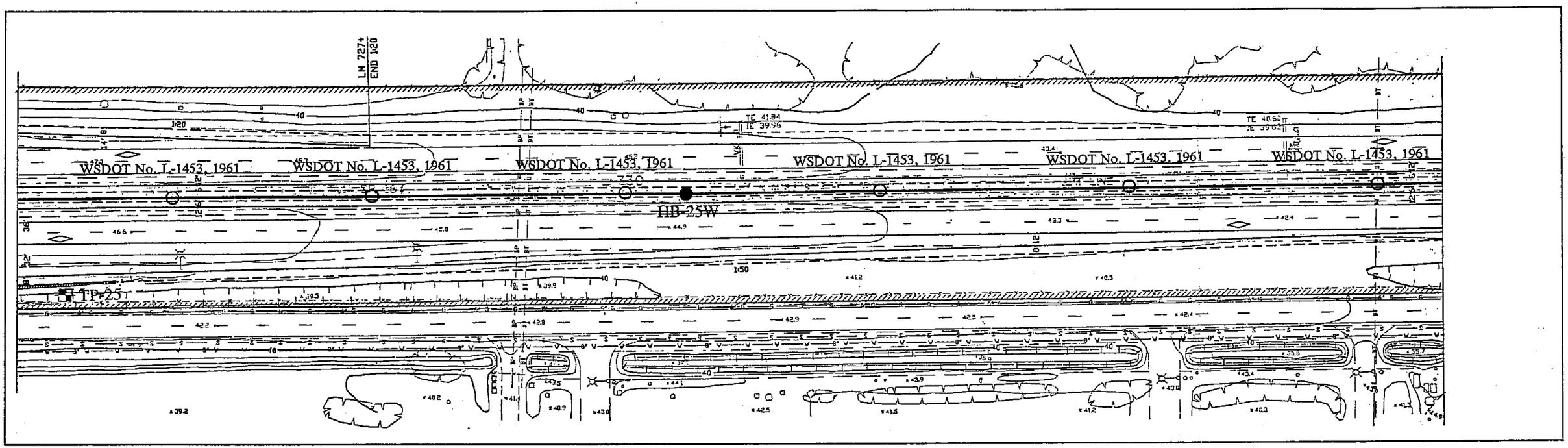
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

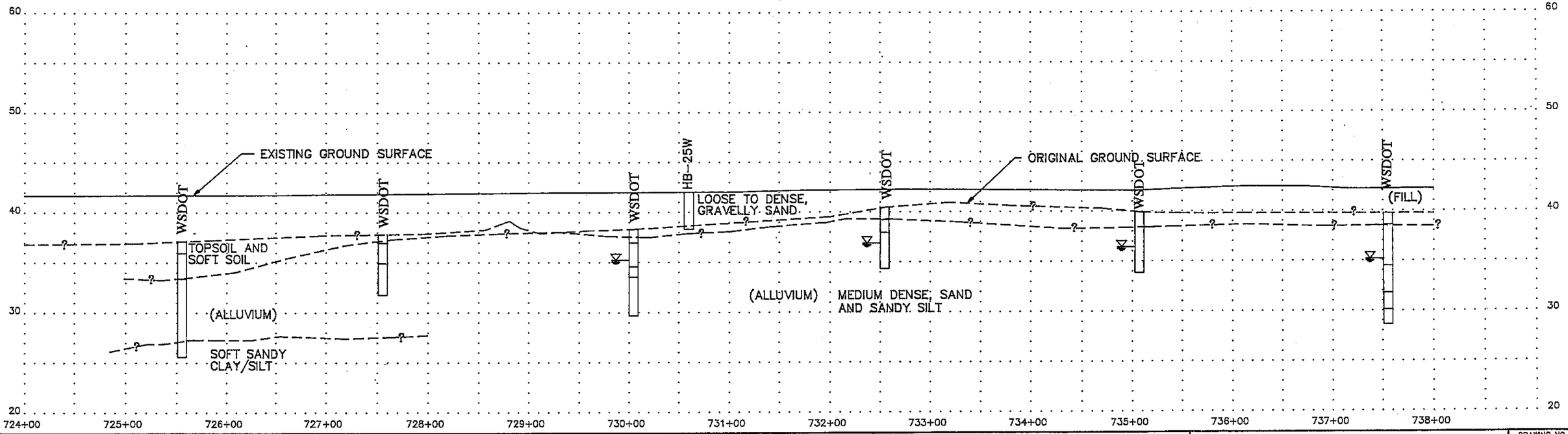
STA 708+00 TO STA 724+00

DRAWING NO.
18

FIGURE NUMBER
19B



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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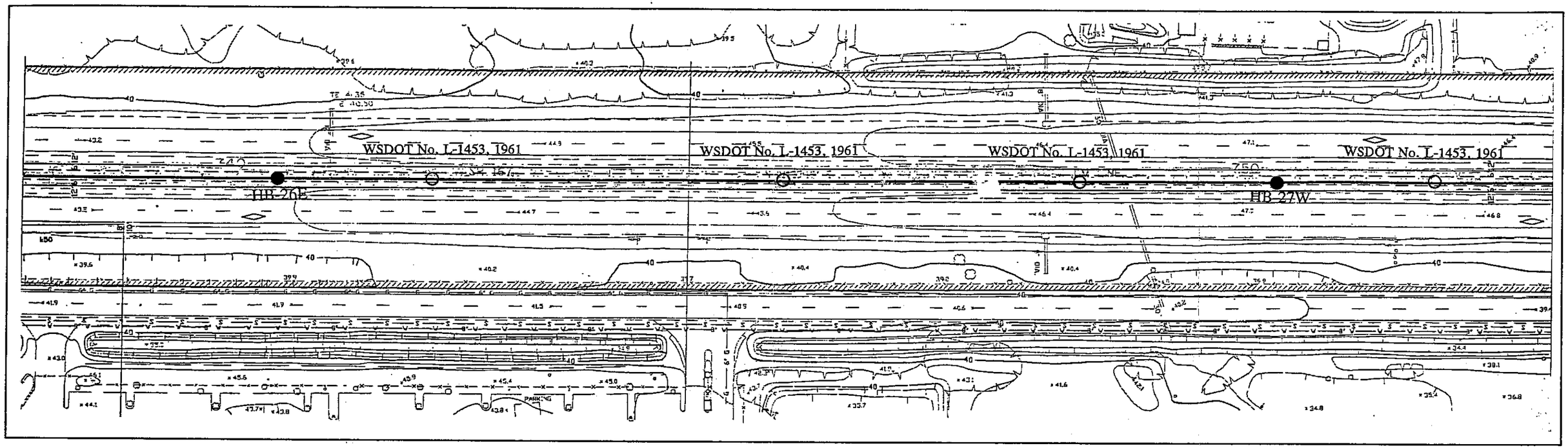
Washington State Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

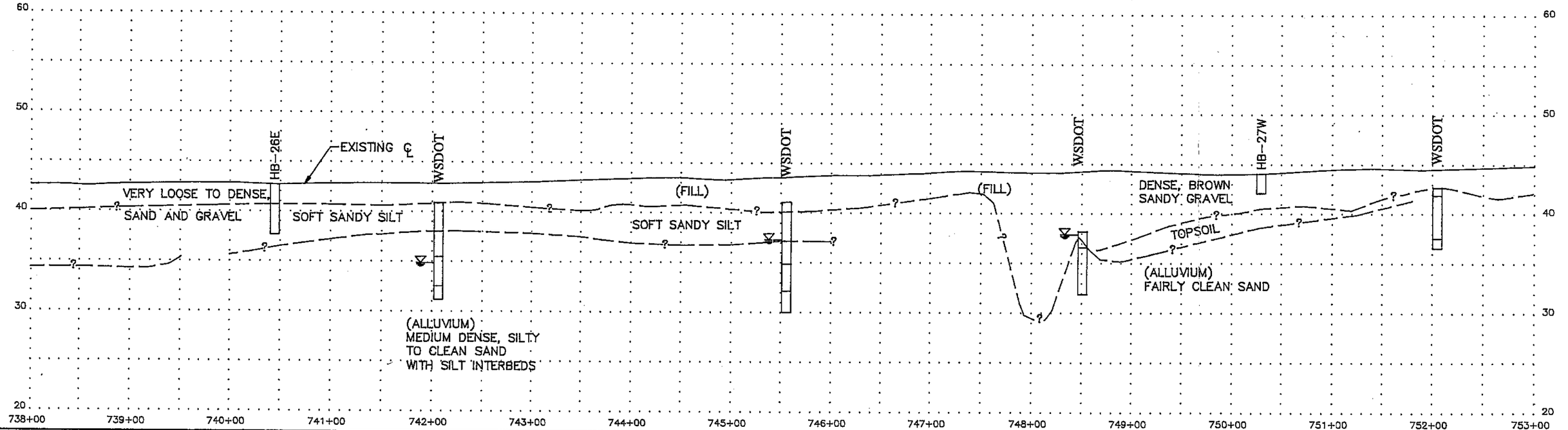
STA 724+00 TO STA 738+00

DRAWING NO. 19

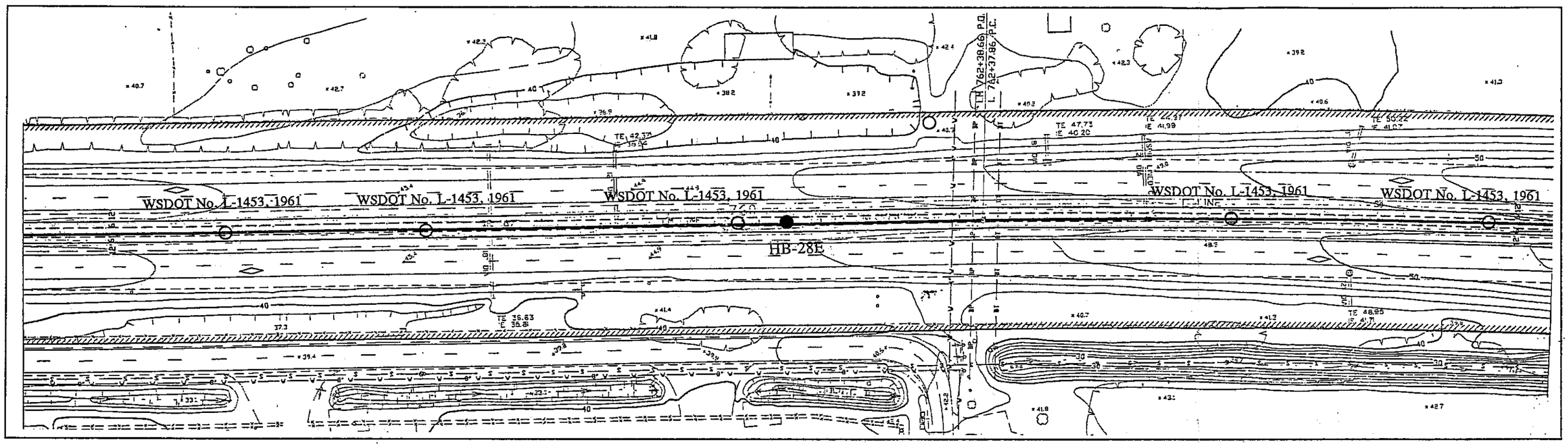
FIGURE NUMBER 20



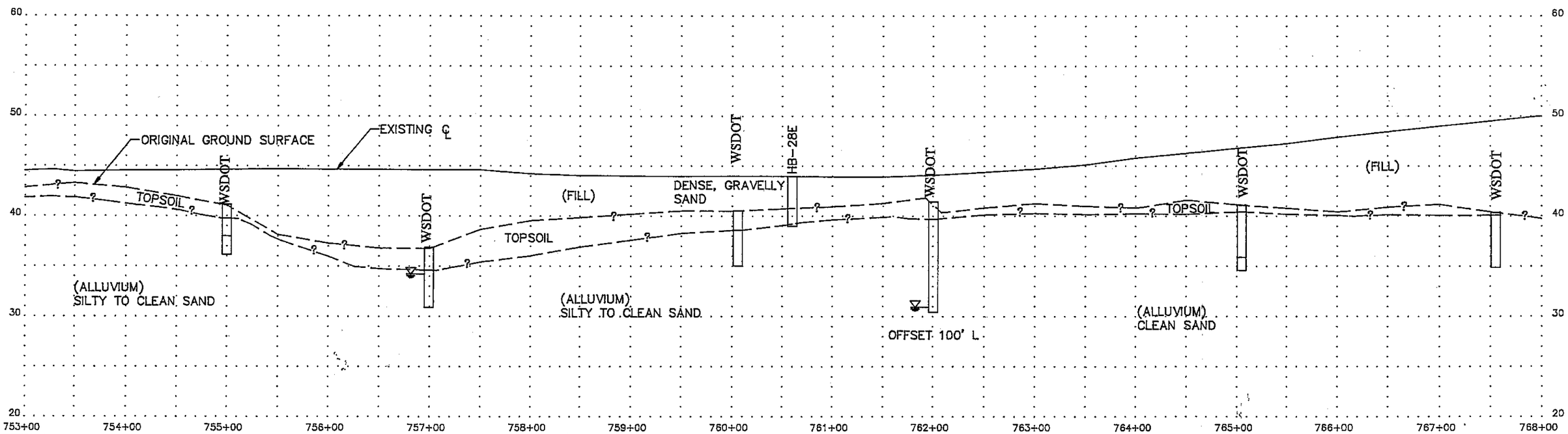
SCALE: HORIZ. 1"=100' VERT. 1"=10'



Hong West & Associates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES STA 738+00 TO STA 753+00	DRAWING NO. 20 FIGURE NUMBER 21



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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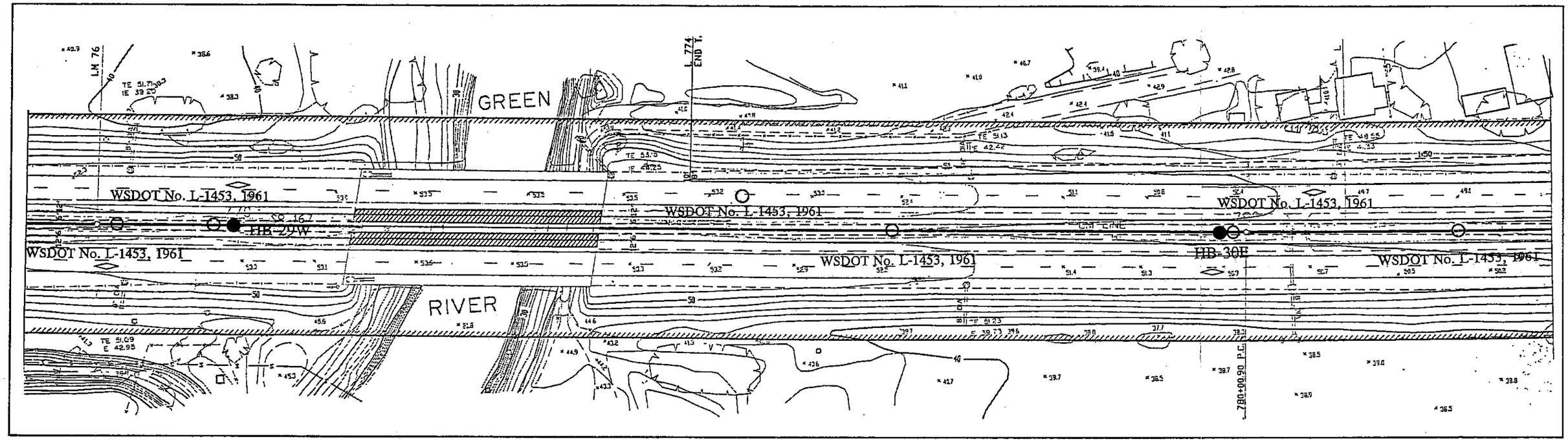
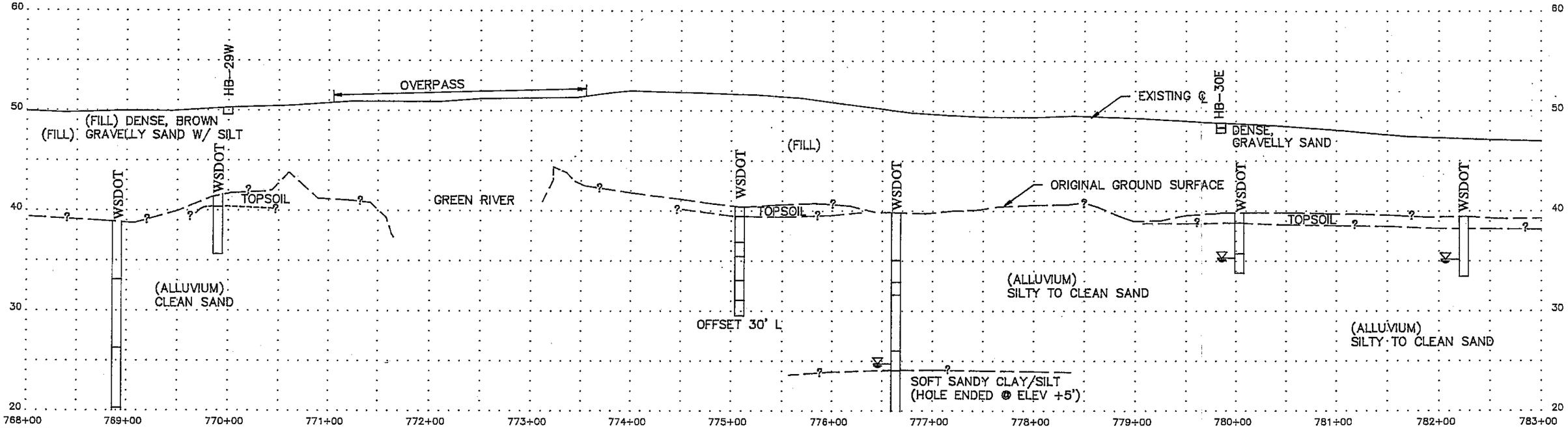


SCALE: HORIZ. 1"=100' VERT. 1"=10'



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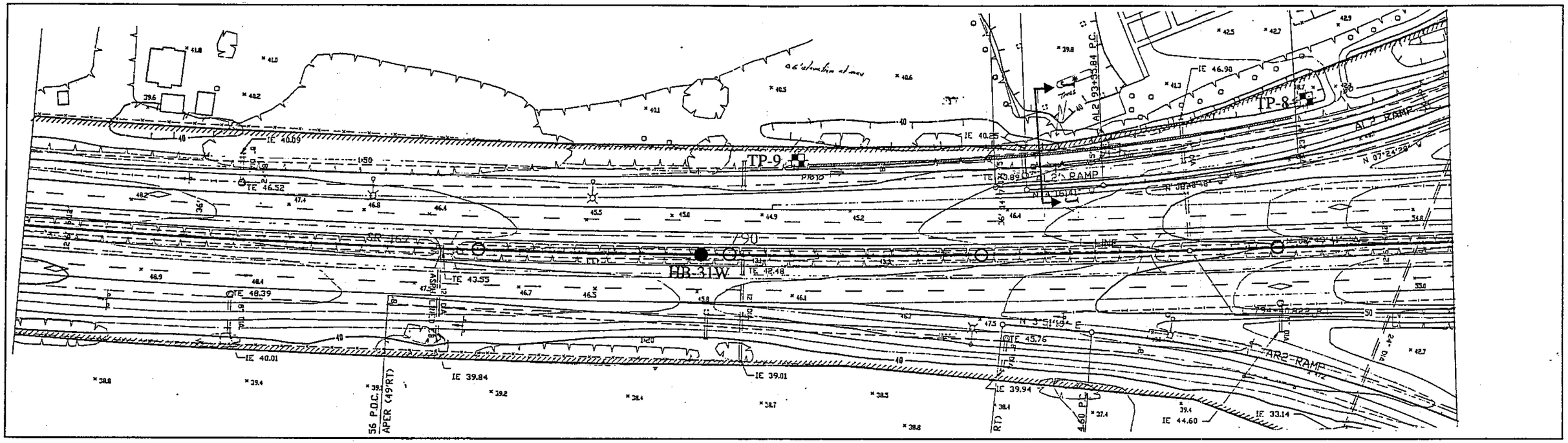
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

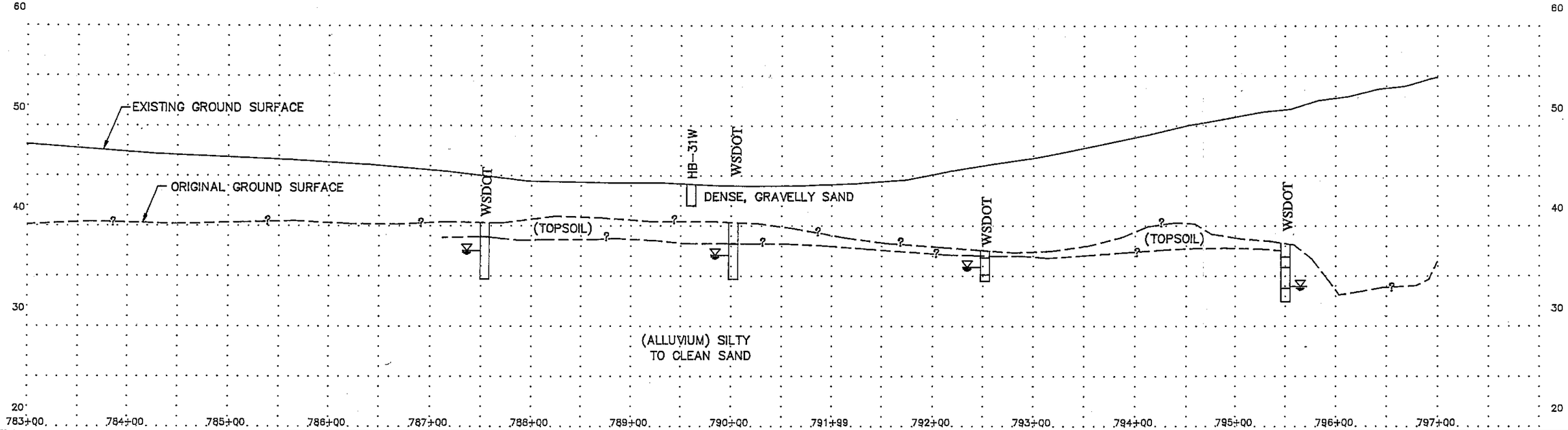
STA 768+00 TO STA 783+00

DRAWING NO.
22

FIGURE NUMBER
23



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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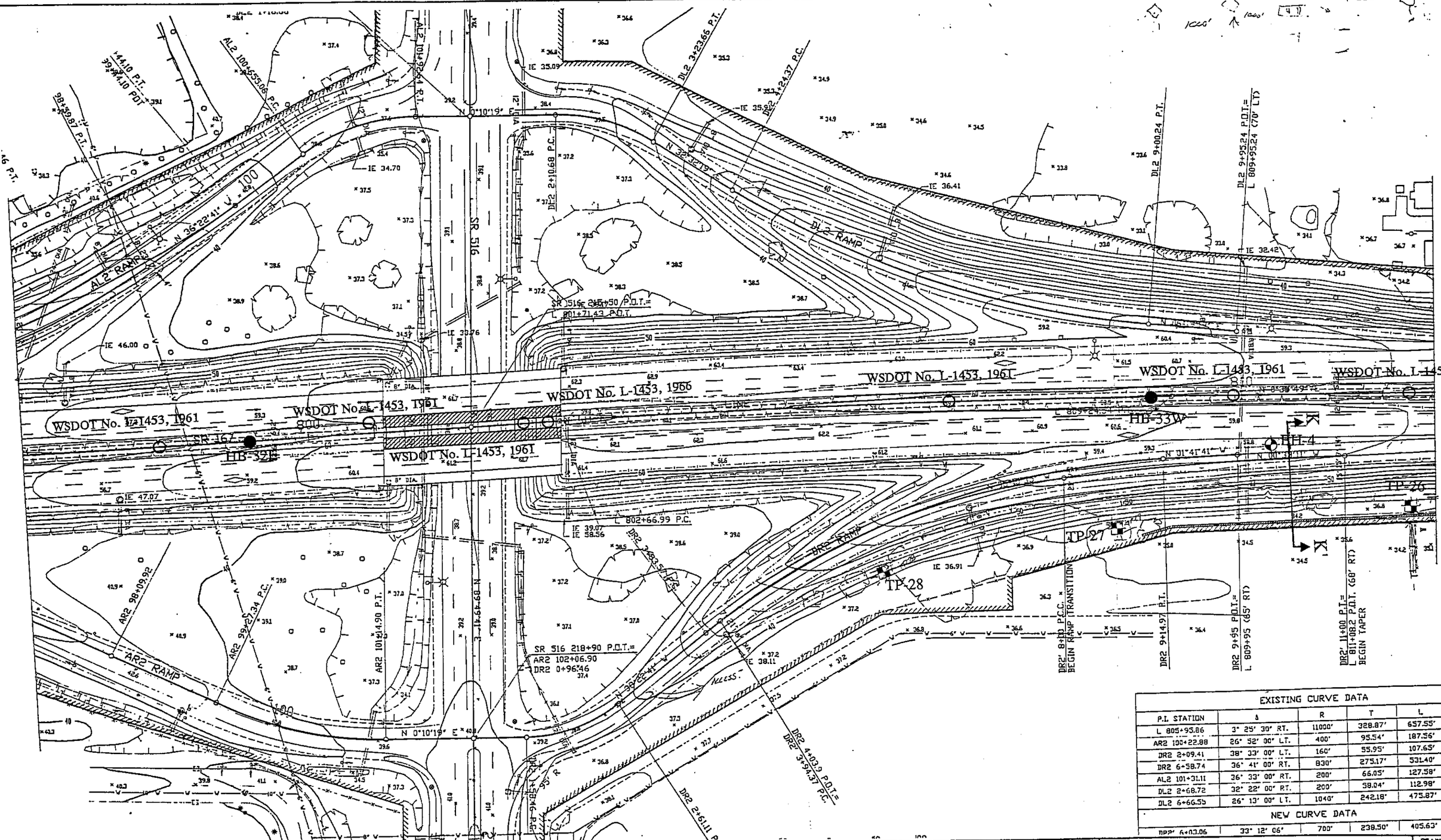
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 783+00 TP STA 797+00

DRAWING NO. 23

FIGURE NUMBER 24



EXISTING CURVE DATA				
P.I. STATION	Δ	R	T	L
L 805+93.86	3° 25' 30" RT.	11000'	328.87'	657.55'
AR2 100+22.88	26° 52' 00" LT.	400'	95.54'	187.56'
DR2 2+09.41	38° 33' 00" LT.	160'	55.95'	107.65'
DR2 6+58.74	36° 41' 00" RT.	830'	275.17'	531.40'
AL2 101+31.11	36° 33' 00" RT.	200'	66.05'	127.58'
DL2 2+68.72	32° 22' 00" RT.	200'	58.04'	112.98'
DL2 6+66.55	26° 13' 00" LT.	1040'	242.18'	475.87'
NEW CURVE DATA				
DR2' 6+03.06	33° 12' 06"	700'	238.50'	405.63'

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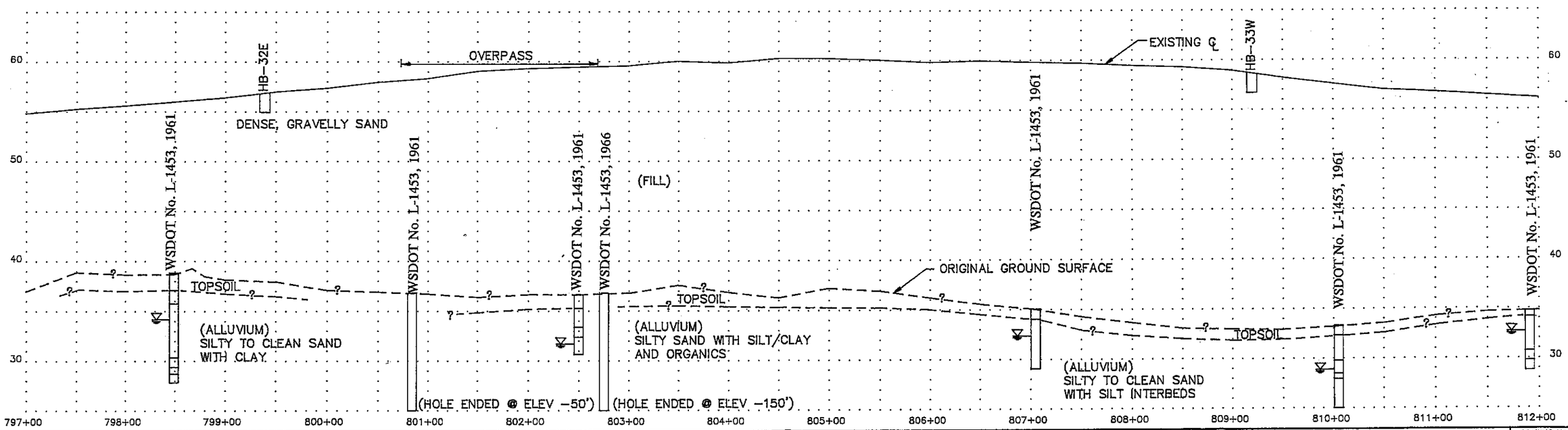
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 797+00 TO STA 812+00

DRAWING NO. 24

FIGURE NUMBER 25A

SCALE: HORIZ. 1"=100' VERT. 1"=10'



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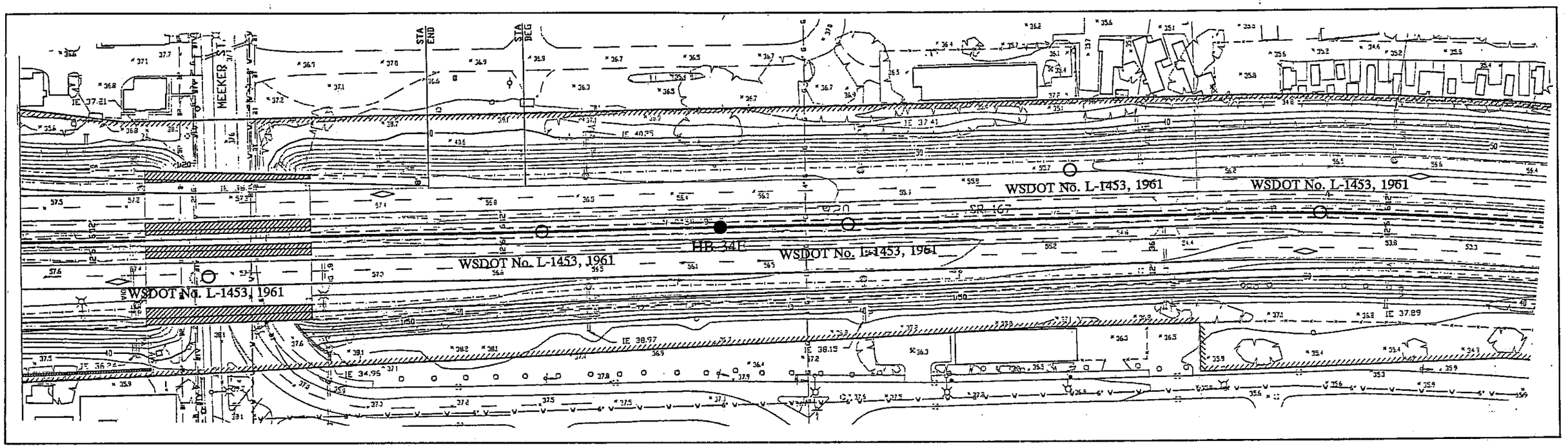
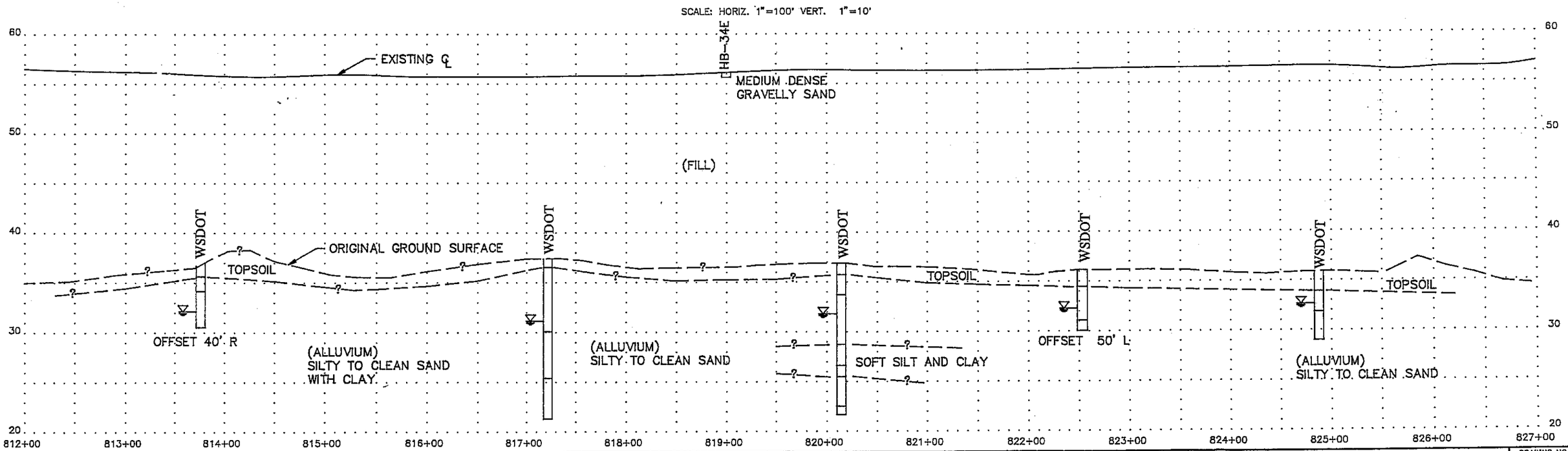
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 797+00 TO STA 812+00

DRAWING NO.
24

FIGURE NUMBER
25B





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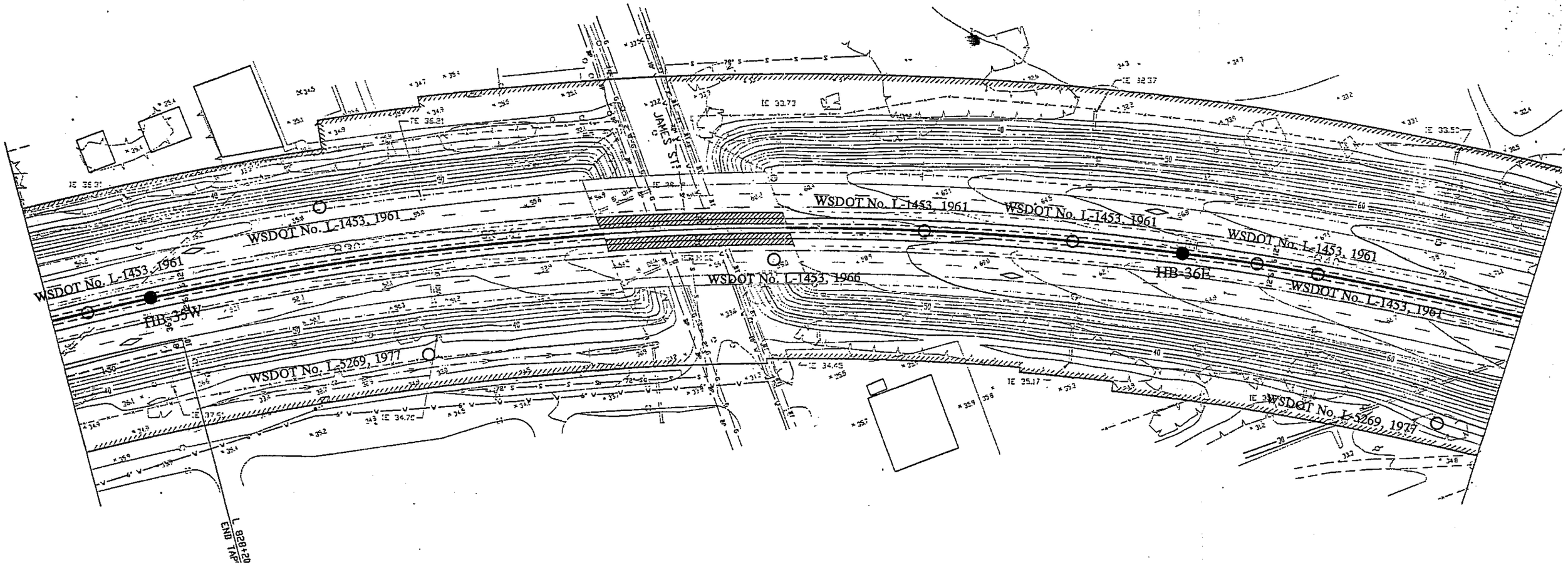

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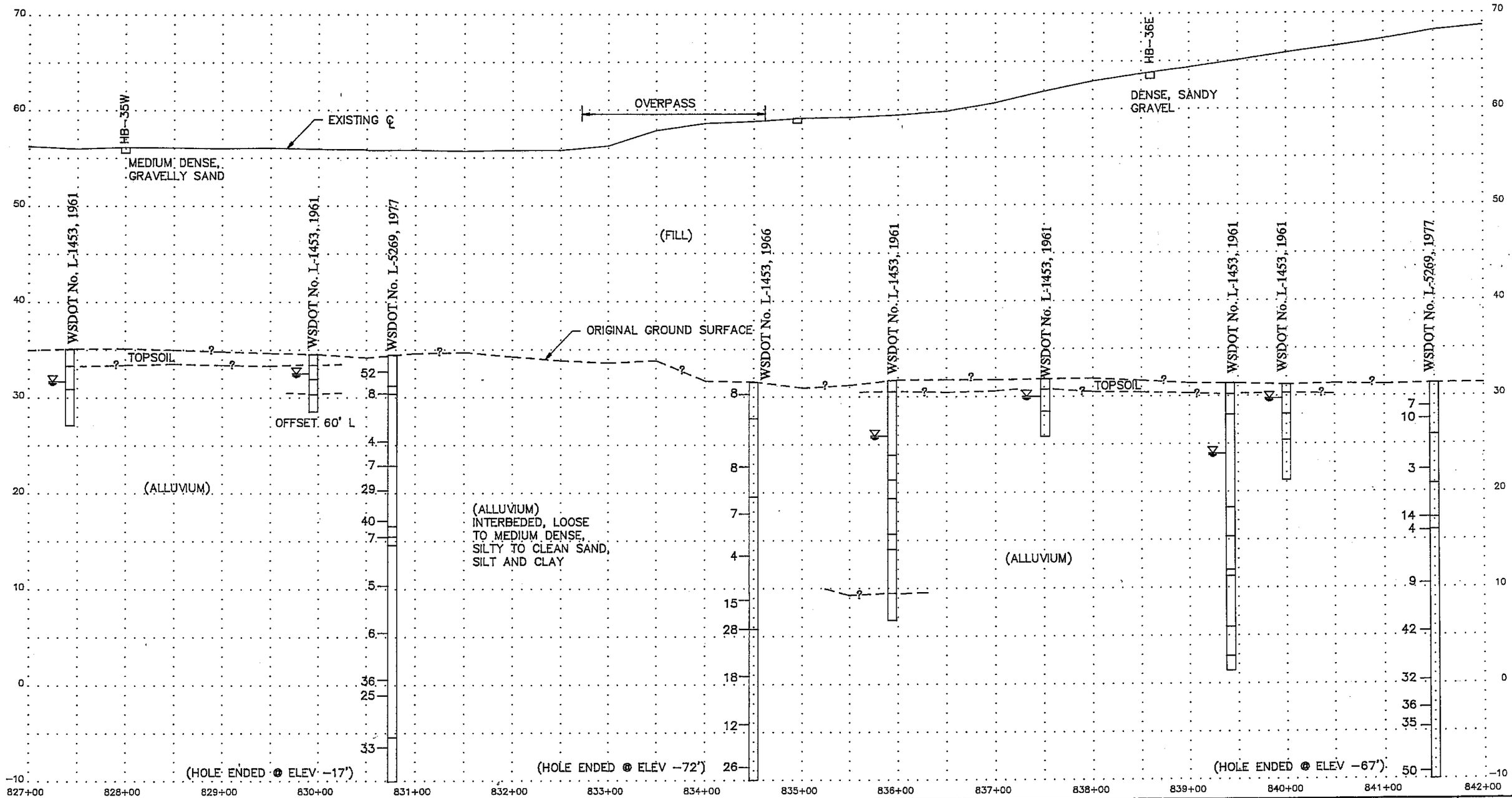
SCALE: HORIZ. 1"=100' VERT. 1"=10'



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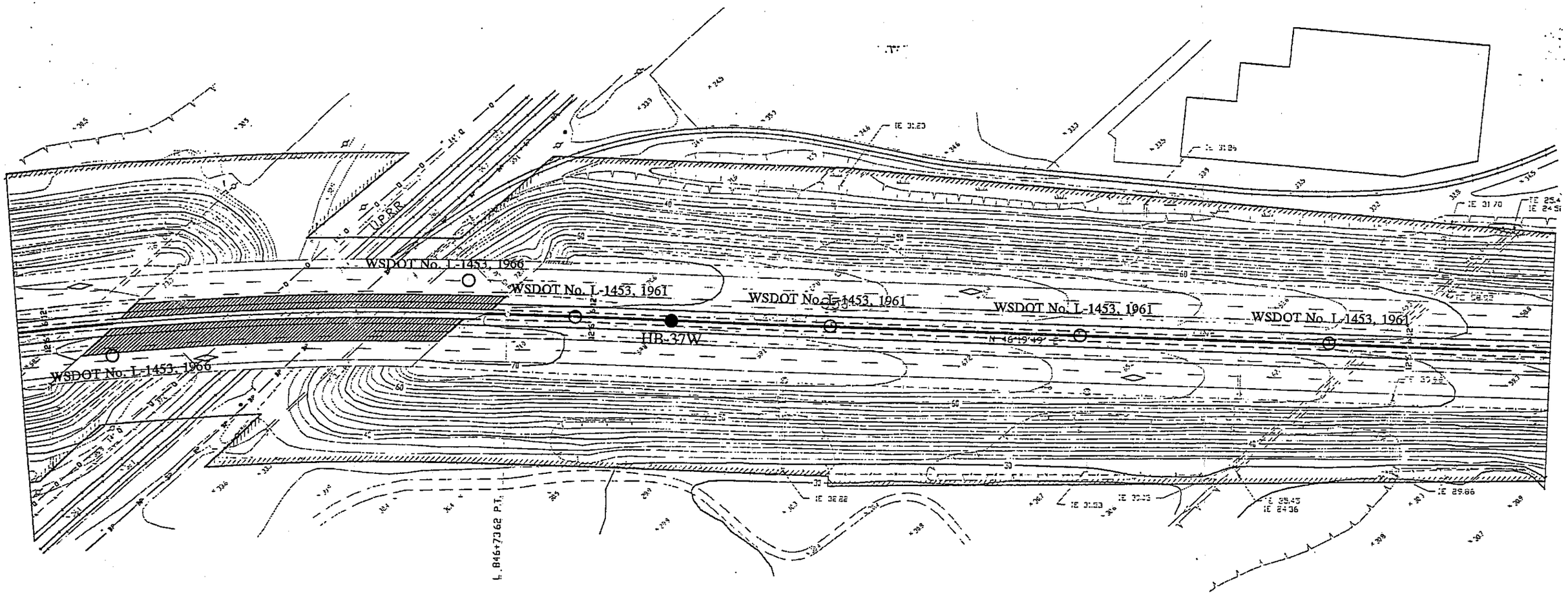

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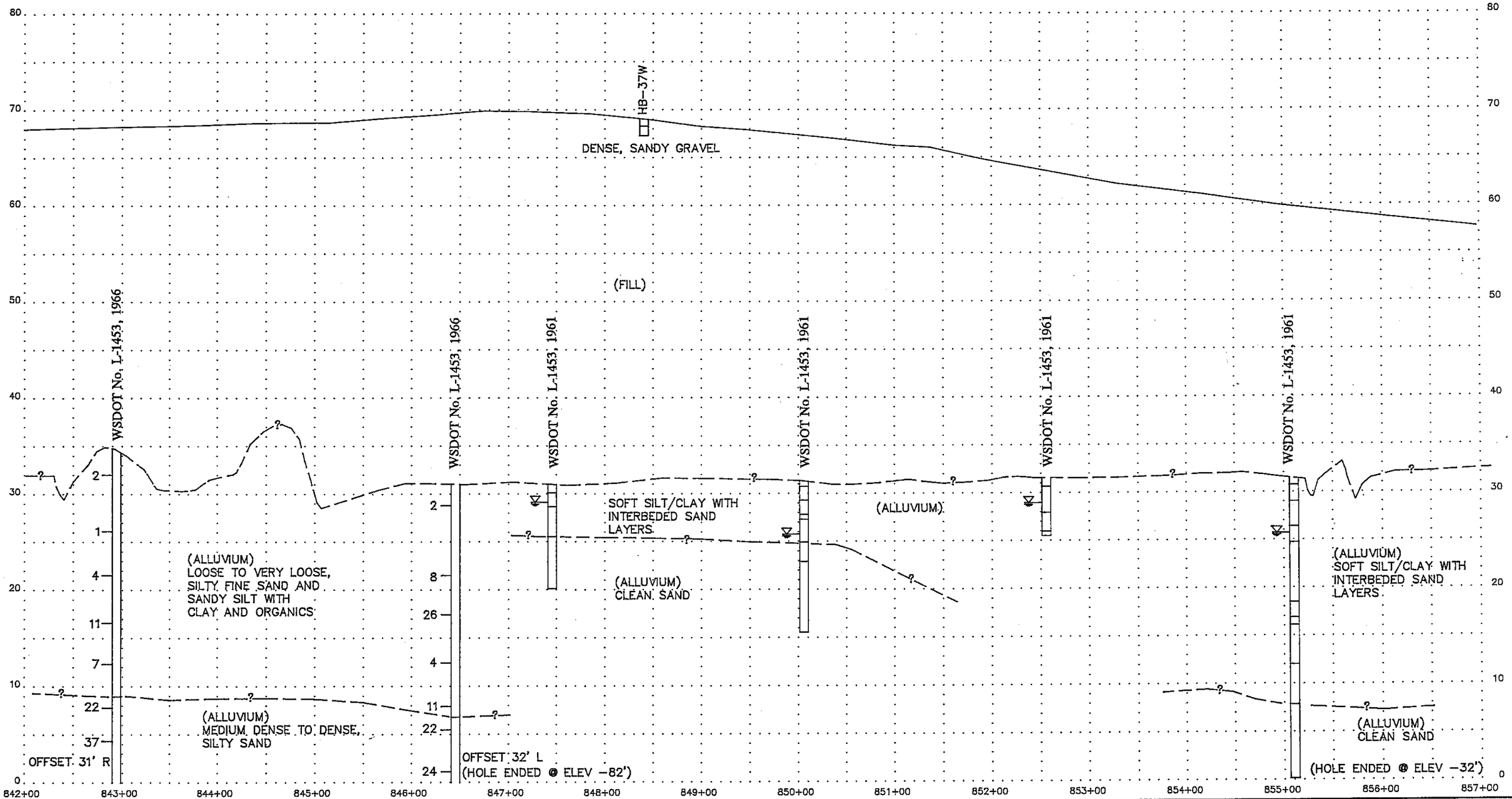
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 842+00 TO STA 857+00

DRAWING NO.
27

FIGURE NUMBER
28A



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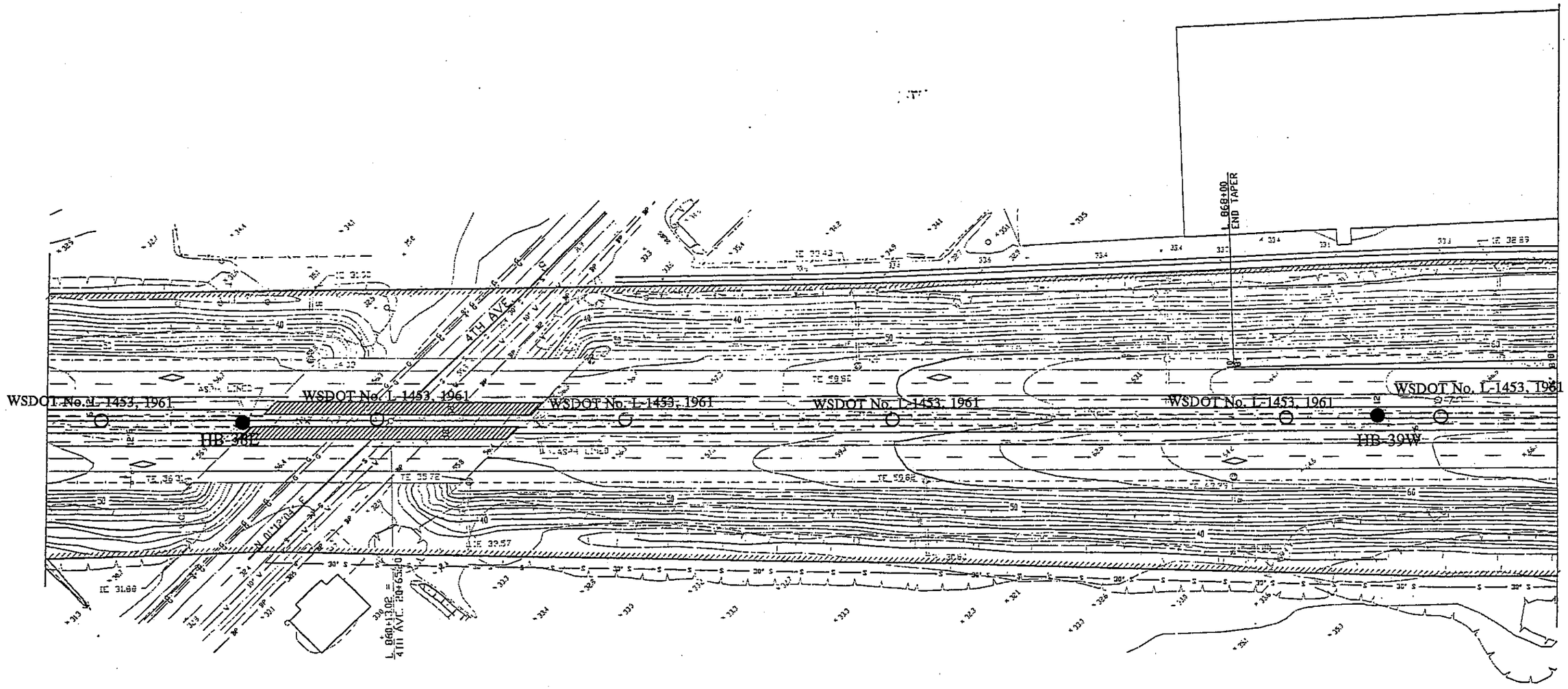
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 842+00 TO STA 857+00

DRAWING NO.
27

FIGURE NUMBER
28B



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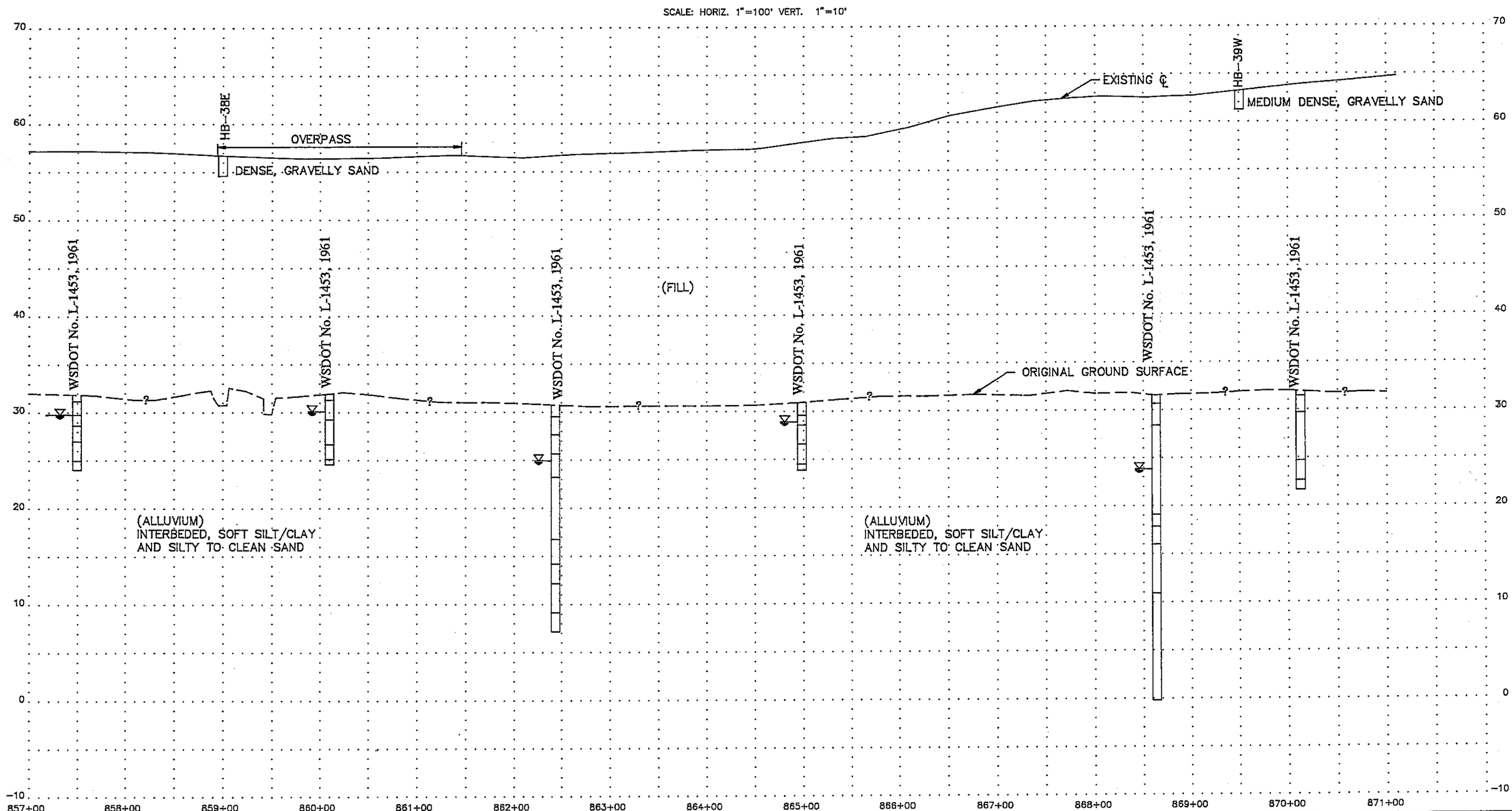
DRAWING NO. 28

FIGURE NUMBER 29A



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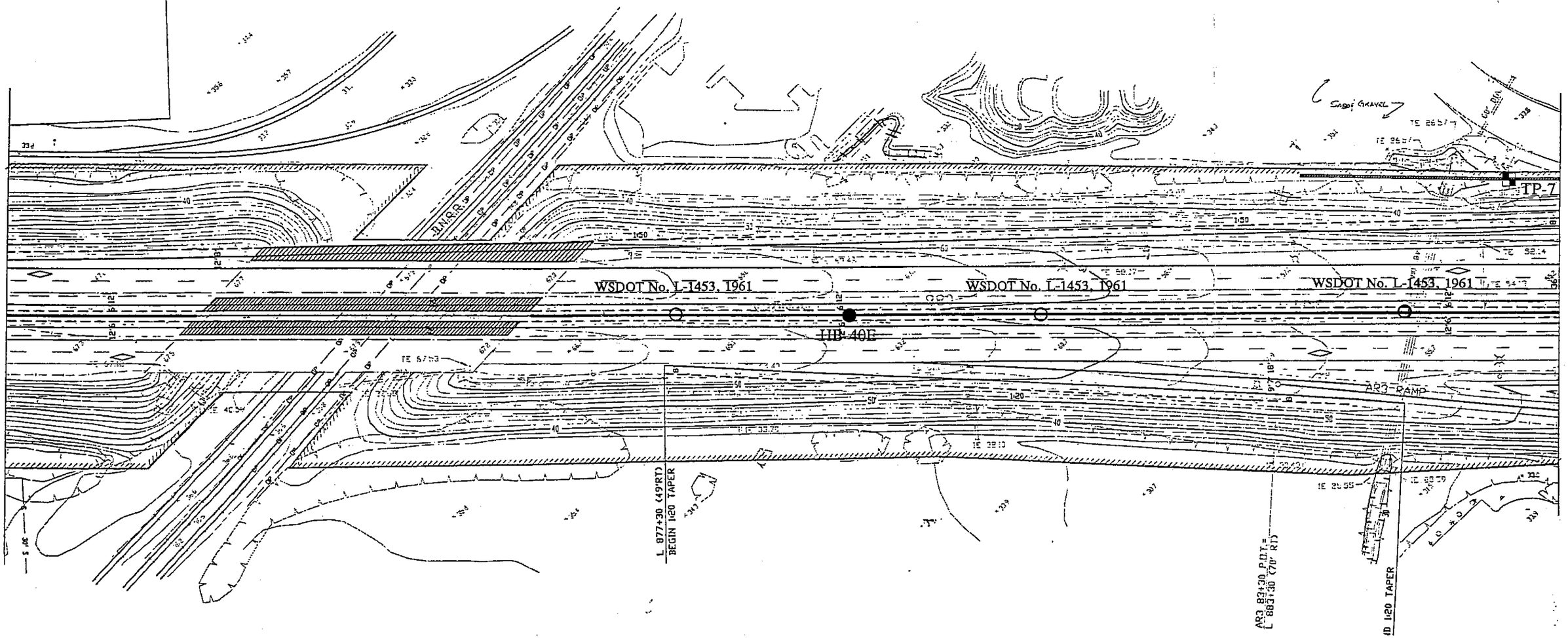
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 857+00 TO STA 871+00

DRAWING NO.
28

FIGURE NUMBER
29B



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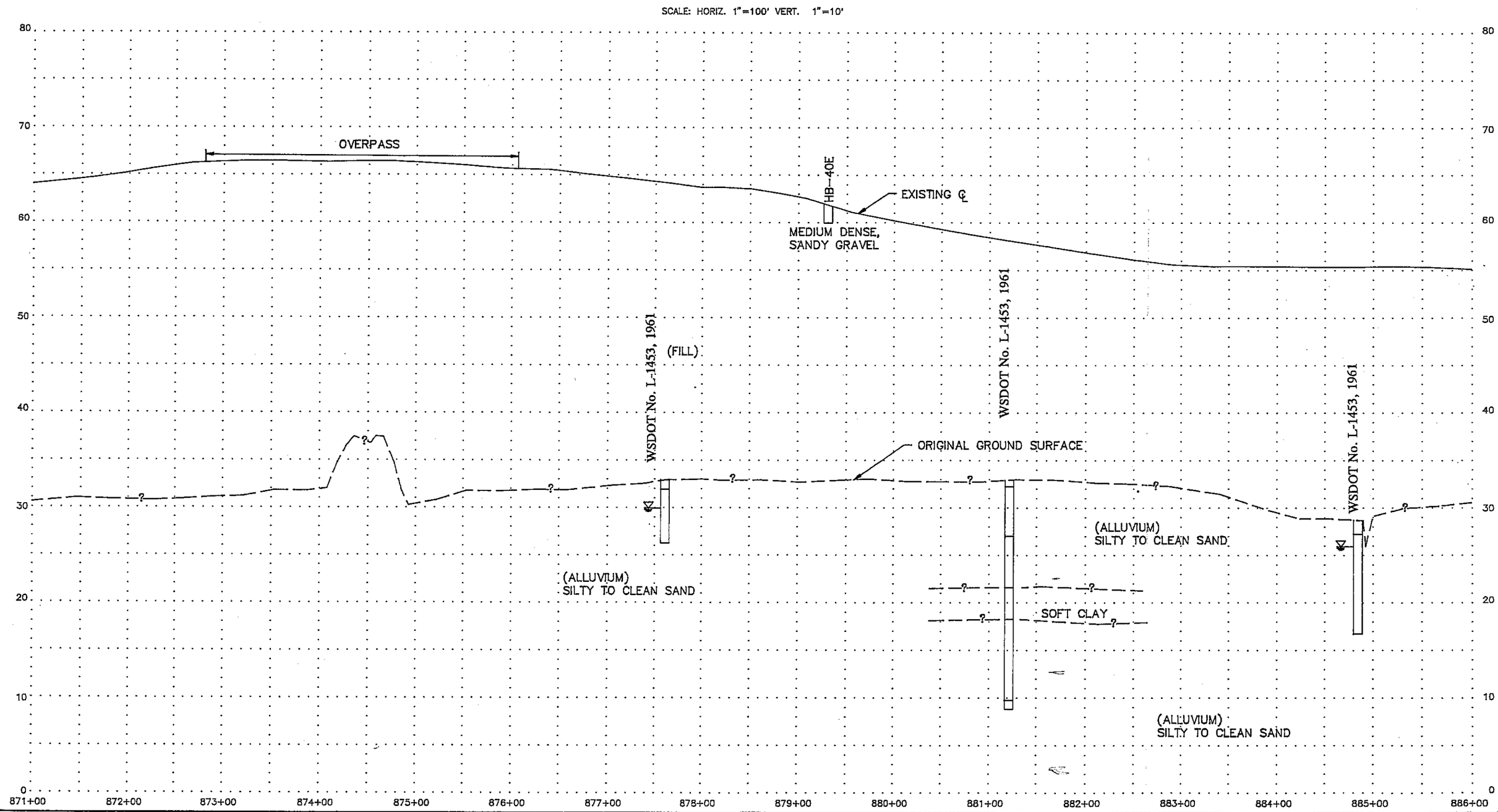

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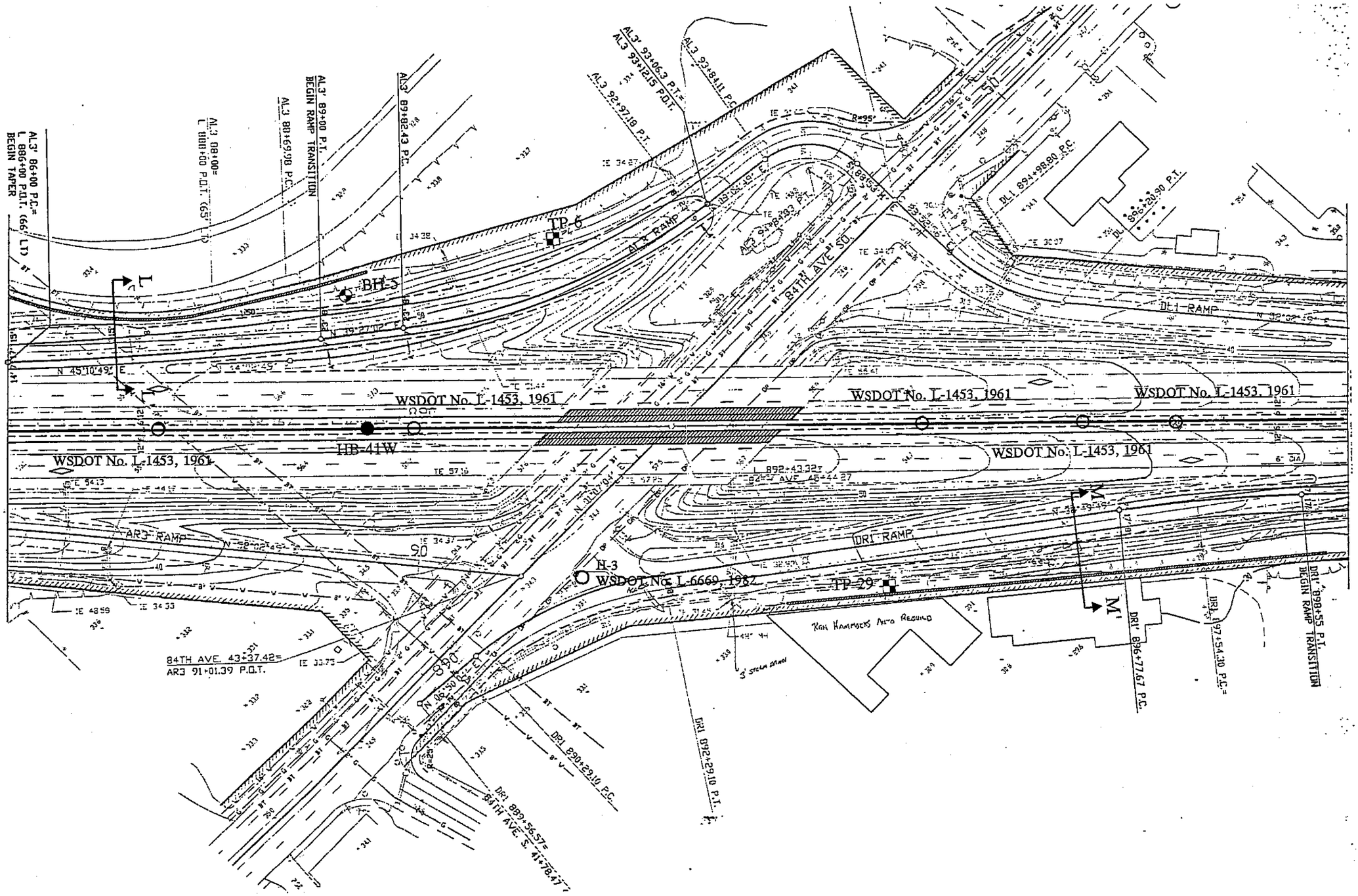
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 871+00 TO STA 886+00

DRAWING NO.
29

FIGURE NUMBER
30B



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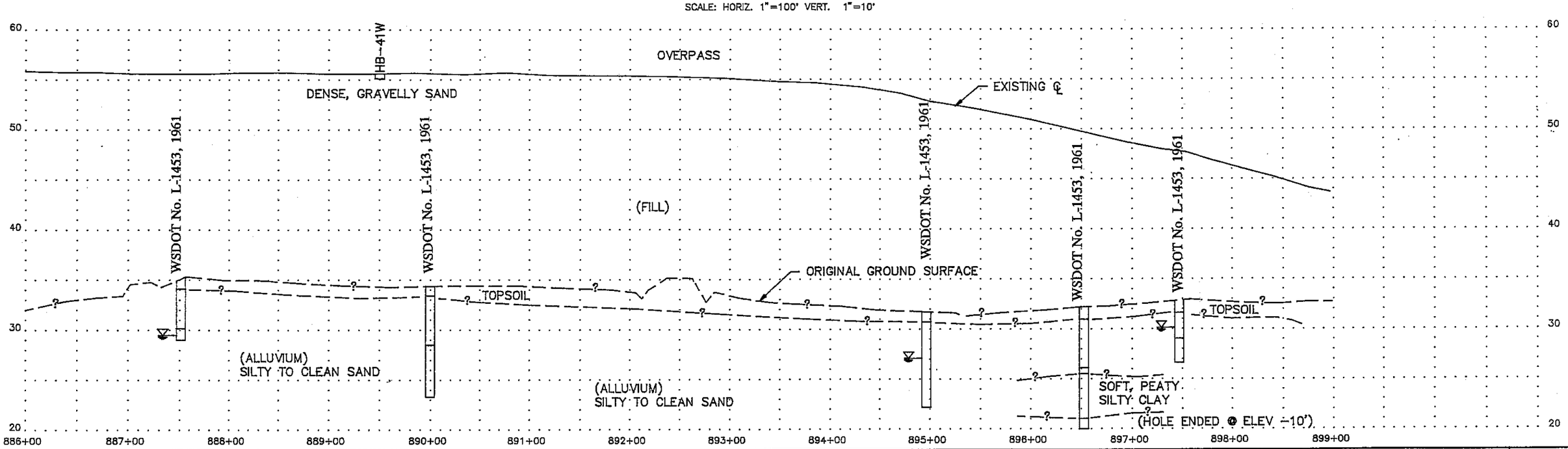
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 886+00 TO STA 899+00

DRAWING NO. 30

FIGURE NUMBER 31A



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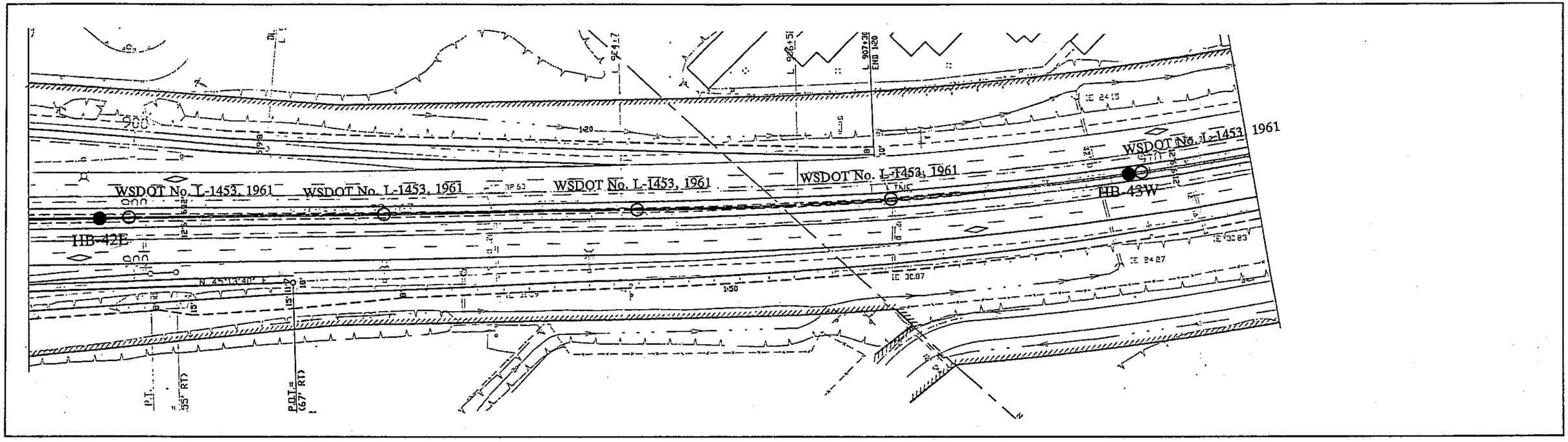
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

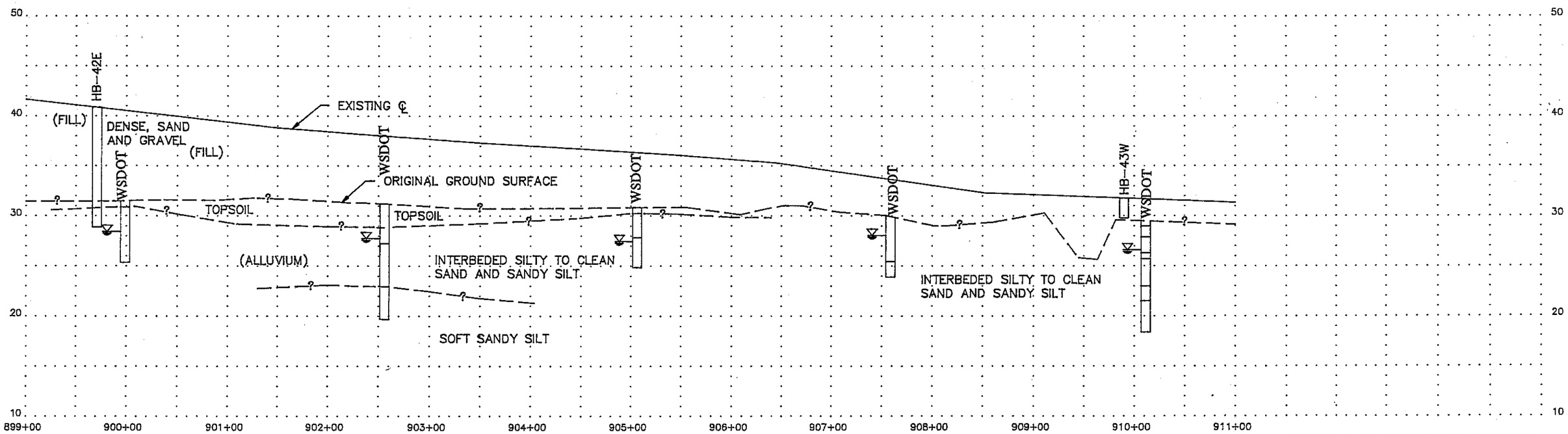
STA 886+00 TO STA 899+00

DRAWING NO.
30

FIGURE NUMBER
31B



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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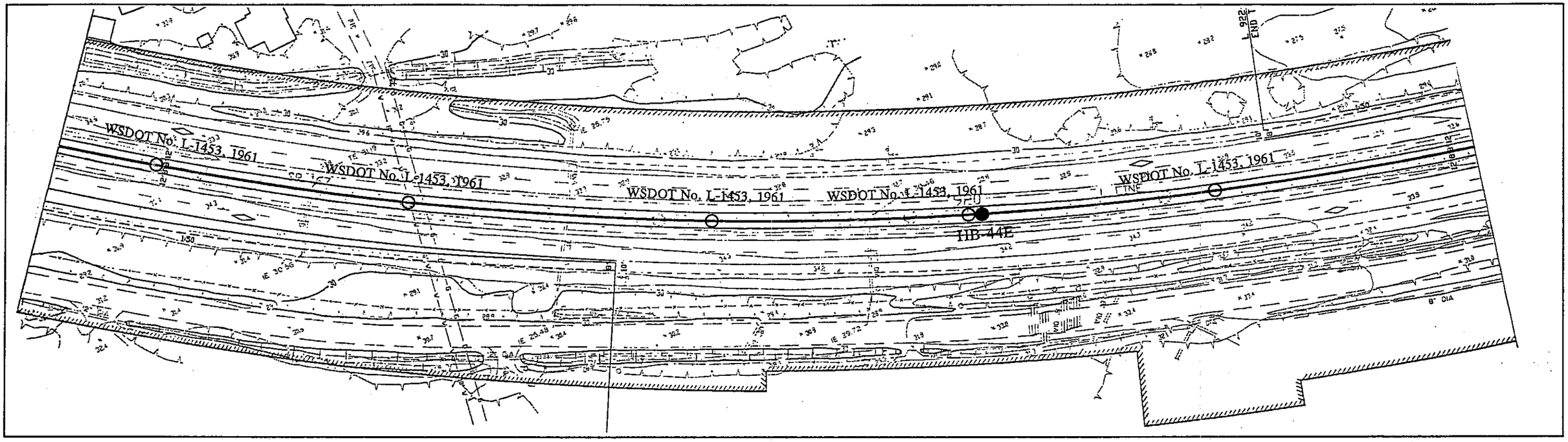
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

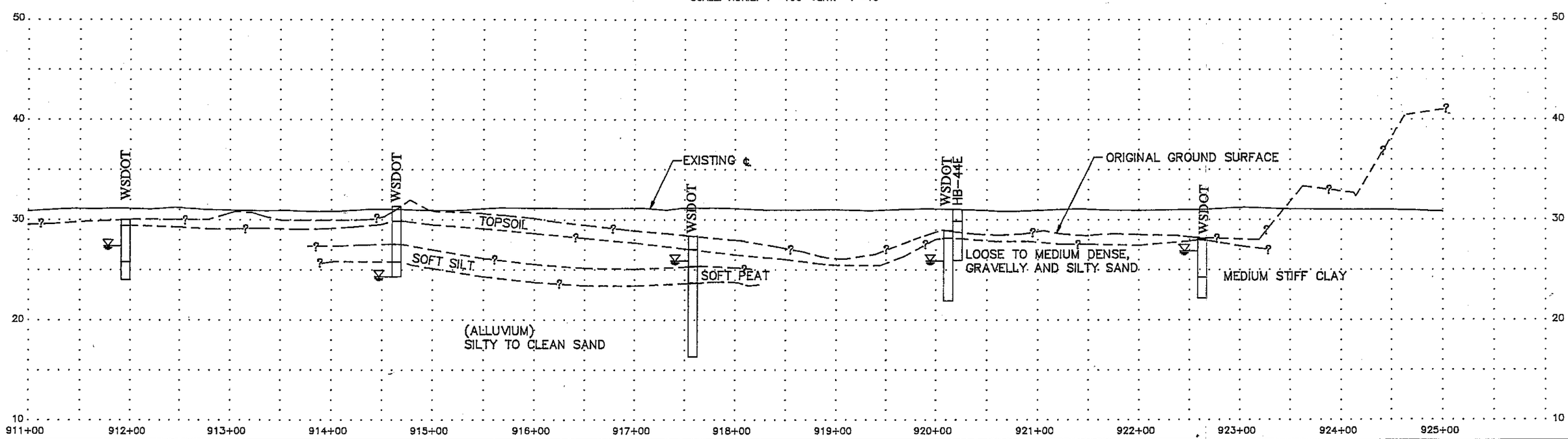
STA 899+00 TO STA 911+00

DRAWING NO. 31

FIGURE NUMBER 32



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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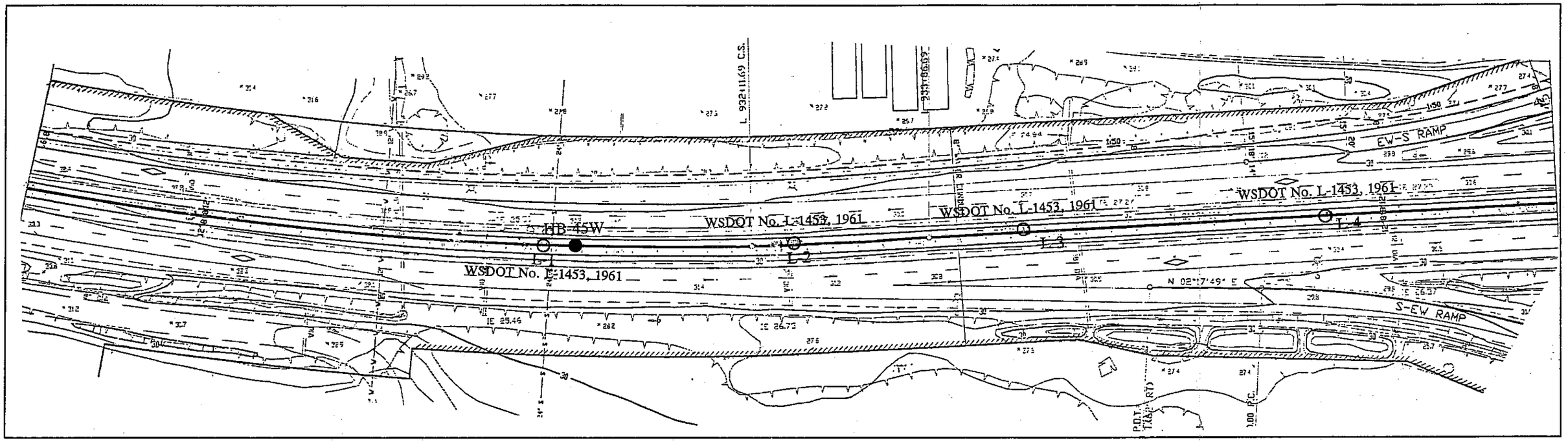
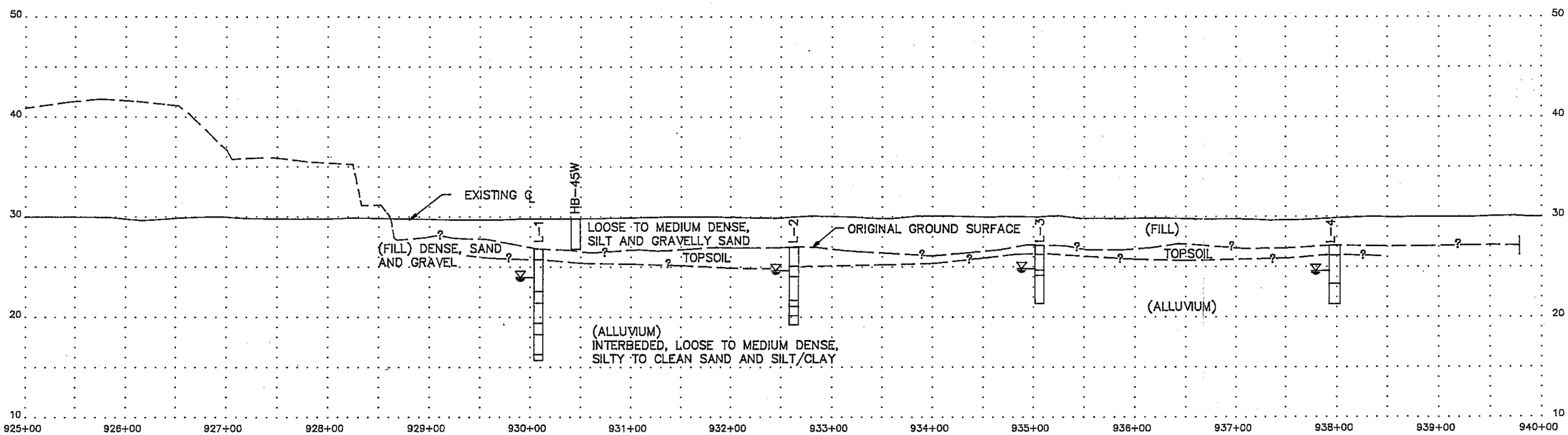


SCALE: HORIZ. 1"=100' VERT. 1"=10'



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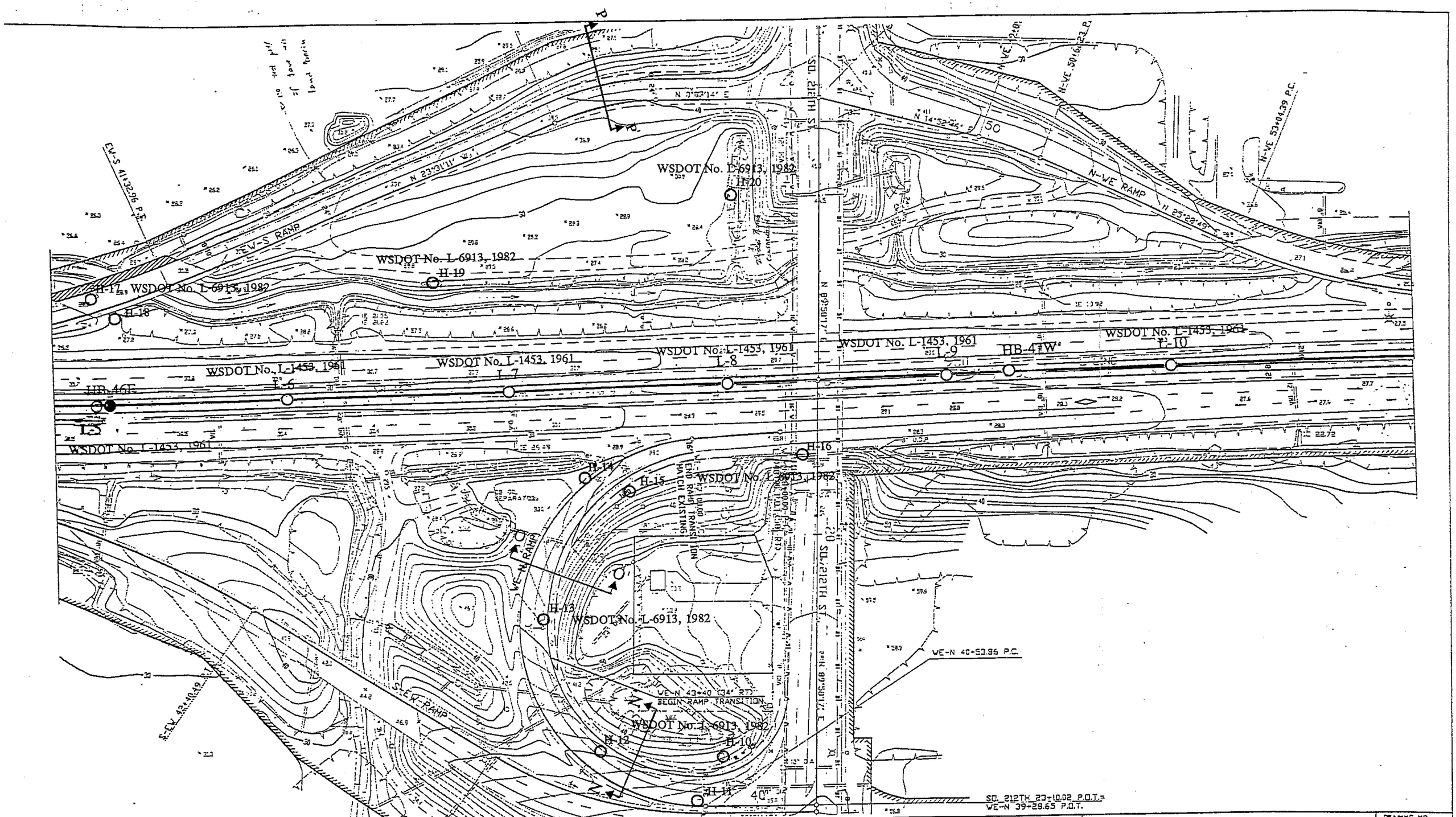
Washington State Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 925+00 TO STA 940+00

DRAWING NO. 33

FIGURE NUMBER 34



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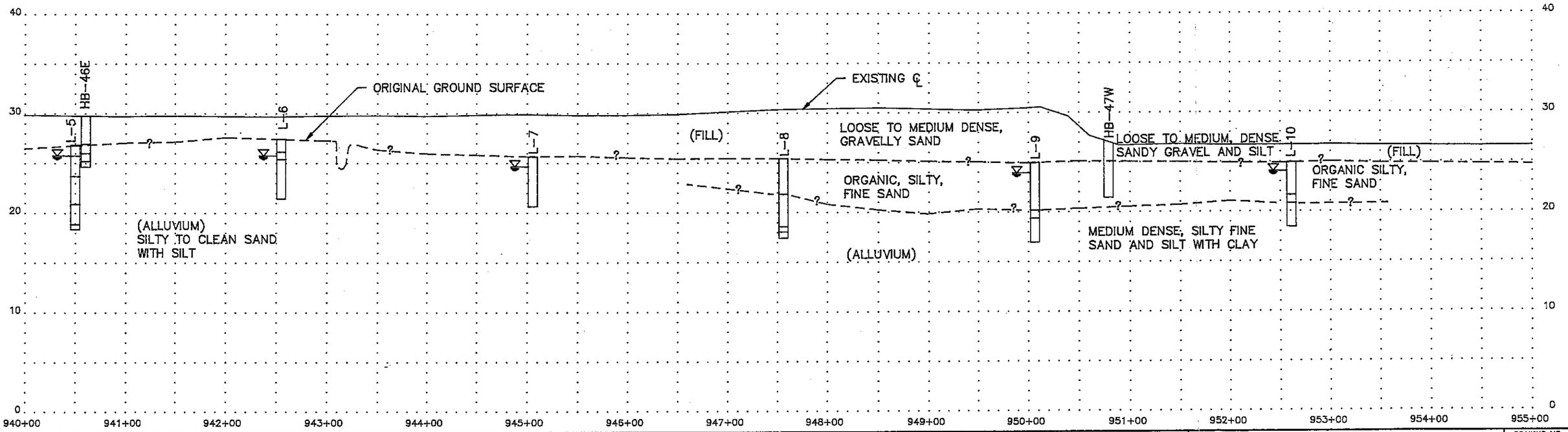
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 940+00 TO STA 955+00

DRAWING NO.
34

FIGURE NUMBER
35A

SCALE: HORIZ. 1"=100' VERT. 1"=10'



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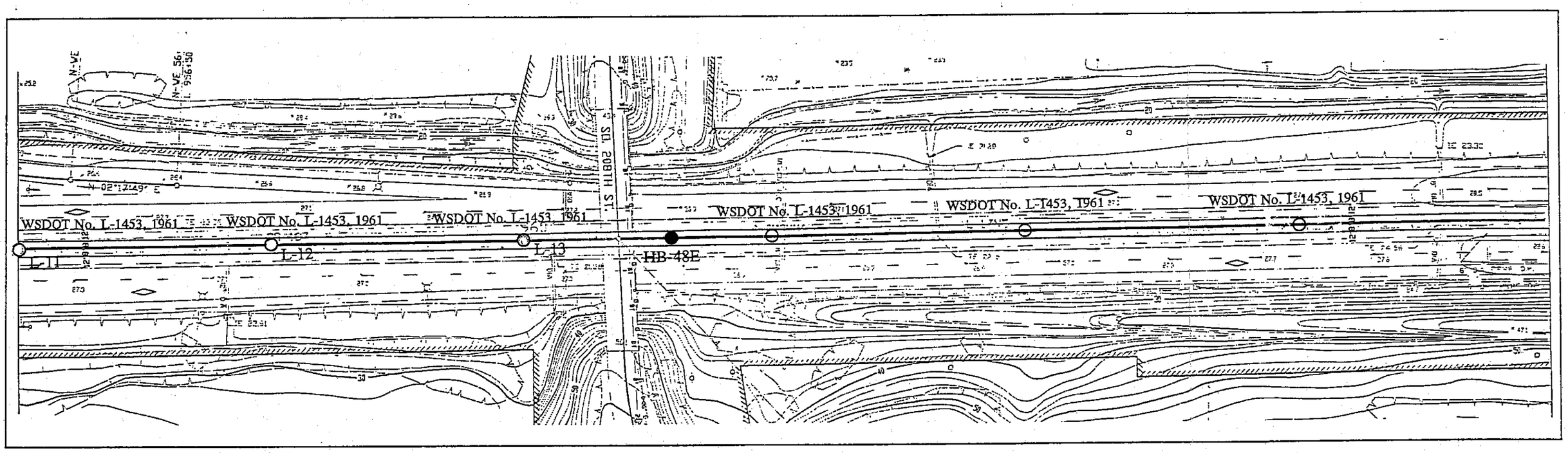
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

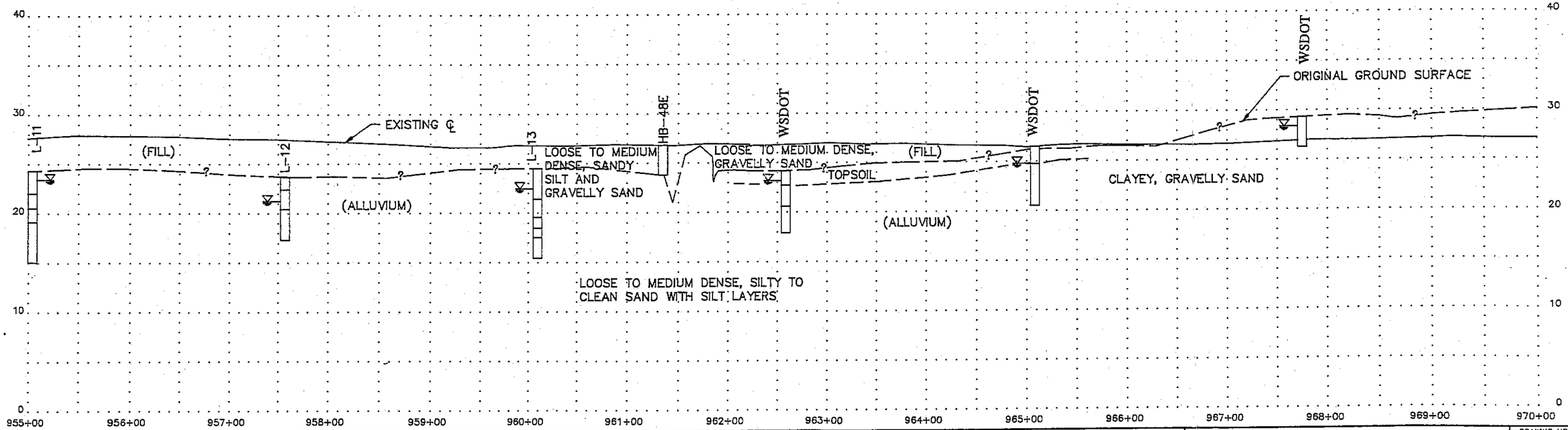
STA 940+00 TO STA 955+00

DRAWING NO. 34/35

FIGURE NUMBER 35B



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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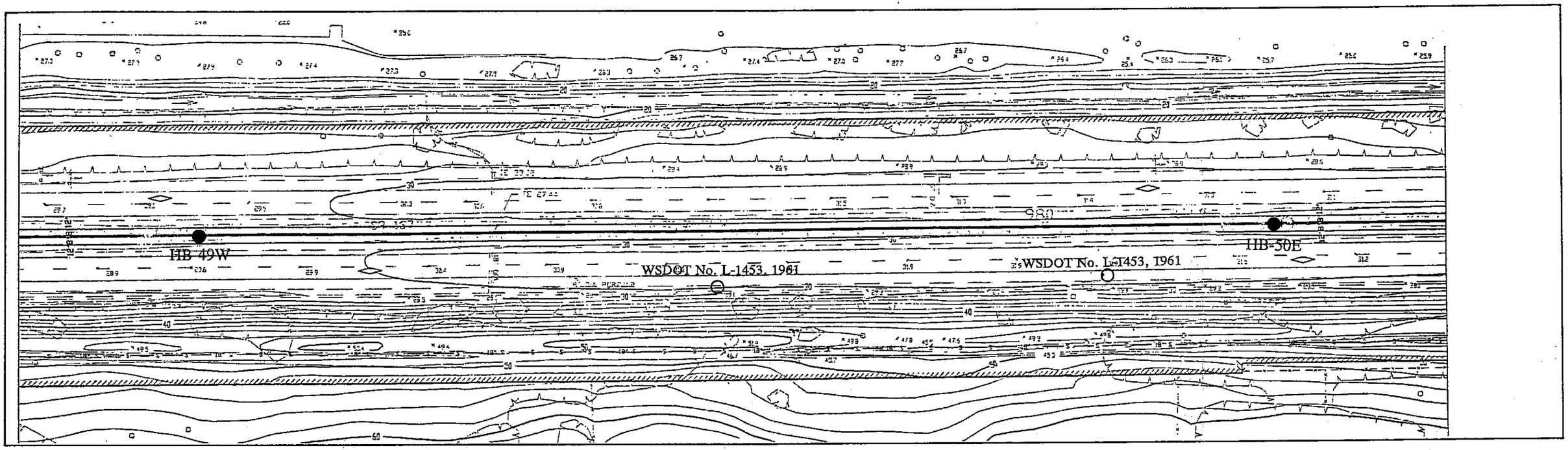
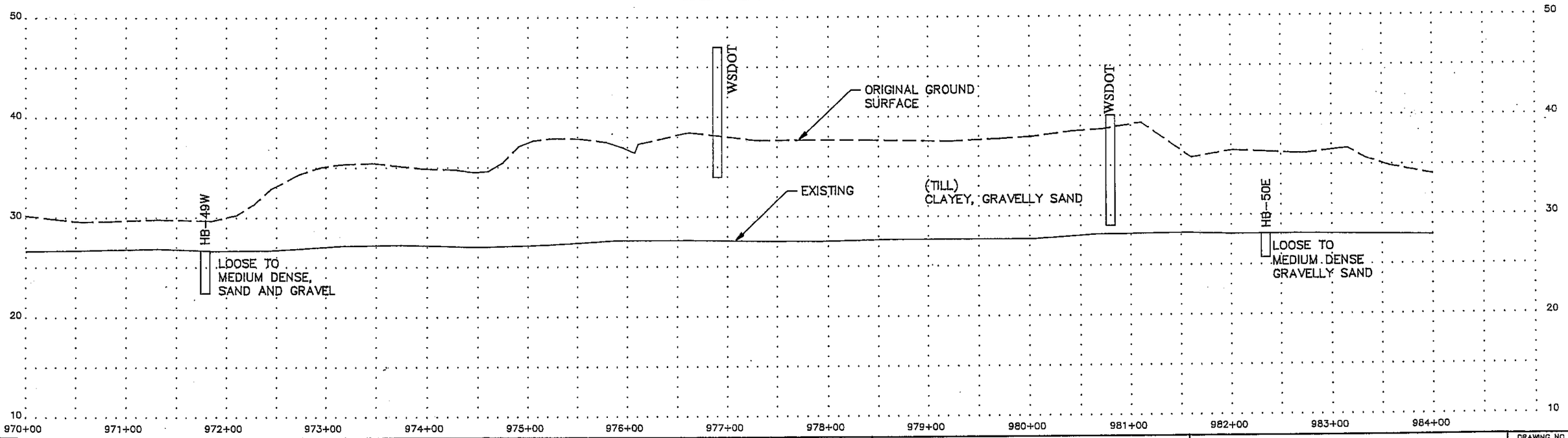


SCALE: HORIZ. 1"=100' VERT. 1"=10'



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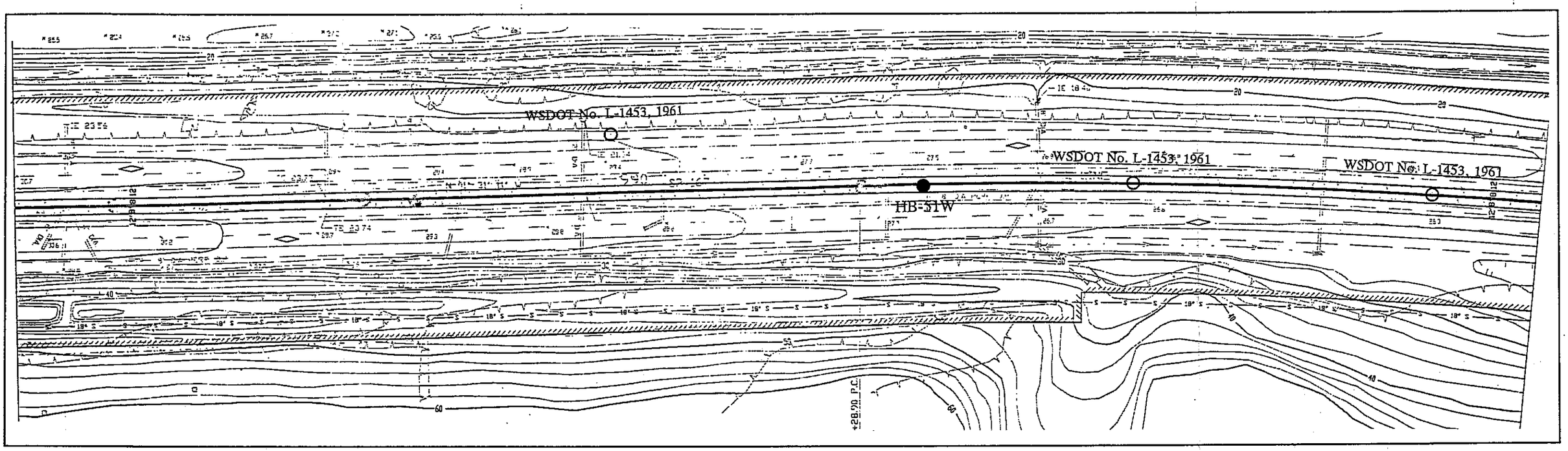
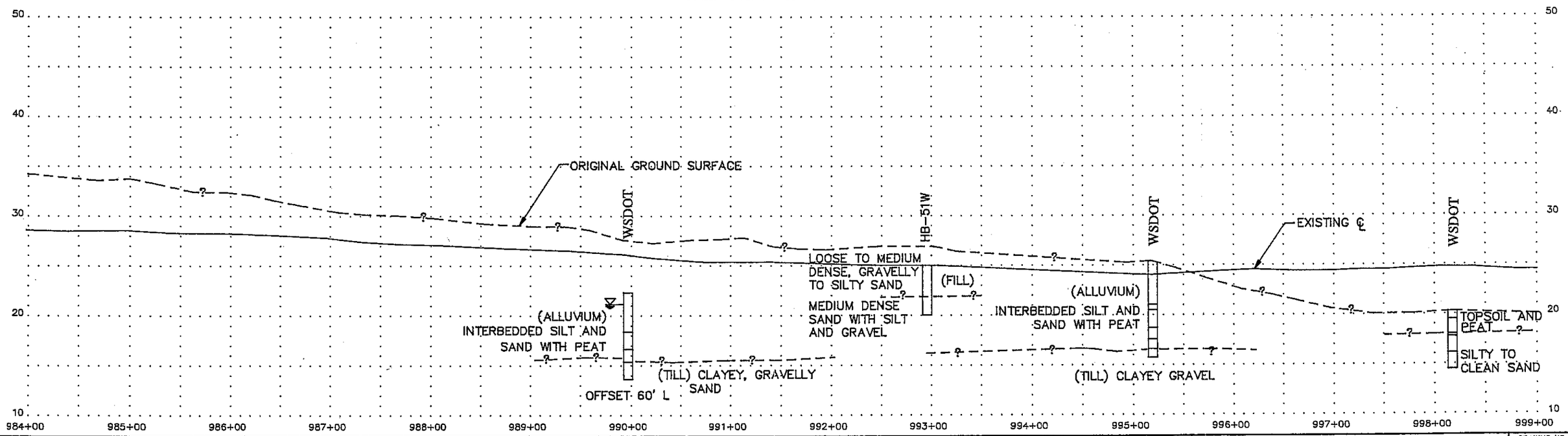


SCALE: HORIZ. 1"=100' VERT. 1"=10'



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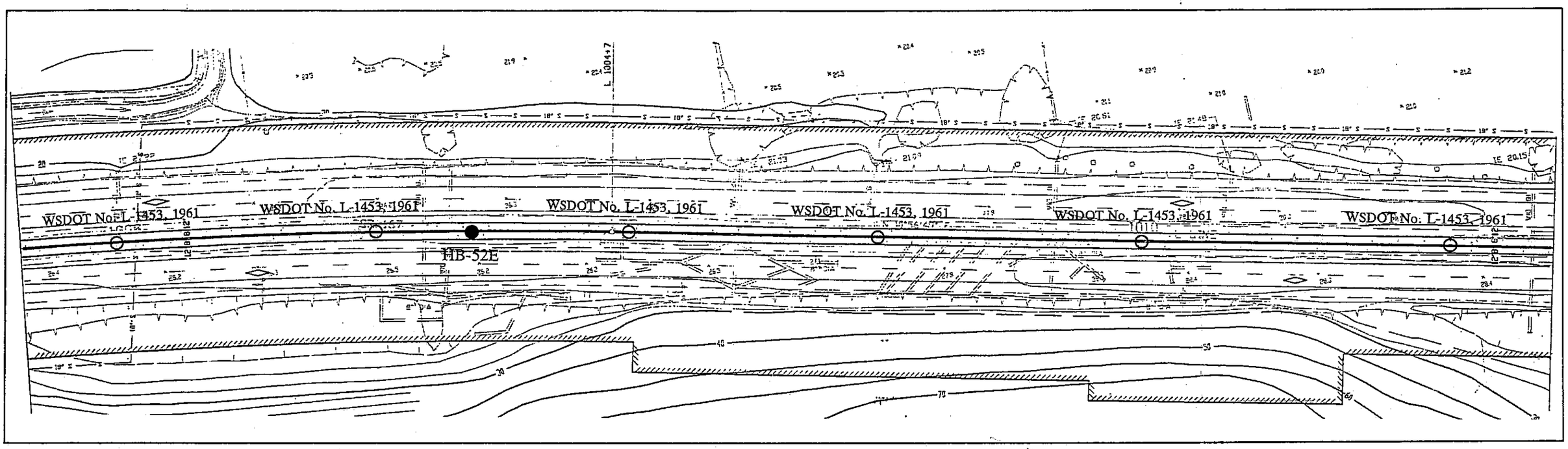
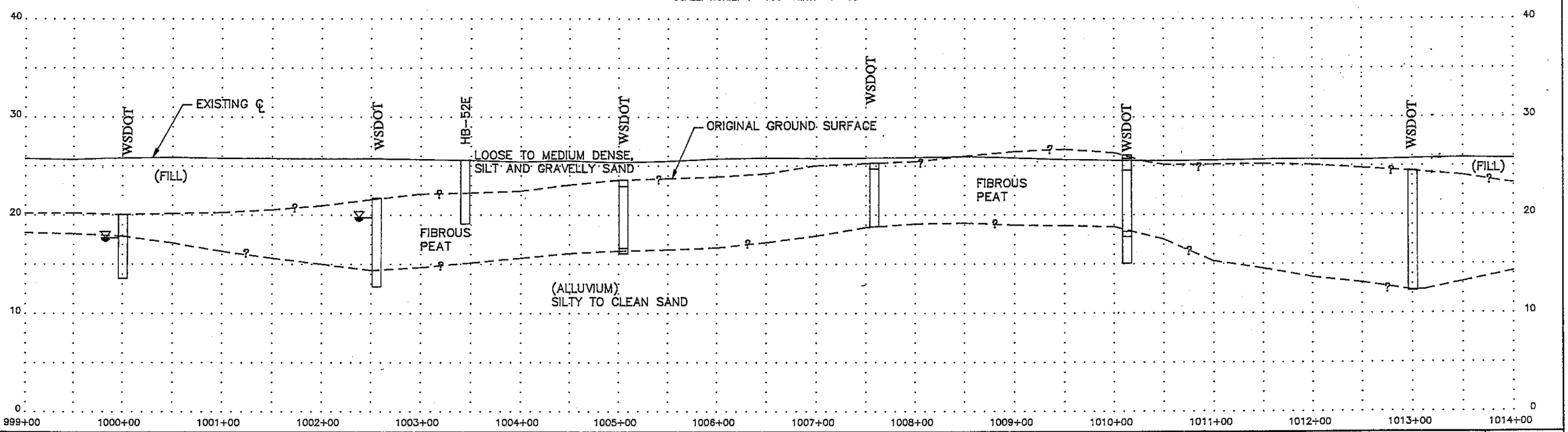


SCALE: HORIZ. 1"=100' VERT. 1"=10'



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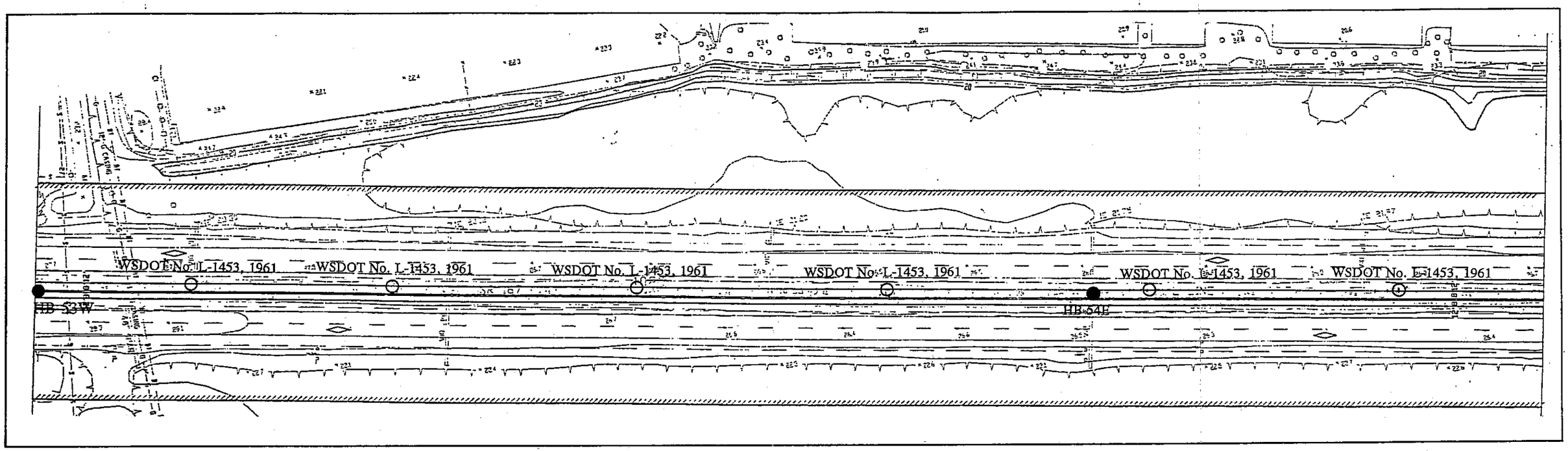
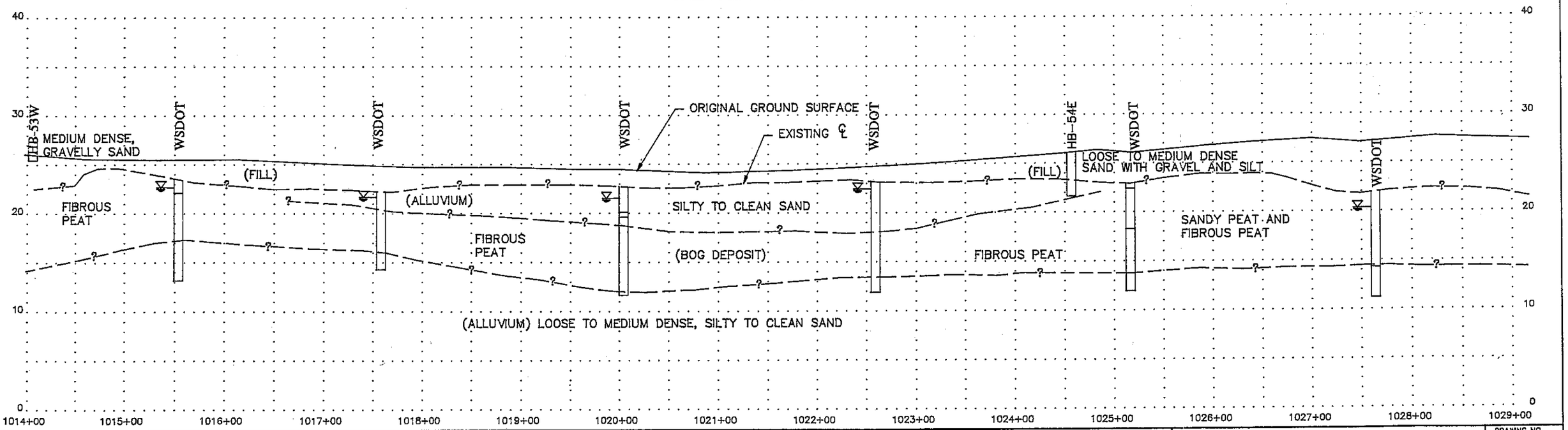


SCALE: HORIZ. 1"=100' VERT. 1"=10'



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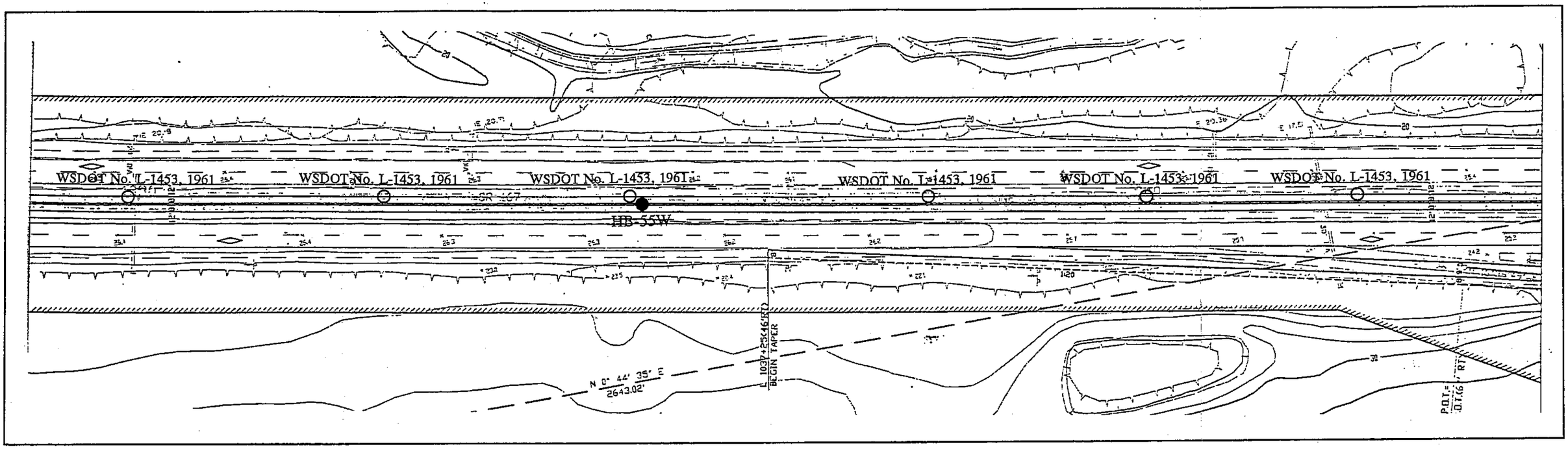
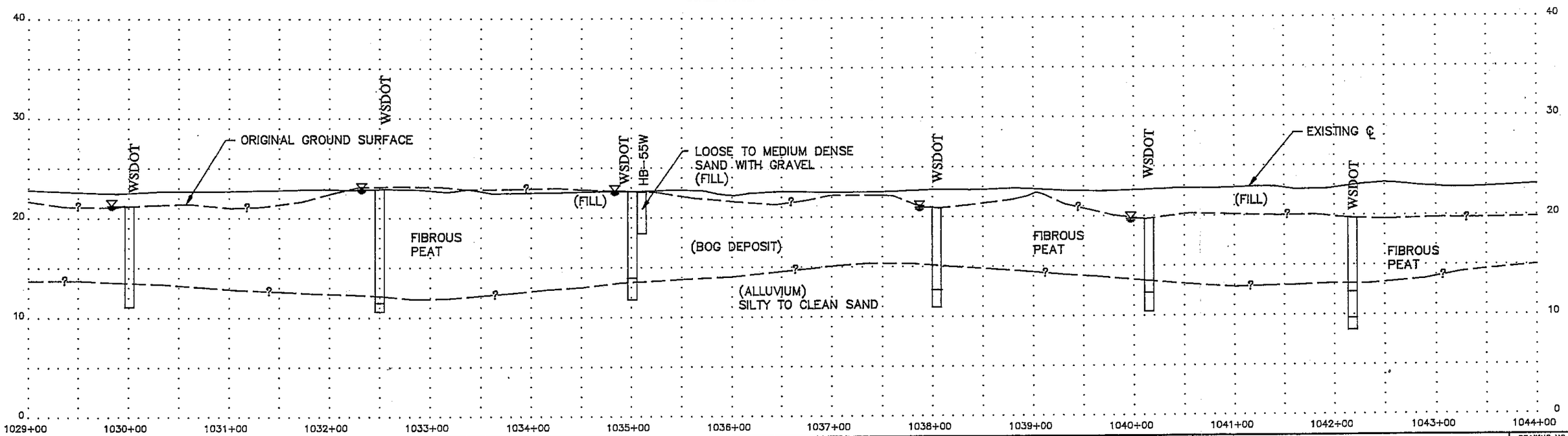


SCALE: HORIZ. 1"=100' VERT. 1"=10'



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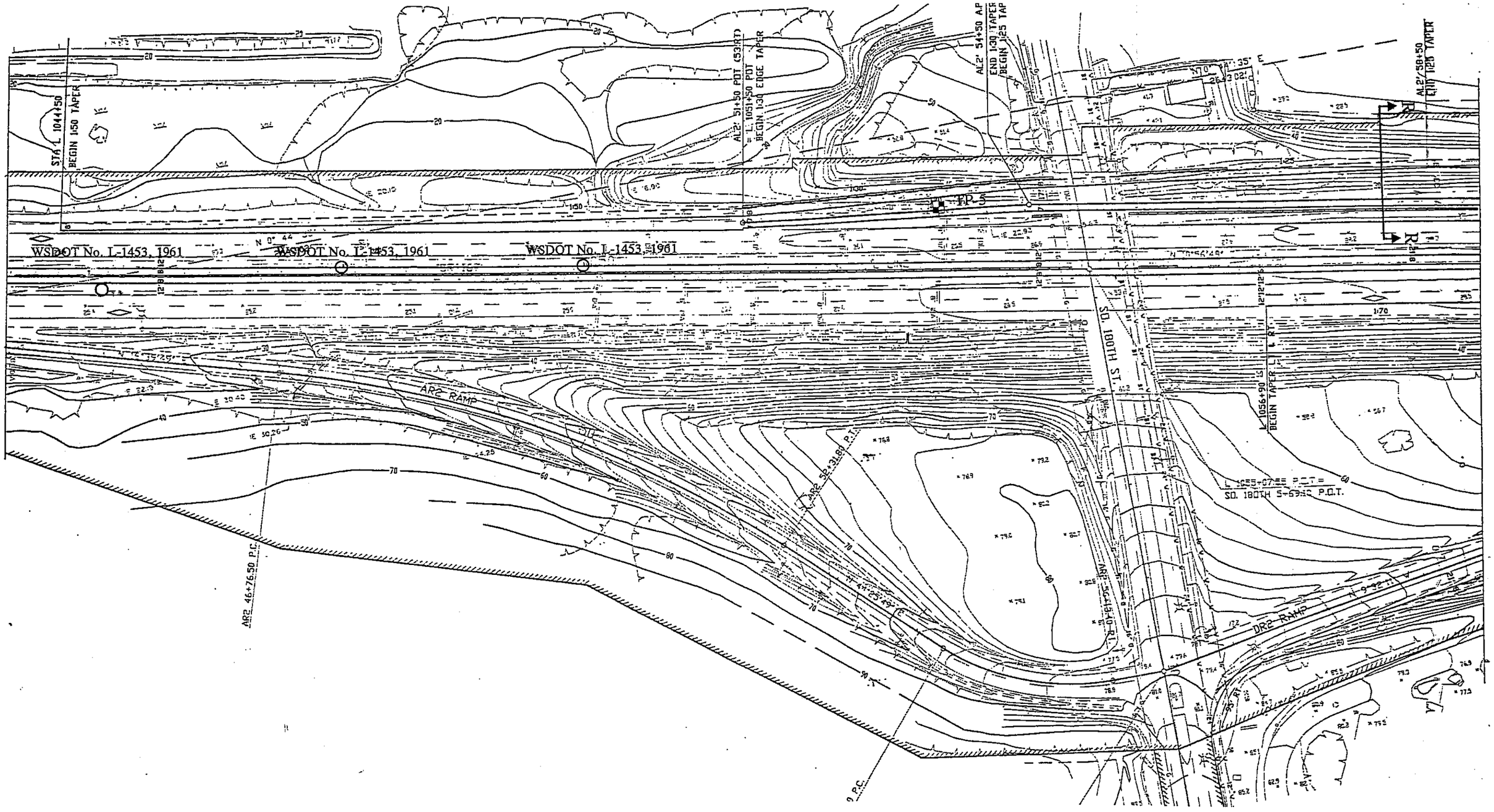
Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 1029+00 TO STA 1044+00

DRAWING NO. 41

FIGURE NUMBER 41



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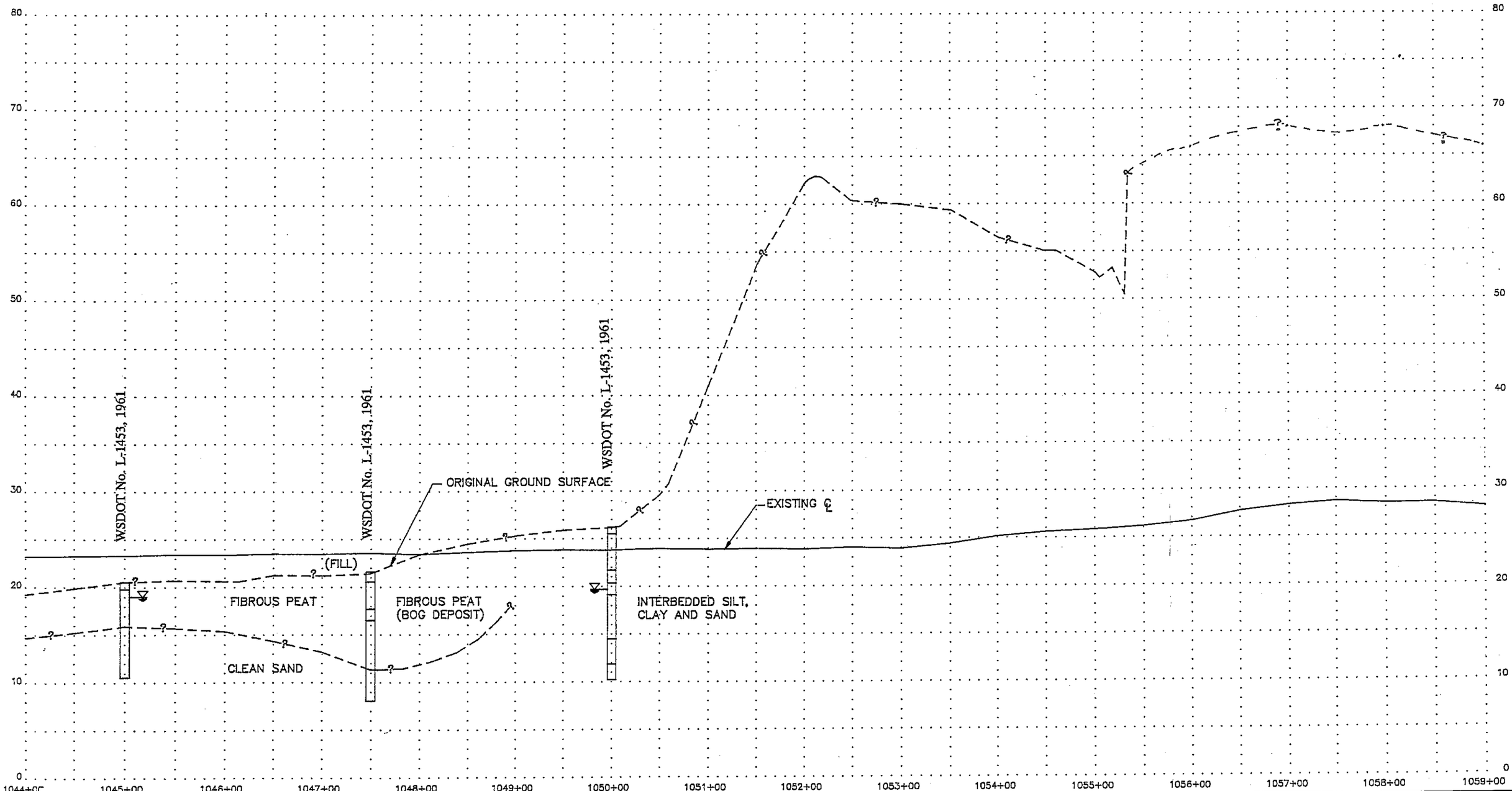
SCALE: HORIZ. 1"=100' VERT. 1"=10'



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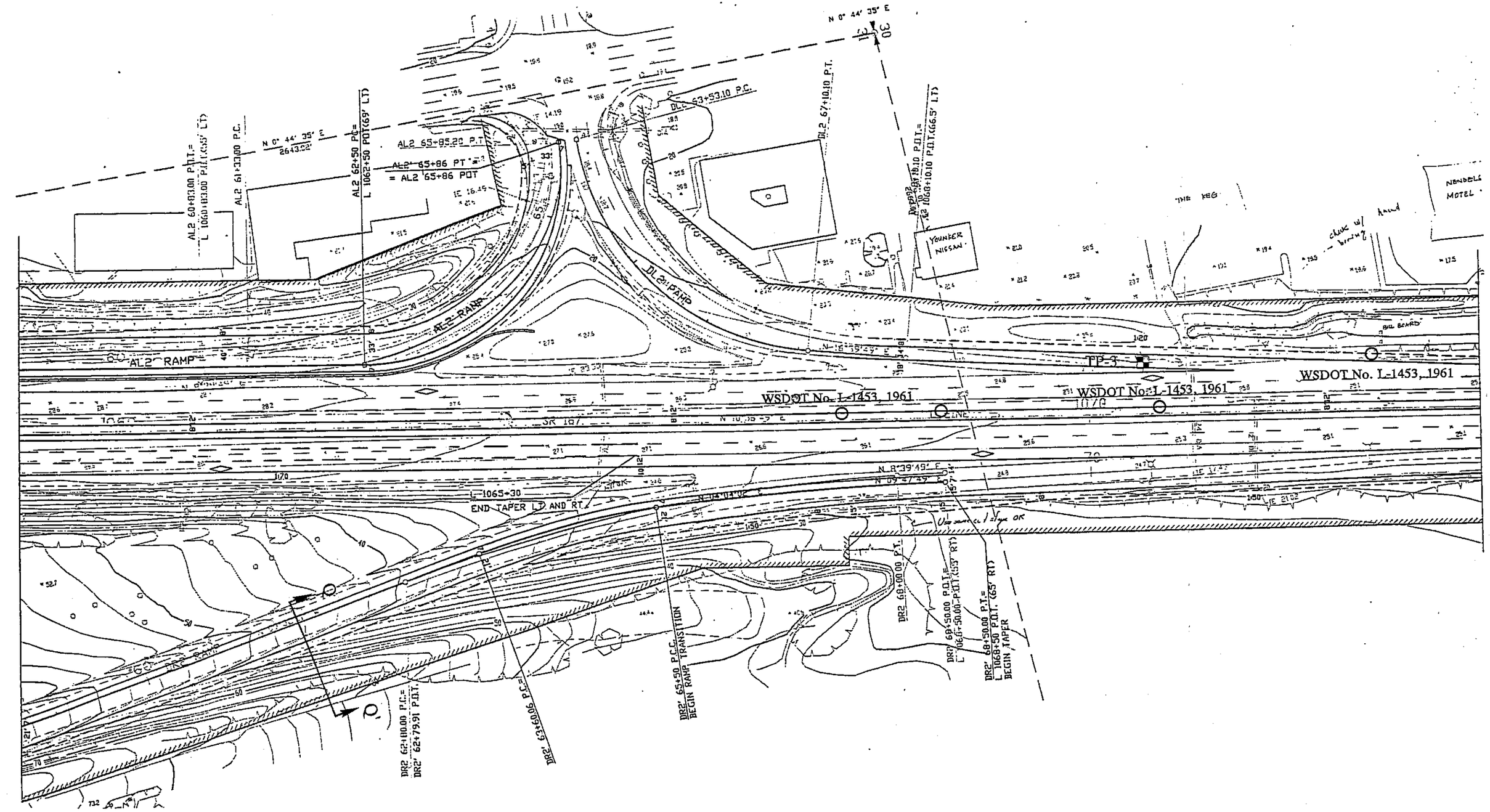
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 1044+00 TO STA 1059+00

DRAWING NO.
42

FIGURE NUMBER
42B



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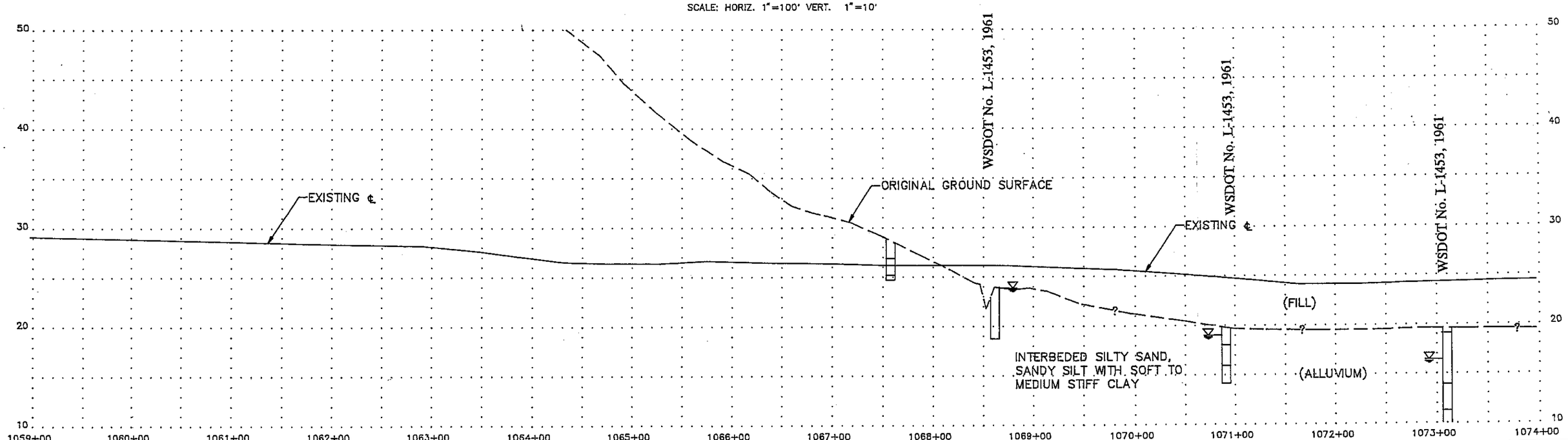
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 1059+00 TO STA 1074+00

DRAWING NO. 43

FIGURE NUMBER 43A

SCALE: HORIZ. 1"=100' VERT. 1"=10'



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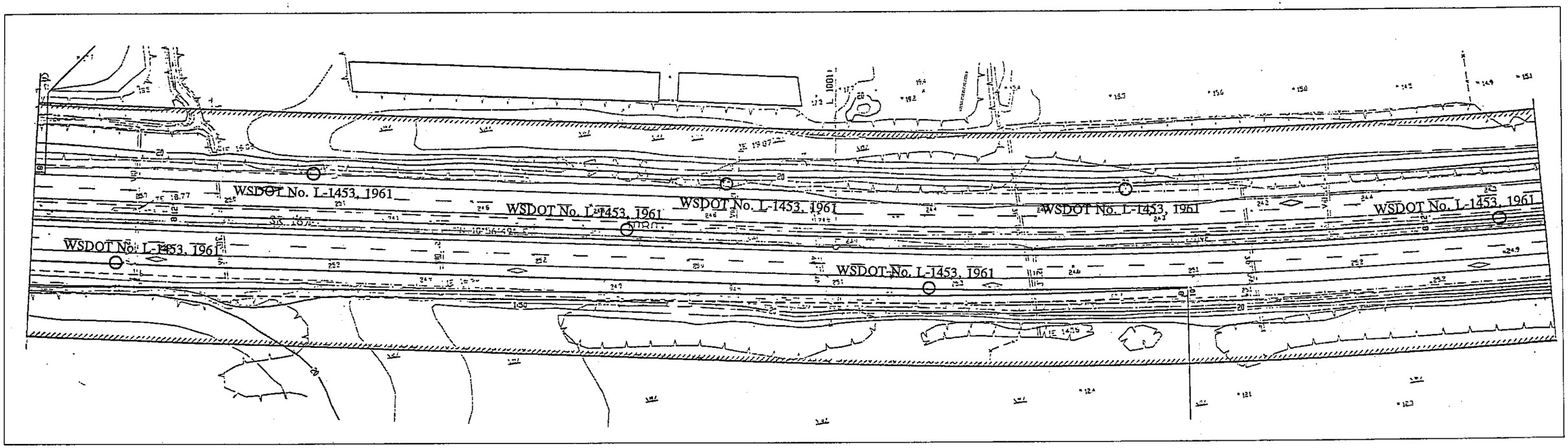
Washington State Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

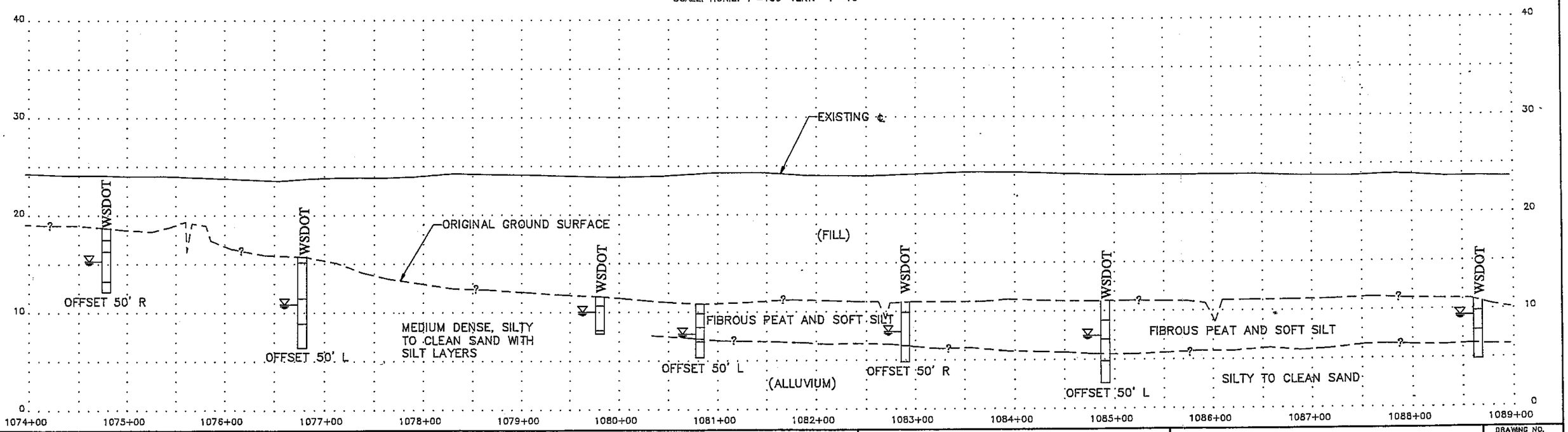
STA 1059+00 TO STA 1074+00

DRAWING NO. 43

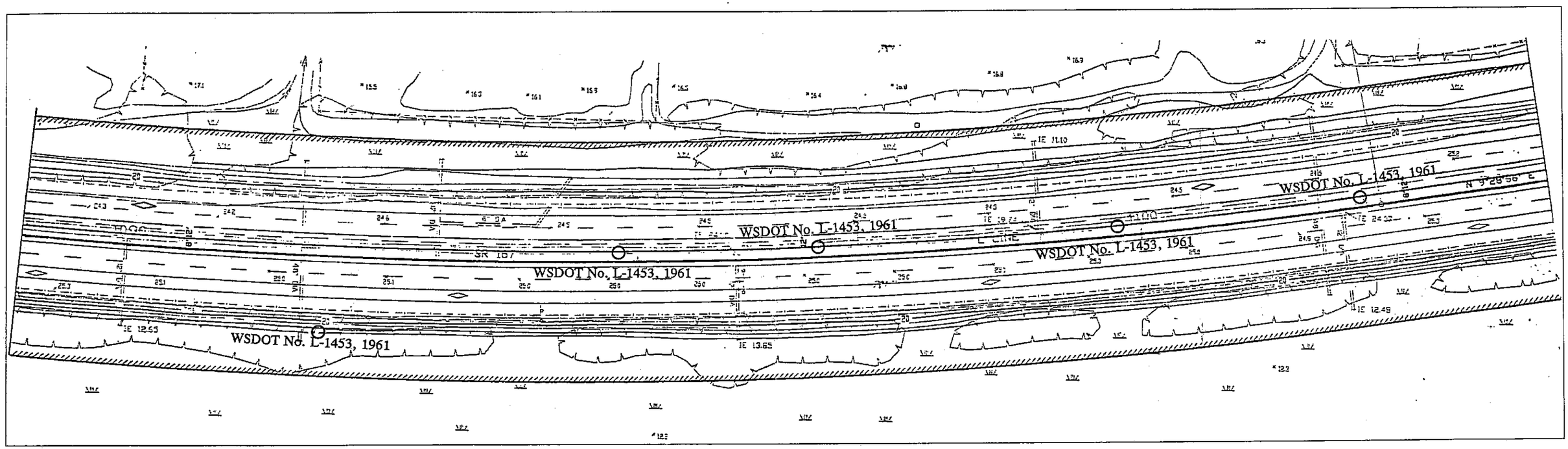
FIGURE NUMBER 43B



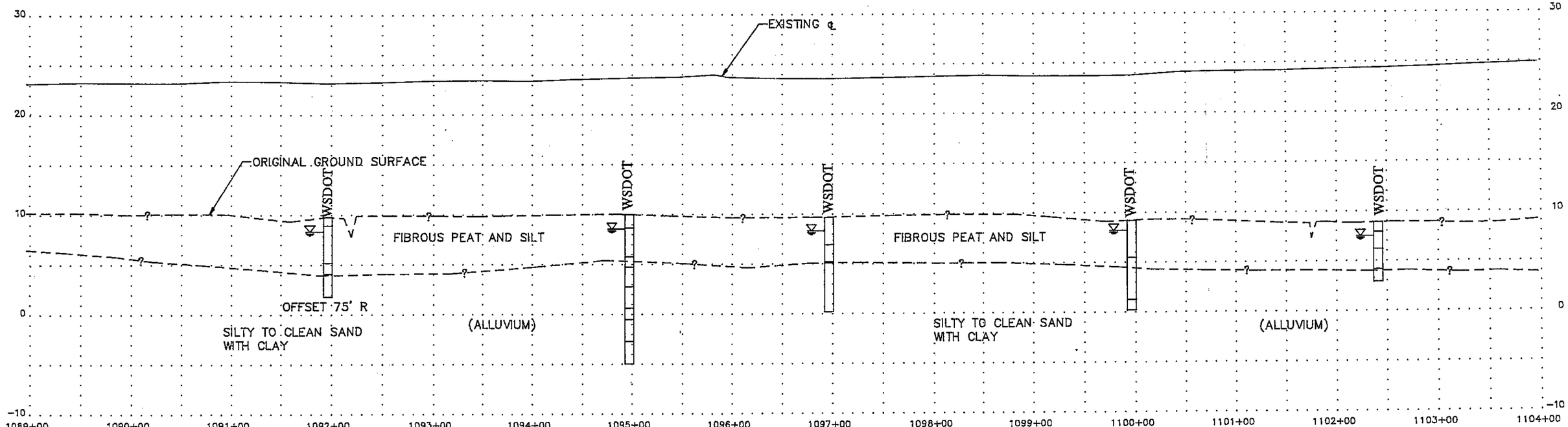
SCALE: HORIZ. 1"=100' VERT. 1"=10'



Hong West & Associates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES STA 1074+00 TO STA 1089+00	DRAWING NO. 44 FIGURE NUMBER 44



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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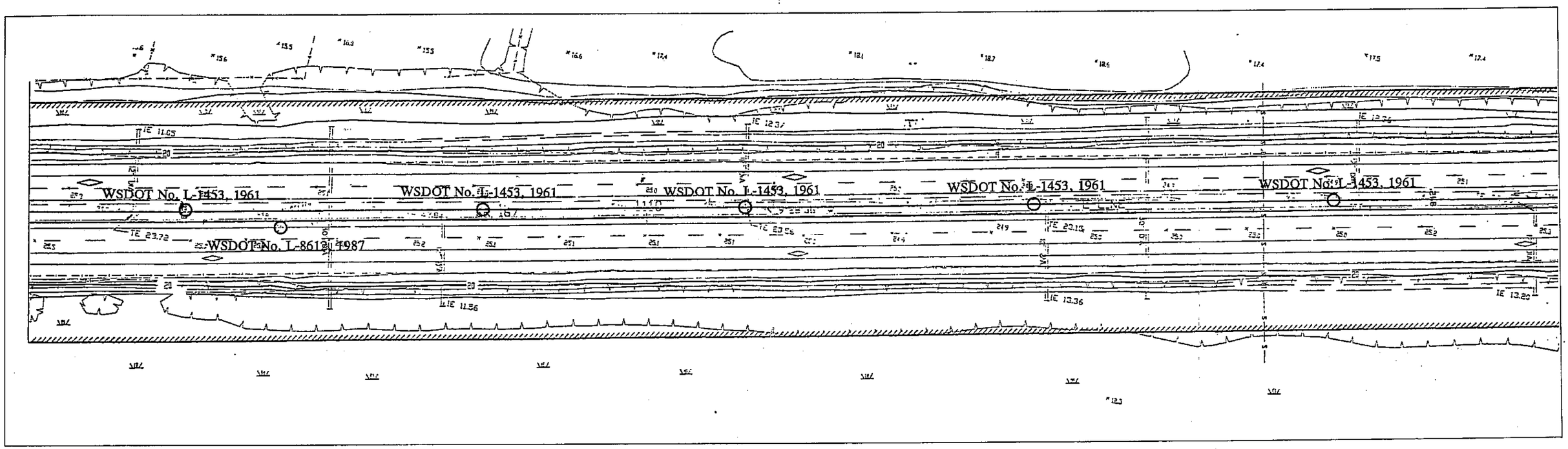
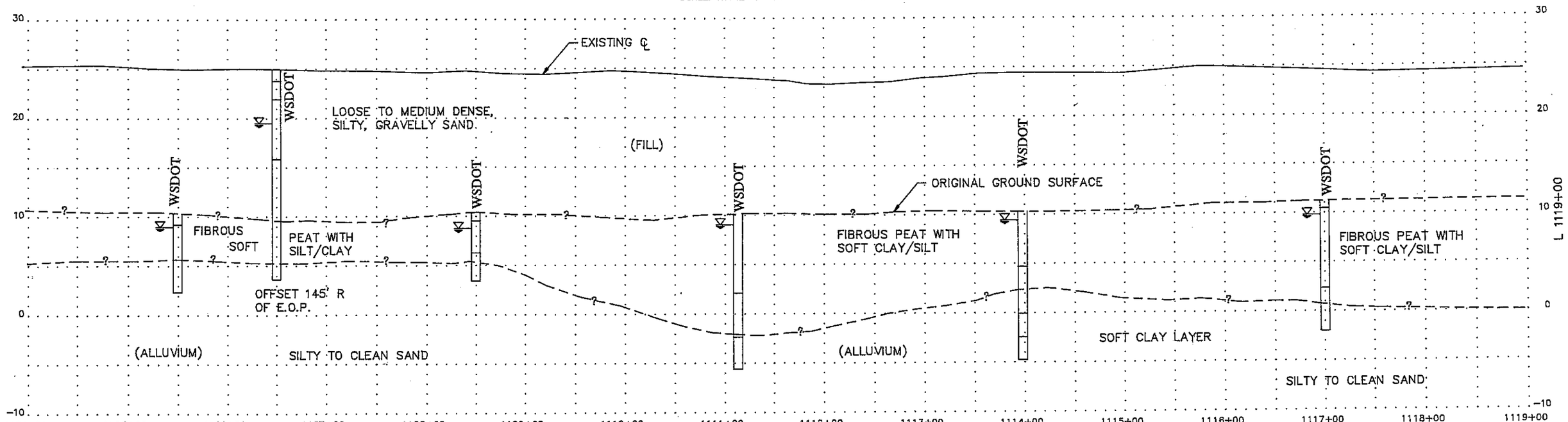


SCALE: HORIZ. 1"=100' VERT. 1"=10'



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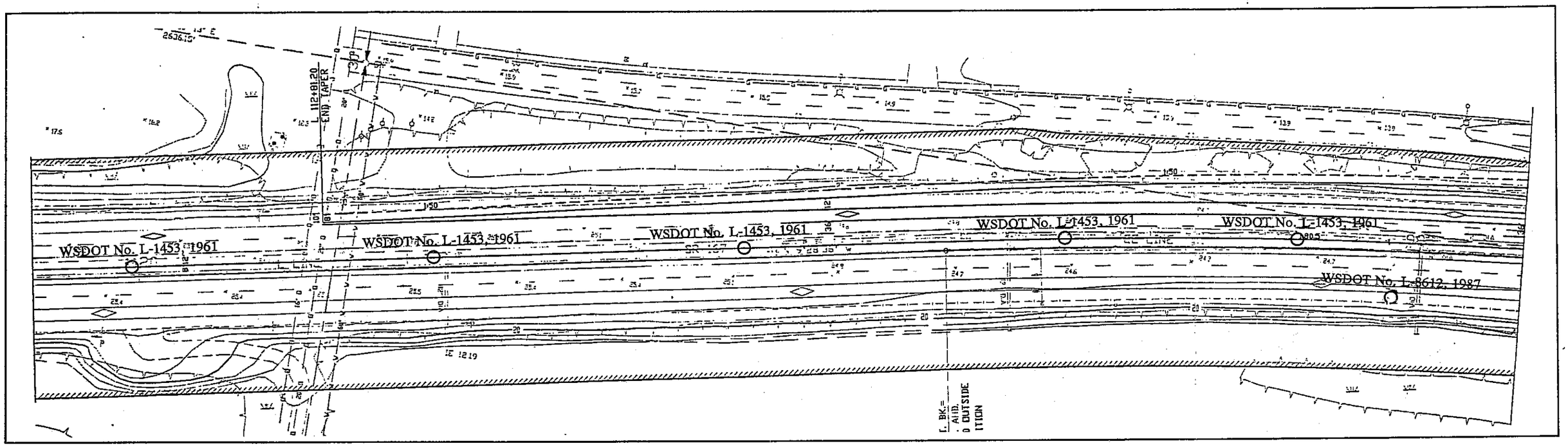
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

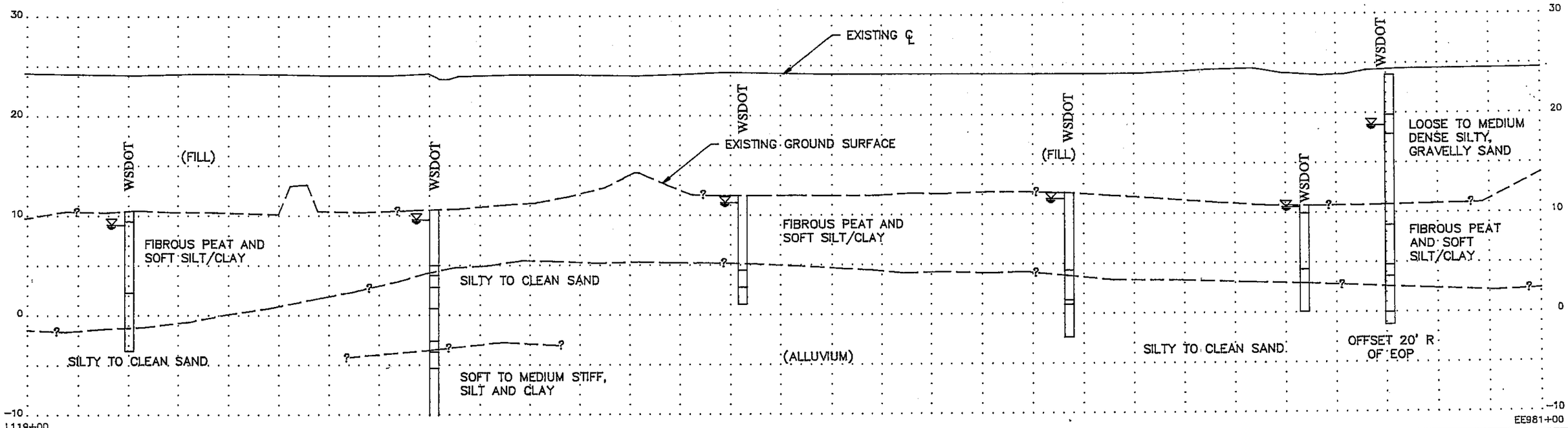
STA 1104+00 TO STA 1119+00

DRAWING NO. 46

FIGURE NUMBER 46



SCALE: HORIZ. 1"=100' VERT. 1"=10'



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SCALE: HORIZ. 1"=100' VERT. 1"=10'

EXISTING ℄

ORIGINAL GROUND SURFACE

TP-1

16
20
35

MEDIUM DENSE TO DENSE SILTY GRAVELLY SAND

OFFSET 25' R OF EOP

(HOLE ENDED @ ELEV -21')

TP-2

(FILL)

11
7
4
3
6
2

VERY LOOSE TO LOOSE SILTY SAND AND SANDY SILT

SOFT PEAT AND SILT

VERY LOOSE TO MEDIUM DENSE, SILTY SAND TO SANDY SILT

MEDIUM DENSE TO DENSE, SILTY TO SANDY GRAVEL

TP-3

4
2
19
17
2
27

(ALLUVIUM)

(HOLE ENDED @ ELEV. -20')

PP-4

8
1
1
16
8

VERY LOOSE, SILTY SAND AND SANDY SILT

SOFT PEAT AND SILT

(ALLUVIUM)

(HOLE ENDED @ ELEV. -18')

TP-5

1
4
4
10
3
18

VERY LOOSE TO MEDIUM DENSE, SILTY SAND TO SANDY SILT

MEDIUM DENSE TO DENSE, SILTY SANDY GRAVEL

TP-6

2
1
8
7
2
19

SOFT PEAT AND PEAT

(HOLE ENDED @ ELEV. -13')

30 20 10 0 -10

EE 981+00 982+00 983+00 984+00 985+00 986+00 987+00 988+00 989+00 990+00 991+00 992+00 993+00 994+00 995+00 996+00

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Washington State Department of Transportation

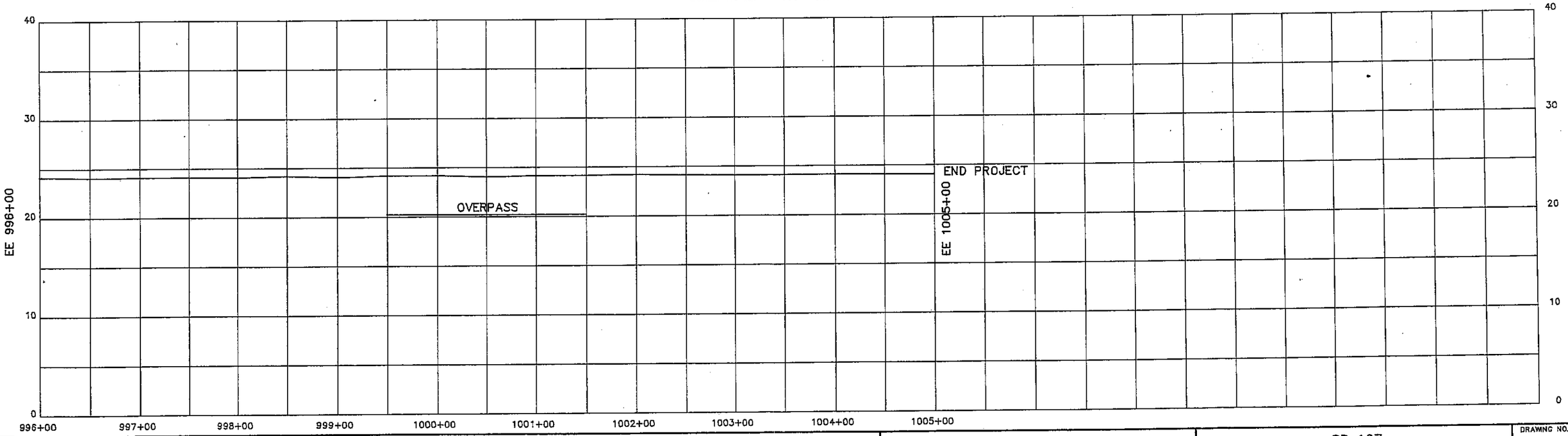
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 981+00 TO STA 996+00

DRAWING NO. 48

FIGURE NUMBER 48B

SCALE: HORIZ. 1"=100' VERT. 1"=10'



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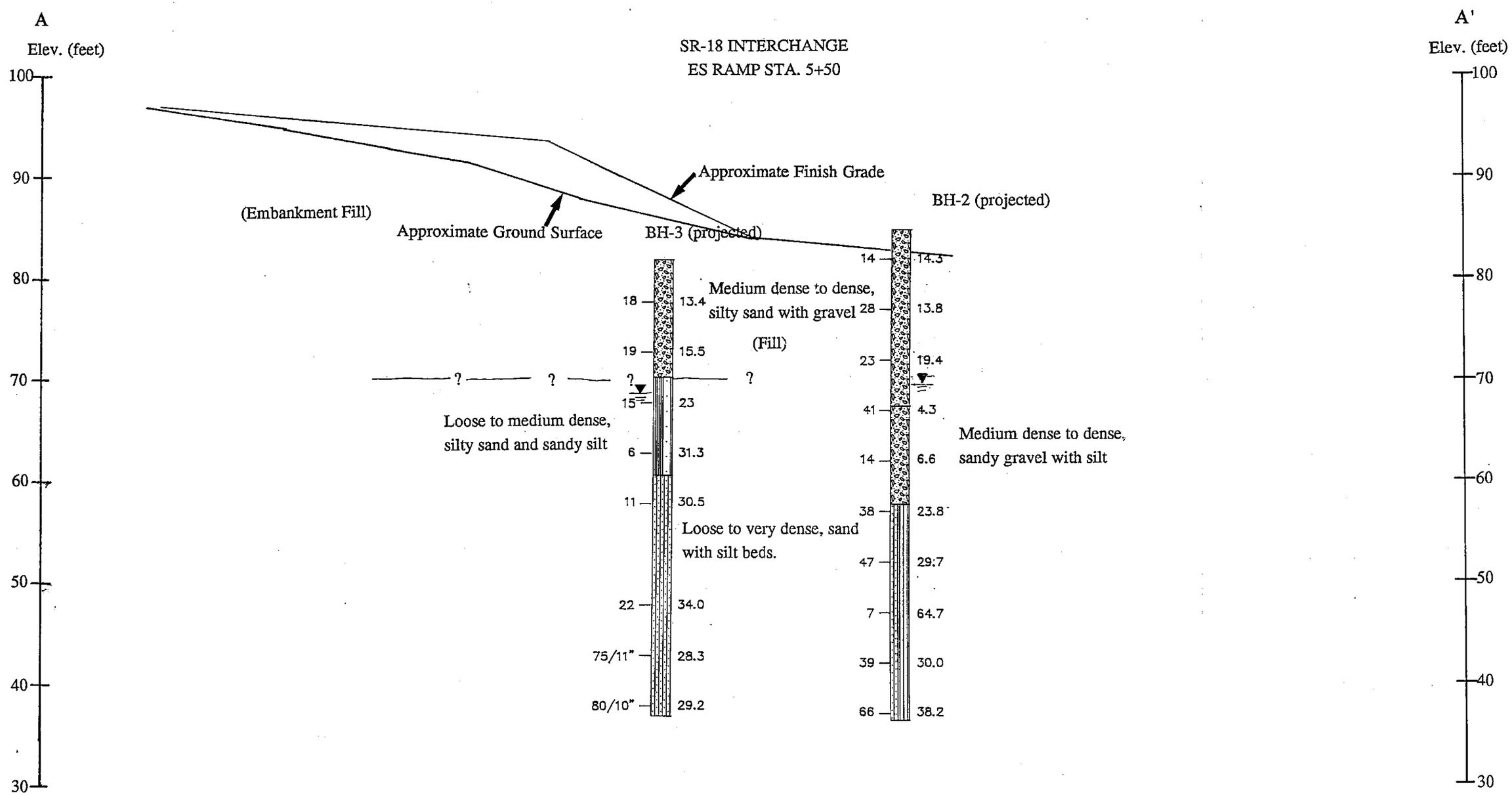
Washington State
Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

STA 996+00 TO STA 1005+00

DRAWING NO.
49/50

FIGURE NUMBER
49B



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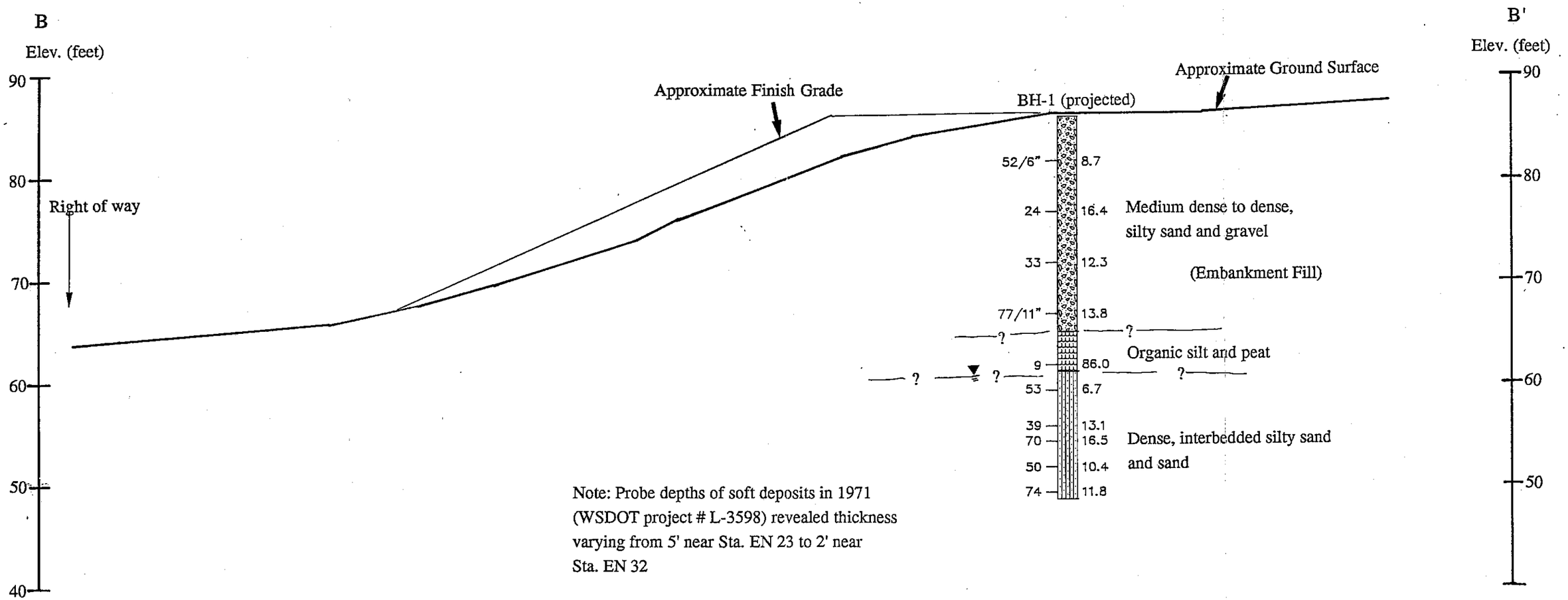
Washington State
Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

DRAWING NO.

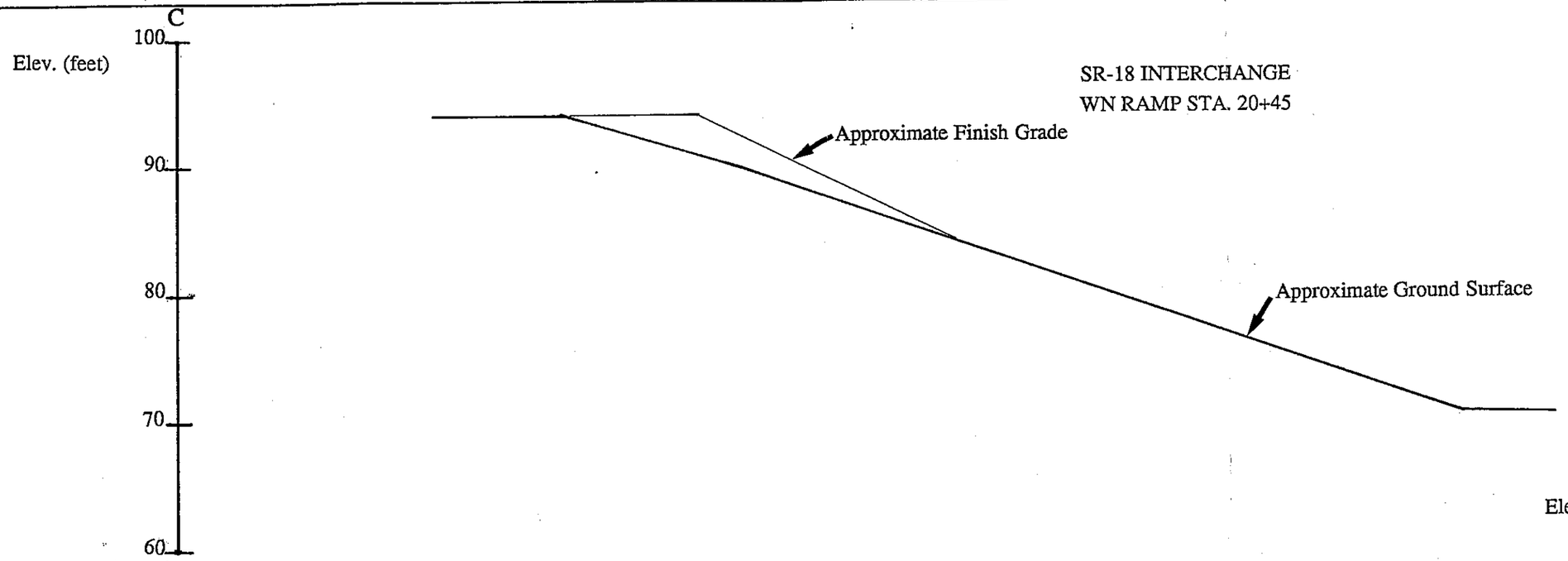
FIGURE NUMBER
50

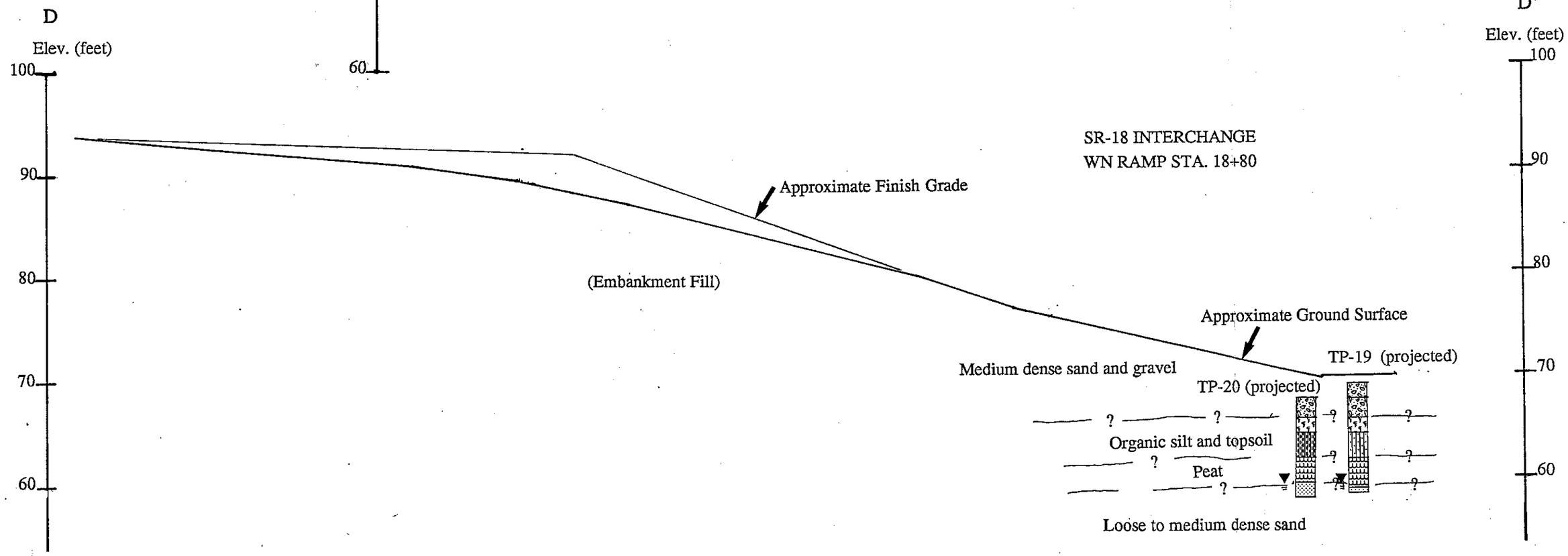
SR-18 INTERCHANGE
EN RAMP STA. 30+25



Note: Probe depths of soft deposits in 1971 (WSDOT project # L-3598) revealed thickness varying from 5' near Sta. EN 23 to 2' near Sta. EN 32

Hong West & Associates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES	DRAWING NO. FIGURE NUMBER 51





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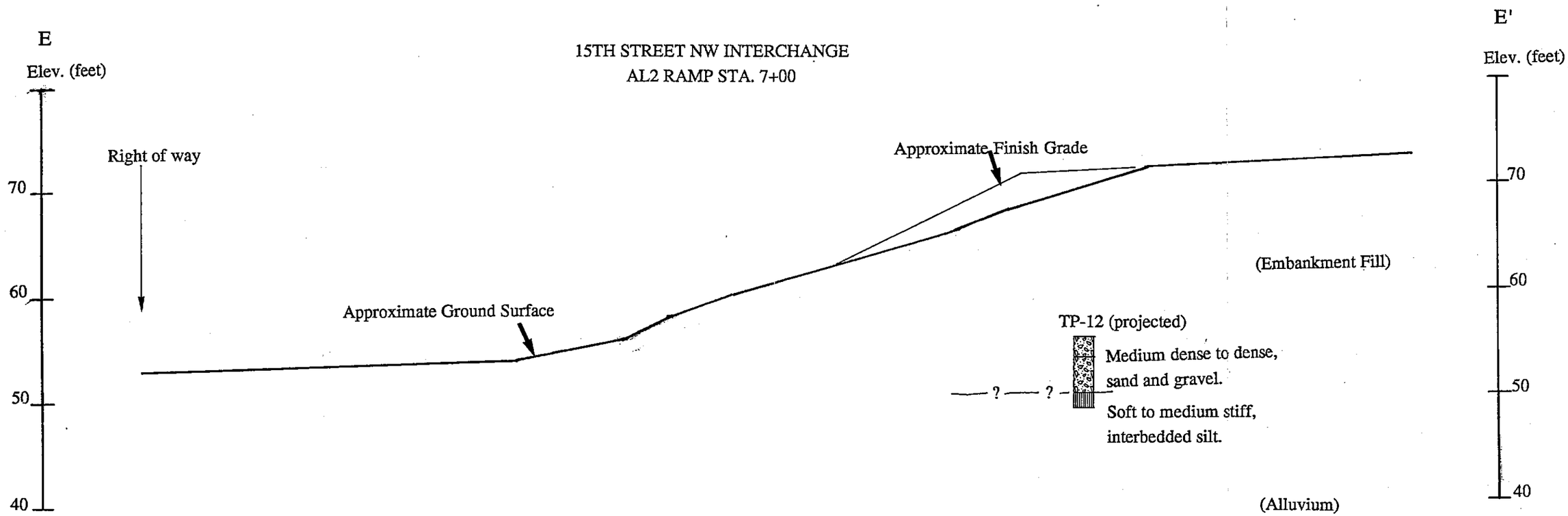
Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

DRAWING NO.

FIGURE NUMBER
52



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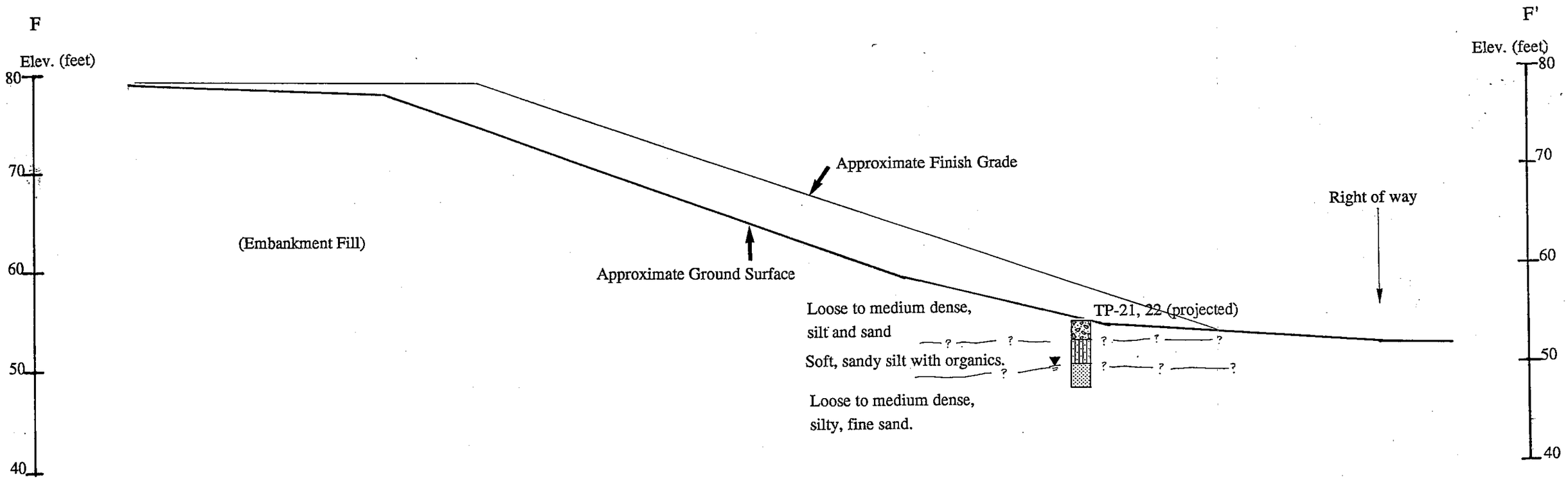
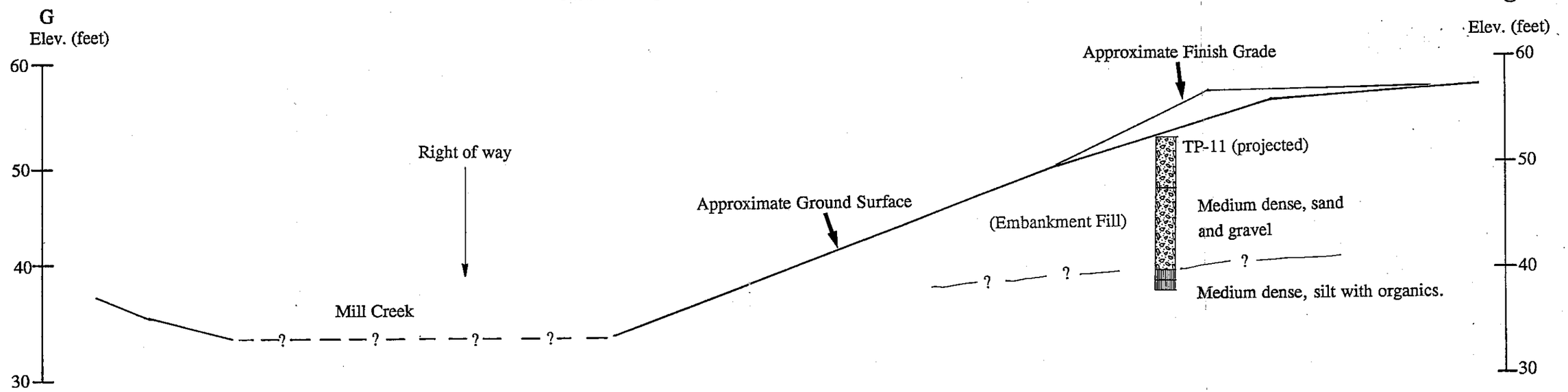
15TH STREET NW INTERCHANGE
DR2 RAMP STA. 9+20



Hong West & Associates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES	DRAWING NO. FIGURE NUMBER 54

SOUTH 277TH STREET INTERCHANGE
AL1 RAMP STA.11+60



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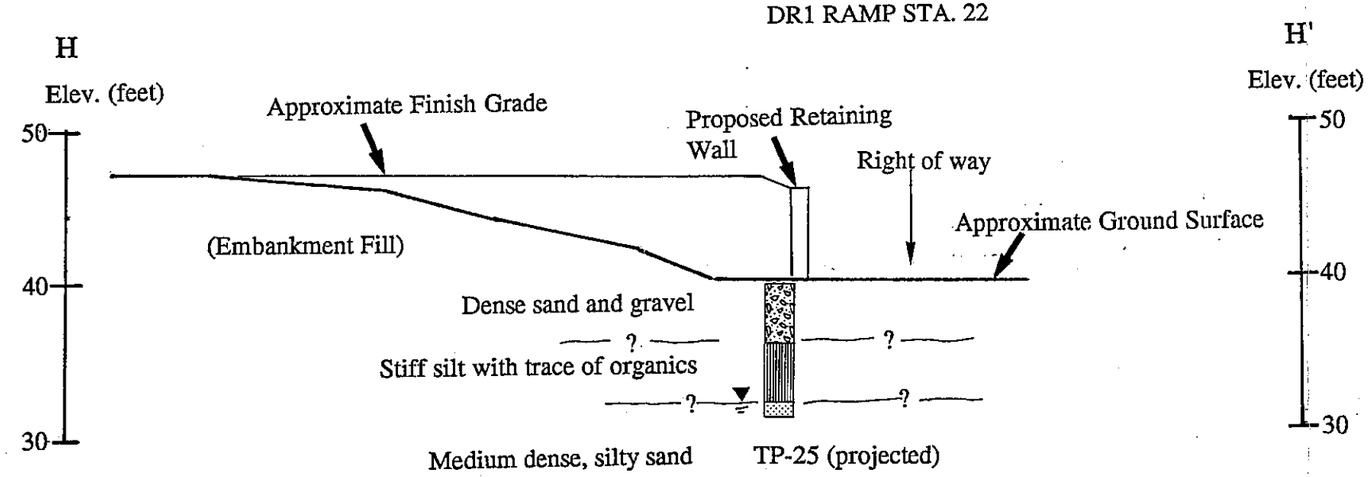
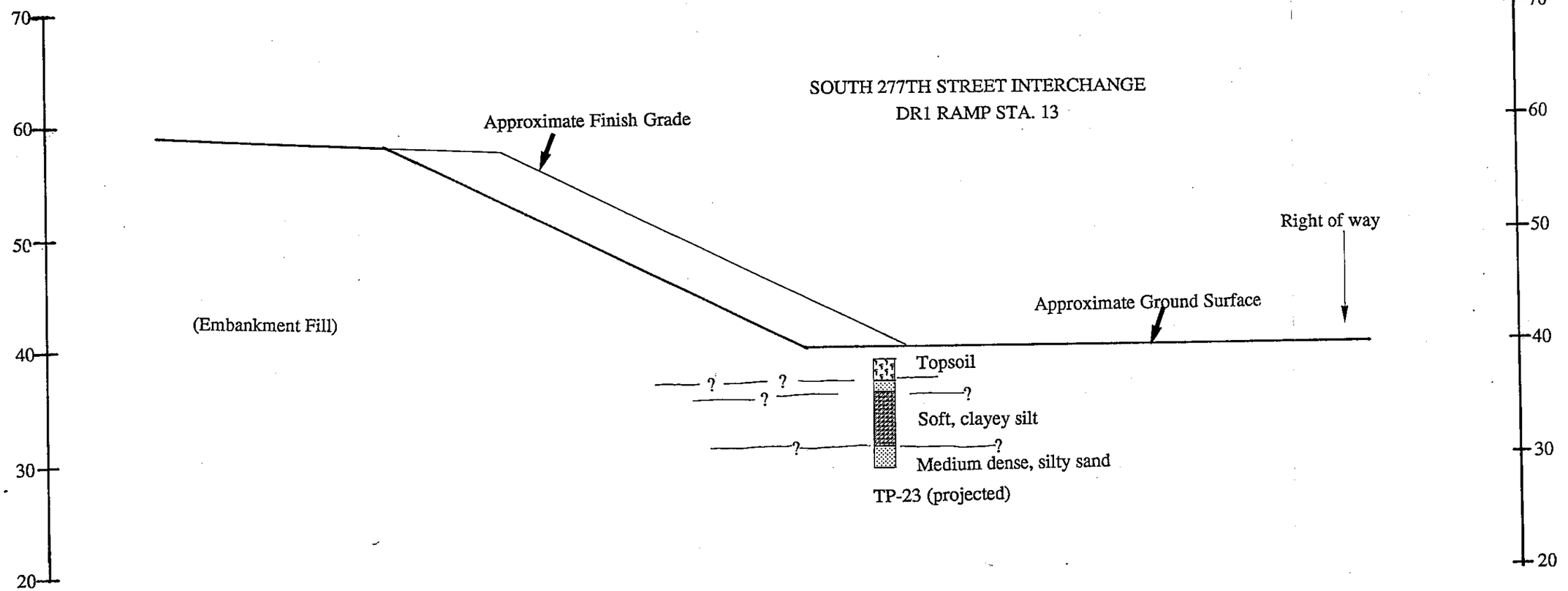
SOUTH 277TH STREET INTERCHANGE
DR1 RAMP STA. 22



SOUTH 277TH STREET INTERCHANGE
DR1 RAMP STA. 13



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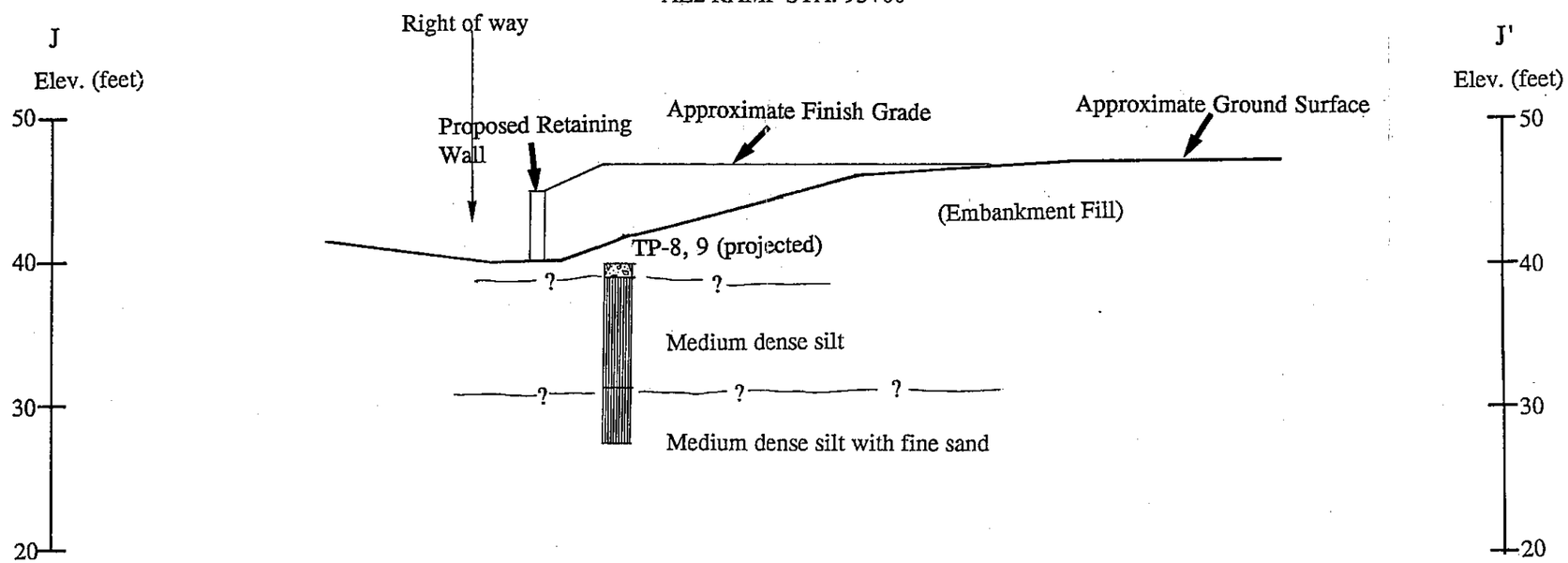
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

DRAWING NO.

FIGURE NUMBER
56

SR-516 INTRCHANGE
AL2 RAMP STA. 93+00



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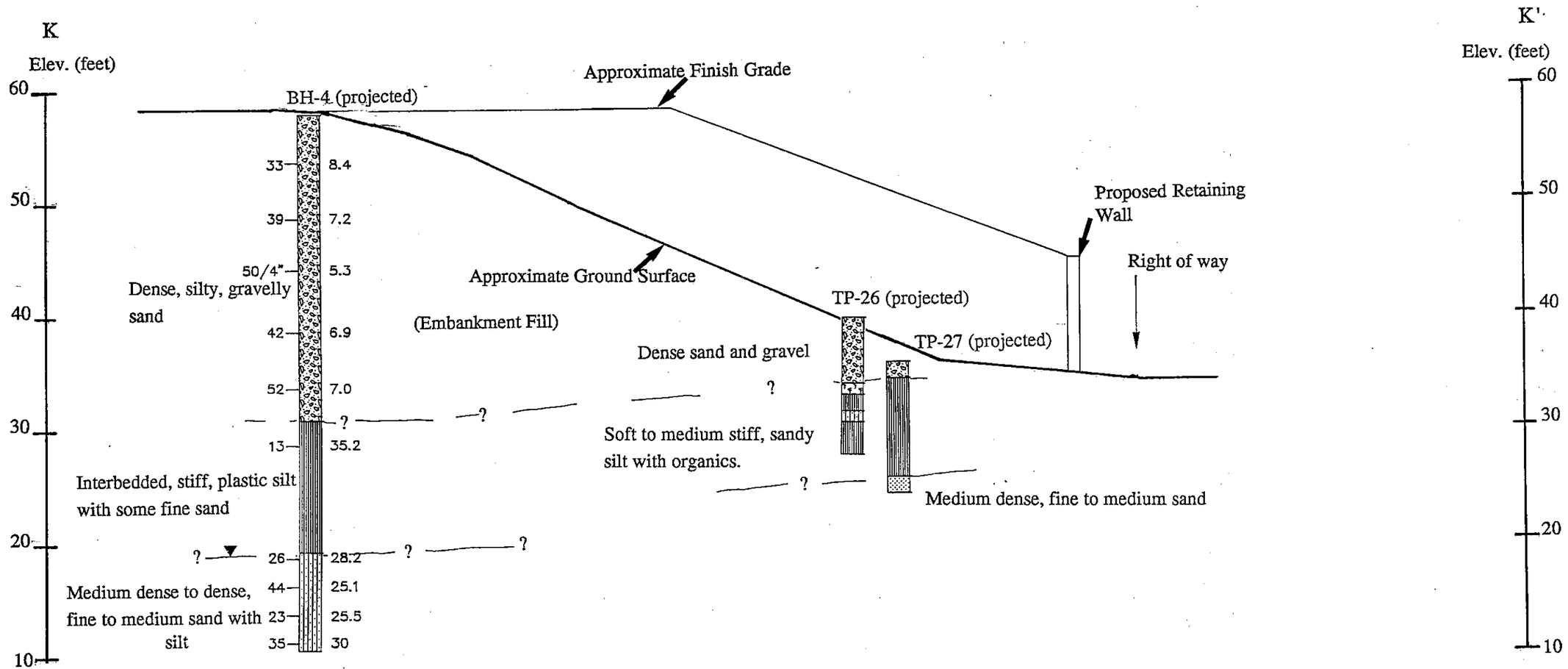
SR-516 INTERCHANGE
DR2 RAMP STA. 10+40



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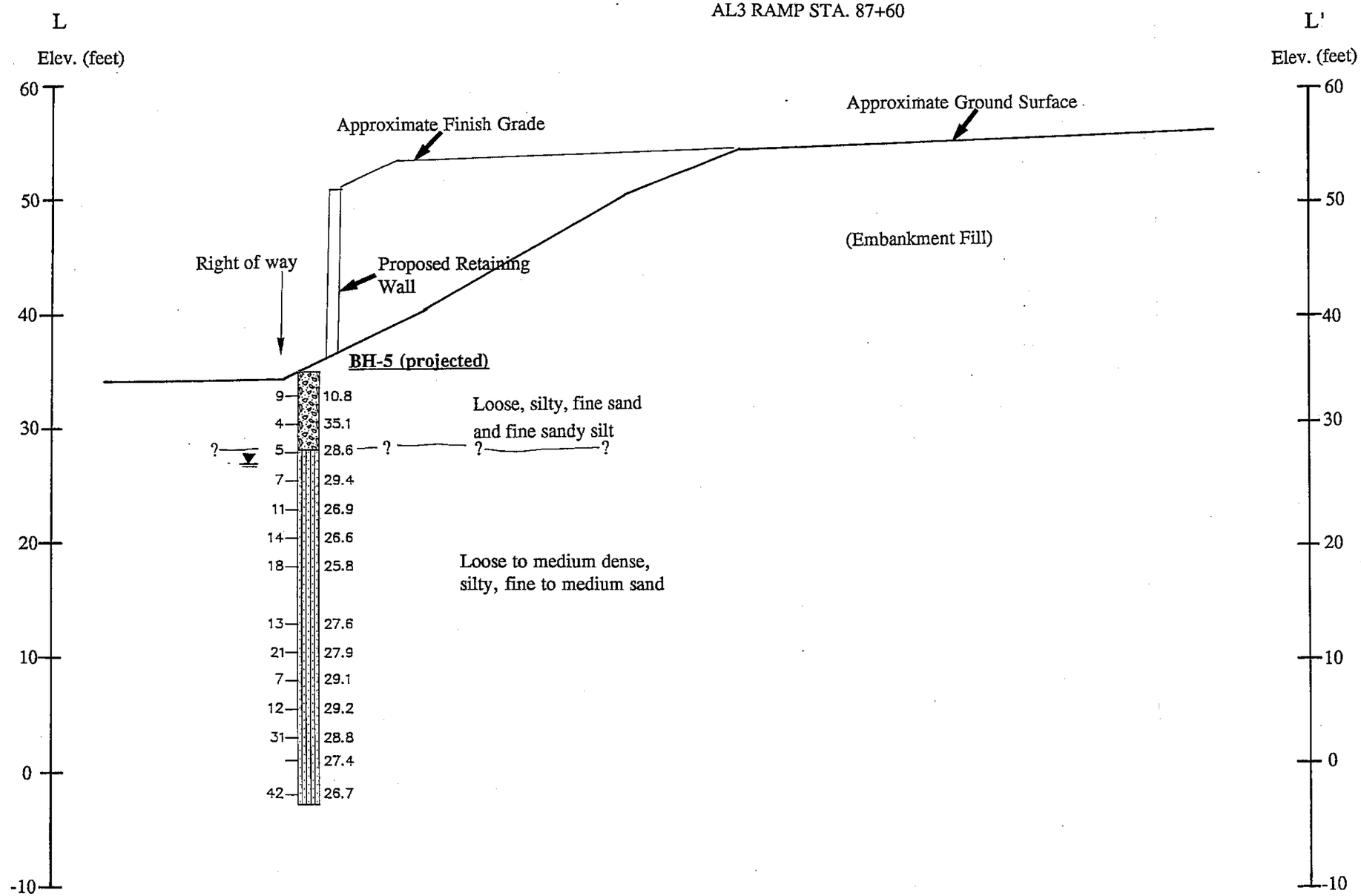
SR 167
15TH ST SW TO S GRADY WY
HOV LANES

DRAWING NO.

FIGURE NUMBER
58

84TH AVENUE SOUTH
AL3 RAMP STA. 87+60



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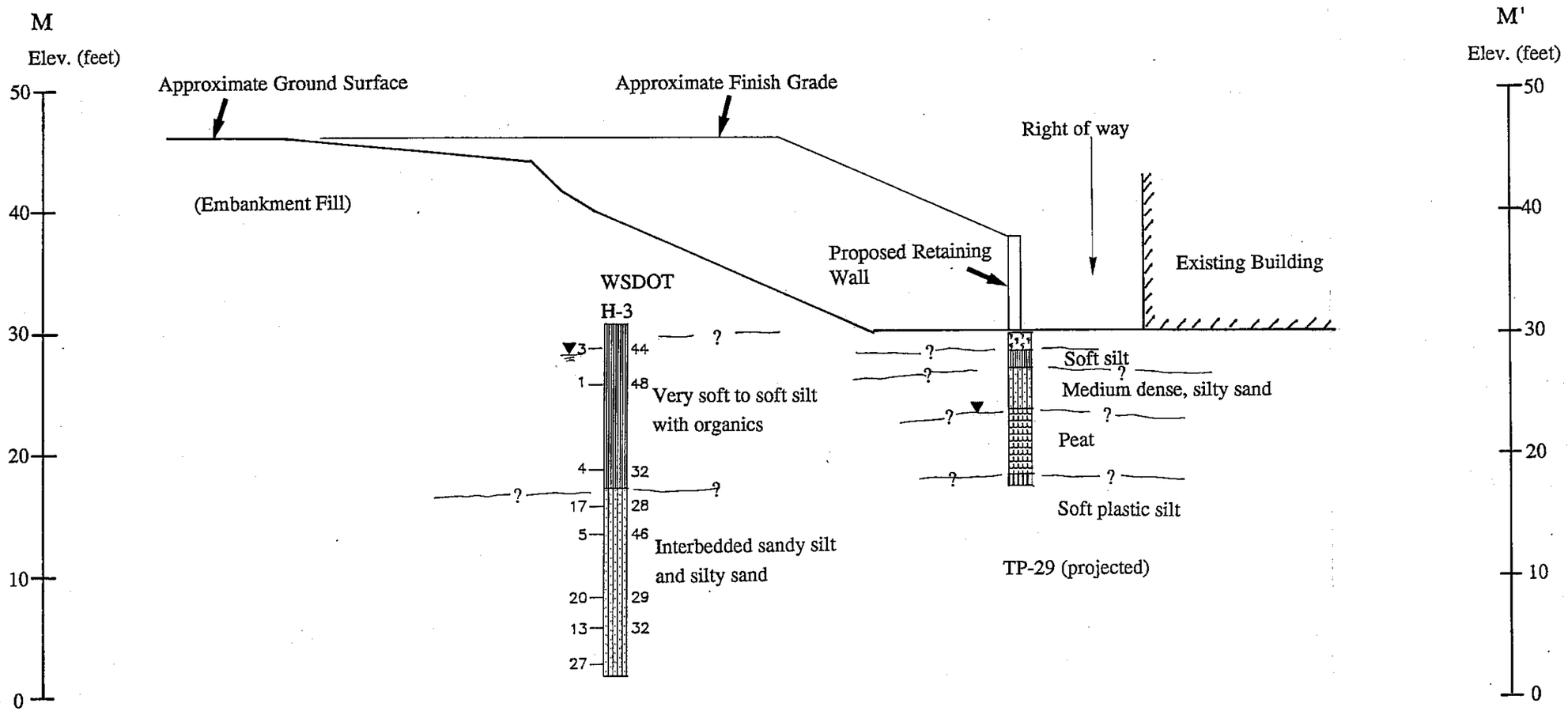
Washington State Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

DRAWING NO.

FIGURE NUMBER
59

84TH AVENUE SOUTH INTERCHANGE
DR1 RAMP STA. 896+25



Ref: WSDOT No. L-6669, 1982

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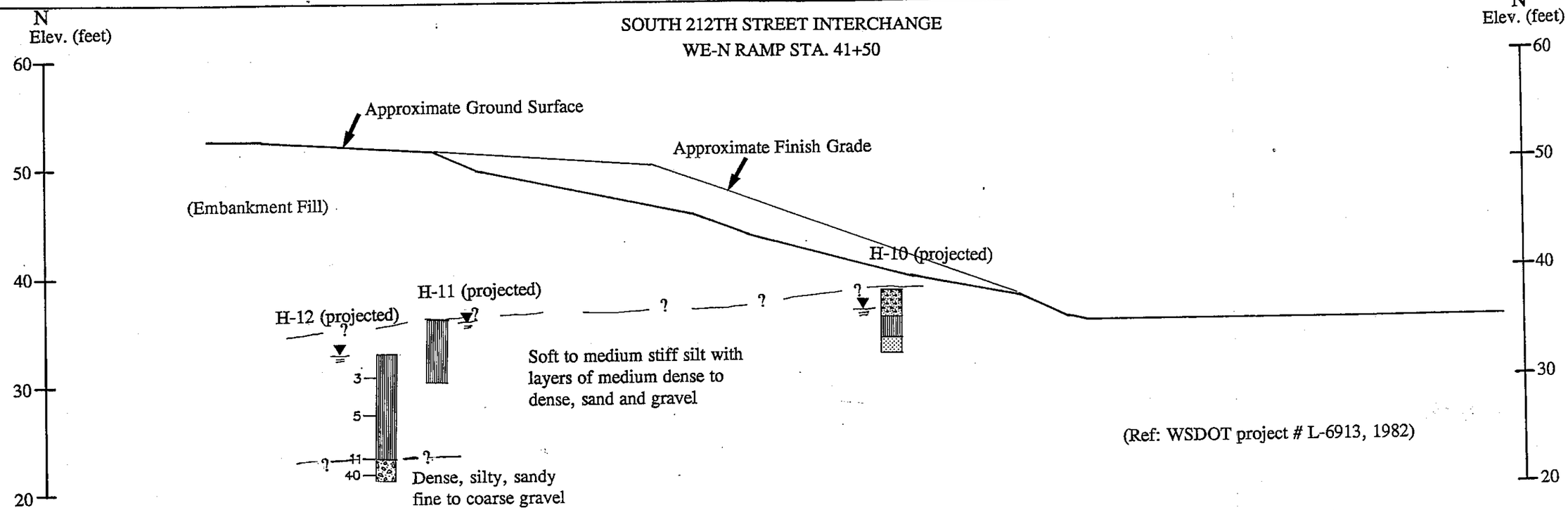

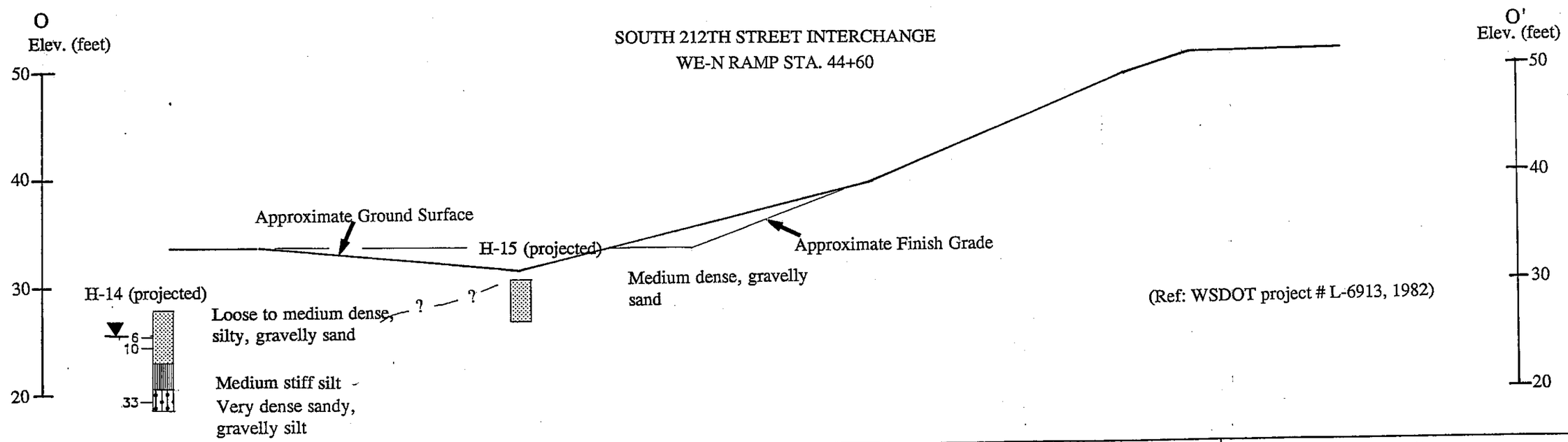

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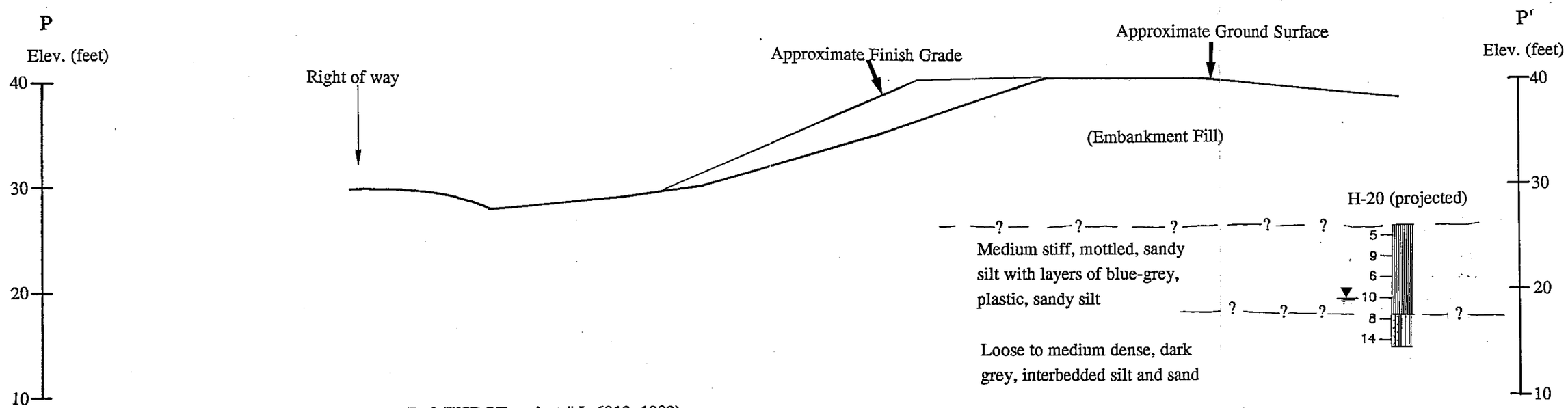
Washington State Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

DRAWING NO.

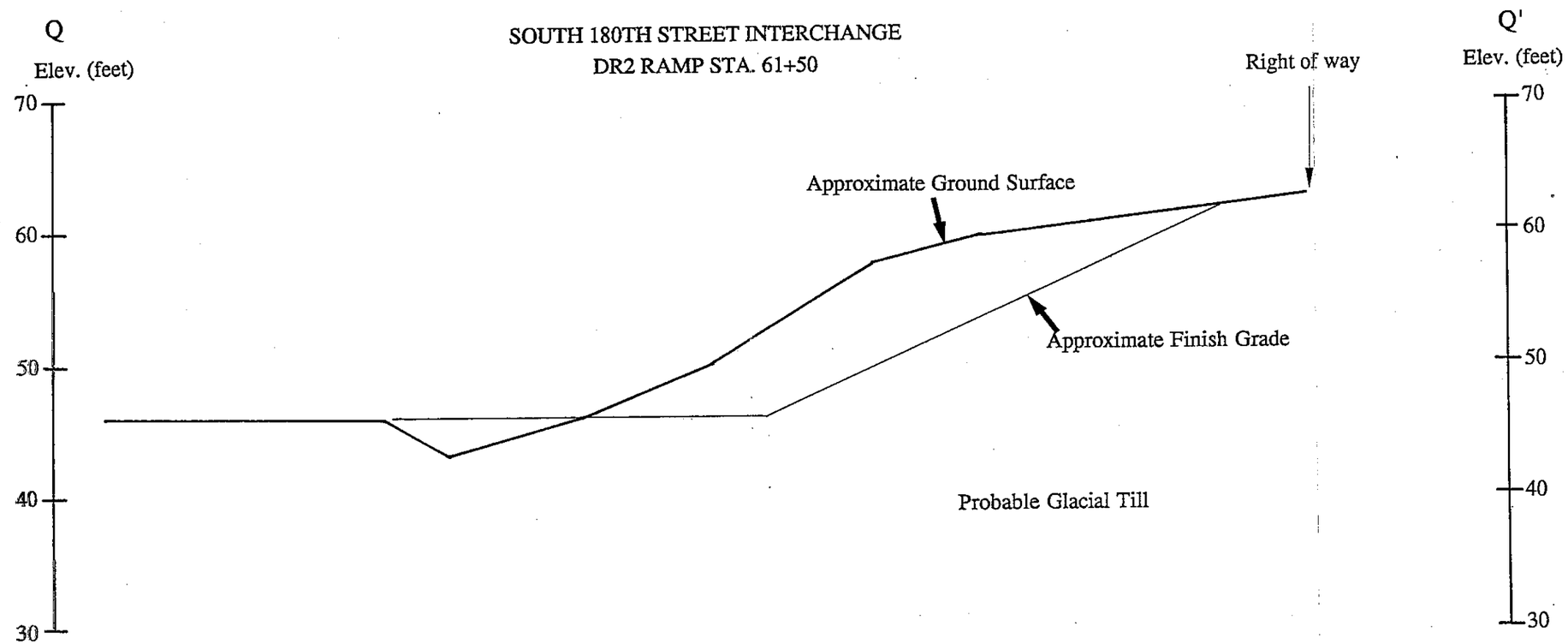
FIGURE NUMBER
61

SOUTH 212TH STREET INTERCHANGE
EW-S RAMP STA.46+50



(Ref: WSDOT project # L-6913, 1982)

Hong West & Associates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES	DRAWING NO. FIGURE NUMBER 62



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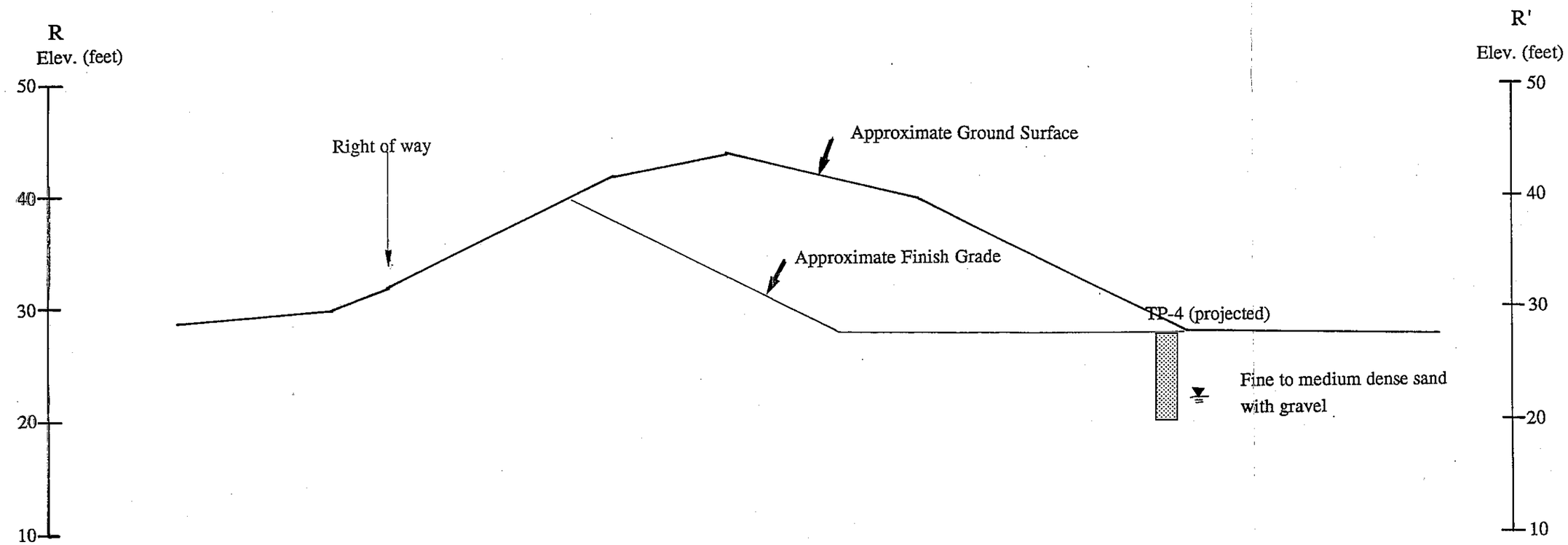
Washington State
Department of Transportation

SR 167
15TH ST SW TO S GRADY WY
HOV LANES

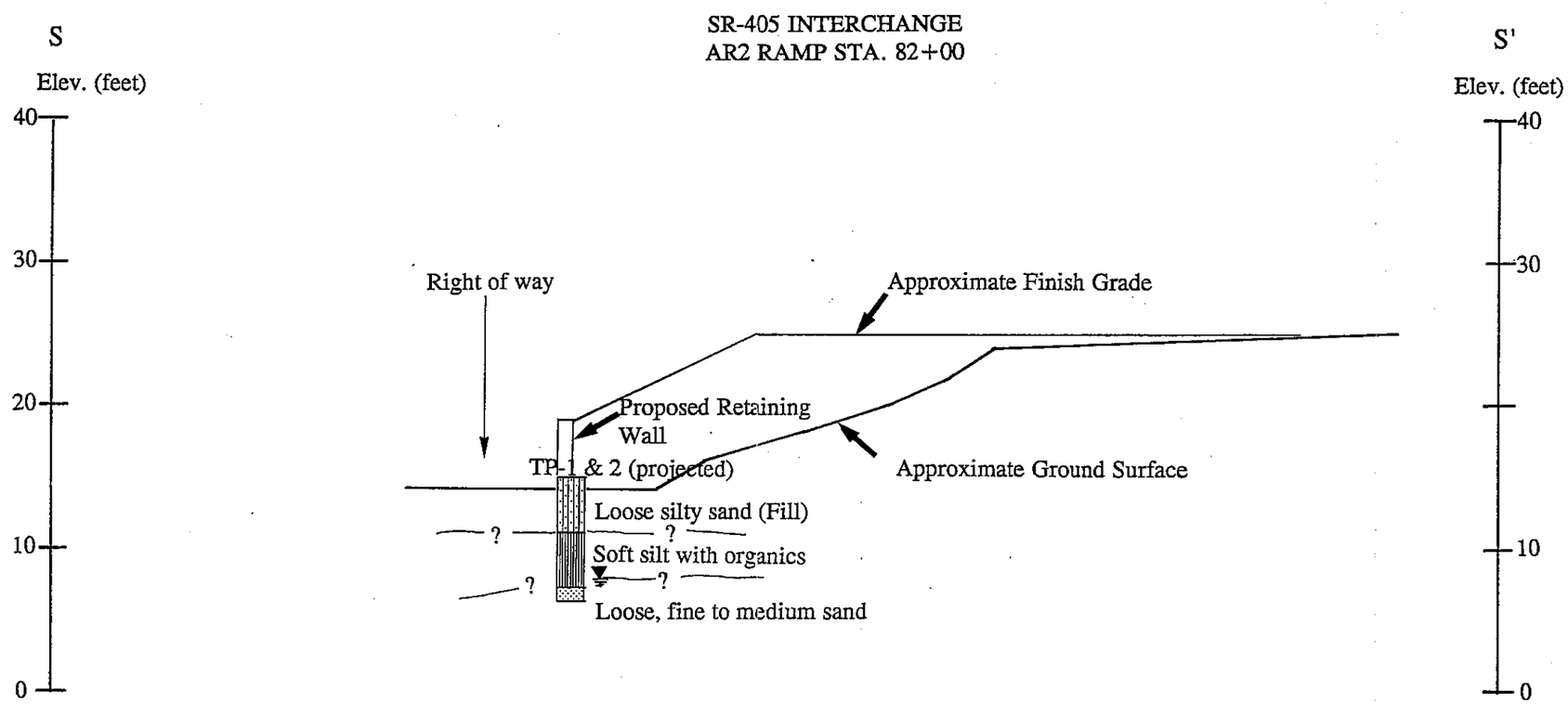
DRAWING NO.

FIGURE NUMBER
63

SOUTH 180TH STREET INTERCHANGE
AL2 RAMP STA. 57+75



Hong West & Associates Geotechnical Consultants PO Box 596, Lynnwood, WA 98046		Washington State Department of Transportation	SR 167 15TH ST SW TO S GRADY WY HOV LANES	DRAWING NO. FIGURE NUMBER 64



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SR 167
15TH ST SW TO S GRADY WY
HOV LANES

DRAWING NO.

FIGURE NUMBER
65

APPENDIX A

LOGS OF EXPLORATORY HAND BORINGS

HONG WEST & ASSOCIATES

LEGEND OF SYMBOLS APPEARING ON THE SOIL LOGS

GRAPHICAL SYMBOLS FOR SOIL TYPES

NON-COHESIVE SOILS (<50% passing the 200 sieve)

- GW — well graded gravel and gravel/sand mix
- GP — poorly graded gravel, gravel/sand mix
- GM — silty gravels, gravel/sand/silt mix
- GC — clayey gravels, gravel/sand/clay mix
- SW — well graded sands, gravelly sands
- SP — poorly graded sands, few fines
- SM — silty sands, sand/silt mix
- SC — clayey sands, sand/clay mix

COHESIVE SOILS (>50% passing 200 sieve)

- ML — inorganic silts and very fine sands
- CL — inorganic, low plastic clay mixes
- OL — organic, low plastic clays, silt/clay mix
- MH — inorganic, micaceous silts, silt/sand mix
- CH — inorganic, high plastic clays
- OH — organic, medium to high plastic clays
- Pt — peat and other highly organic soil

Note: The graphical symbols used for the various soil types are based on the symbols recommendated in the Unified Soil Classification system. Graphical logs are based on subjective field indentification of soils, and laboratory data where available. Letter designations are assigned on the basis of laboratory data and calculations.

SAMPLE TYPE SYMBOLS

BOREHOLE SAMPLES

- 2.0" OD Split Spoon (SPT)
- Shelby Tube
- 3.0" OD Split Spoon with Brass Rings
- Grab Samples (cuttings)
- Core Run

TEST PIT SAMPLES

- Bag (bulk sample)
- Grab (small volumn)
- Shelby Tube

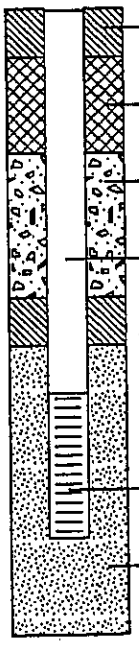
HAND BORING SAMPLES

- Non-standard penetration (40 lb. hammer with 12 inch drop)
- Grab Sample (post hole)
- Shelby Tube

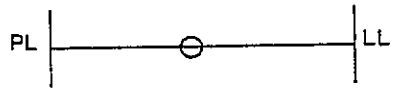
ROTARY BOREHOLE SAMPLES

- Continuous Core Samples

GROUNDWATER INSTALLATIONS AND OBSERVATIONS



ATTERBERG LIMITS



o - Natural Moisture
PL - Plastic Limit
LL - Liquid Limit

HONG WEST & ASSOCIATES

LEGEND OF TERMS USED ON EXPLORATION SOIL LOGS

The classification of soils in these logs is based on visual field and laboratory observations, based on ASTM D 2488. Soil descriptions consist of the following: Density/consistency, color, modifier, MAJOR CONSTITUENT, minor constituents, wetness, soil structures, additional remarks.

Density/Consistency

Soil density/consistency in test borings is usually based on the SPT, the standard penetration test or resistance, ASTM D1586. The test result is the sum of the of the blow counts for the last 12 inches of sampler drive.

Non-Cohesive Soil Density	Standard Penetration Resistance (Blows/foot)	Cohesive Soil Consistancy	Standard Penetration Resistance (Blows/foot)	Unconfined Compressive Strength in TSF
Very Loose	0 - 4	Very Soft	0 - 2	<0.25
Loose	4 - 10	Soft	2 - 4	0.25 - 0.5
Medium Dense	10 - 30	Medium Stiff	4 - 8	0.5 - 1.0
Dense	30 - 50	Stiff	8 - 15	1.0 - 2.0
Very Dense	>50	Very Stiff	15 - 30	2.0 - 4.0
		Hard	>30	>4.0

Wetness

Dry	Little perceptible moisture
Damp	Some perceptible moisture probably below optimum
Moist	probably near optimum moisture content
Wet	Much perceptible moisture probably above optimum

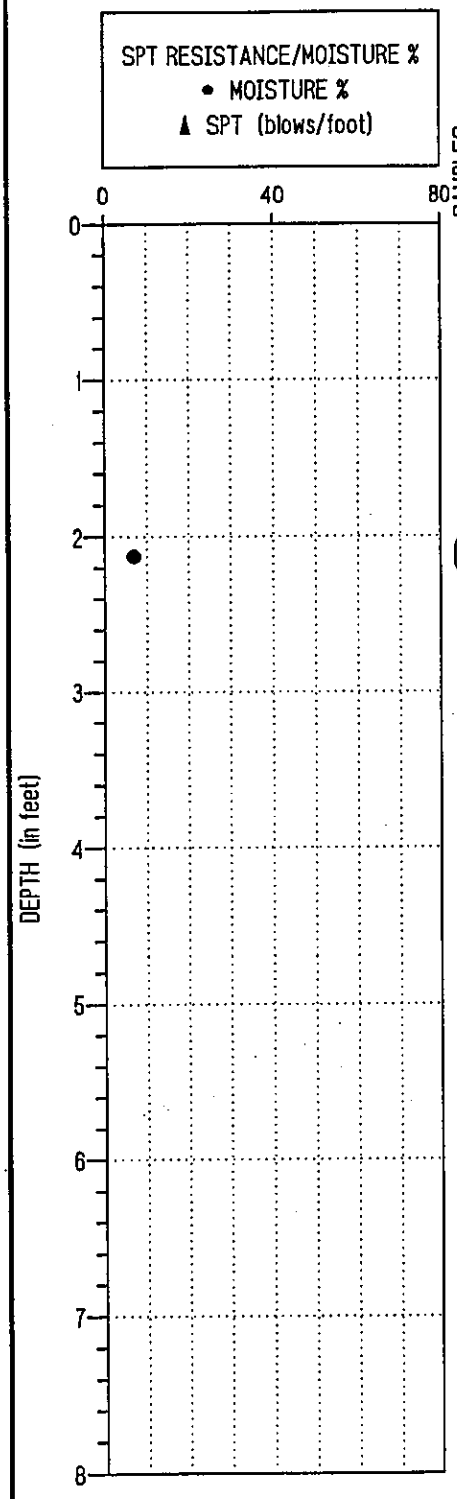
Minor Constituents

	Estimated Percentage
Trace	0 - 5
Some	5 - 12
Modifier (sandy, silty, etc.)	12 - 30
very plus modifier	30 - 50

Terms Describing Soil Structures

laminated	composed of thin (less than 1 cm.) layers of varying color and texture.
bedded	composed of laminations greater than 1 cm in thickness of varying color and texture.
interbedded	composed of alternating beds of different soil types.
well graded	having a wide range of grain sizes, with substantial amounts of all intermediate particle sizes.
poorly graded	predominantly one grain size, or having a range of sizes with some intermediate sizes missing.
fissured	containing shrinkage cracks, frequently filled with fine sand or silt, usually more or less vertical.
slickensided	having inclined planes of weakness that are slick and glossy in appearance.
calcareous	containing appreciable quantities of calcium carbonate.

HONG WEST & ASSOCIATES
HAND BORING LOG



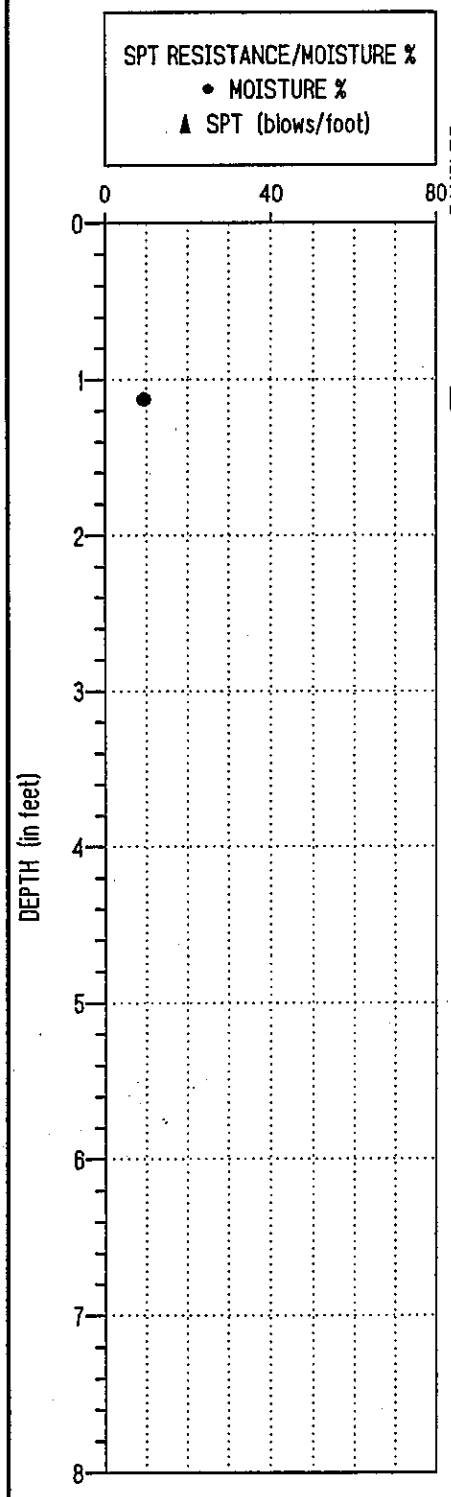
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Medium dense, brown, gravelly SAND, occasional cobbles. (FILL)	
		GW / GM	Medium dense, gray-brown, sandy GRAVEL, some silt, wet, becomes dense gray sandy gravel at depth.	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta 497+85 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-1C

DATE DRILLED: 8-15-91
SURFACE ELEVATION: 67 ft.
TOTAL DEPTH: 2.25 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



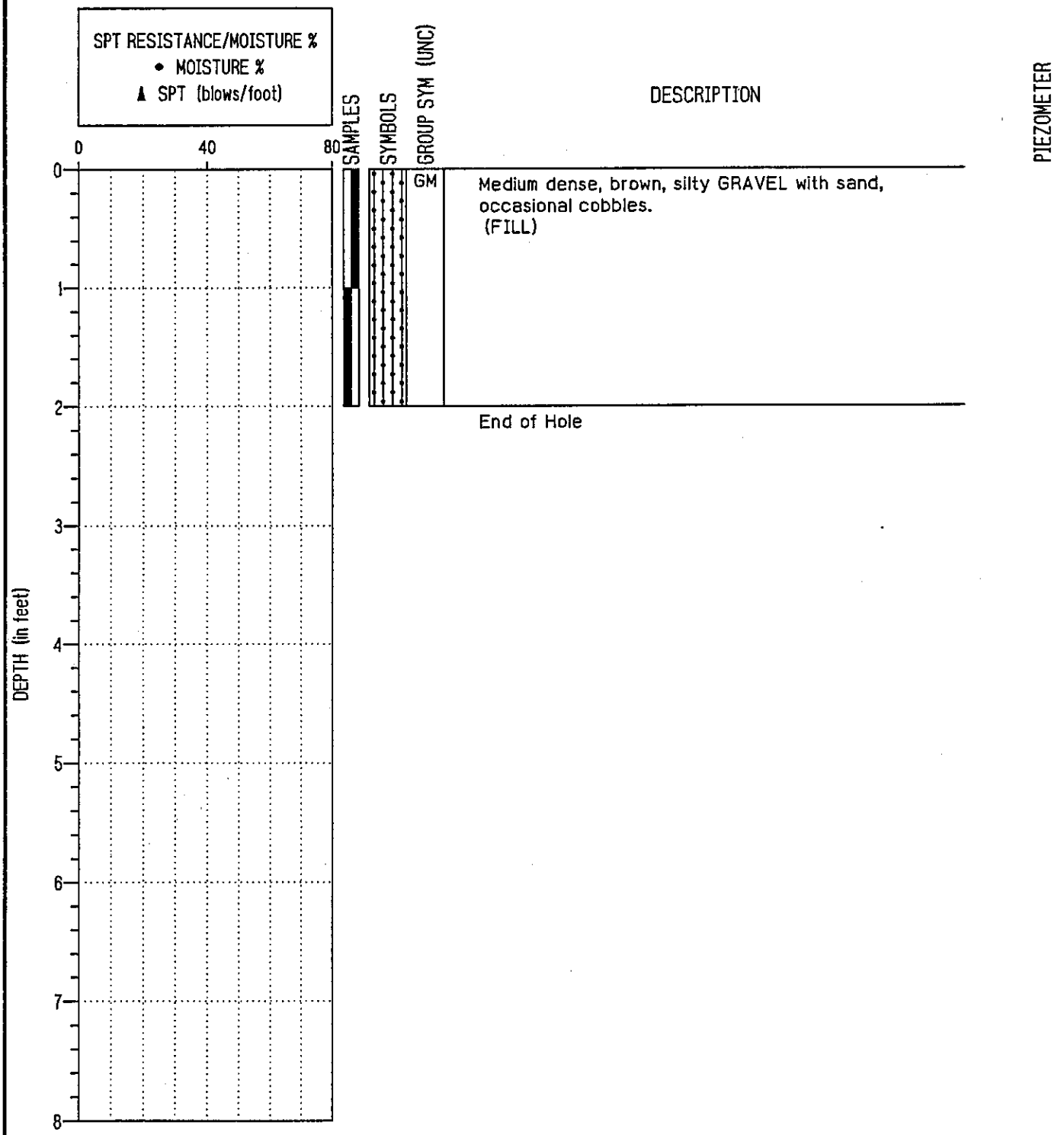
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Medium dense, brown, gravelly SAND, occasional cobbles. (FILL)	
			Stiff gray, low plastic SILT.	
		GM	Dense, gray, silty GRAVEL with sand.	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta 497+85 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-1W

DATE DRILLED: 8-15-91
SURFACE ELEVATION: 67 ft.
TOTAL DEPTH: 1.25 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

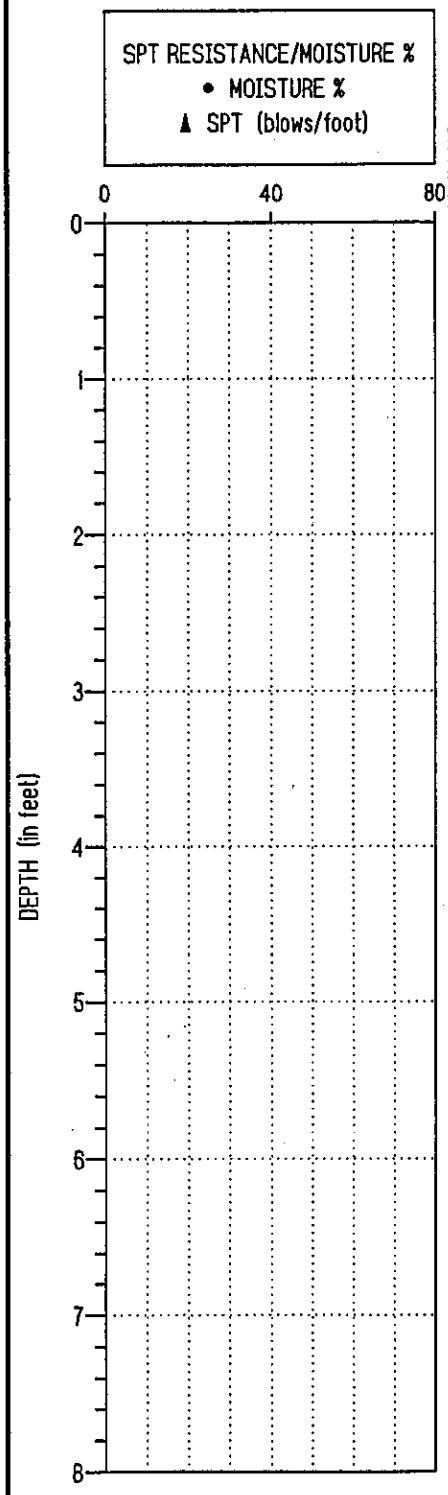


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 508+30 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-2E

DATE DRILLED: 8-15-91
SURFACE ELEVATION: 80 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Medium dense to dense, brown, gravelly SAND, trace to some silt, occasional cobbles. (FILL)	

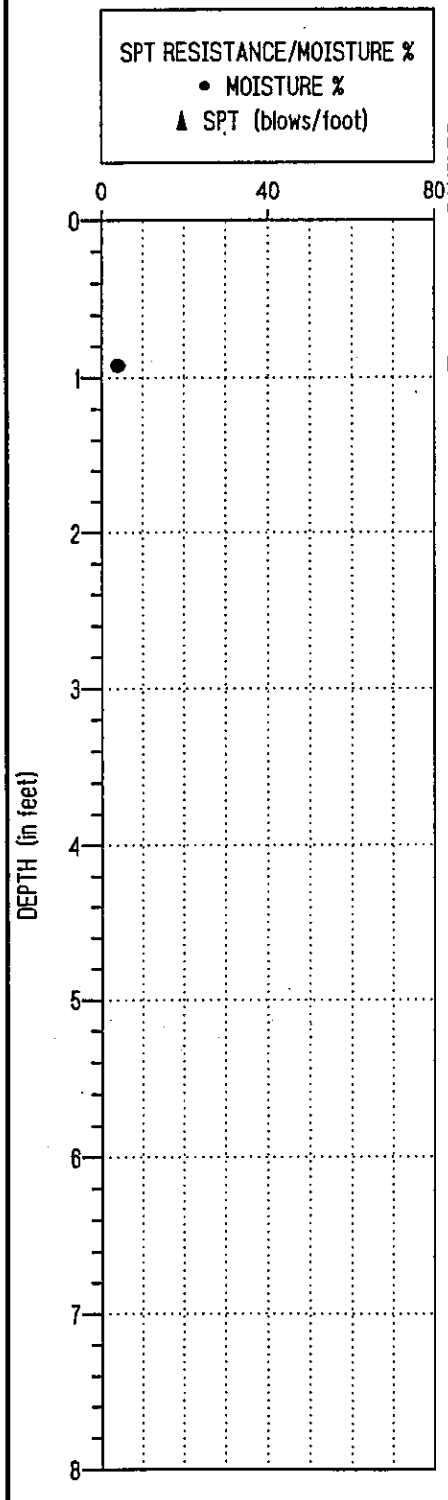
End of Hole

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 508+30 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-2W

DATE DRILLED: 8-15-91
SURFACE ELEVATION: 80 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
O			Medium dense to dense, brown, gravelly SAND, trace silt, occasional cobbles. (FILL)	

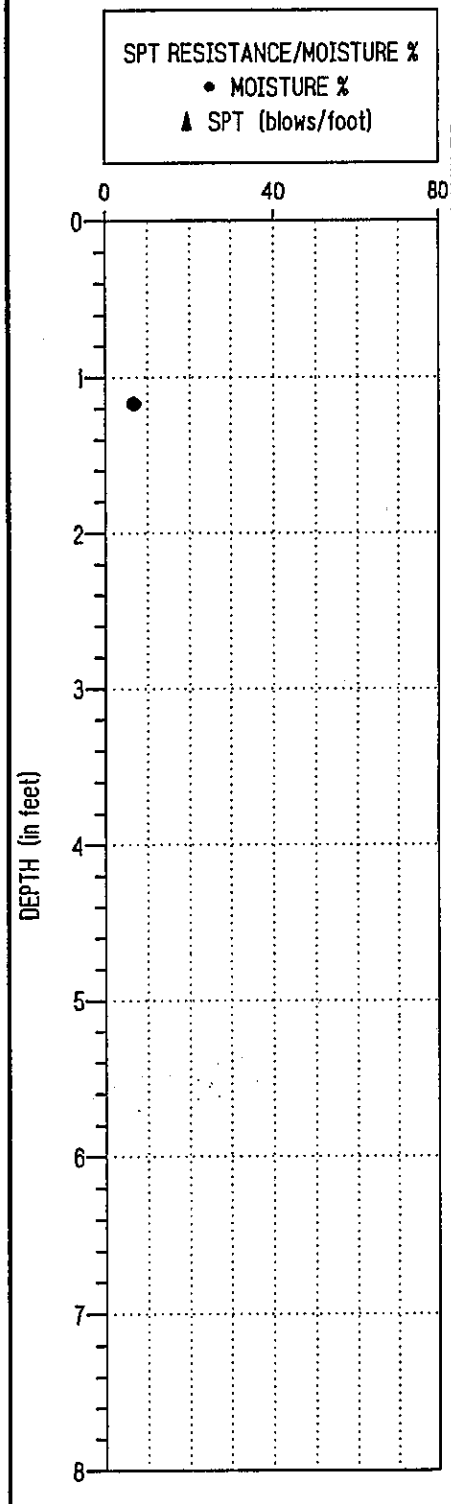
End of Hole

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 517+35 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-3E

DATE DRILLED: 8-15-91
SURFACE ELEVATION: 97 ft.
TOTAL DEPTH: 1.00 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
		GM	Medium dense to dense, brown, silty GRAVEL with sand, occasional cobbles. (FILL)	
			End of Hole	

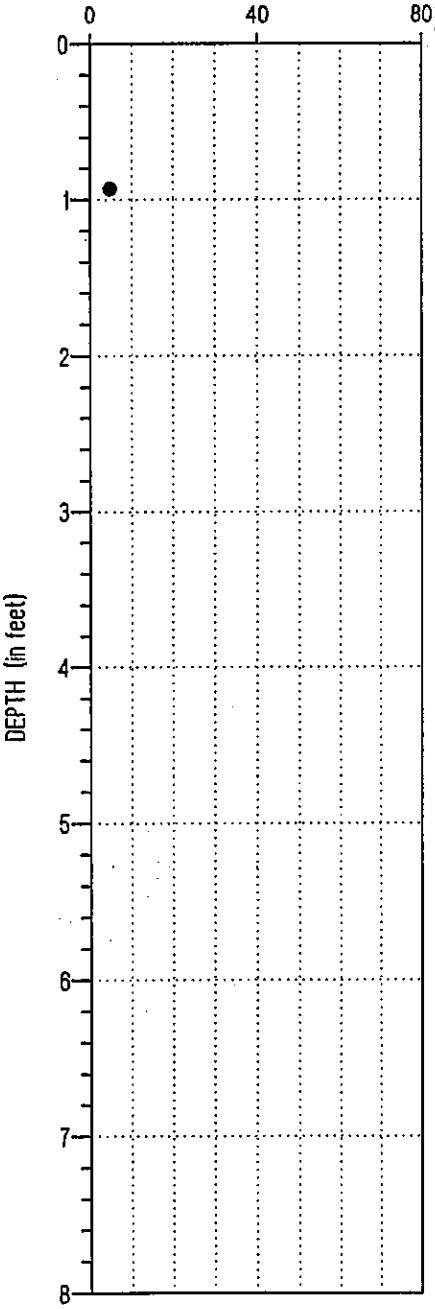
PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 517+35 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-3W

DATE DRILLED: 8-15-91
SURFACE ELEVATION: 97 ft.
TOTAL DEPTH: 1.00 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

SPT RESISTANCE/MOISTURE %
• MOISTURE %
▲ SPT (blows/foot)



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
		GM	Medium dense to dense, brown, silty GRAVEL with sand, occasional cobbles. (FILL)	
			End of Hole	

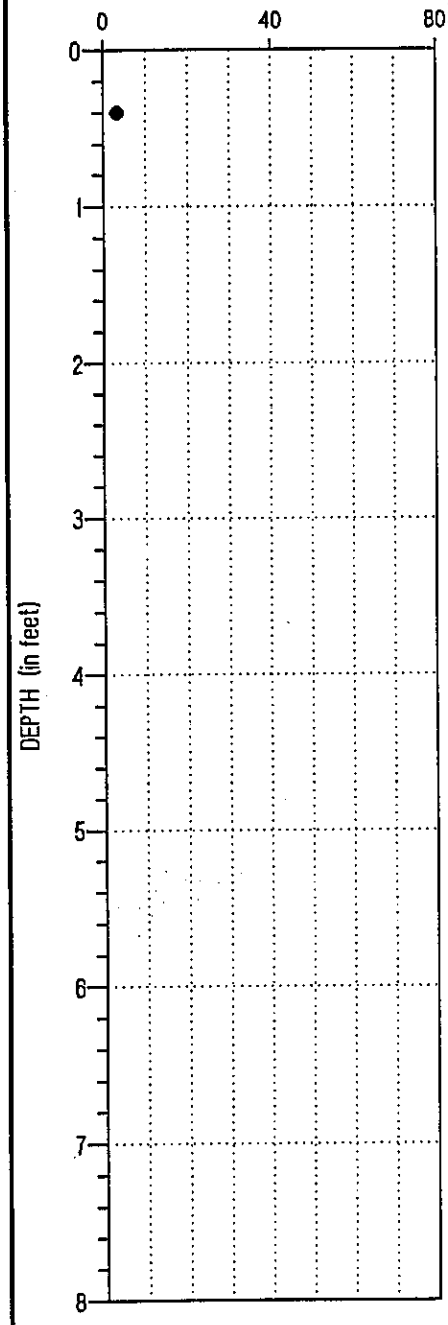
PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 527+45 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-4E

DATE DRILLED: 8-15-91
SURFACE ELEVATION: 96 ft.
TOTAL DEPTH: 1.00 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

SPT RESISTANCE/MOISTURE %
• MOISTURE %
▲ SPT (blows/foot)



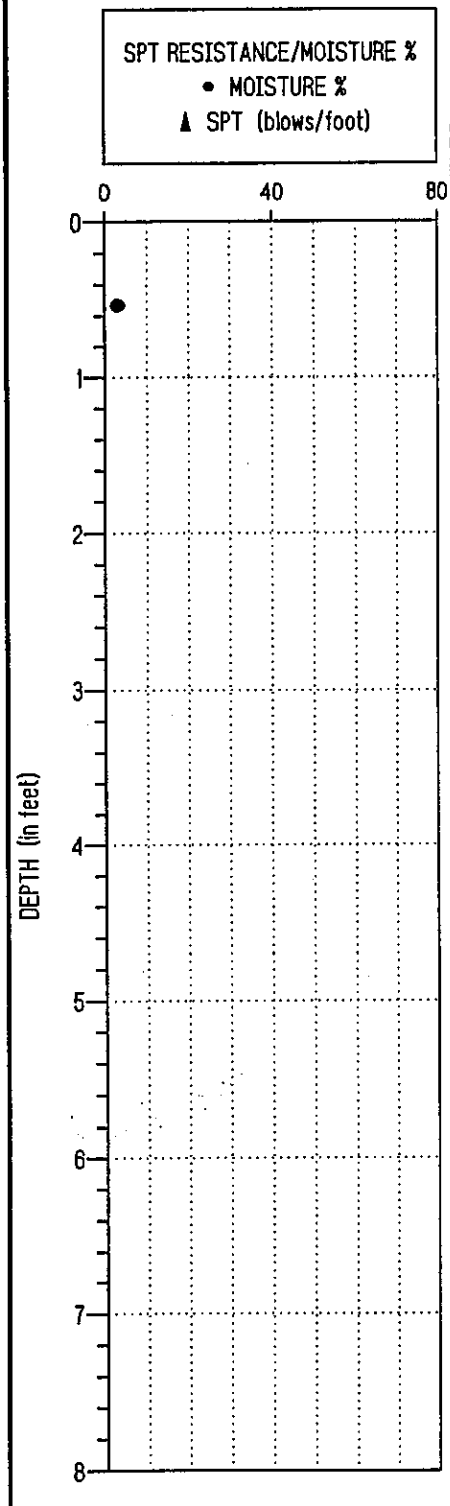
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND with some silt, occasional cobbles. (FILL)	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 539+80 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-5W

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 72 ft.
TOTAL DEPTH: 0.50 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
		GP GM	Dense, brown, gravelly SAND with some silt, occasional cobbles. (FILL)	

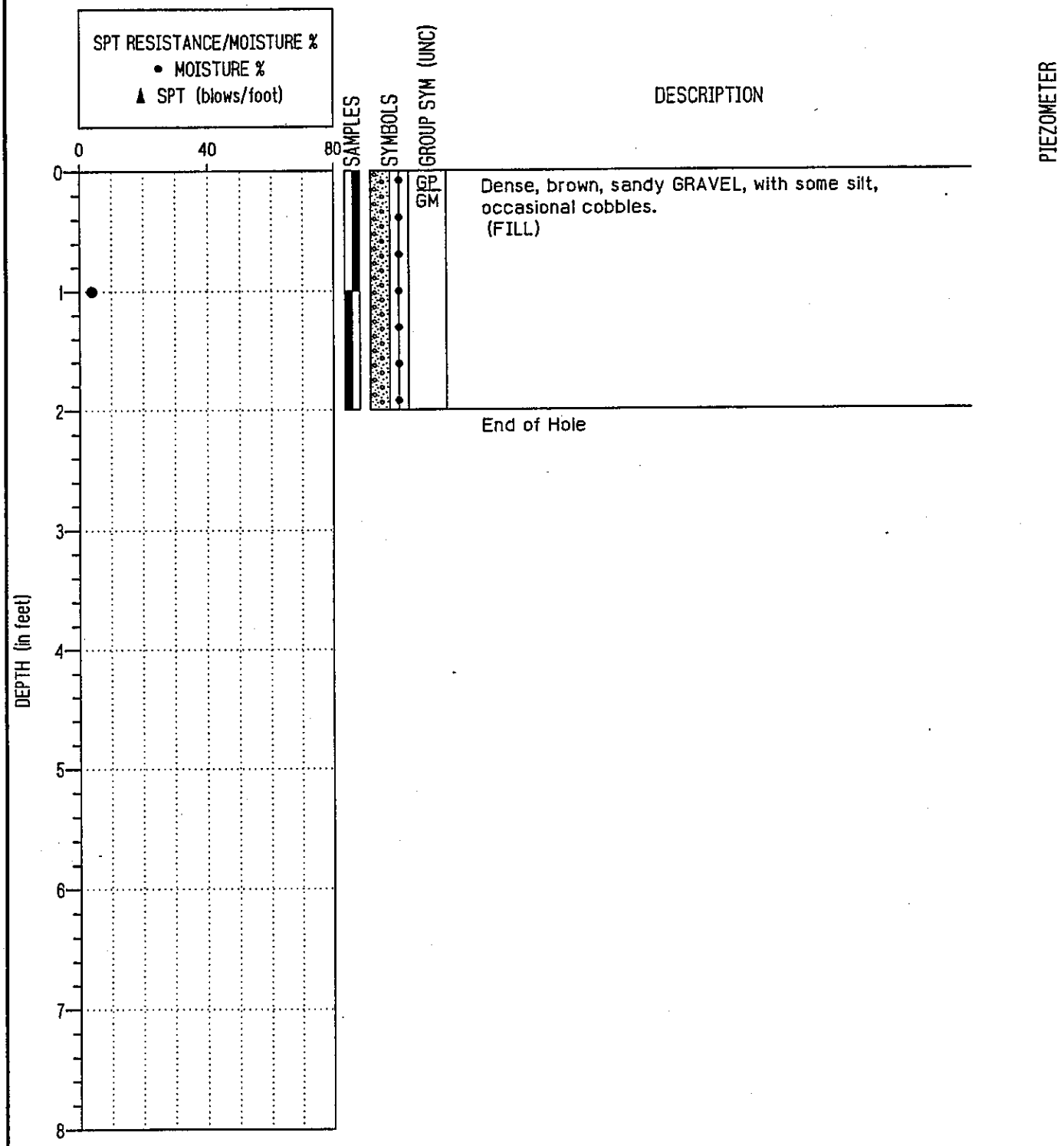
End of Hole

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 551+75 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-6E

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 65 ft.
TOTAL DEPTH: 0.83 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

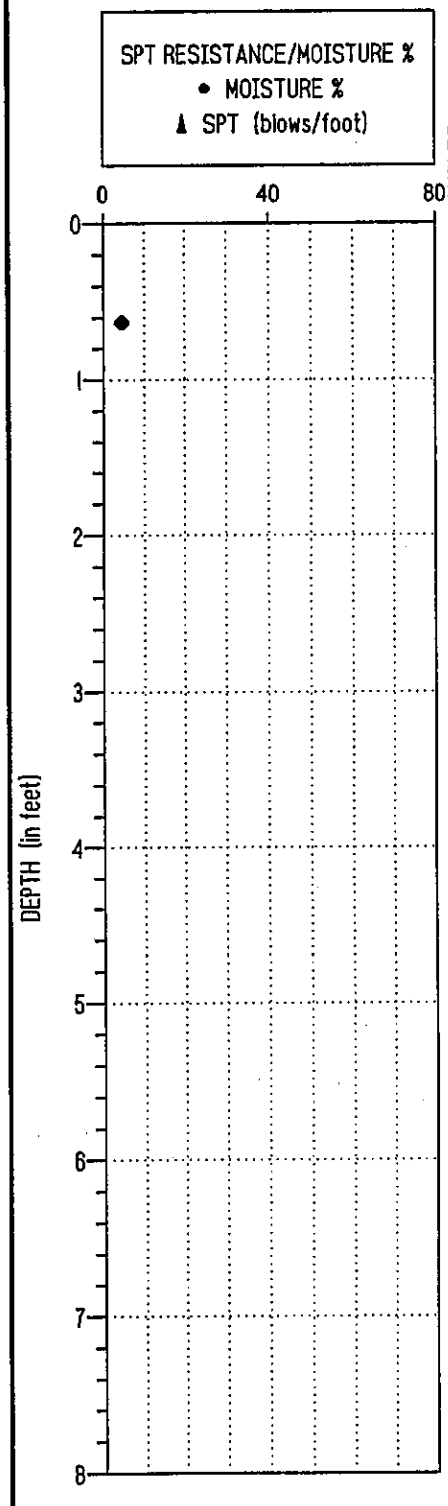


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 564+00 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-7W

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 62 ft.
TOTAL DEPTH: 2.00 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Medium dense to dense, brown, SAND with some gravel, trace silt, occasional cobbles. (FILL)	
			End of Hole	

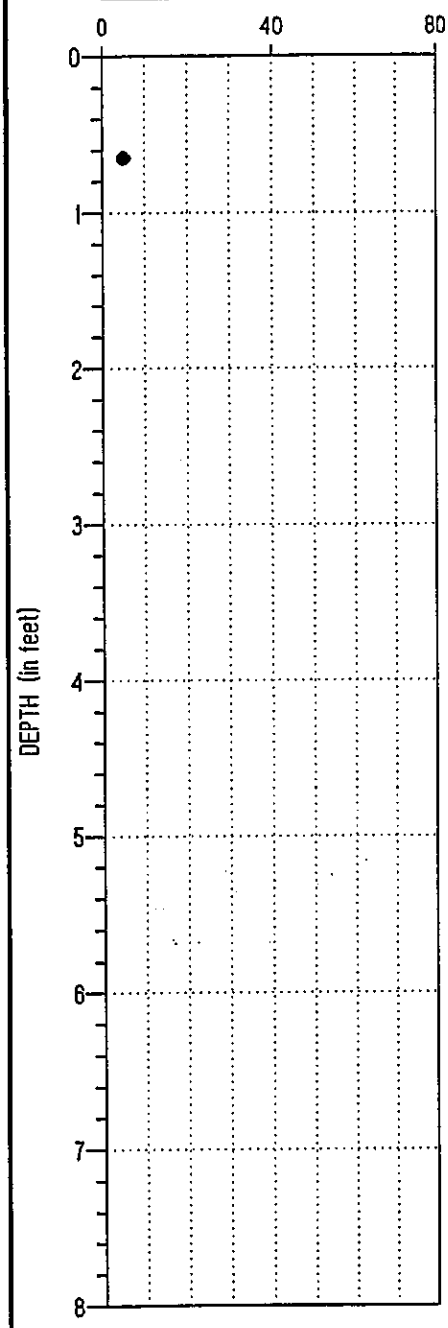
PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 572+75 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-8E

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 60 ft.
TOTAL DEPTH: 1.00 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

SPT RESISTANCE/MOISTURE %
• MOISTURE %
▲ SPT (blows/foot)



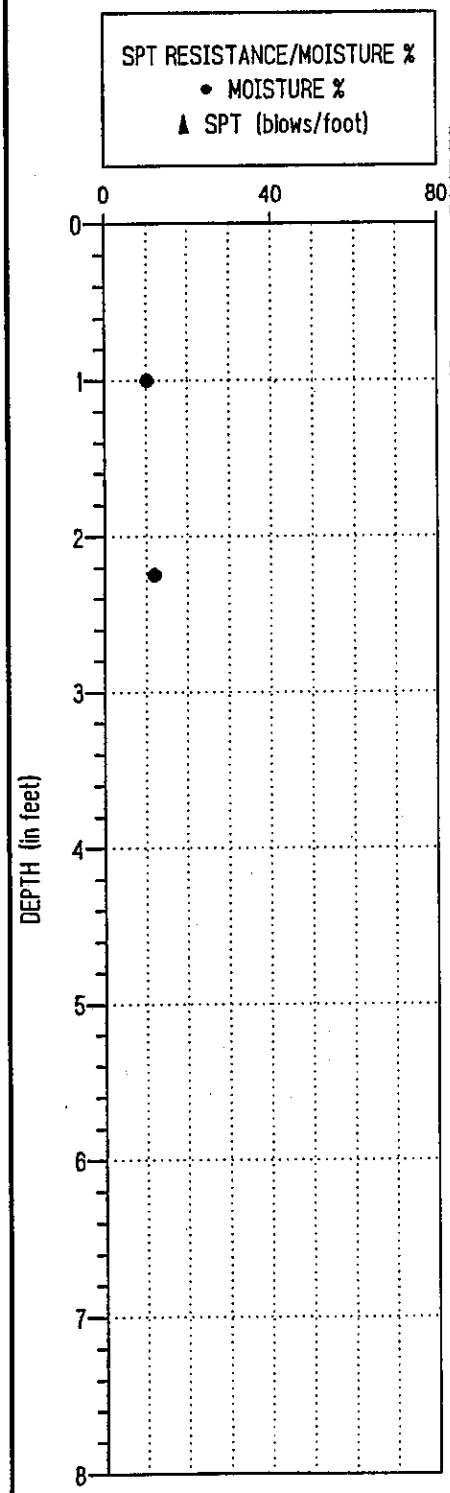
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND with some silt, occasional cobbles. (FILL)	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 582+60 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-9W

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 59 ft.
TOTAL DEPTH: 1.17 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



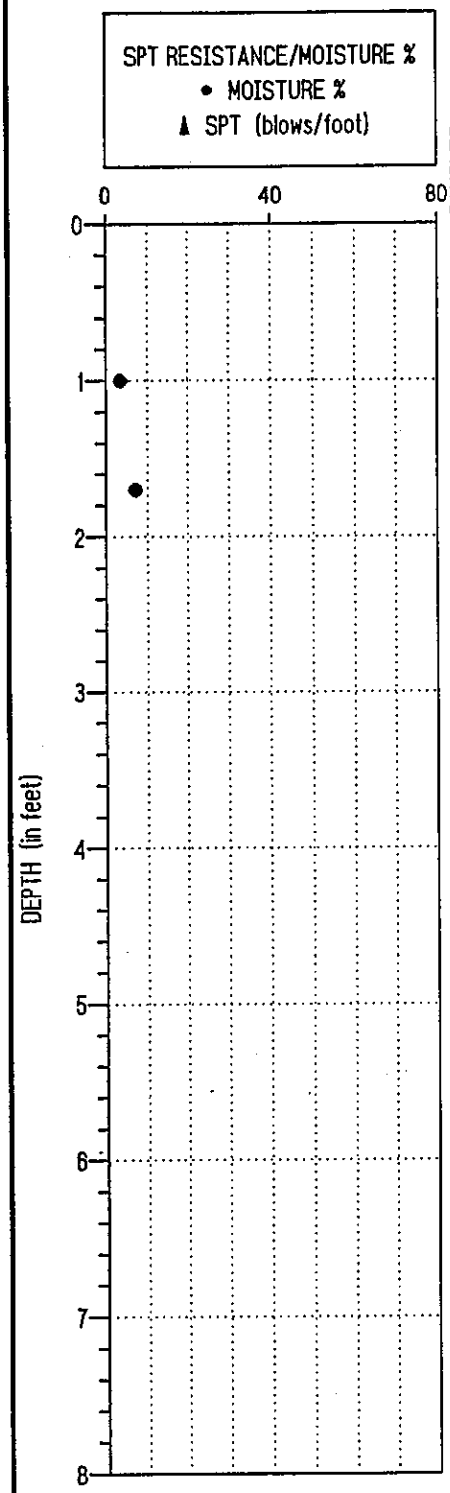
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown SAND, some gravel, trace silt, occasional cobbles. (FILL)	
			Medium dense, mottled gray-brown, gravelly SAND, trace silt, wet.	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 592+75 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-10E

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 58 ft.
TOTAL DEPTH: 2.50 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



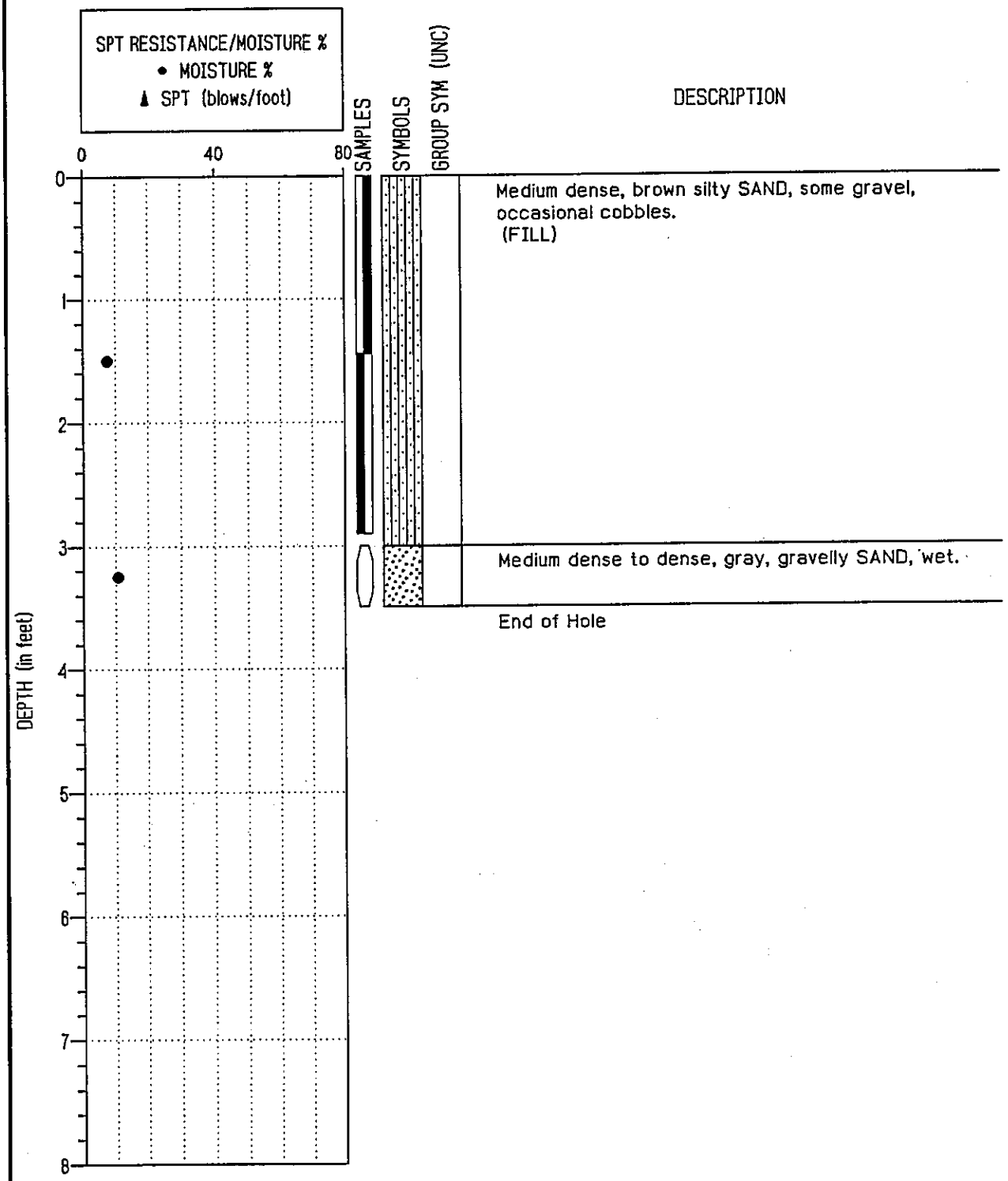
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles. (FILL)	
			Dense, gray, gravelly SAND, damp to wet.	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 603+00 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-11W

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 58 ft.
TOTAL DEPTH: 1.83 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

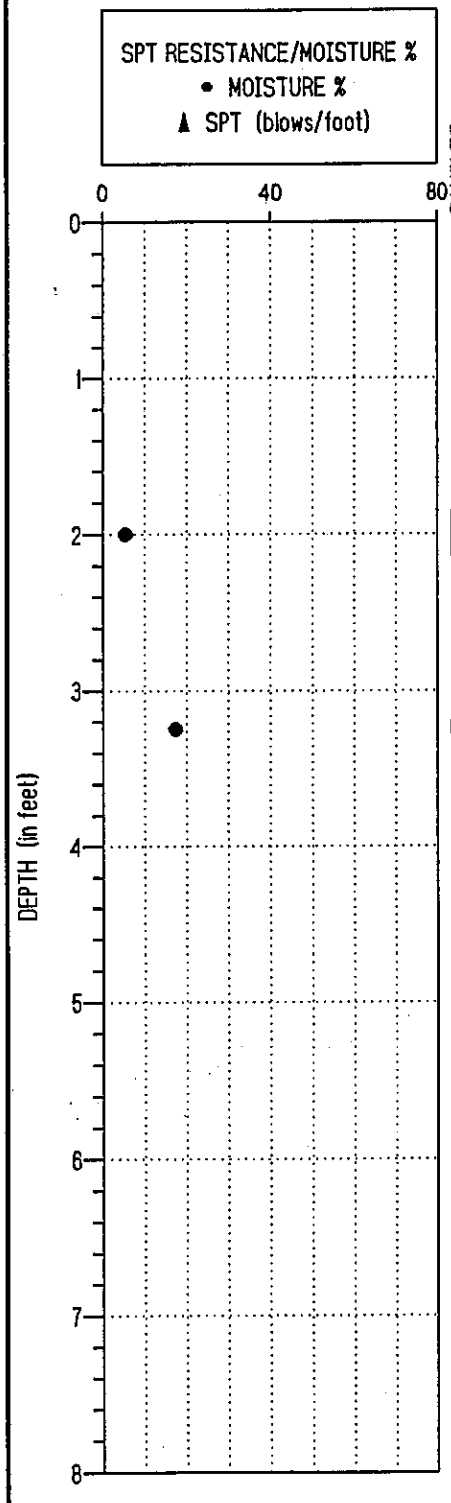


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 612+10 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-12E

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 55 ft.
TOTAL DEPTH: 3.50 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



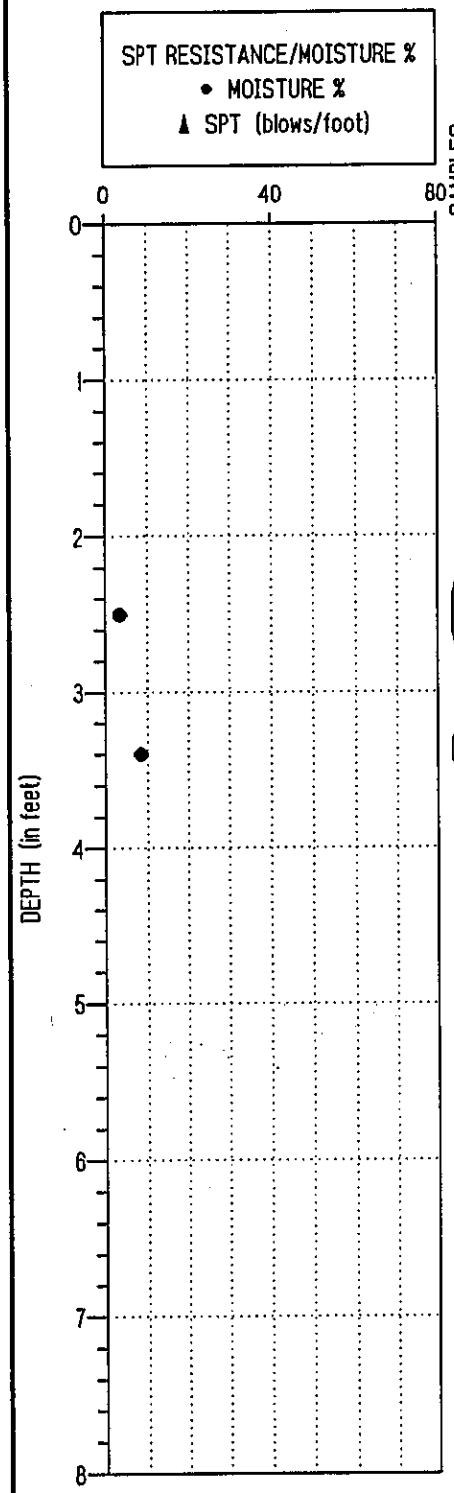
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, occasional cobbles. (FILL)	
			Dense, gray, SAND with interbedded gray low plastic silt, damp.	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 620+25 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-13W

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 51 ft.
TOTAL DEPTH: 3.33 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



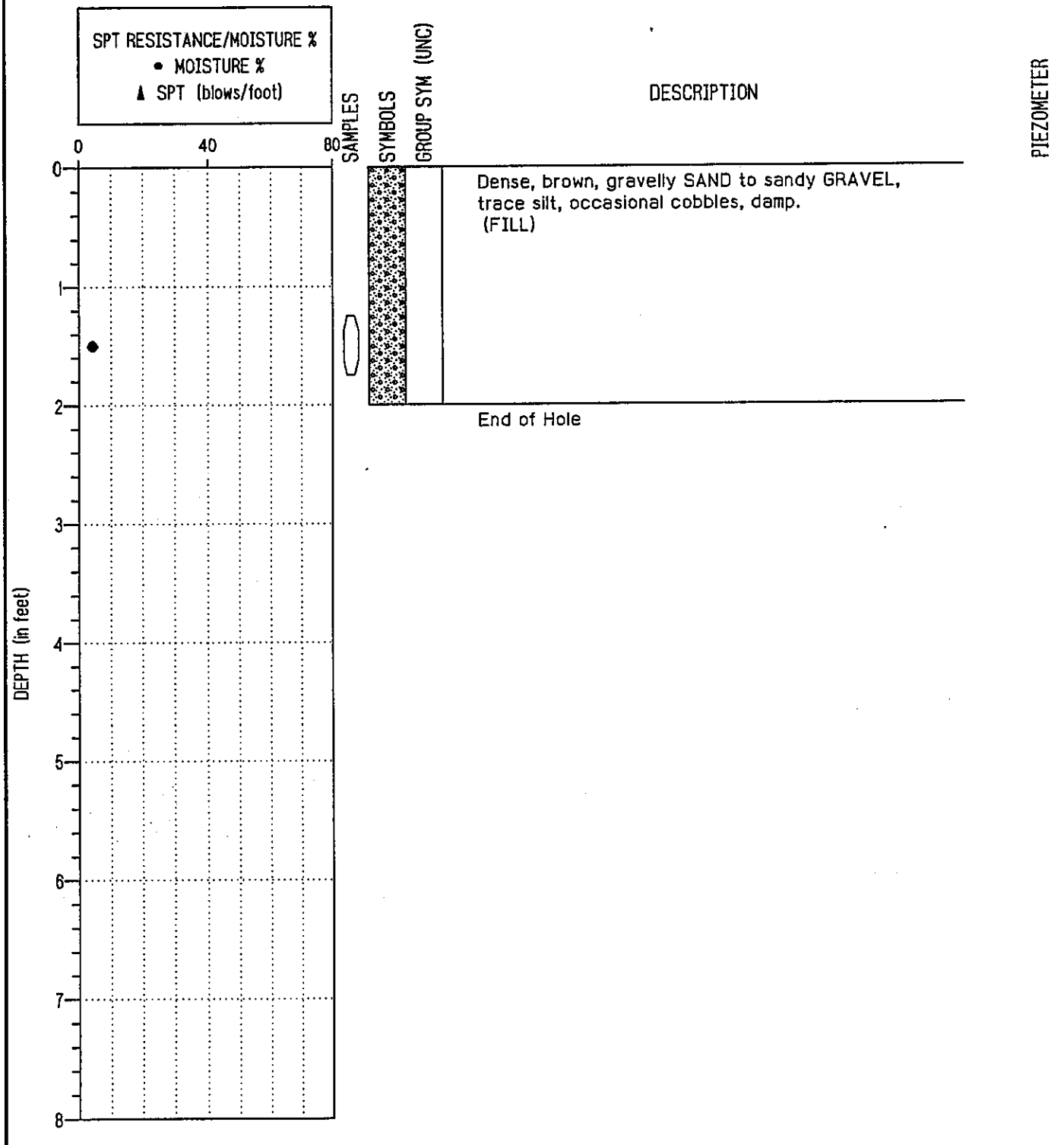
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles. (FILL)	
			Dense, gray, SAND with some gravel, damp	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 628+40 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-14E

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 53 ft.
TOTAL DEPTH: 3.50 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

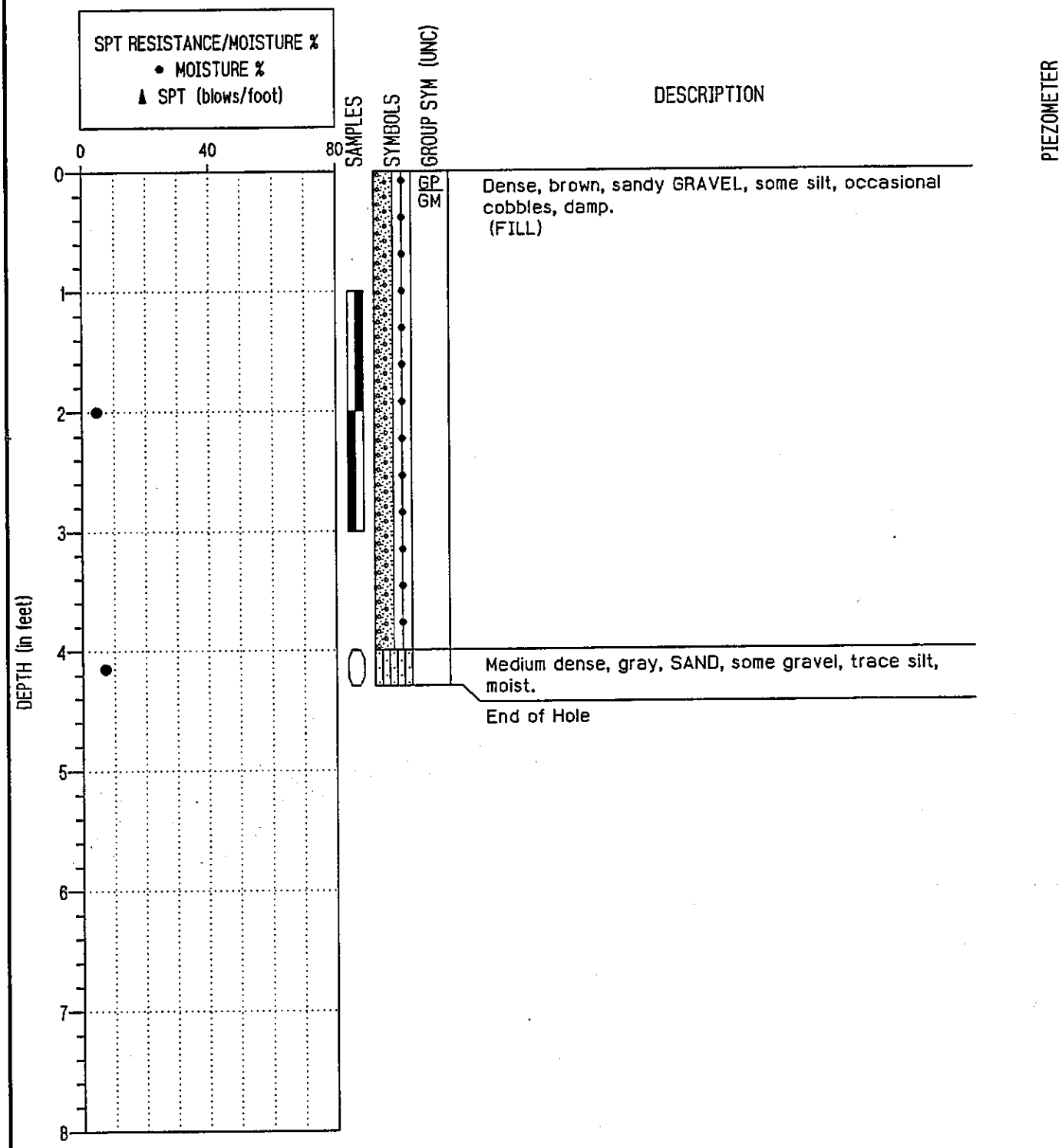


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 636+50 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-15W

DATE DRILLED: 8-16-91
SURFACE ELEVATION: 50 ft.
TOTAL DEPTH: 2.00 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

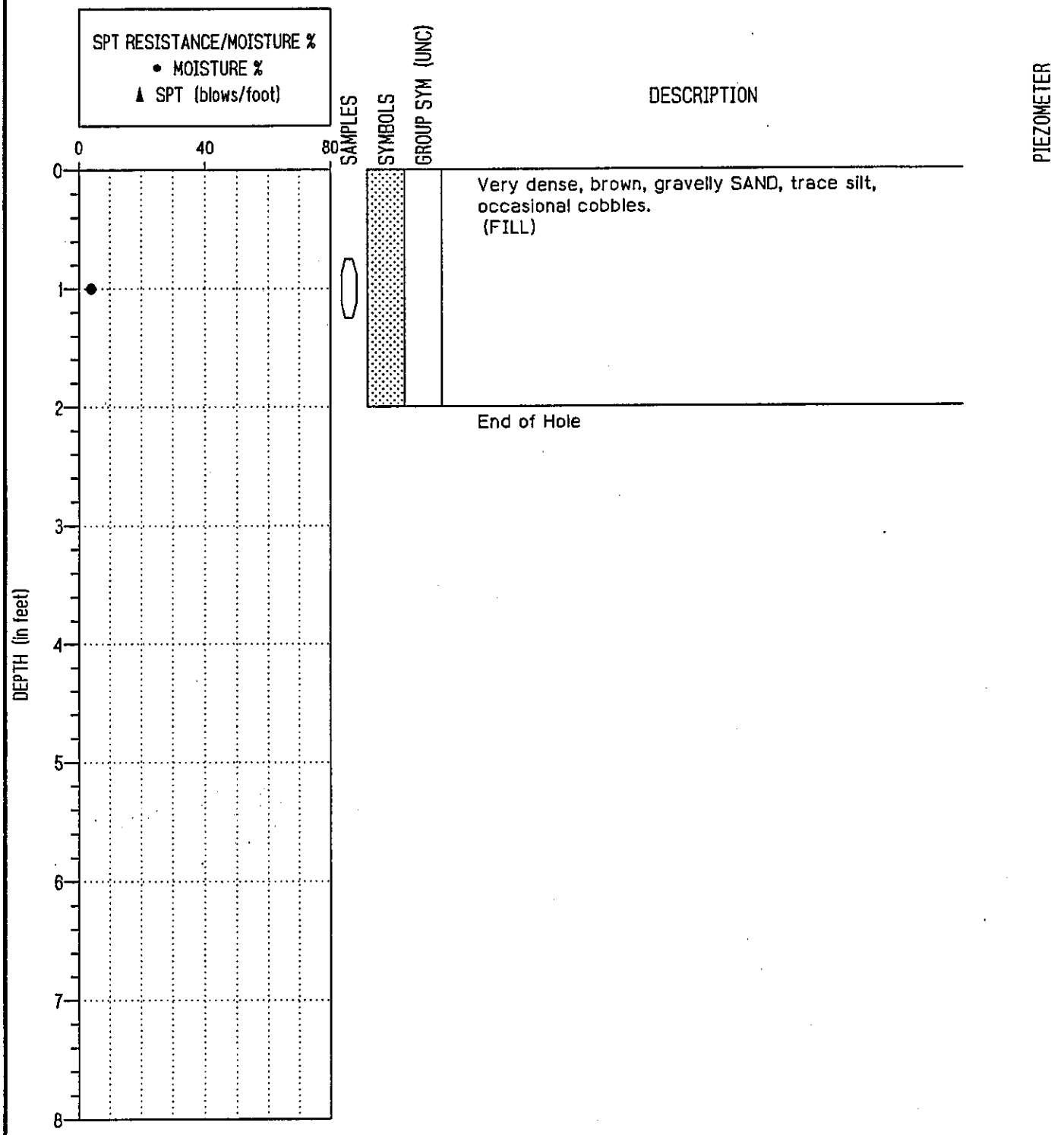


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 644+65 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-16E

DATE DRILLED: 8-19-91
SURFACE ELEVATION: 53 ft.
TOTAL DEPTH: 4.3 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

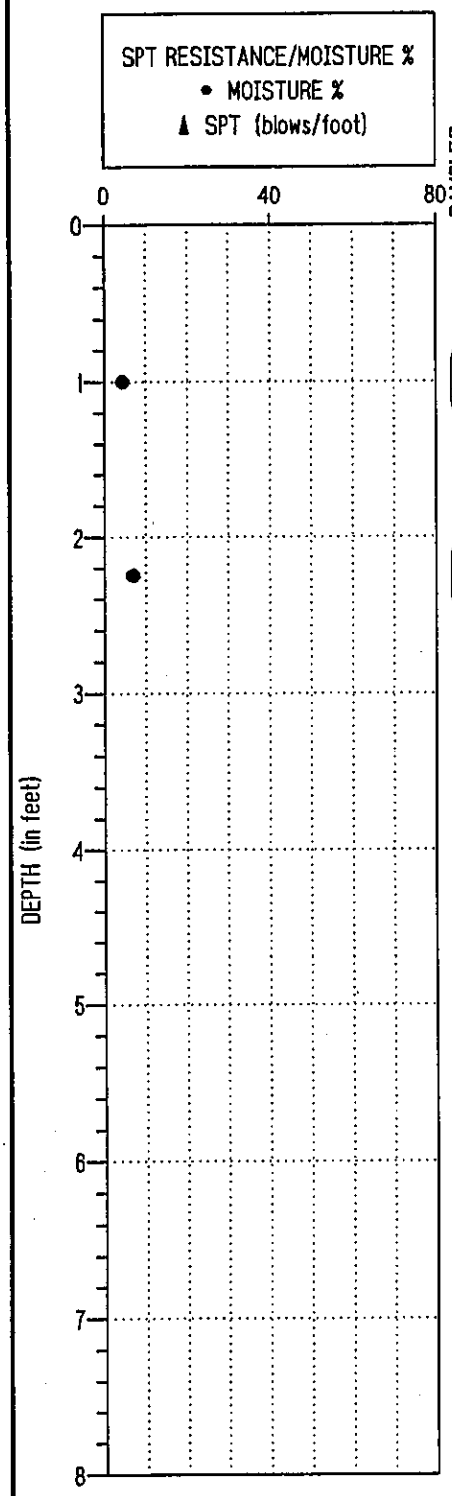


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 652+80 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-17W

DATE DRILLED: 8-19-91
SURFACE ELEVATION: 52 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



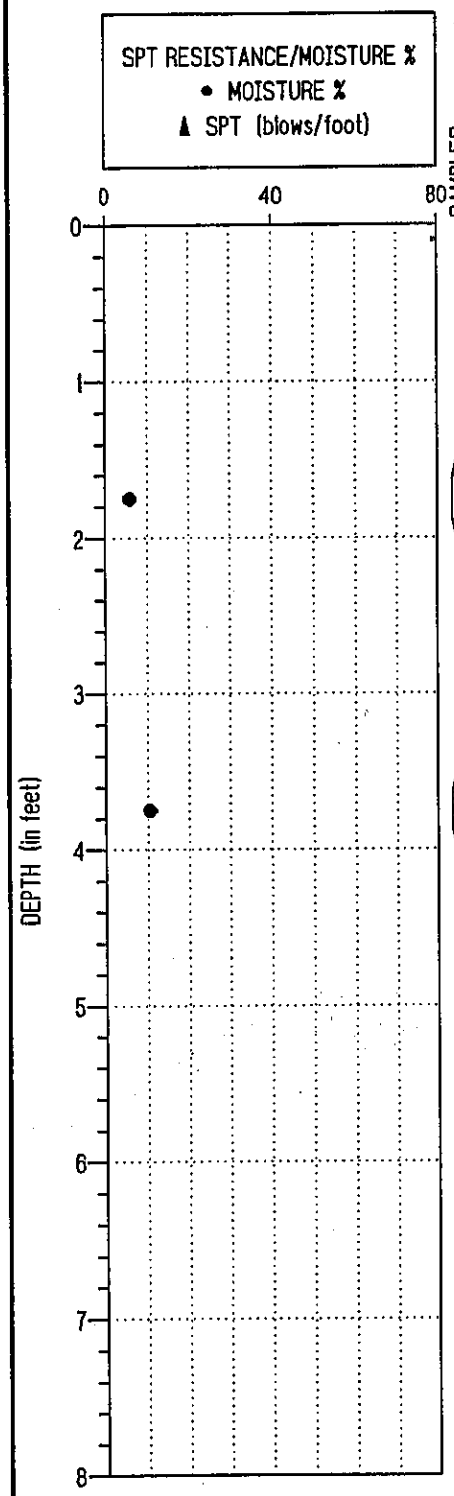
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, damp. (FILL)	
			Dense, gray, gravelly SAND, trace silt, damp.	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 660+90 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-18E

DATE DRILLED: 8-19-91
SURFACE ELEVATION: 48 ft.
TOTAL DEPTH: 2.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



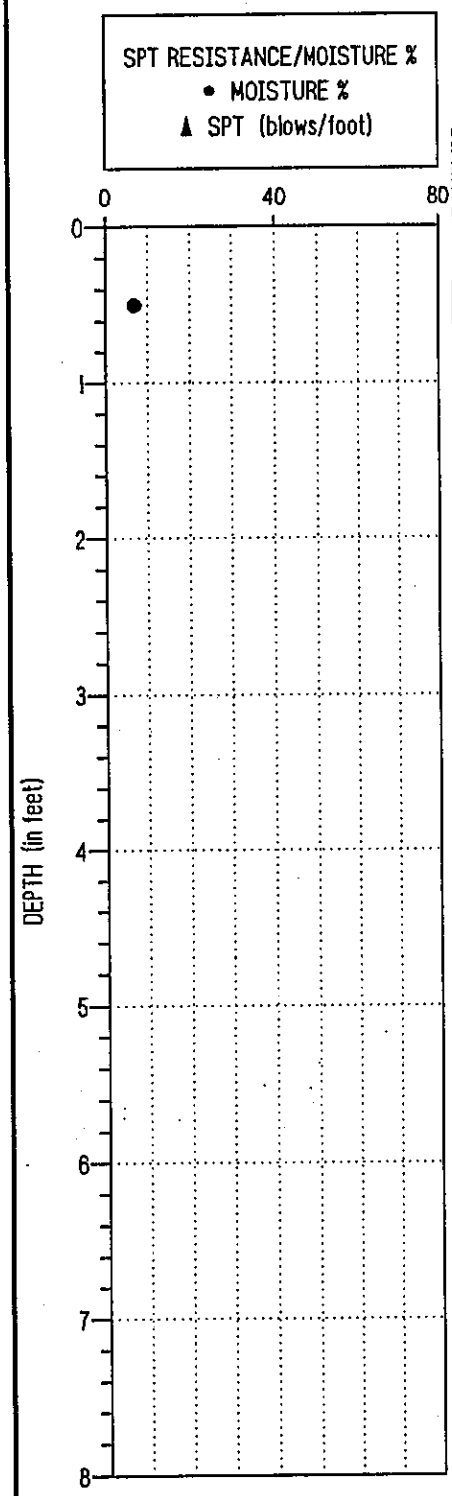
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, damp. (FILL)	
			Dense, gray, gravelly SAND, trace silt, moist.	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 670+80 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-19W

DATE DRILLED: 8-19-91
SURFACE ELEVATION: 47 ft.
TOTAL DEPTH: 4.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



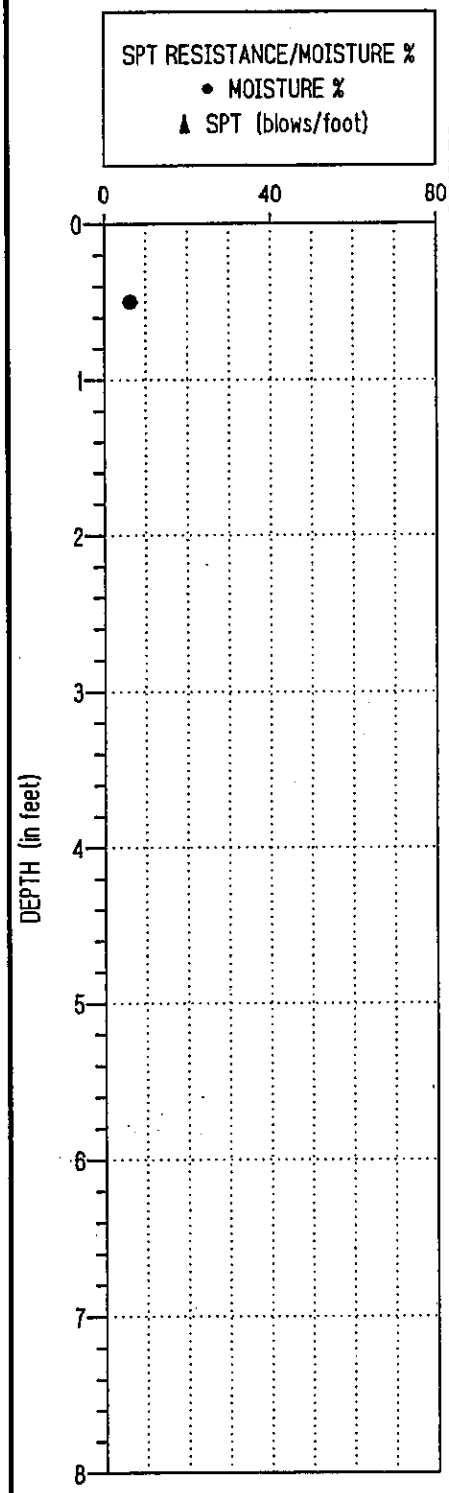
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
		SM	Dense, brown, silty SAND with gravel, occasional cobbles, damp. (FILL)	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 680+90 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-20E

DATE DRILLED: 8-19-91
SURFACE ELEVATION: 48 ft.
TOTAL DEPTH: 1.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



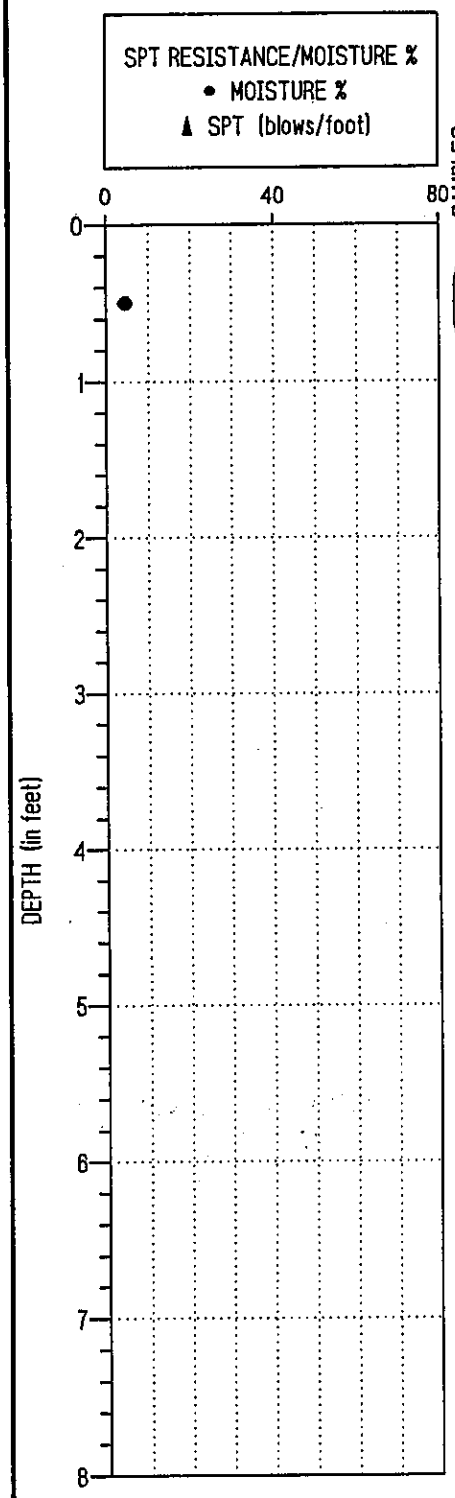
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, moist. (FILL)	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 690+95 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-21W

DATE DRILLED: 8-19-91
SURFACE ELEVATION: 48 ft.
TOTAL DEPTH: 1.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



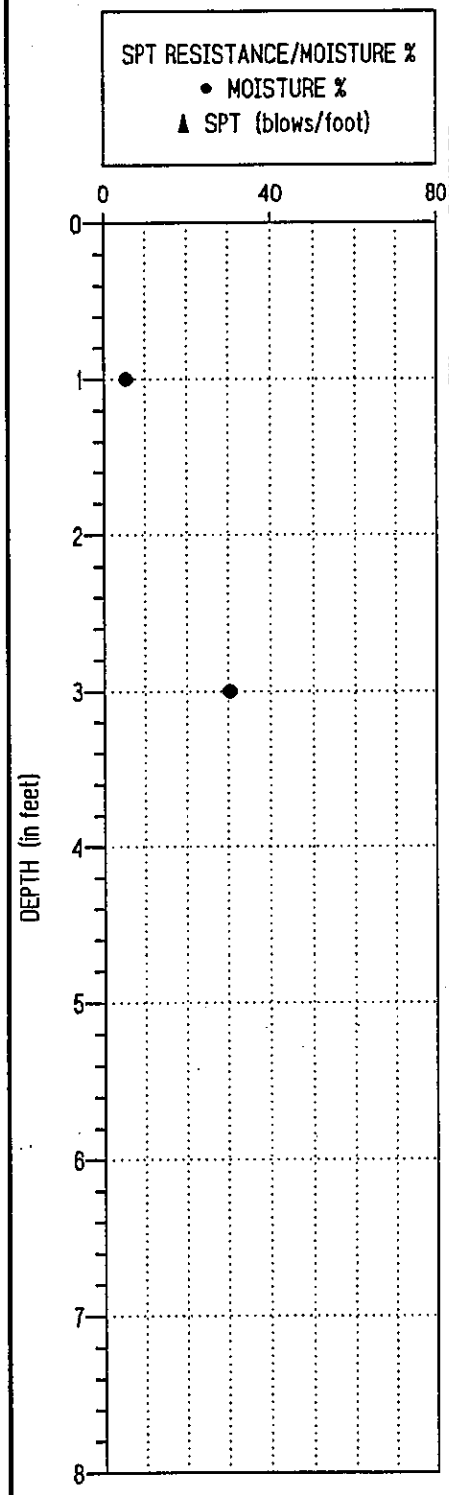
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, sandy GRAVEL, trace silt, occasional cobbles, damp. (FILL)	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 700+85 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-22E

DATE DRILLED: 8-19-91
SURFACE ELEVATION: 45 ft.
TOTAL DEPTH: 1.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



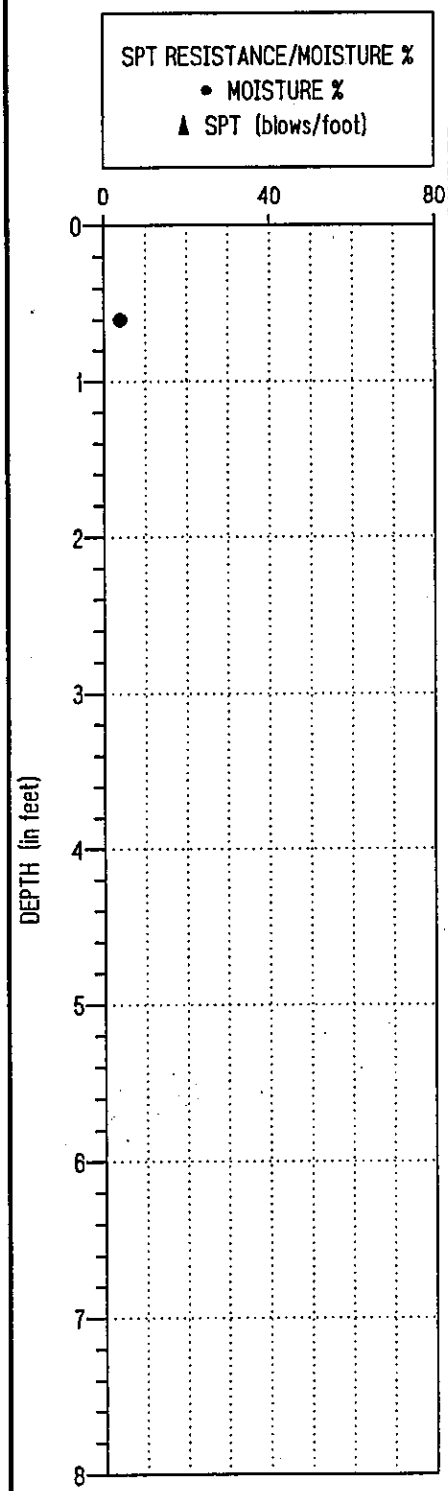
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, moist. (FILL)	
			Dense, gray, gravelly SAND, moist.	
			Soft, brown, sandy SILT to silty SAND, moist becoming wet at 4.5'.	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 710+90 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-23W

DATE DRILLED: 8-19-91
SURFACE ELEVATION: 44 ft.
TOTAL DEPTH: 5.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
		GW	Dense, brown, sandy GRAVEL, trace silt, occasional cobbles, damp. (FILL)	

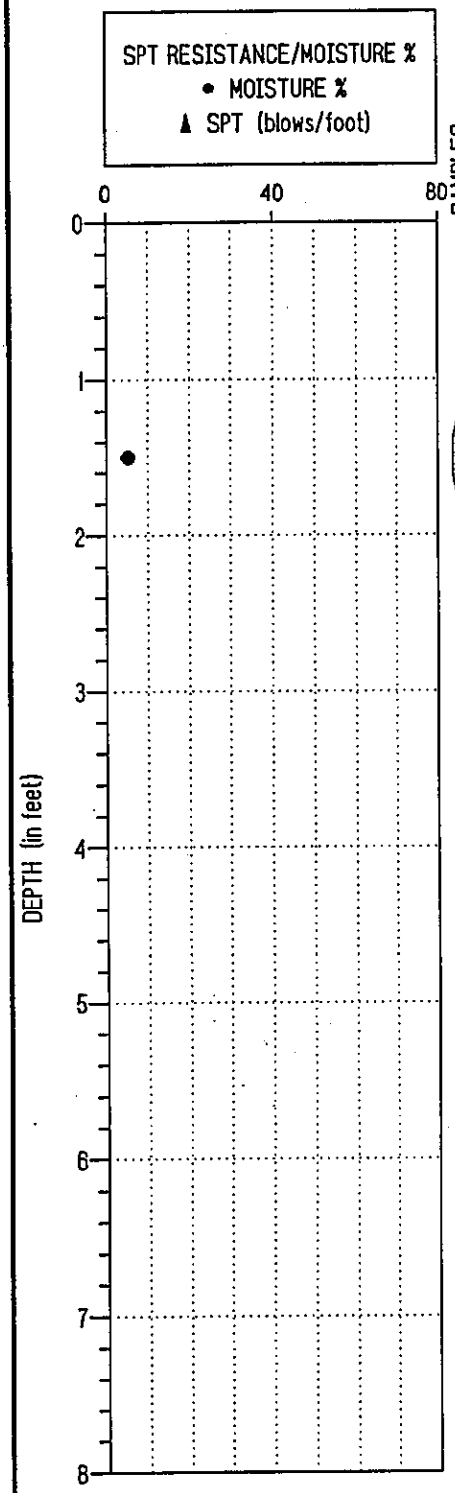
End of Hole

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 720+80 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-24E

DATE DRILLED: 8-19-91
SURFACE ELEVATION: 45 ft.
TOTAL DEPTH: 1.25 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



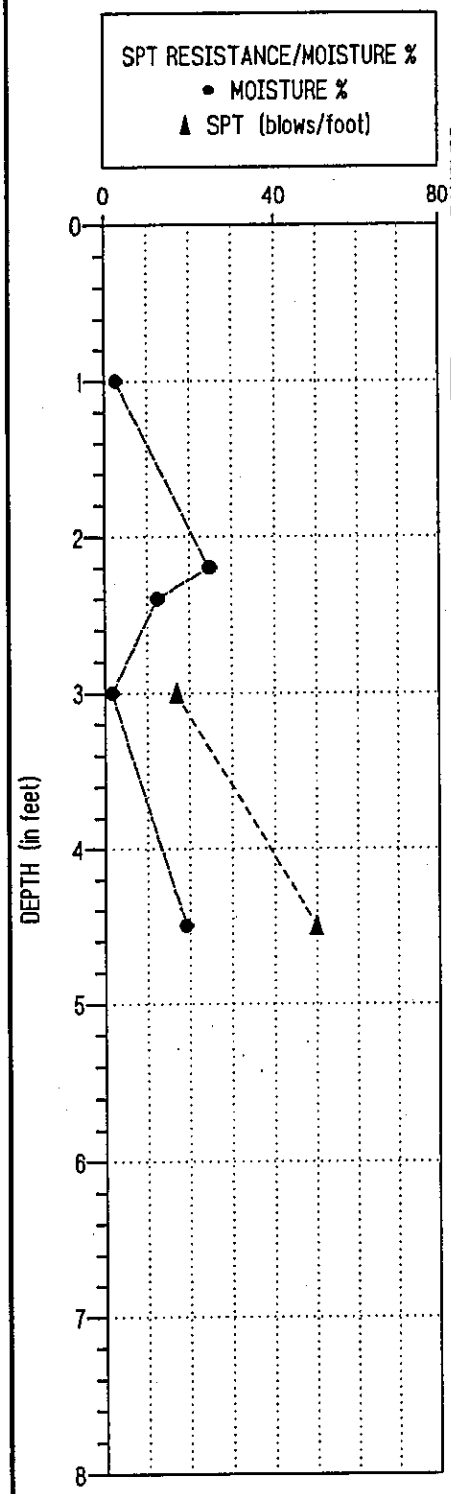
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Medium dense to dense, brown, gravelly SAND, trace silt, occasional cobbles, damp. (FILL).	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 730+60 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-25W

DATE DRILLED: 8-20-91
SURFACE ELEVATION: 43 ft.
TOTAL DEPTH: 3.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, damp. (FILL)	
			Dry density = 127pcf @ Moisture = 4.9%	
			3" layer of topsoil underlain by loose, brown, silty SAND; moist to damp.	
			Very loose, brown, SAND, some silt, damp.	
			Very loose to medium dense, brown SAND, some silt, damp.	
			Becomes medium dense at 5.5'	
			End of Hole	

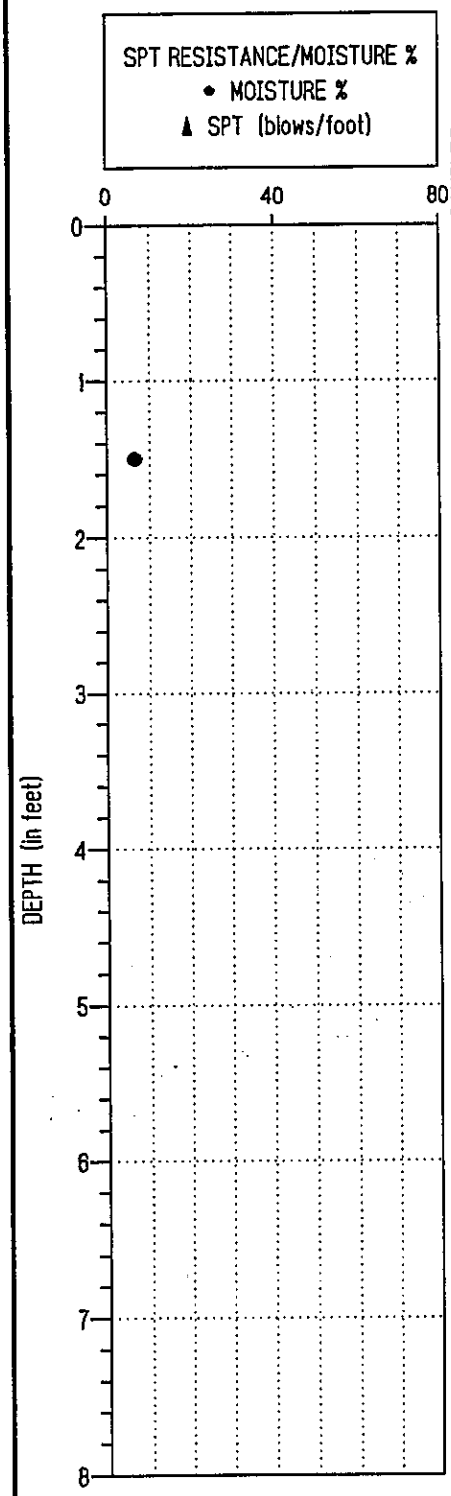
Note: Nonstandard penetration test: 40 lb hammer with 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 740+45 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-26E

DATE DRILLED: 8-20-91
SURFACE ELEVATION: 42 ft.
TOTAL DEPTH: 5.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



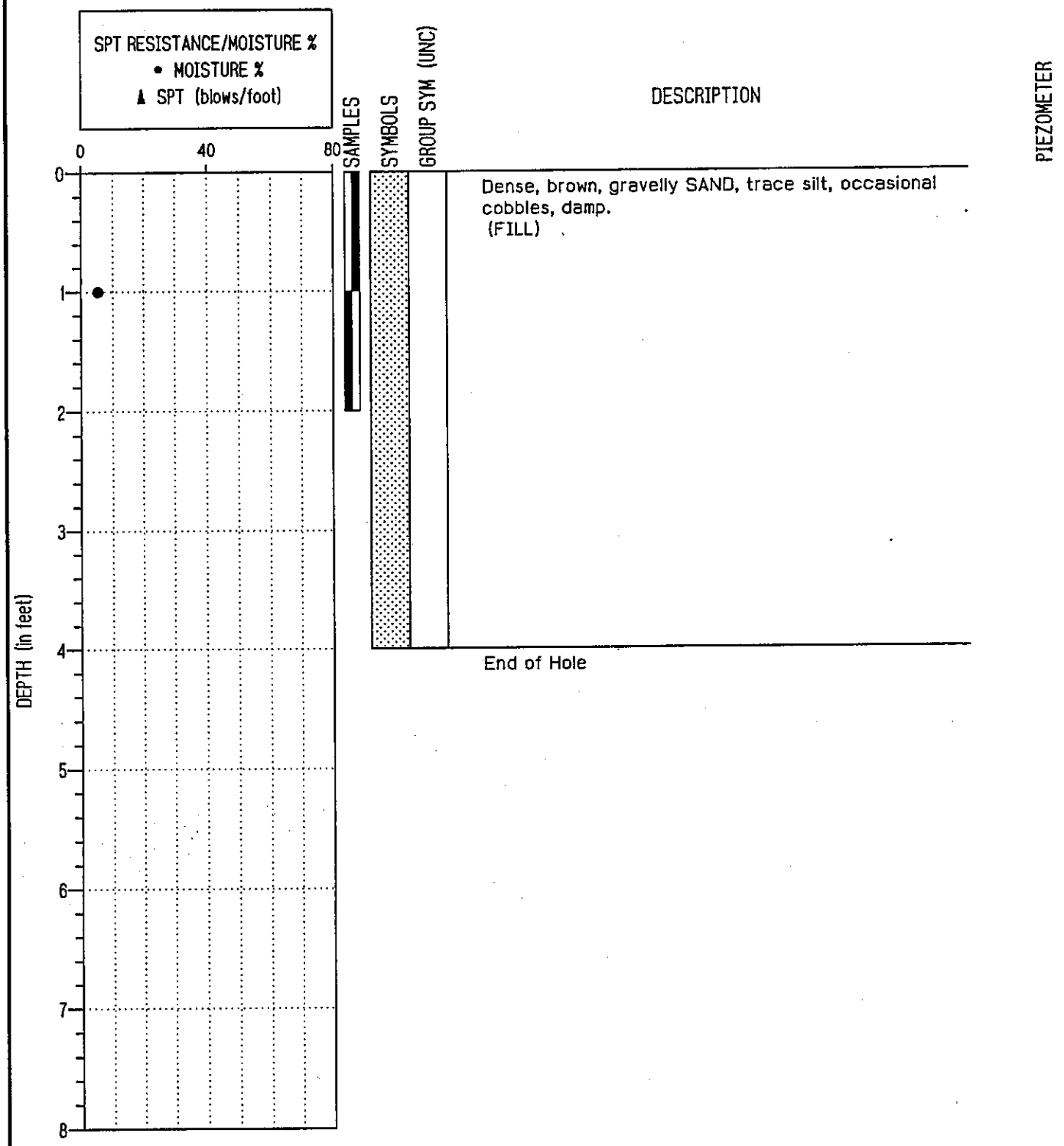
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, sandy GRAVEL, trace silt, occasional cobbles, damp. (FILL)	
			Dry density = 132 pcf @ Moisture = 5.3%	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 750+30 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-27W

DATE DRILLED: 8-20-91
SURFACE ELEVATION: 45 ft.
TOTAL DEPTH: 3.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

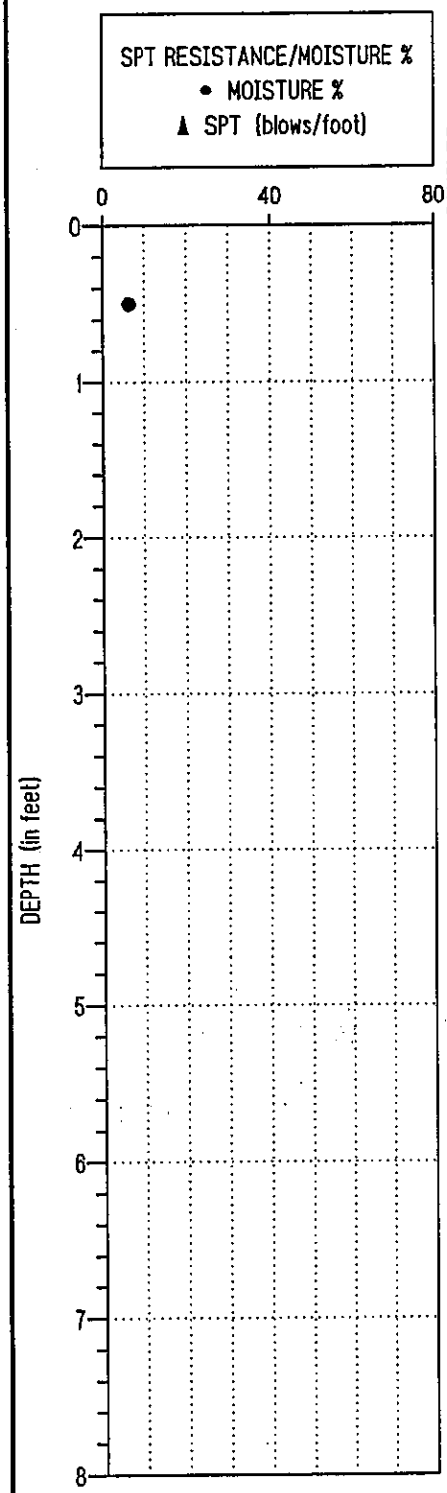


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 760+20 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-28E

DATE DRILLED: 8-20-91
SURFACE ELEVATION: 44 ft.
TOTAL DEPTH: 4.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



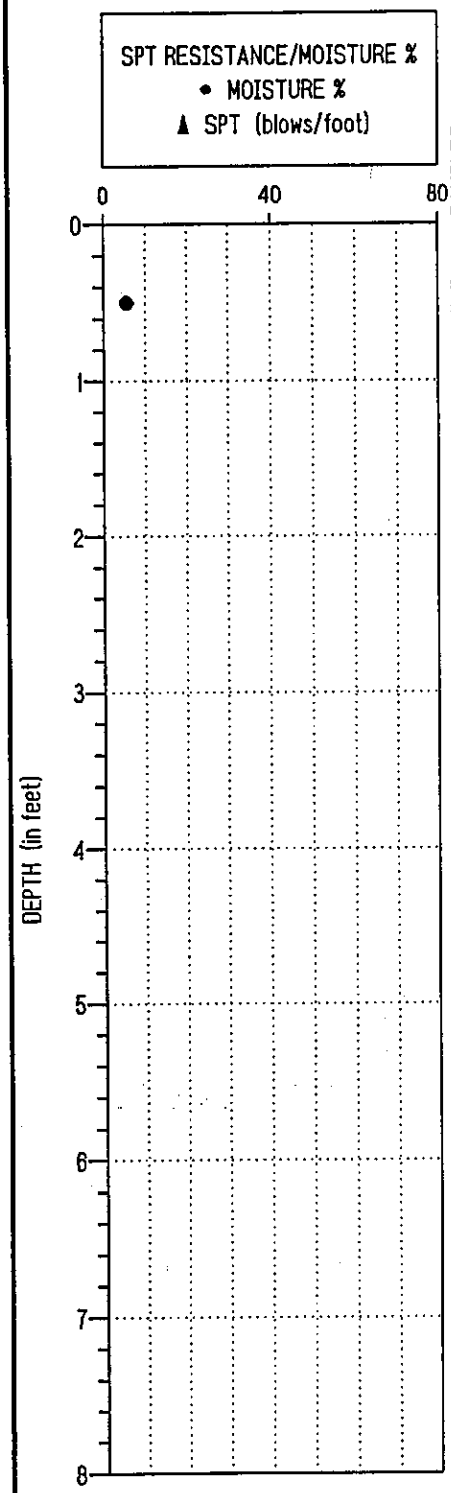
SAMPLES	SYMBOLS	GROUP SYM. (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, dry. (FILL)	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 770+00 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-29W

DATE DRILLED: 8-20-91
SURFACE ELEVATION: 51 ft.
TOTAL DEPTH: 1.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, dry. (FILL)	
			Dry density = 131 pcf @ Moisture = 3.9%	
			End of Hole	

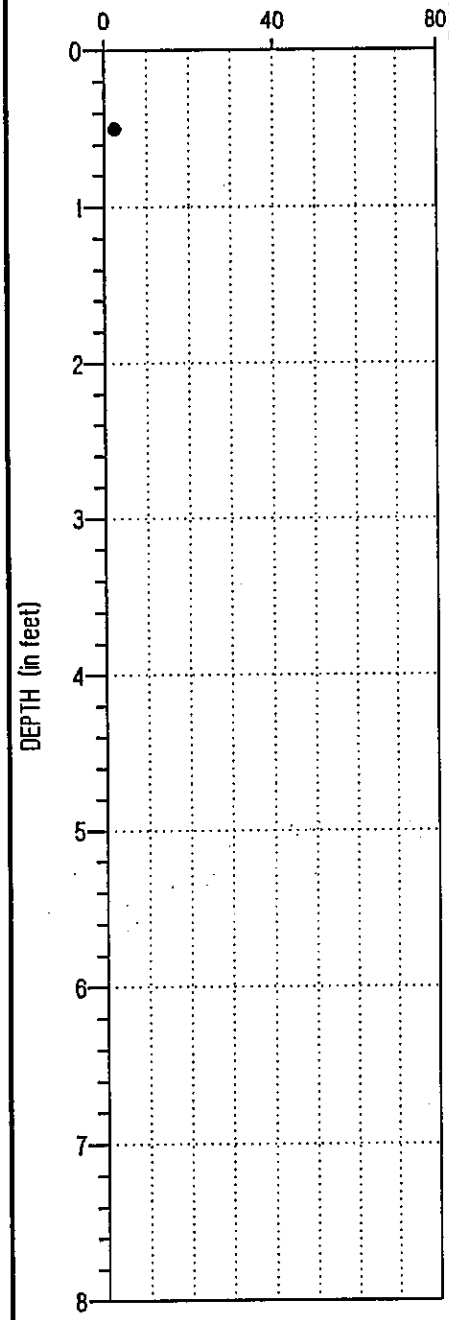
PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 779+80 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-30E

DATE DRILLED: 8-20-91
SURFACE ELEVATION: 49 ft.
TOTAL DEPTH: 1.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

SPT RESISTANCE/MOISTURE %
• MOISTURE %
▲ SPT (blows/foot)



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND to sandy GRAVEL, trace silt, dry. (FILL) Dry density = 127 pcf @ Moisture = 3.4%	

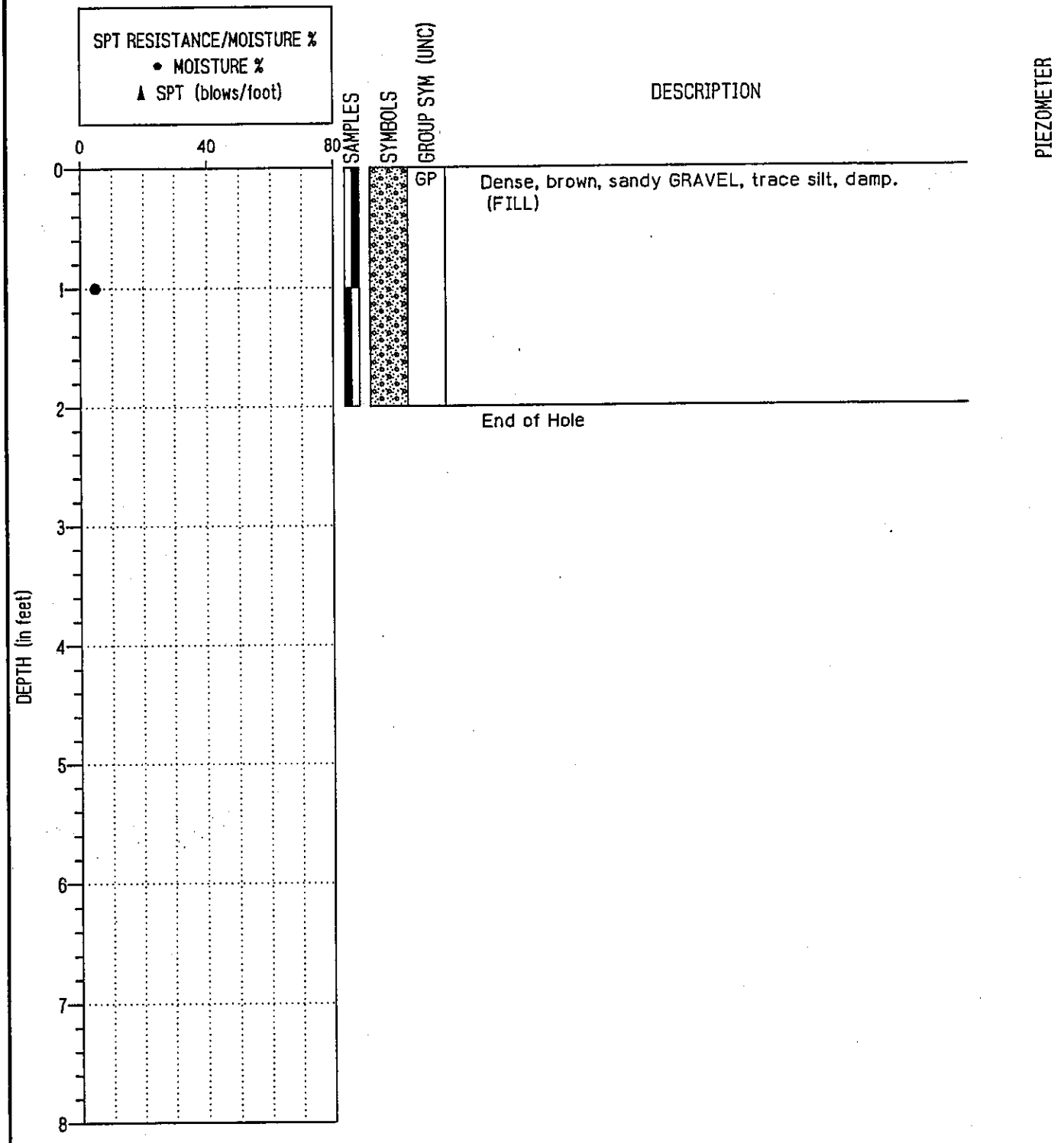
End of Hole

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 789+60 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-31W

DATE DRILLED: 8-20-91
SURFACE ELEVATION: 43 ft.
TOTAL DEPTH: 1.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

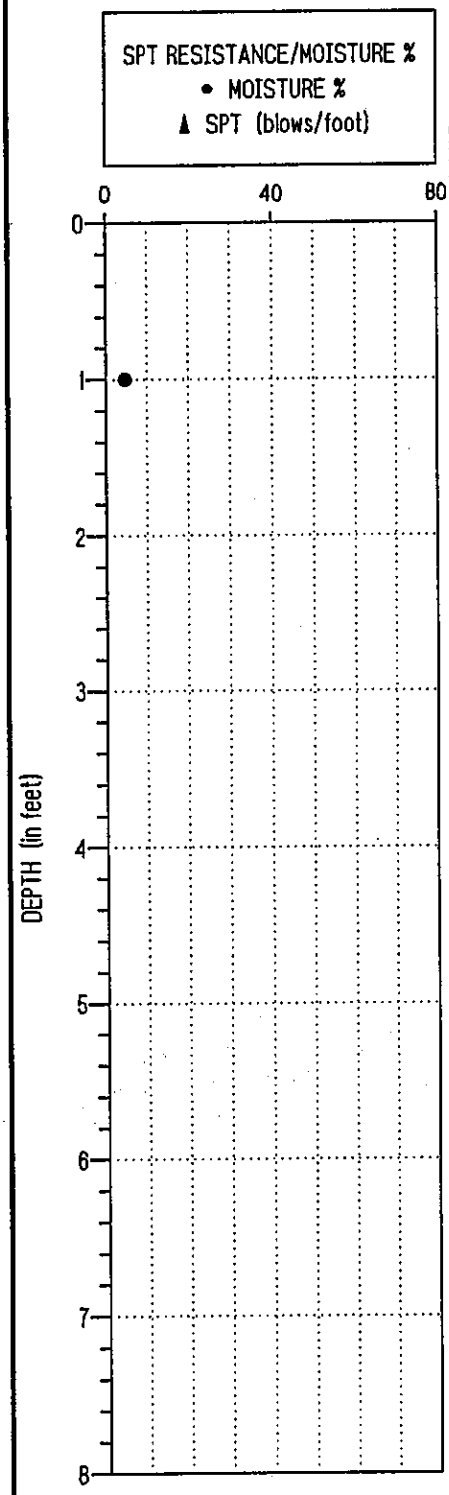


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 799+40 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-32E

DATE DRILLED: 8-22-91
SURFACE ELEVATION: 57 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



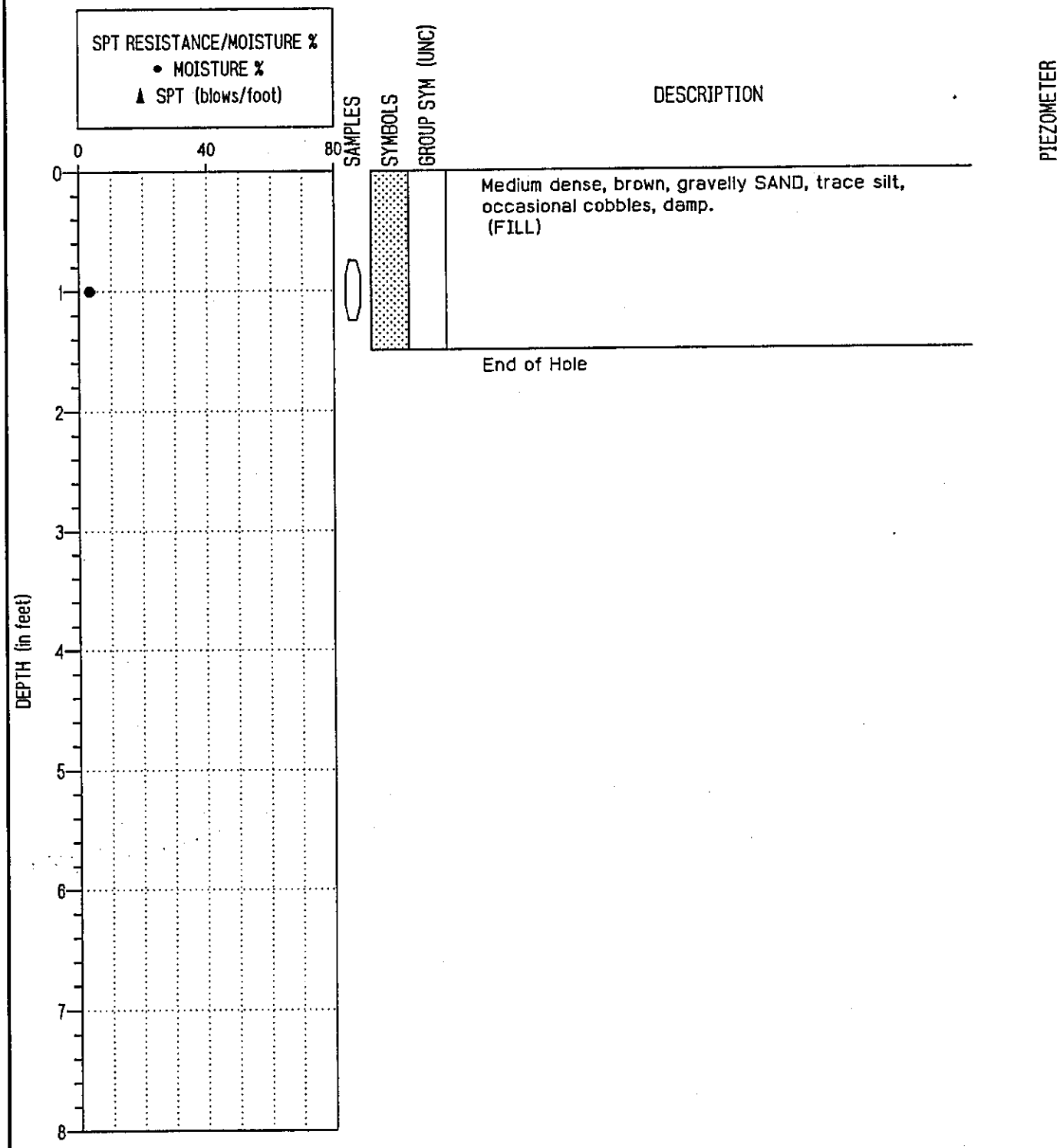
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, damp. (FILL)	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 809+20 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-33W

DATE DRILLED: 8-22-91
SURFACE ELEVATION: 59 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



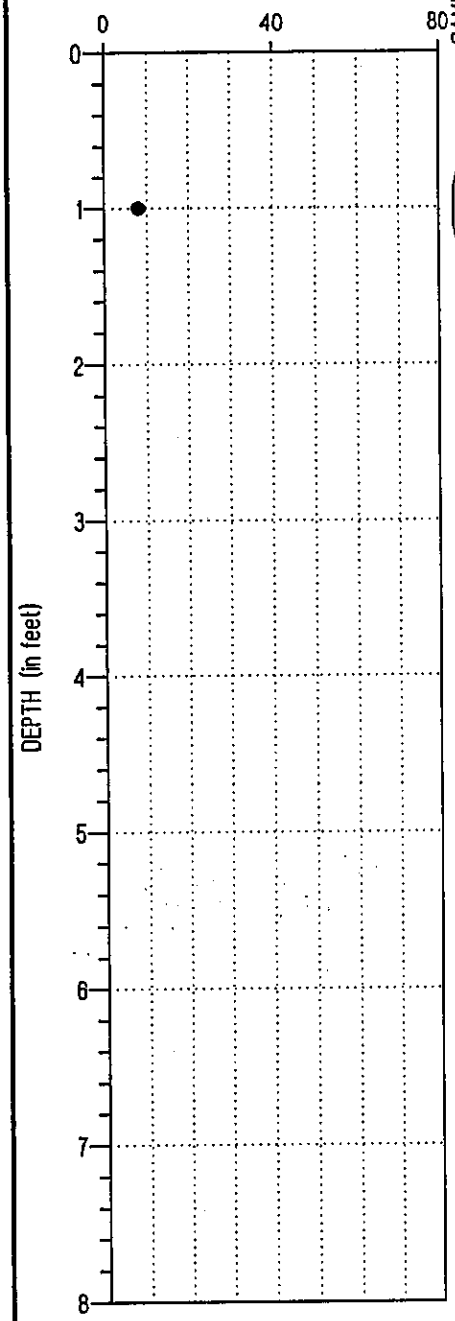
PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 819+00 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-34E

DATE DRILLED: 8-22-91
SURFACE ELEVATION: 55 ft.
TOTAL DEPTH: 1.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

SPT RESISTANCE/MOISTURE %
• MOISTURE %
▲ SPT (blows/foot)



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Medium dense, brown, gravelly SAND, trace silt, occasional cobbles, damp. (FILL)	

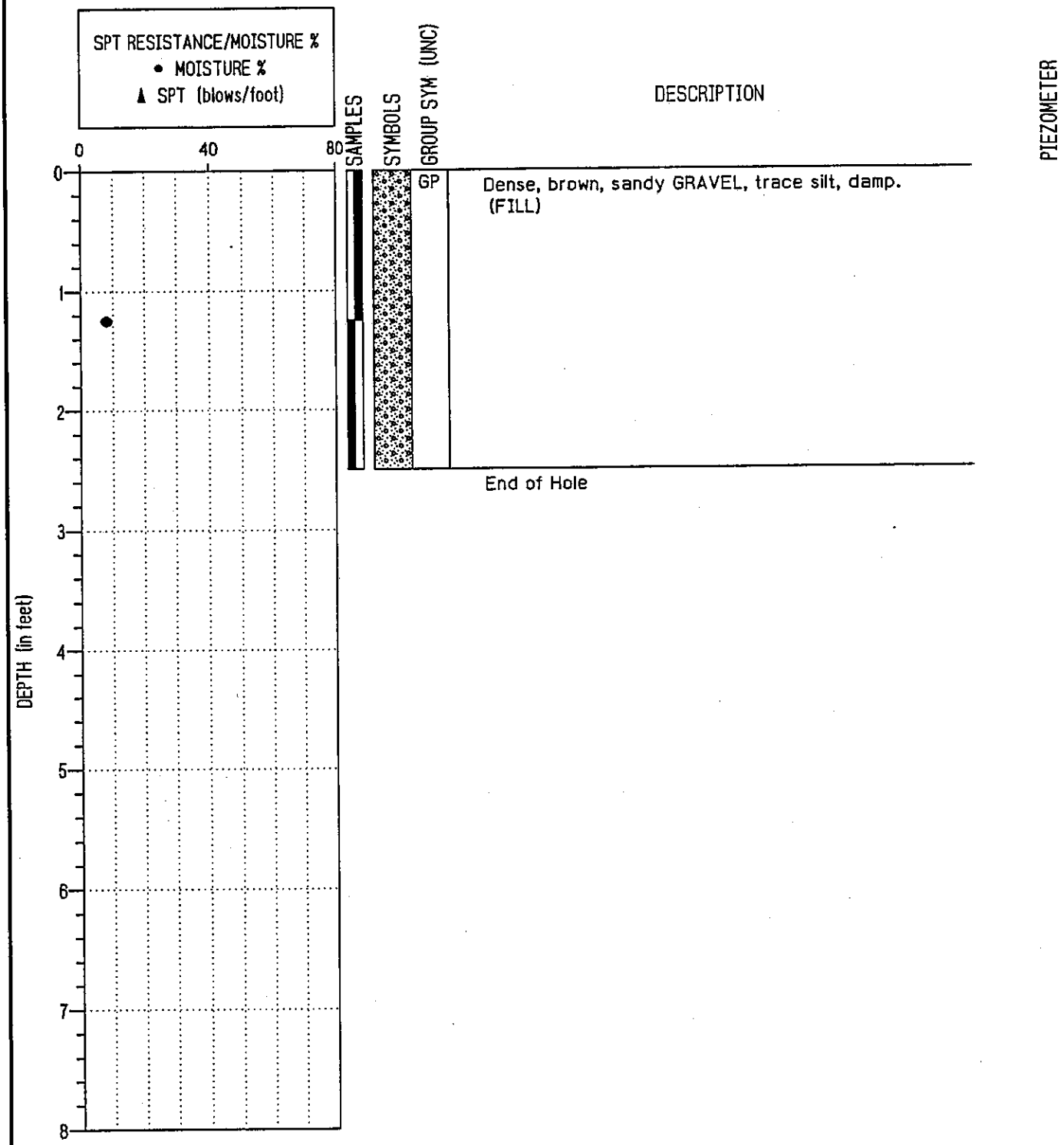
End of Hole

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 828+80 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-35W

DATE DRILLED: 8-22-91
SURFACE ELEVATION: 53 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

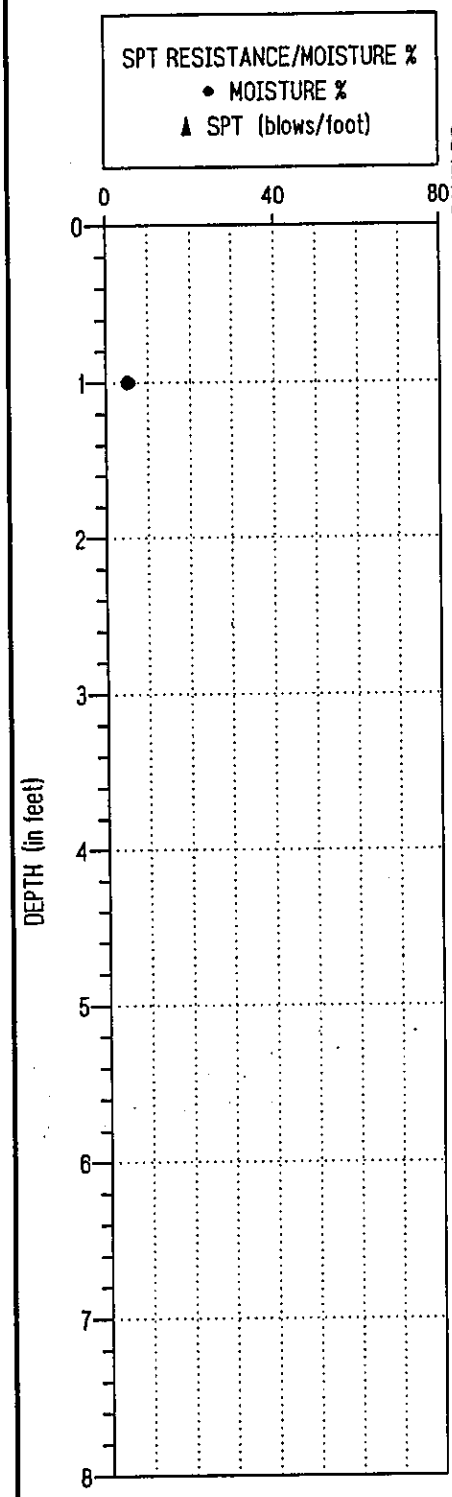


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 838+60 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-36E

DATE DRILLED: 8-22-91
SURFACE ELEVATION: 63 ft.
TOTAL DEPTH: 2.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, sandy GRAVEL, trace silt, occasional cobbles, damp. (FILL)	
			End of Hole	

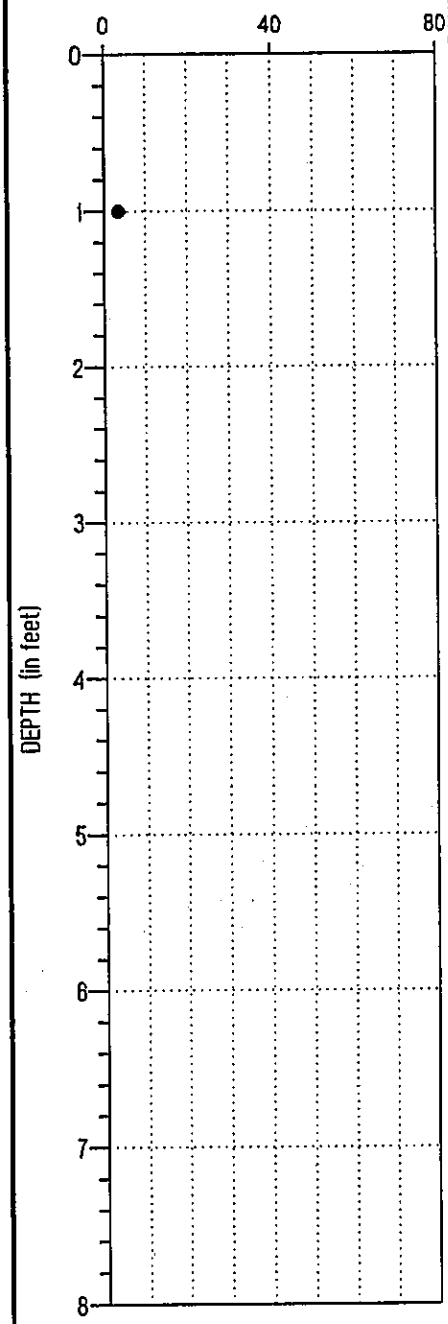
PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 848+40 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-37W

DATE DRILLED: 8-22-91
SURFACE ELEVATION: 68 ft.
TOTAL DEPTH: 1.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

SPT RESISTANCE/MOISTURE %
• MOISTURE %
▲ SPT (blows/foot)



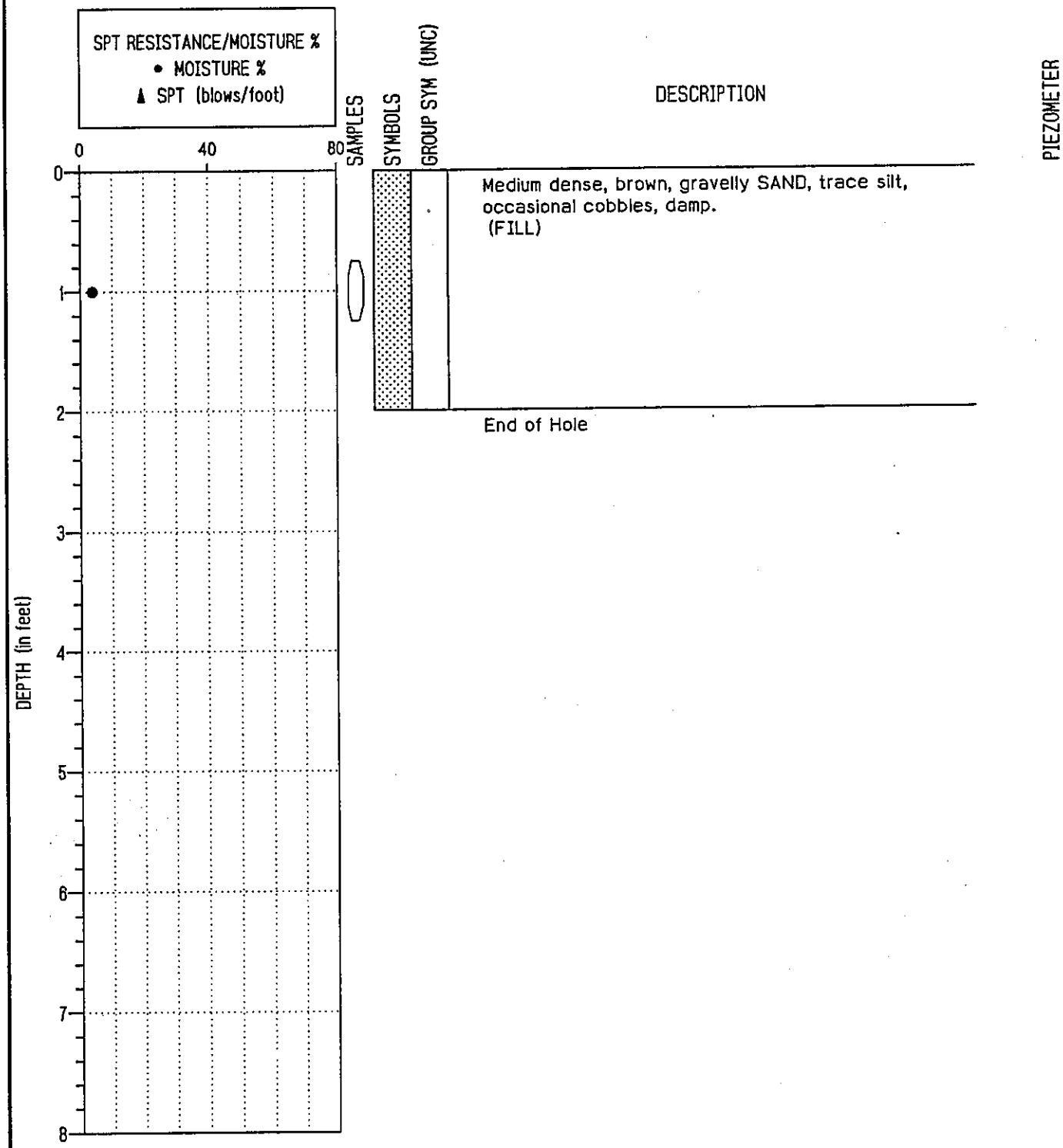
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, dry to damp. (FILL)	
			Dry density = 130 pcf @ Moisture = 3.4%	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 859+00 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-38E

DATE DRILLED: 8-22-91
SURFACE ELEVATION: 55 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

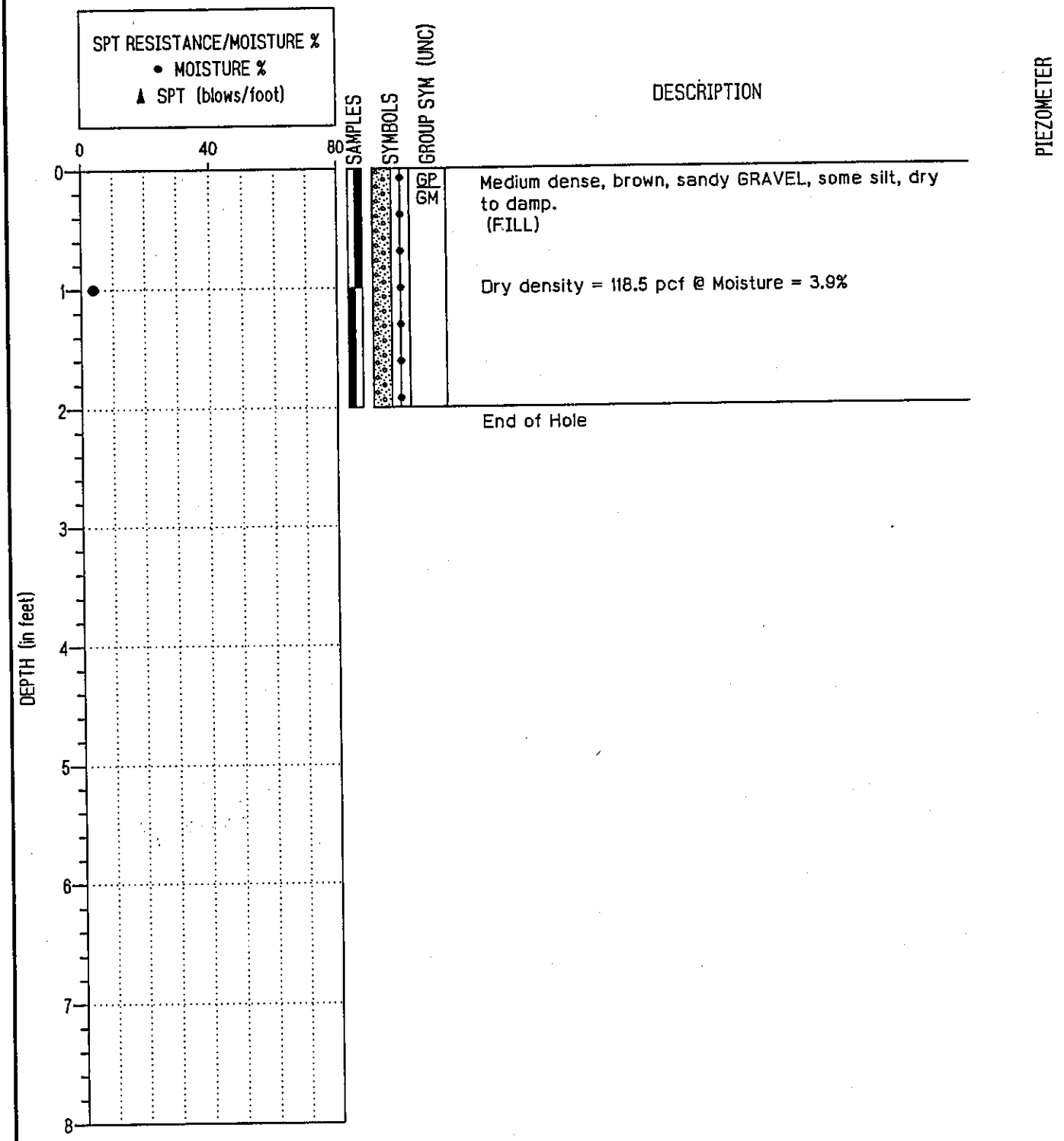


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 869+50 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-39W

DATE DRILLED: 8-22-91
SURFACE ELEVATION: 65 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

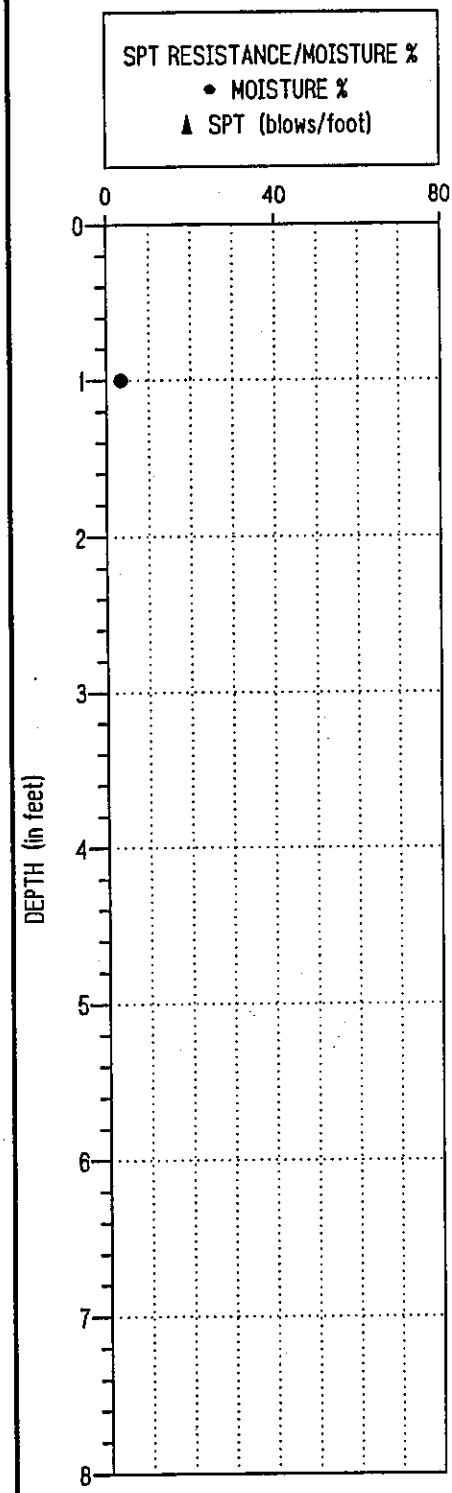


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 879+30 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-40E

DATE DRILLED: 8-22-91
SURFACE ELEVATION: 63 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



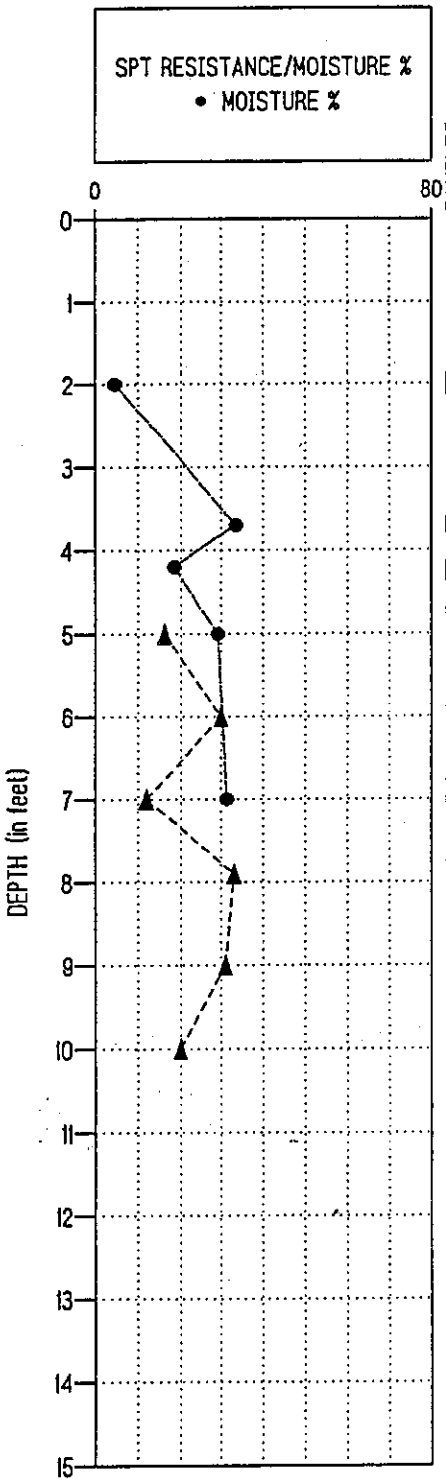
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, gravelly SAND, trace silt, occasional cobbles, dry to damp. (FILL)	
			Dry density = 113 pcf @ Moisture =4.2%	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 889+50 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-41W

DATE DRILLED: 8-23-91
SURFACE ELEVATION: 56 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Very dense, brown, sandy GRAVEL, trace silt, occasional cobbles, dry to damp. (FILL)	
			Dry density = 138 pcf @ Moisture = 4.5%	
			Loose, brown, silty SAND, organic, damp.	
			Loose, gray, fine SAND, some silt, damp, becomes wet at 6'.	
			Sampler overdriven for density values only. No sample retrieved.	
			End of Hole	

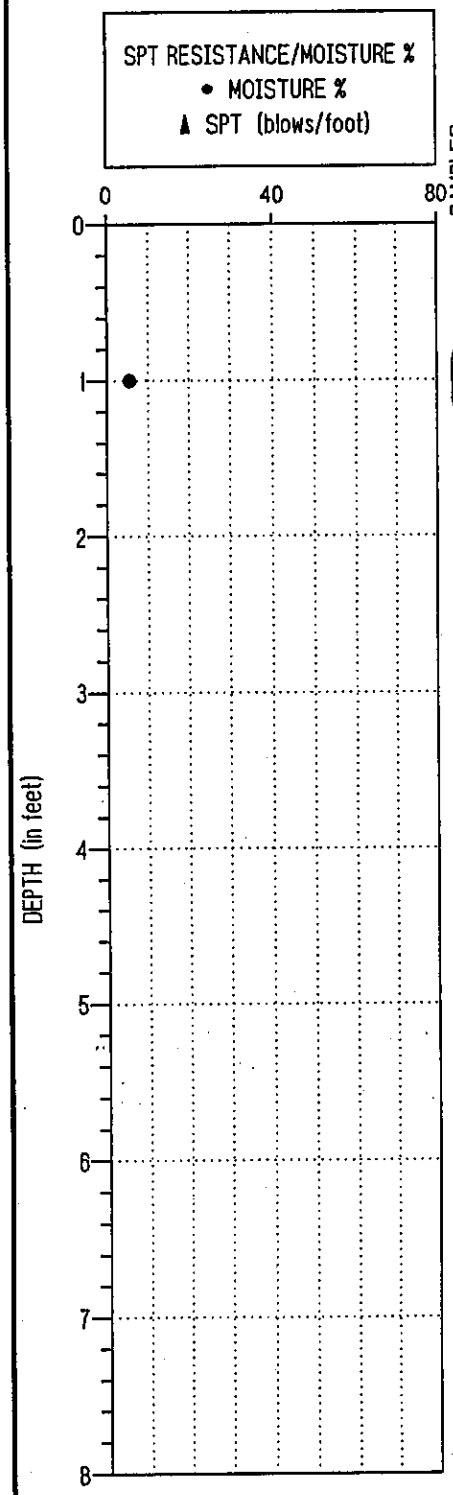
Note: Nonstandard penetration test; 40 lb hammer with 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 899+70 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-42E

DATE EXCAVATED: 8-23-91
SURFACE ELEVATION: 40 ft.
TOTAL DEPTH: 10.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



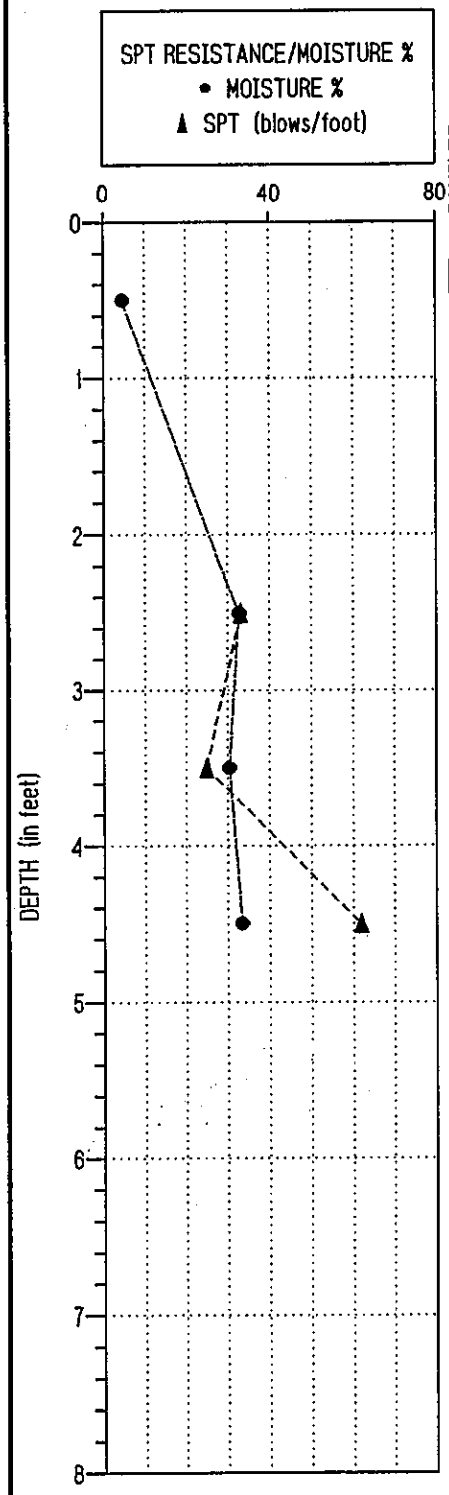
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, sandy GRAVEL, trace silt, occasional cobbles, dry to damp. (FILL)	
			Dry density = 127 pcf @ Moisture = 4.7%	
			End of Hole	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 909+90 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-43W

DATE DRILLED: 8-23-91
SURFACE ELEVATION: 31 ft.
TOTAL DEPTH: 2.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



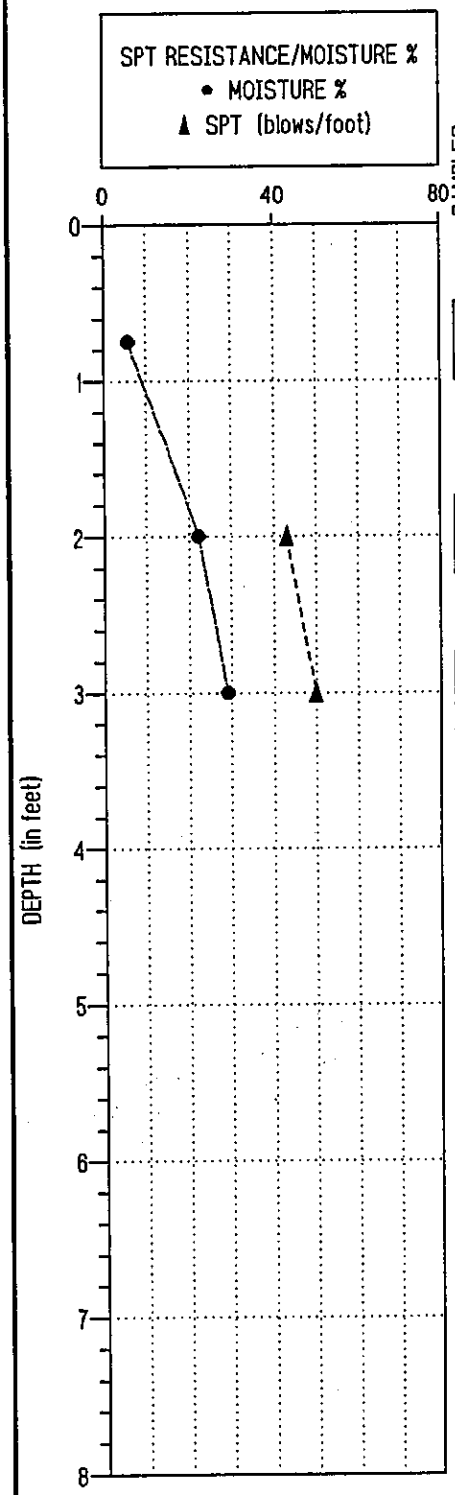
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
		SM	Medium dense, brown, silty SAND with some gravel. (FILL) Dry density = 122 pcf @ Moisture = 6.1%	
			Loose to medium dense, mottled brown and gray, silty fine SAND, interbedded with clayey SILT, plastic, trace organics, damp.	
			End of Hole Note: Nonstandard penetration values: 40 lb hammer with 24" drop	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 920+15 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-44E

DATE DRILLED: 8-23-91
SURFACE ELEVATION: 30 ft.
TOTAL DEPTH: 5.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose to medium dense, brown, gravelly SAND, trace to some silt, trace organics, occasional cobbles, dry to damp. Dry density = 117 pcf @ Moisture = 6.8%	
			Loose to medium dense, mottled brown SILT, some fine sand, damp.	
			End of Hole	

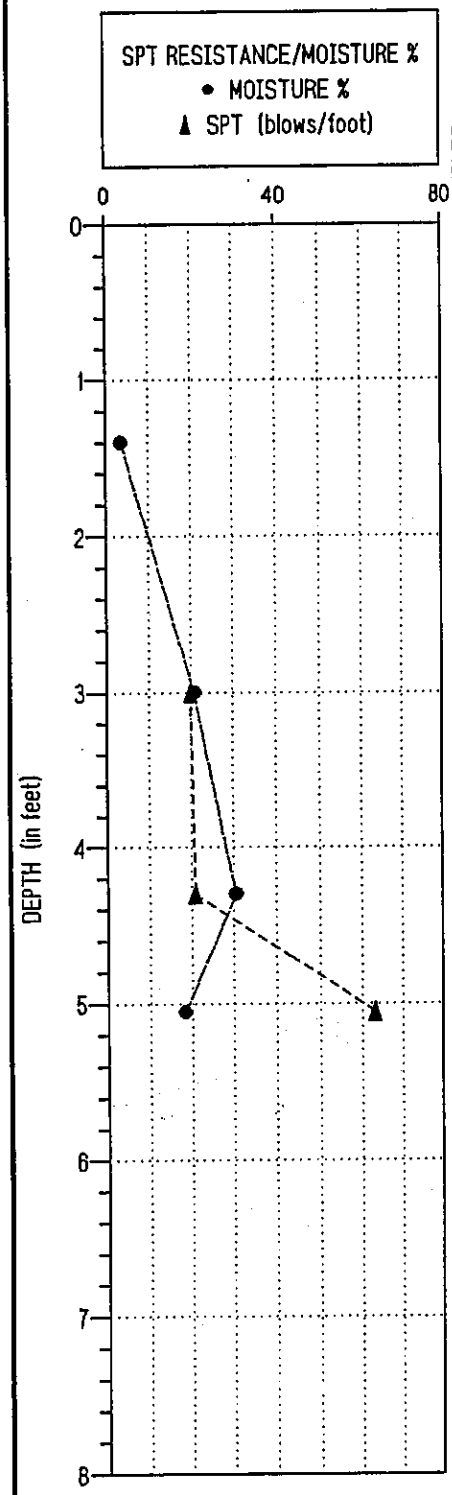
Note: Nonstandard penetration values: 40 lb hammer with 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 930+40 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-45W

DATE DRILLED: 8-26-91
SURFACE ELEVATION: 30 ft.
TOTAL DEPTH: 3.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose to medium dense, brown, gravelly SAND, trace silt, occasional cobbles, dry. (FILL)	
			Dry density = 118 pcf @ Moisture = 4.9%	
			Loose, brown-gray, fine to medium SAND, some silt, trace organics, trace fine gravel.	
			Loose to medium dense, brown to gray, silty fine SAND to sandy SILT, moist.	
			End of Hole	

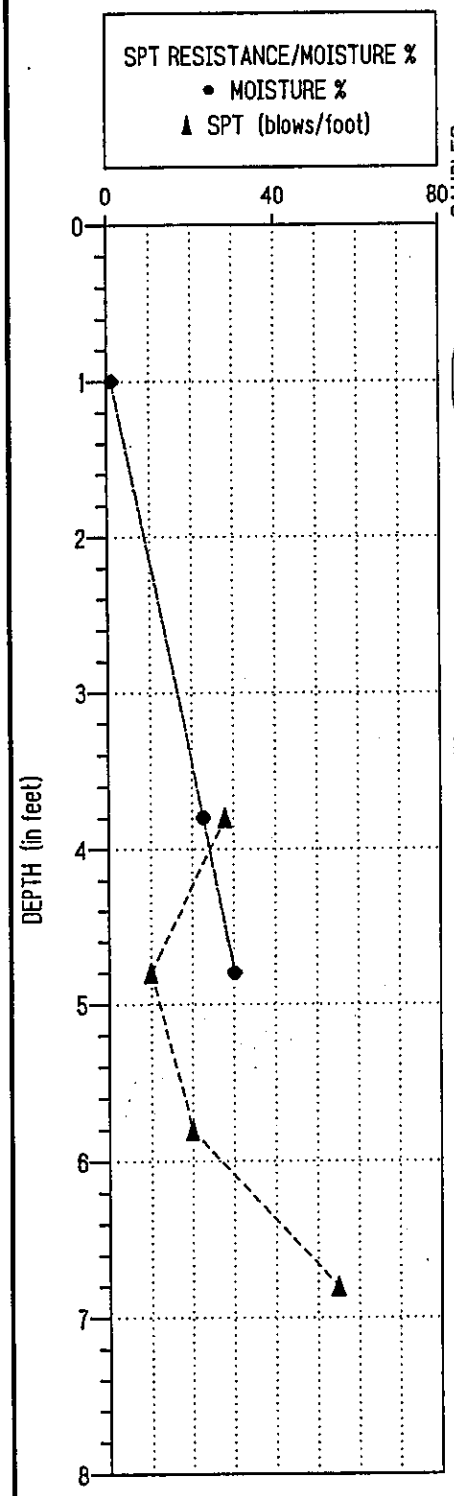
Note: Nonstandard penetration values: 40 lb hammer with 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 940+60 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-46E

DATE DRILLED: 8-26-91
SURFACE ELEVATION: 29 ft.
TOTAL DEPTH: 5.8 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



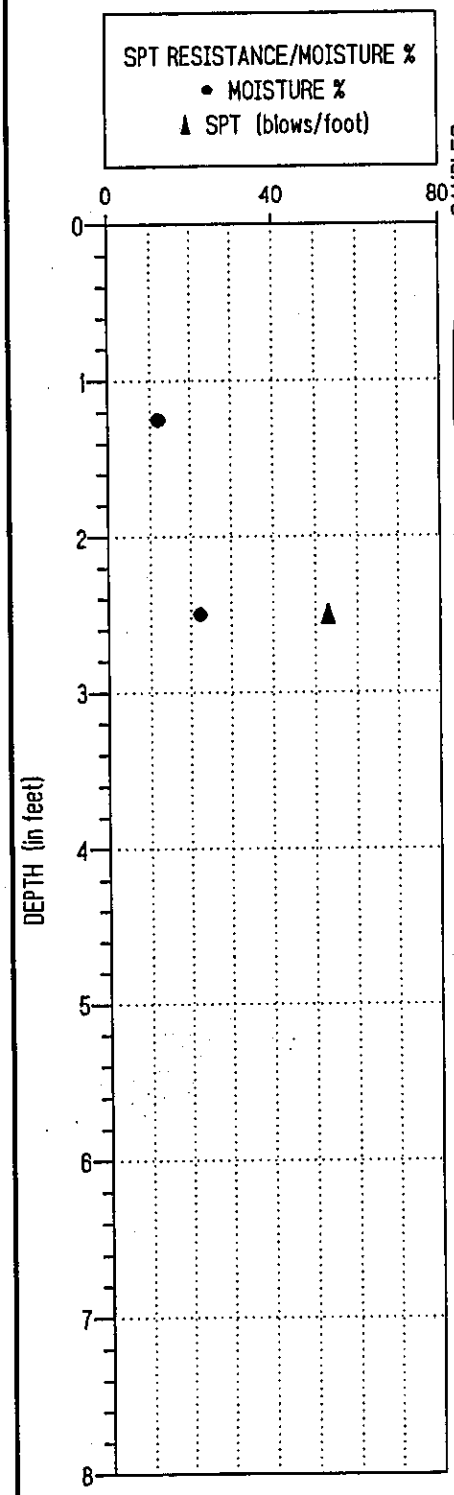
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose to medium dense, brown, sandy GRAVEL, trace silt, occasional cobbles, dry. (FILL)	
			Dry density = 117 pcf @ Moisture = 4.8%	
			Loose, mottled brown and gray, sandy SILT, some fine gravel, trace organics, damp. (FILL)	
			Loose to medium dense, gray, interbedded fine to coarse SAND and silty fine SAND; moist to wet.	
			Sampler overdriven, no sample	
			Sampler overdriven, no sample	
			Note: Nonstandard penetration values: 40 lb hammer, 24" drop	

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 950+80 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-47W

DATE DRILLED: 8-26-91
SURFACE ELEVATION: 27 ft.
TOTAL DEPTH: 5.3 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose to medium dense, brown, gravelly SAND, trace silt, dry. (FILL) Dry density = 118 pcf @ Moisture = 8.1%	
			Loose to medium dense, brown, sandy SILT to silty SAND, some fine gravel.	
			Medium dense, gray, silty fine SAND; some mottling, damp.	
			End of Hole	

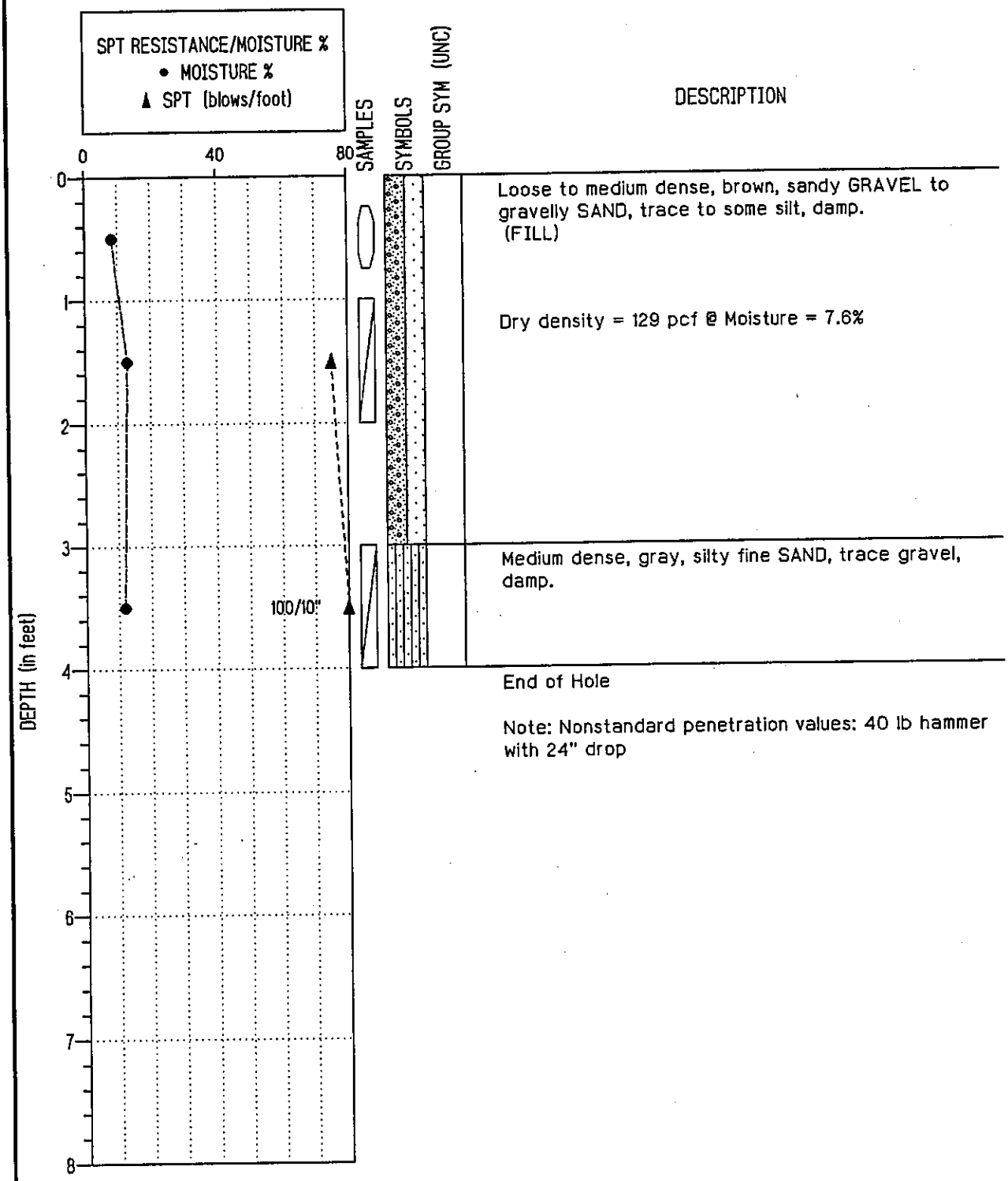
Note: Nonstandard penetration values: 40 lb hammer @ 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 961+35 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-48E

DATE DRILLED: 8-26-91
SURFACE ELEVATION: 27 ft.
TOTAL DEPTH: 3.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

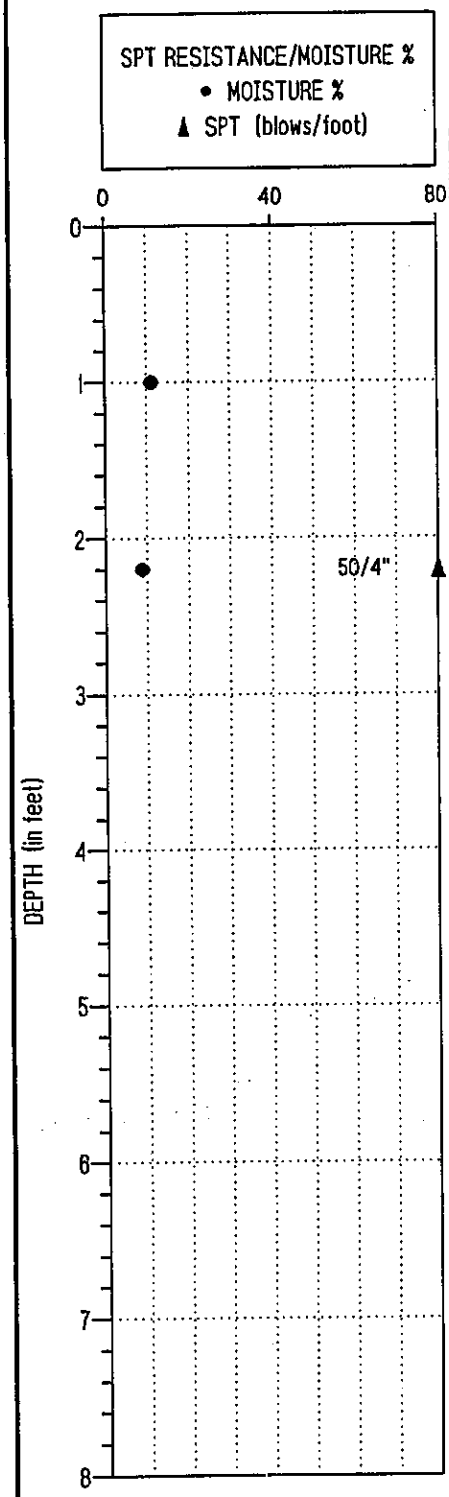


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 971+80 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-49W

DATE DRILLED: 8-27-91
SURFACE ELEVATION: 29 ft.
TOTAL DEPTH: 4.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose to medium dense, brown, gravelly SAND, trace silt, occasional cobbles, damp. (FILL)	
			Dry density = 125 pcf @ Moisture = 10.3%	
			Medium dense to dense, gray, silty fine SAND, trace gravel, damp.	
			End of Hole	

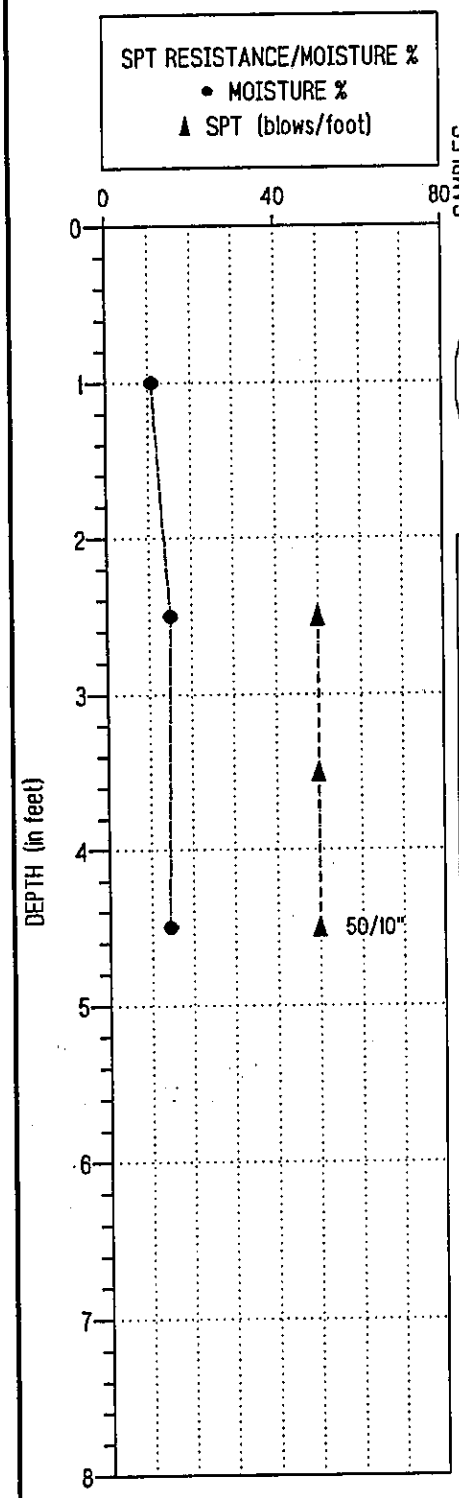
Note: Nonstandard penetration values: 40 lb hammer with 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 982+35 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-50E

DATE DRILLED: 8-27-91
SURFACE ELEVATION: 30 ft.
TOTAL DEPTH: 2.3 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose to medium dense, brown, gravelly SAND, trace to some silt, trace organics, damp. (FILL)	
			Dry density = 122 pcf @ Moisture = 10.9%	
			Medium dense, mottled brown and gray, gravelly silty SAND.	
			End of Hole	

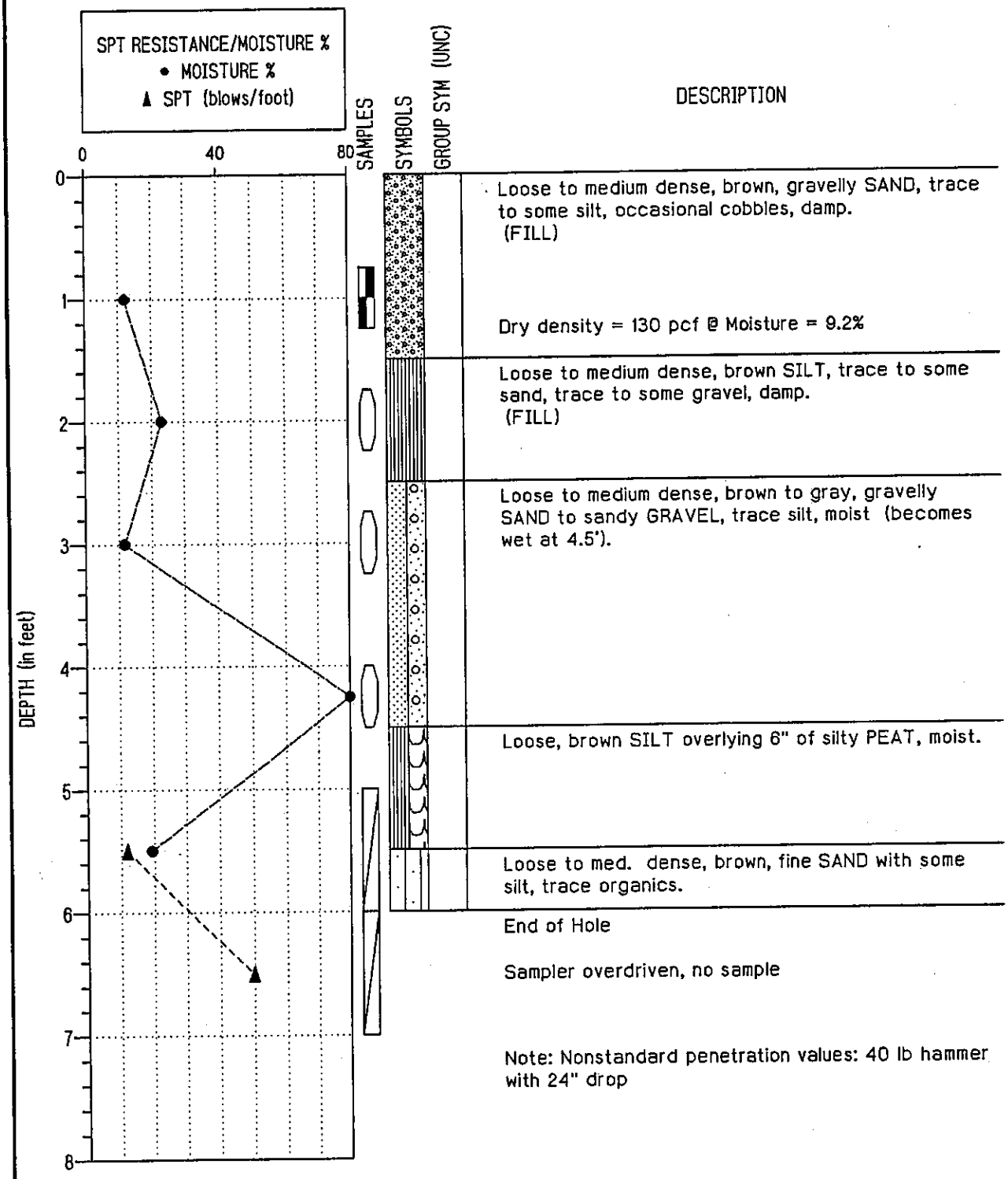
Note: Nonstandard penetration values: 40 lb hammer with 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 992+90 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-51W

DATE DRILLED: 8-27-91
SURFACE ELEVATION: 27 ft.
TOTAL DEPTH: 5.0 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG

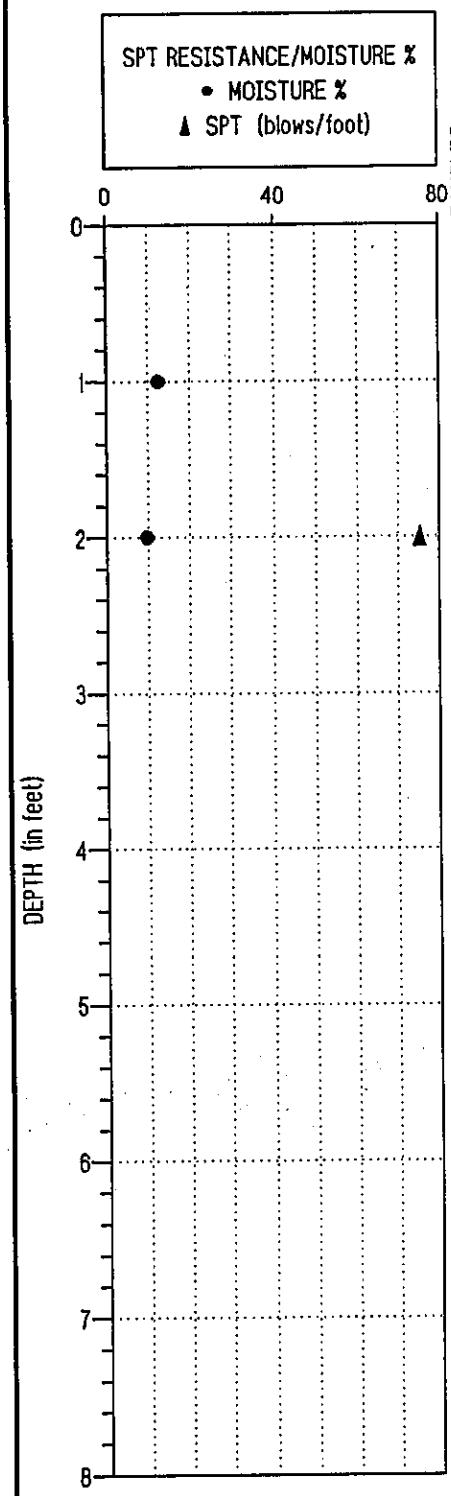


PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 1003+00 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-52E

DATE DRILLED: 8-27-91
SURFACE ELEVATION: 25 ft.
TOTAL DEPTH: 6 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose, brown, sandy GRAVEL, trace to some silt, trace organics, moist. (FILL)	
			Dry density = 119 pcf @ Moisture = 7.2%	
			Medium dense, gray, gravelly SAND, trace silt, moist.	
			End of Hole	

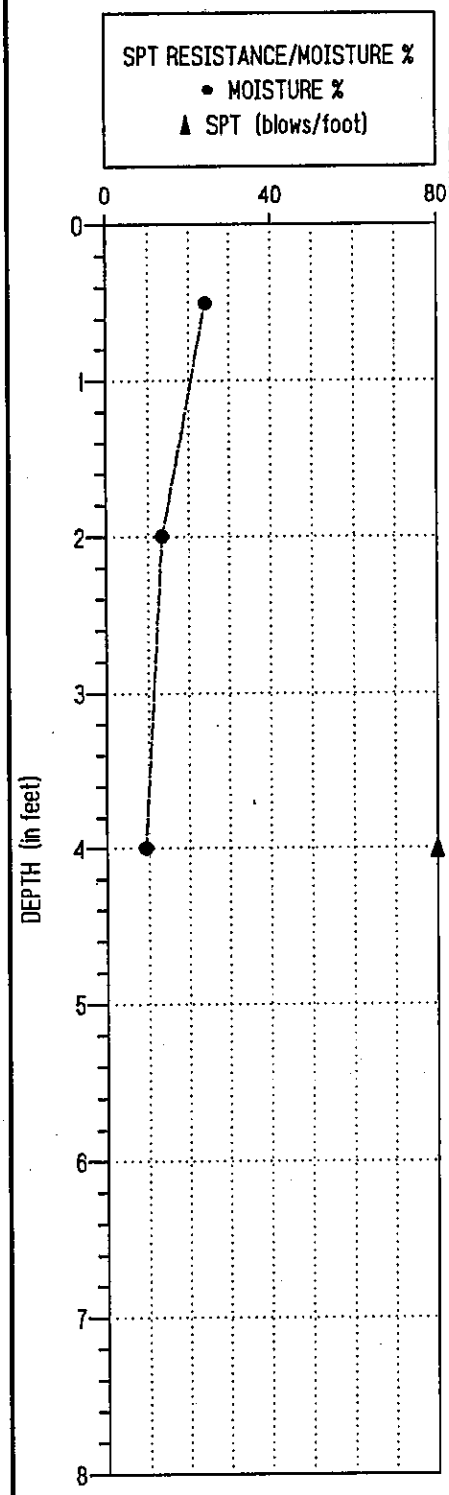
Note: Nonstandard penetration values: 40 lb hammer with 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 1014+00 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-53W

DATE DRILLED: 8-29-91
SURFACE ELEVATION: 27 ft.
TOTAL DEPTH: 2.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose, brown, gravelly SAND, trace to some silt, trace organics, wet. (FILL) Dry density = 104 pcf @ Moisture = 23.9%	
			Loose to medium dense, mottled brown and gray, silty fine SAND, some gravel, trace organics, moist.	
			Medium dense, gray, gravelly SAND, trace silt, moist.	
			End of Hole	

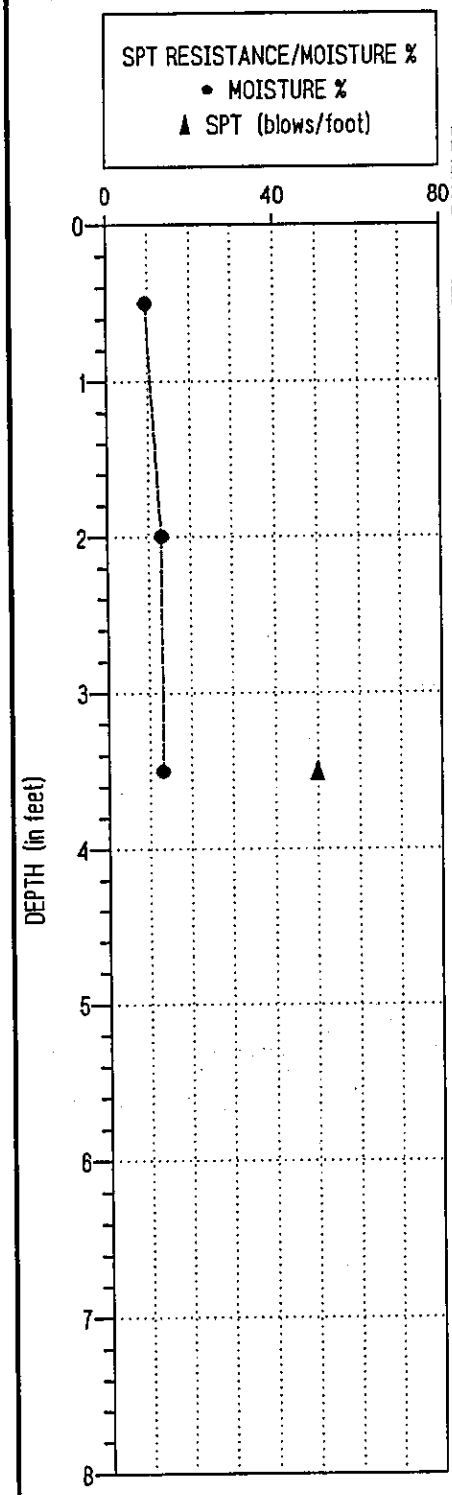
Note: Nonstandard penetration values: 40 lb hammer with 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 1024+55 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-54E

DATE DRILLED: 8-29-91
SURFACE ELEVATION: 25 ft.
TOTAL DEPTH: 4.5 ft.

HONG WEST & ASSOCIATES
HAND BORING LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose to medium dense, brown sandy GRAVEL to mottled brown and gray gravelly SAND, some silt, moist. (FILL)	
			Dry density = 122 pcf @ Moisture = 11.5%	
			Medium dense, gray-brown, silty fine SAND, trace peat, moist.	
			Medium dense, gray, gravelly SAND, trace silt, moist.	
			End of Hole	

Note: Nonstandard penetration values: 40 lb hammer with 24" drop

PROJECT NAME: SR 167: 15th SW to S Grady Way
LOCATION: Sta LM 1035+10 in median
PROJECT NUMBER: 91101
LOGGED BY: BS

BORING HB-55W

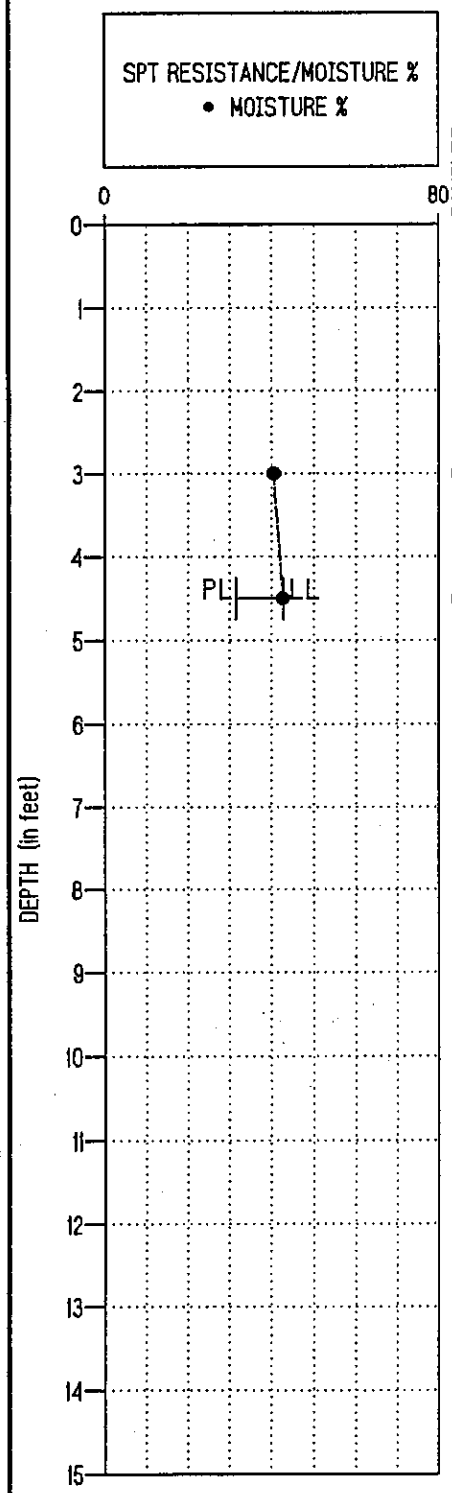
DATE DRILLED: 8-29-91
SURFACE ELEVATION: 25 ft.
TOTAL DEPTH: 4.0 ft.

APPENDIX B

LOGS OF BACKHOE TEST PITS

HONG WEST & ASSOCIATES

HONG WEST & ASSOCIATES
TEST PIT LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose, brown to gray with reddish mottling, silty SAND. Some roots to a depth of 3 feet. (FILL)	
		ML	Very soft, blue gray, SILT. Plastic. Moist to wet. Increasing sand fraction with depth.	
			Loose, gray, SAND. Trace to gravelly. Wet. Water table at 8.5 feet.	▼
			End of pit at 9 feet.	

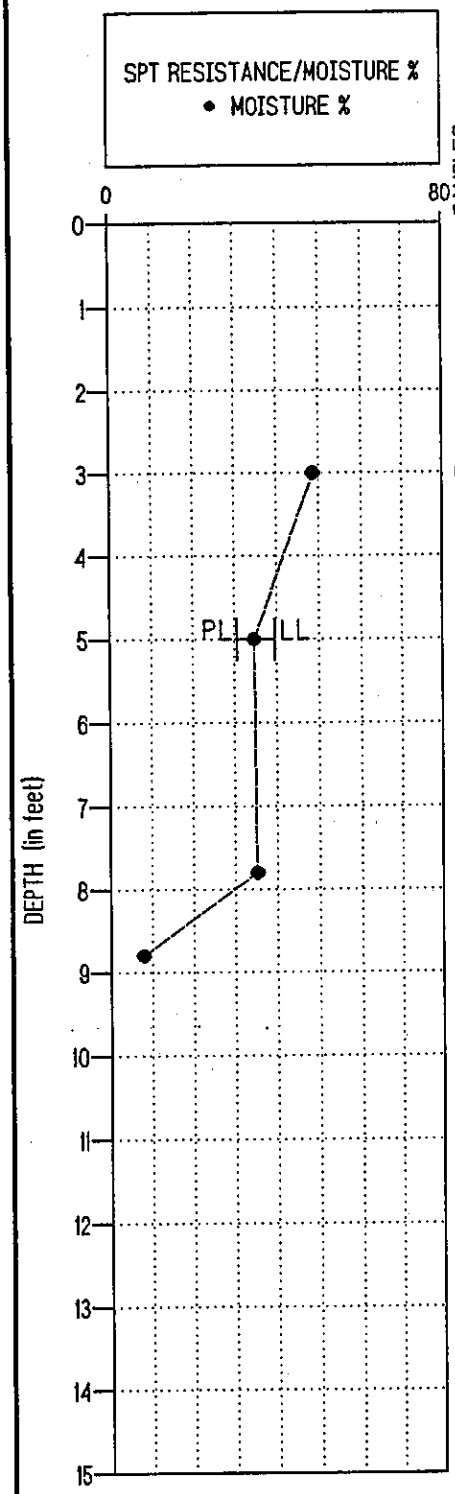
Test pit sides caved in below 6 feet, progresses upward.

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR-405 Interchange
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-1

DATE DRILLED: 08/28/91
SURFACE ELEVATION: 15 ft.
TOTAL DEPTH: 9 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



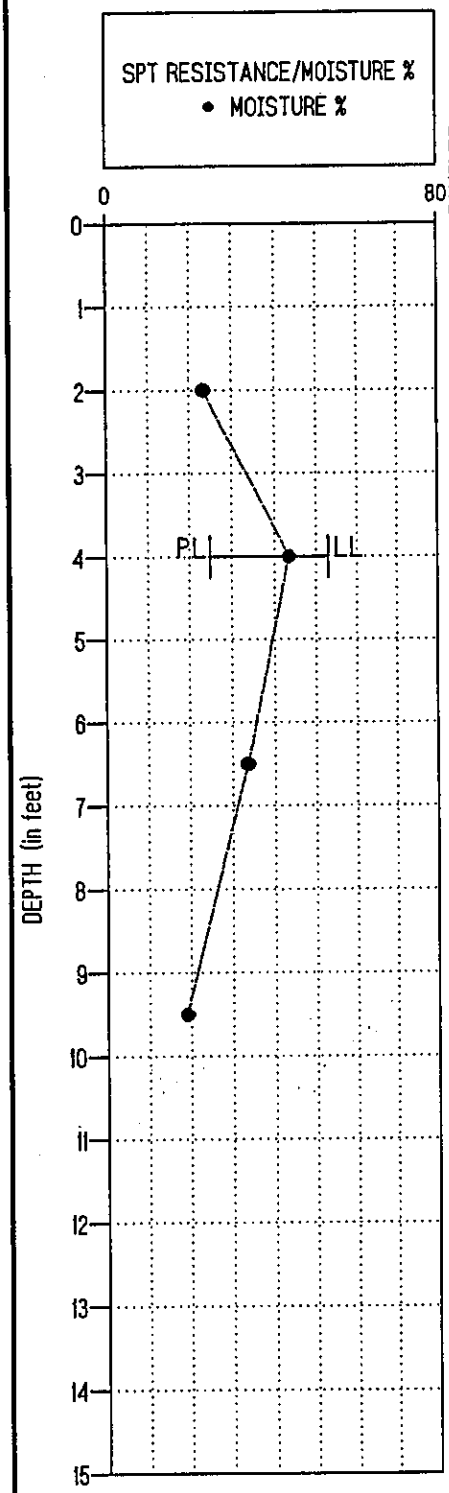
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Very soft, brown to gray, clayey SILT. Plastic. Mottled in layers. Small roots to a depth of 3 feet. Seepage at 4 feet. (FILL)	
		ML	Very soft, blue gray, SILT; interbedded with fine sand and clay, wet. Layer of organics at 4 feet.	
			Loose, gray, fine to medium clean SAND; wet	▼
			coarsens to gravelly SAND; wet	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR-405 Interchange
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-2

DATE DRILLED: 08/28/91
SURFACE ELEVATION: 15 ft.
TOTAL DEPTH: 9 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



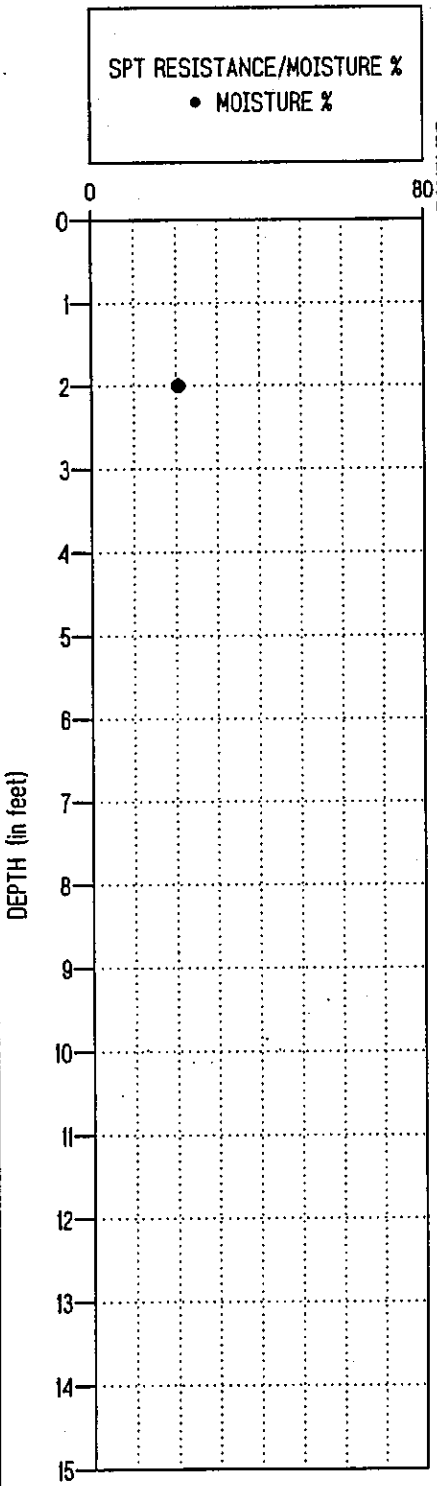
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Very stiff, brownish gray, fine sandy SILT. Some organic matter throughout. Color grades to mottled and less sand fraction in lower 2 feet. (FILL)	
			A 4" bed of matted organic material at 3.5' depth	
		CH	Soft, dark brown, organic SILT. Plastic. Interbedded with fine sand and blue gray silt. A trace to some cobbles. Wet.	
			Medium stiff, brown to mottled, sandy SILT. Slightly plastic. Wet. Water seepage.	
			Medium dense, gray, silty SAND. Trace shale.	
			End of pit at 10 feet.	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/S. 180th Interchange; DL2 ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-3

DATE DRILLED: 08/28/91
SURFACE ELEVATION: 25 ft.
TOTAL DEPTH: 10 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
		SP	Medium dense to dense, brown, fine to medium SAND. A 4" bed of gravelly sand bed and laminae of water bearing, gravelly, coarse sand at approximately 3.5 feet. Massive below 3.5 feet. (Outwash)	
			A 4" bed of gravelly sand and laminae of water bearing, gravelly, coarse sand	∇
			Some sloughing occured while backfilling test pit.	

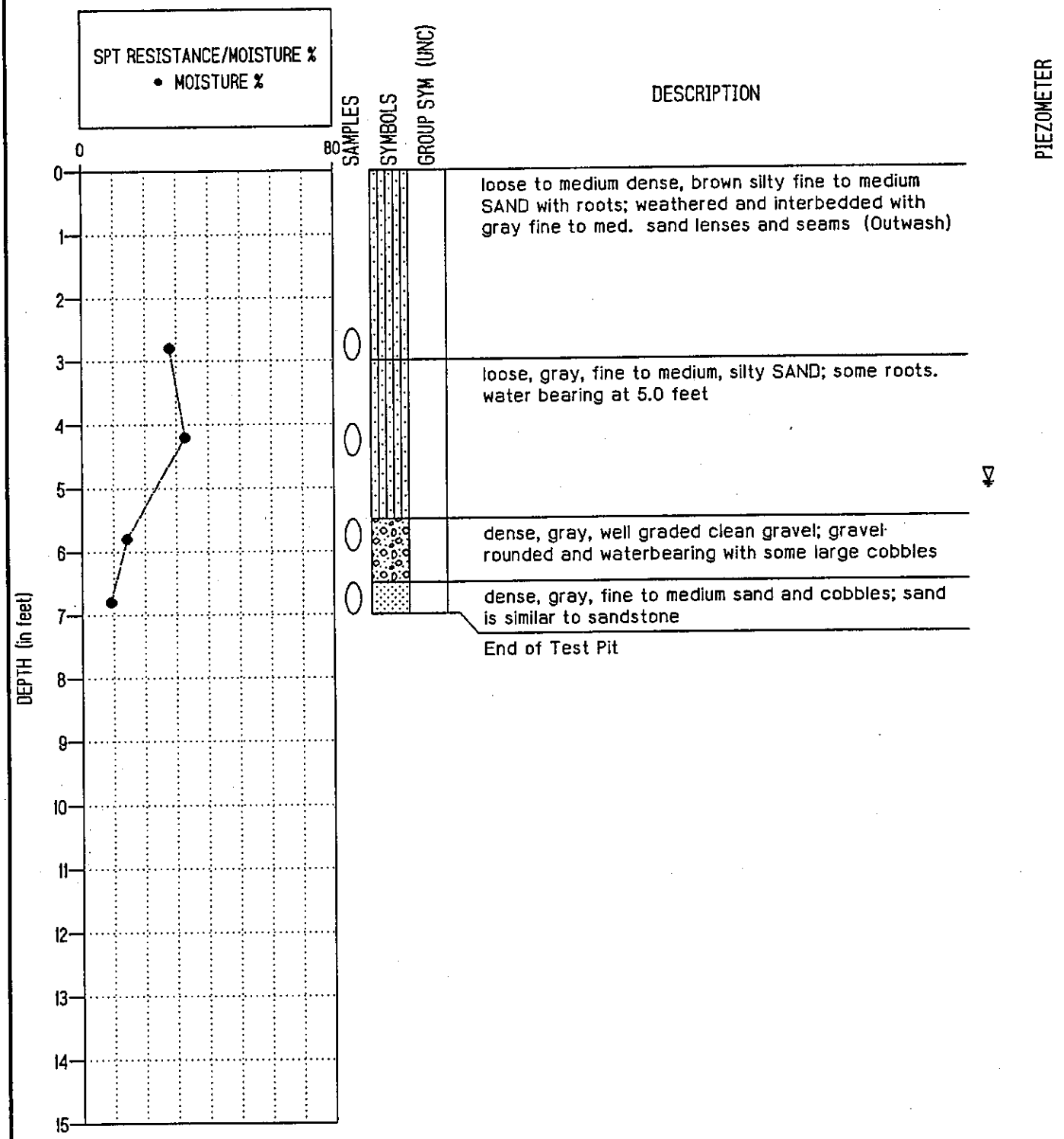
End of pit at 8 feet.

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/S. 180th Interchange; AL2 ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-4

DATE DRILLED: 08/28/91
SURFACE ELEVATION: 28 ft.
TOTAL DEPTH: 8 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG

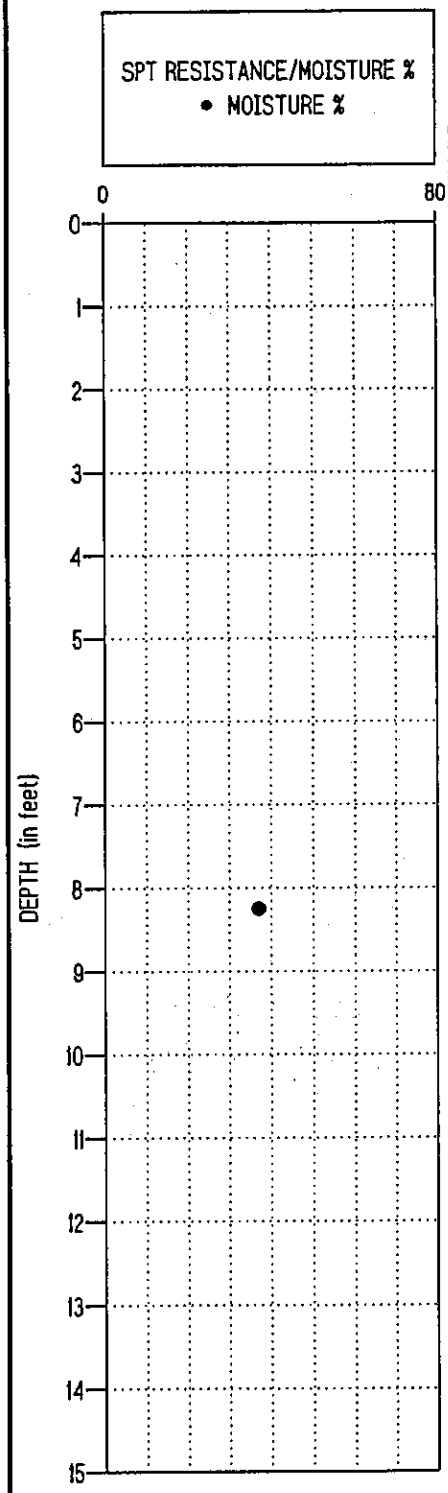


PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/S. 180th Interchange; AL2 ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-5

DATE DRILLED: 08/29/91
SURFACE ELEVATION: 26.5 ft.
TOTAL DEPTH: 6.5 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			loose to medium dense, light brown, sand with some silt; trace organics, damp (FILL)	
			medium dense, grayish brown, silty fine to medium sand; moist; (Old Topsoil)	
		SP	medium dense, gray, fine to medium SAND with trace of silt; wet, waterbearing at 8'	∇

End of Test Pit

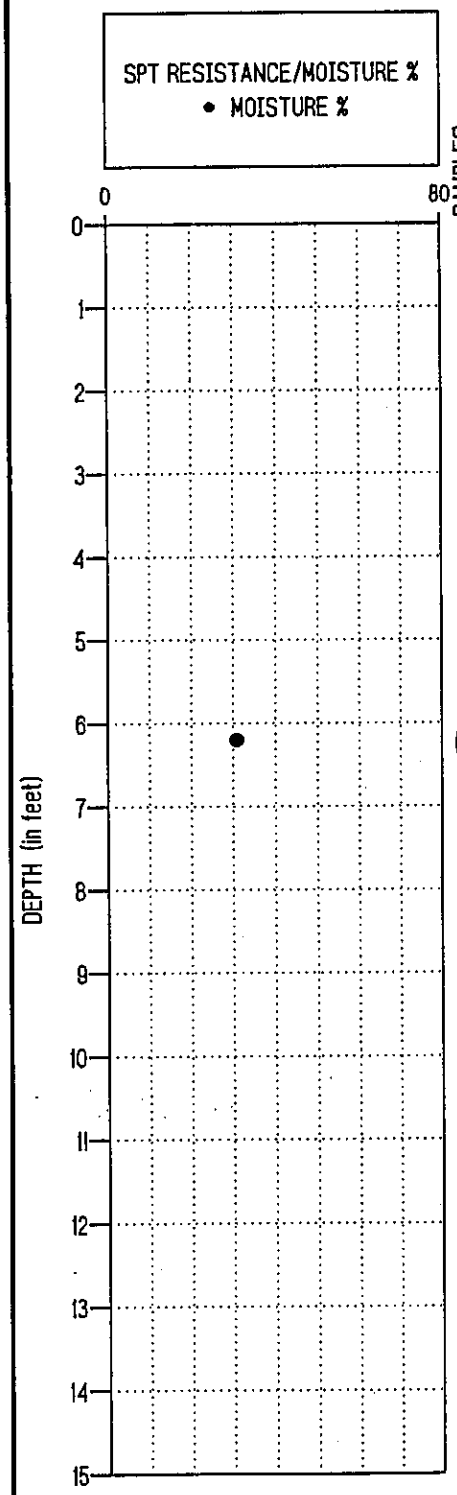
Test Pit wall caves in at 3'

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/84th Ave. S. Interchange: AL3 ramp
PROJECT NUMBER: 91101
LOGGED BY: DH

TEST PIT TP-6

DATE DRILLED: 08/30/91
SURFACE ELEVATION: 36 ft.
TOTAL DEPTH: 9.0 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



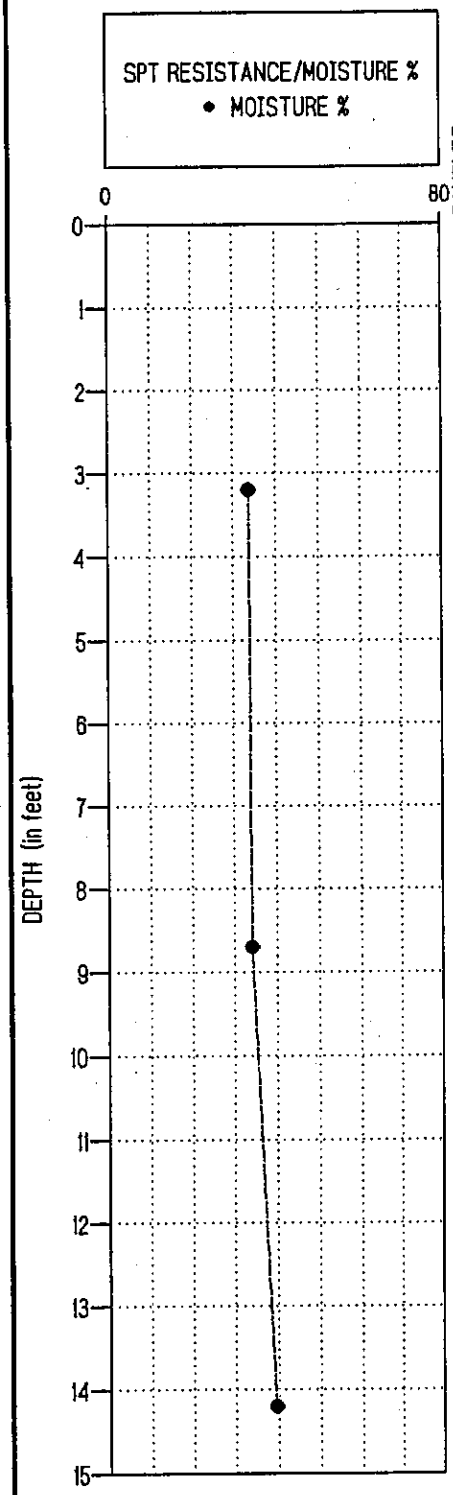
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			loose to medium dense, brown, silty gravelly SAND; wet, trace cobbles (Embankment FILL)	
			medium dense, gray, silty SAND with layers of silt; moist to wet, organic odor (FILL)	
			stiff, light brown, fine sandy silt; moist to wet, some organic matter (Old Topsoil)	
			medium dense, gray, fine to medium SAND with trace of silt; water bearing, massive	
○			Test pit wall caved in below 4 feet	∇
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/84th Ave. S. Interchange: AL3 ramp
PROJECT NUMBER: 91101
LOGGED BY: DH

TEST PIT TP-7

DATE DRILLED: 08/30/91
SURFACE ELEVATION: 31 ft.
TOTAL DEPTH: 8.0 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



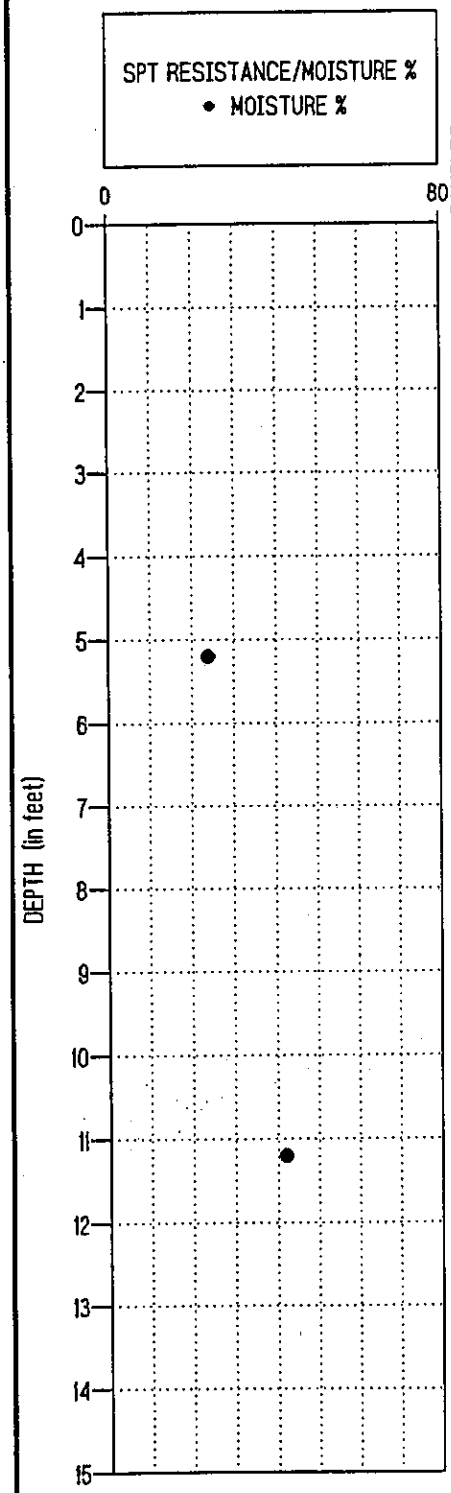
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
		ML	Loose to medium dense, brown to gray, sandy GRAVEL with trace of silt; silt seam at 2', damp (FILL)	
			Medium dense, brown to gray, SILT with fine to medium SAND; mottled, damp	
			Medium dense, gray, fine SAND with trace to some silt; moist to wet, some mottling decreases with depth	
			medium dense, gray, SILT with some fine sand; moist to wet	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 516 Interchange; AL2 ramp
PROJECT NUMBER: 91101
LOGGED BY: dh

TEST PIT TP-8

DATE DRILLED: 08/30/91
SURFACE ELEVATION: 40 ft.
TOTAL DEPTH: 14.5 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



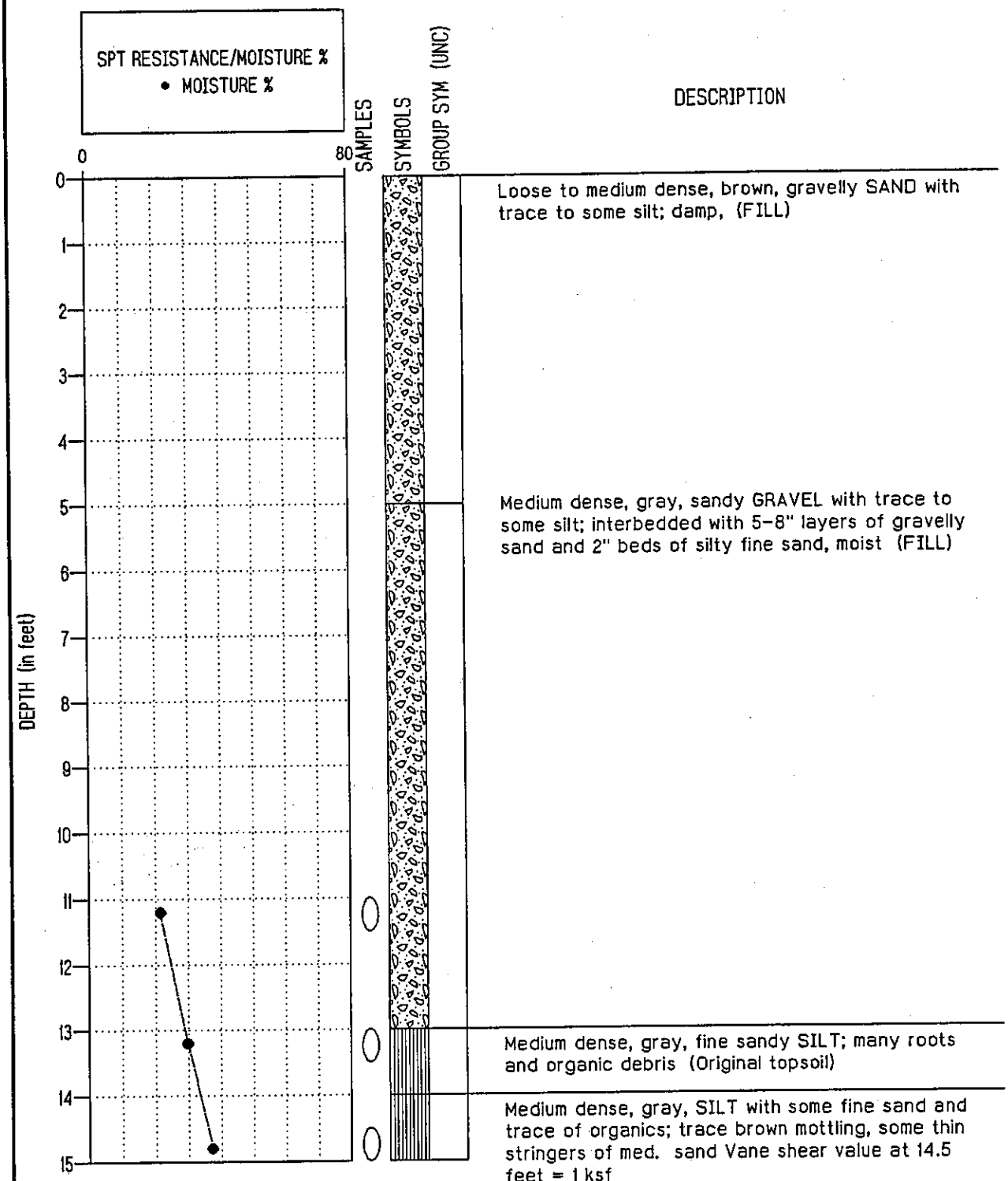
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Medium dense, light brown, SAND and GRAVEL with trace of silt and roots; dry (FILL)	
			Medium dense, brown, fine sandy SILT with trace of organics; reddish weathering	
			Medium dense, gray, SILT with some fine sand; wet, slight weathering, silt with clay	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 516 Interchange; AL2 ramp
PROJECT NUMBER: 91101
LOGGED BY: dh

TEST PIT TP-9

DATE DRILLED: 08/30/91
SURFACE ELEVATION: 40 ft.
TOTAL DEPTH: 13 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG

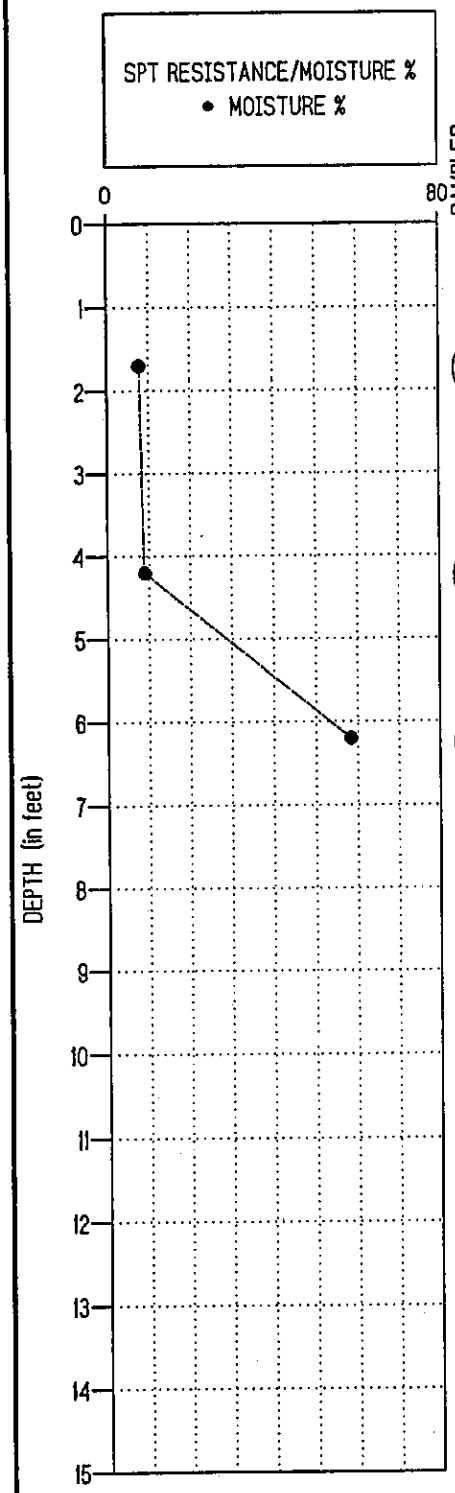


PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/S. 277th St. Interchange: AL1 Ramp
PROJECT NUMBER: 91101
LOGGED BY: dh

TEST PIT TP-11

DATE EXCAVATED: 08/30/91
SURFACE ELEVATION: 53 ft.
TOTAL DEPTH: 15 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



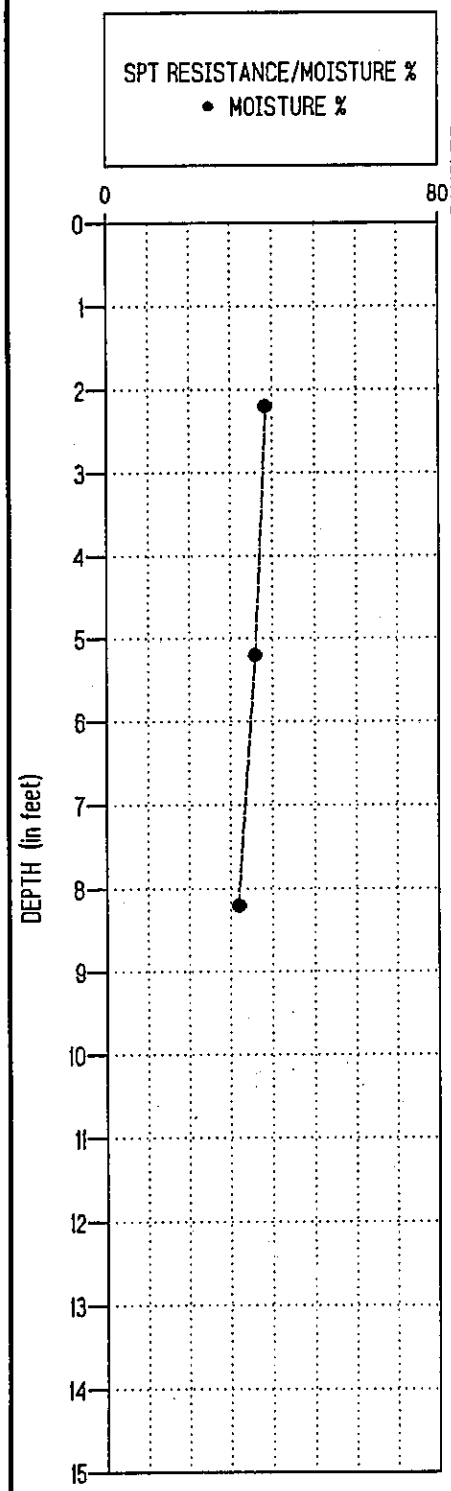
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose to medium dense, brown, silty SAND with some gravel and cobbles; moist (FILL)	
			Dense, gray, SAND and GRAVEL; moist, some cobbles to 6" diameter (FILL)	
			Soft to medium stiff, grayish brown,interbedded SIIT; moist, slightly plastic, trace organic fragments and debris; (Original Soil) Vane shear value at 6.5 feet = 1.5 ksf	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/15th Street NW Interchange: AL2 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-12

DATE EXCAVATED: 09/03/91
SURFACE ELEVATION: 56 ft.
TOTAL DEPTH: 7 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



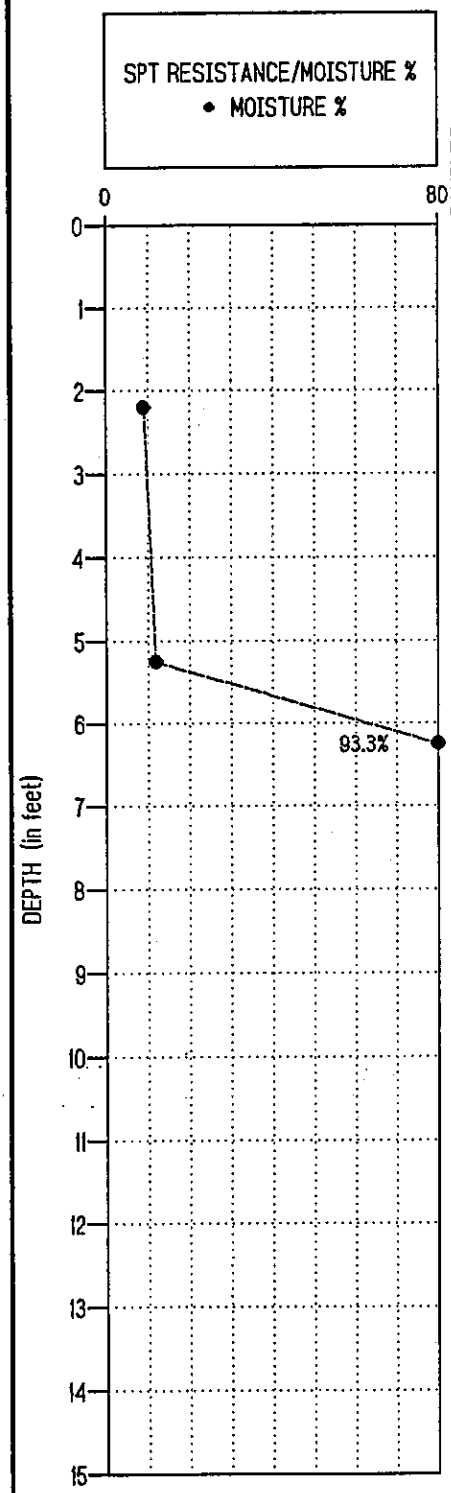
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose, brown, silty sand and rootlets; moist (FILL)	
			8" bed of SAND and GRAVEL	
		SM-ML	Medium stiff to Soft, gray, fine sandy SILT; interbedded with fine to med. sand beds and organics, plastic. Vane shear value at 5' = 0.4 ksf	
			loose to medium dense, gray, silty, fine to medium SAND; becomes cleaner with depth, hole caves in on sides in this unit, water seepage at 6 feet	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/15th Street NW Interchange: AL2 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-13

DATE EXCAVATED: 09/03/91
SURFACE ELEVATION: 56 ft.
TOTAL DEPTH: 8.5 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			loose to medium dense, brown, fine to medium SAND with some gravel and cobbles; damp (Embankment FILL)	
			medium dense to dense, gray, silty SAND with gravel; some cobbles, moist (Compacted FILL)	
			organic-rich, sandy SILT with rootlets mixed in with fill on lower side of embankment	
			End of Test Pit	

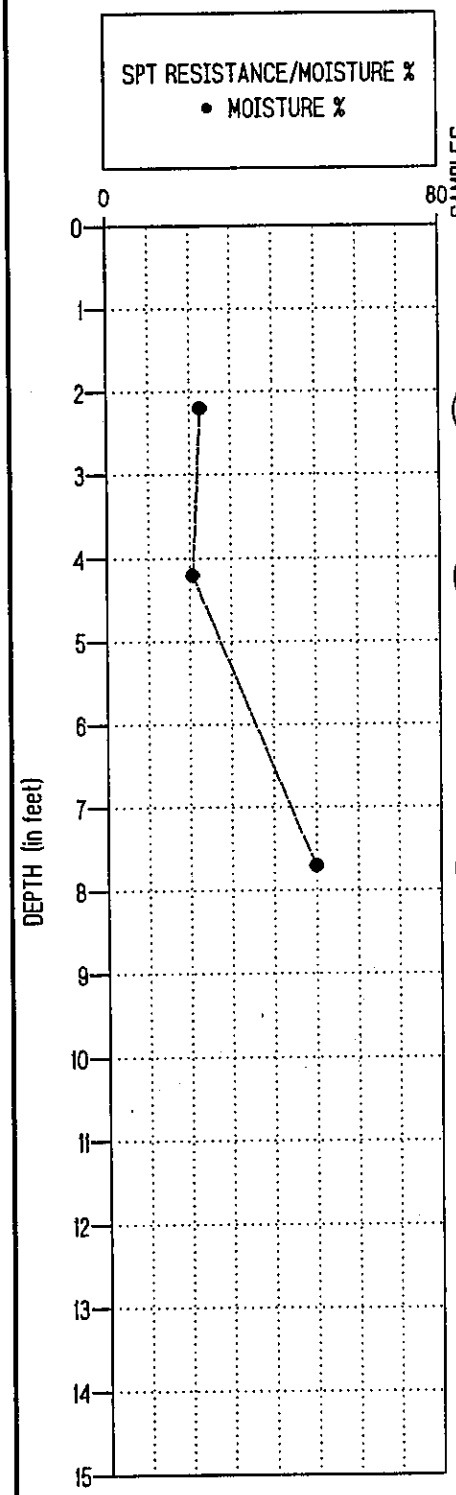
Note: Organic material appears to have been shoved into embankment fill during construction

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 18 Interchange: NW Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-14

DATE DRILLED: 09/03/91
SURFACE ELEVATION: 73 ft.
TOTAL DEPTH: 7 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



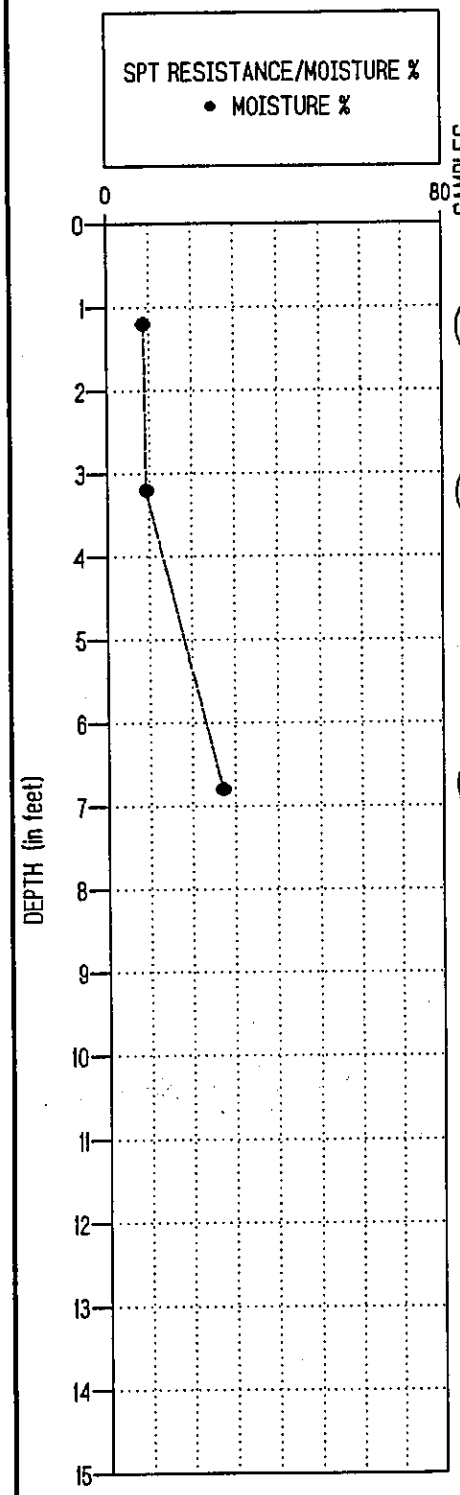
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose, brown, fine, silty SAND with trace gravel; moist (FILL)	
			Medium dense, gray, compacted SAND and GRAVEL; moist, weathered band at 3.5', occasional organics, piece of wood at 6' (FILL)	
			Soft, dark brown, organic-rich, sandy SILT; moist (Old topsoil)	
			Medium dense, dark gray, fine to medium SAND	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 18 Interchange: NW Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-15

DATE DRILLED: 09/03/91
SURFACE ELEVATION: 68 ft.
TOTAL DEPTH: 9.5 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



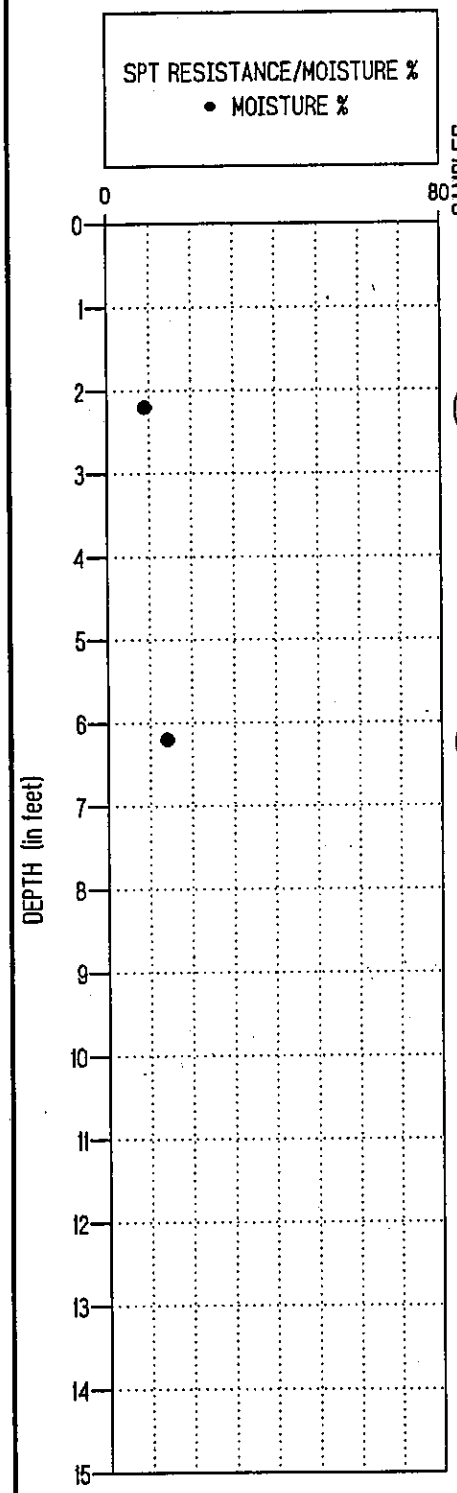
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense to very dense, brown, compacted SAND and GRAVEL; moist (FILL)	
			Dense, gray, SAND and GRAVEL with some cobbles, bricks, and occasional organic debris (FILL)	
			Native original sod and topsoil	
		SM	Medium dense, gray, silty, fine to medium SAND; wet, slight seepage into trench;	
			Found log or stump at 10'	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 18 Interchange: NW Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-16

DATE DRILLED: 09/03/91
SURFACE ELEVATION: 65 ft.
TOTAL DEPTH: 10.0 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



SAMPLES

SYMBOLS

GROUP SYM (UNC)

DESCRIPTION

PIEZOMETER

Dense to very dense, brown, compacted SAND and GRAVEL; well graded, dry to damp, some weathering throughout, wood debris at 3.5' (FILL)

Dense, gray, silty SAND and GRAVEL with occasional cobbles; damp, grades to silty SAND with some gravel at depth; some rootlets to depth (FILL)

No water present to 10' depth

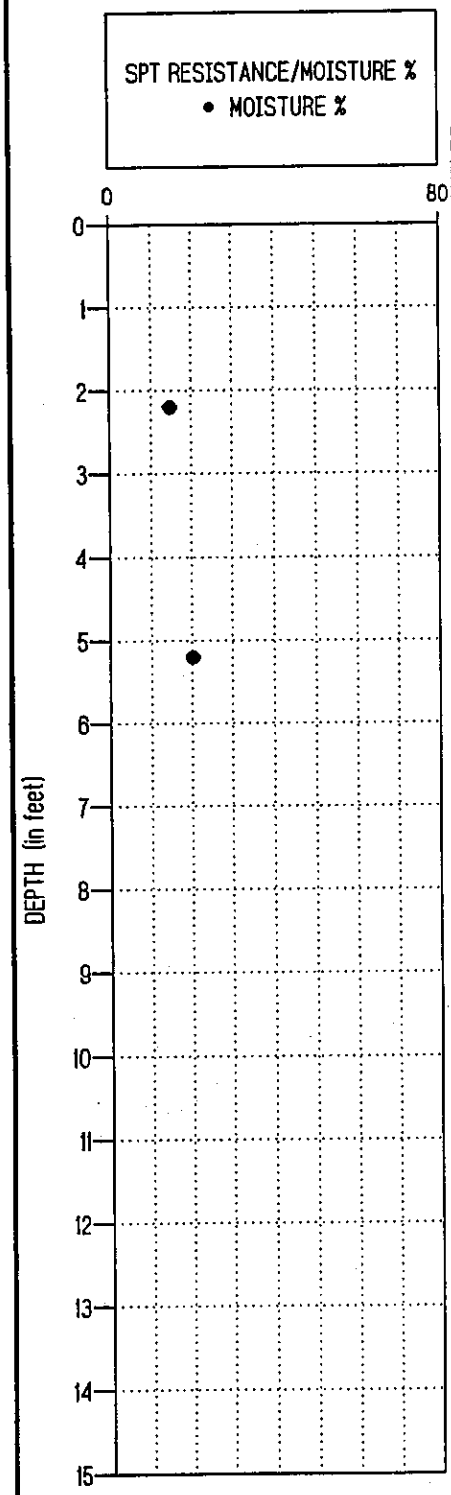
End of Test Pit

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 18 Interchange: ES Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-17

DATE DRILLED: 09/04/91
SURFACE ELEVATION: 84 ft.
TOTAL DEPTH: 10 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



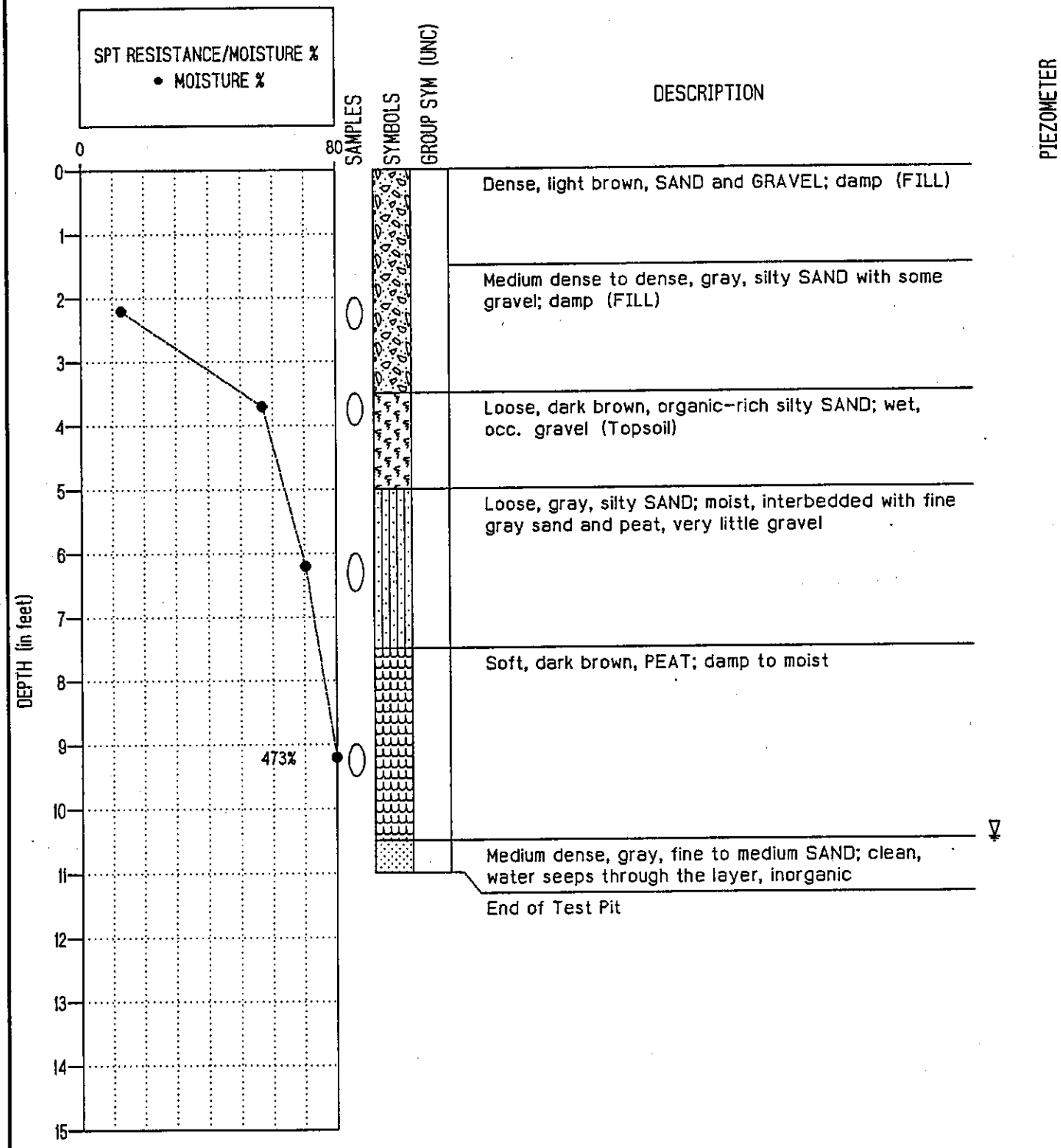
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, SAND and GRAVEL; damp to moist, some cobbles to 4" dia.	
			Medium dense, silty SAND and GRAVEL with some cobbles up to 6" dia.; wet and sticky, slightly plastic (Fill)	
			found some wood pieces	
			grades to more gravel and cobbles with depth	∇
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 18 Interchange: ES Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-18

DATE DRILLED: 09/04/91
SURFACE ELEVATION: 78 ft.
TOTAL DEPTH: 10.5 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG

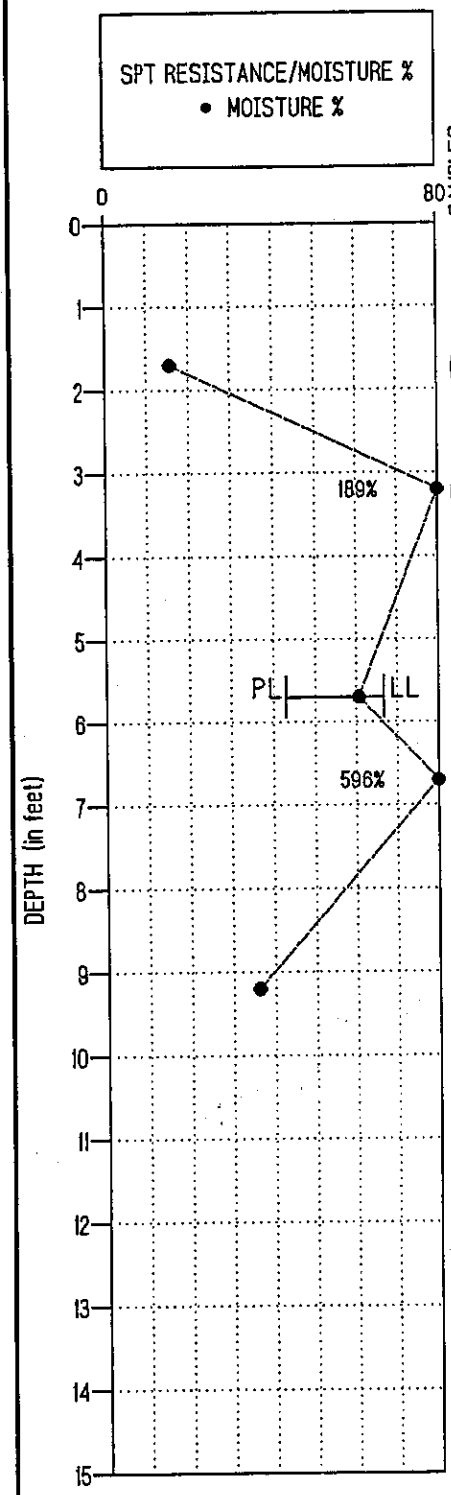


PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 18 Interchange: WN Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-19

DATE DRILLED: 09/04/91
SURFACE ELEVATION: 70 ft.
TOTAL DEPTH: 11 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



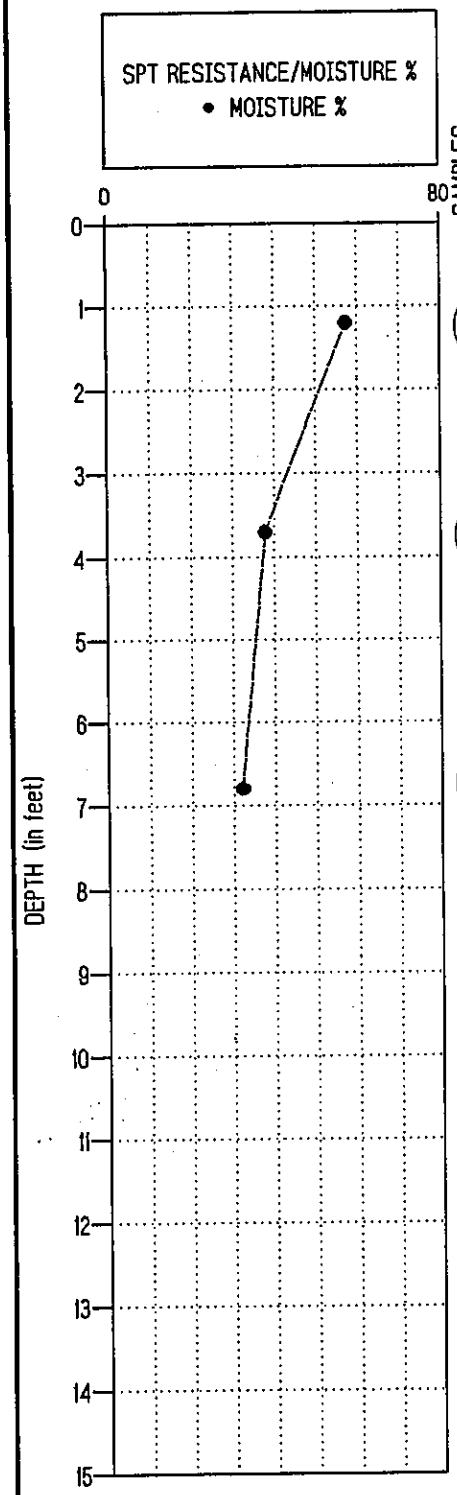
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Medium dense, brown silty SAND and GRAVEL with occ. cobbles; damp (FILL)	
			Soft, dark brown, organic silt with trace of gravel; (Original Soil)	
		OH	Soft, gray, silt with trace of organic fragments; wet, plastic. Vane shear value at 5' = 0.5 ksf	
			Soft, dark brown, organics with some silt; damp (PEAT)	
		SM	Loose to medium dense, gray, very silty, fine to medium SAND; wet, water seeps through layer at 8.5'; grades to cleaner sand with depth	∇
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 18 Interchange: WN Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-20

DATE EXCAVATED: 09/04/91
SURFACE ELEVATION: 68 ft.
TOTAL DEPTH: 10 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



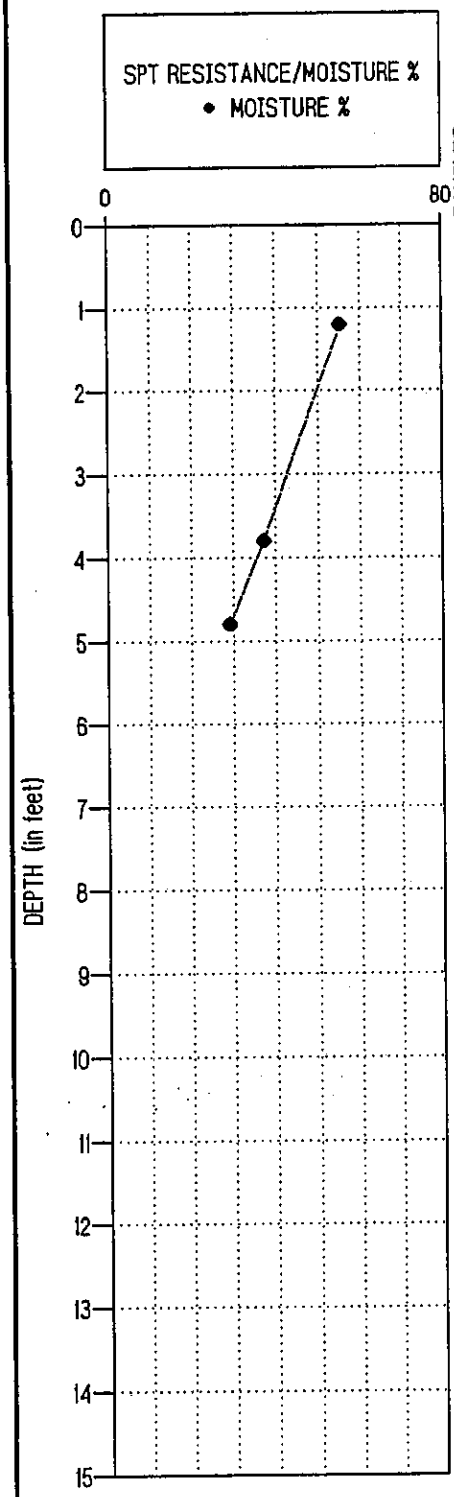
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose to medium dense, brown, weathered silty SAND with some gravel; damp, (FILL)	
			Soft, gray, sandy SILT with trace organic fragments; slightly plastic, becomes sandier with depth; interbedded with organics; slight seepage at 4' depth	
			loose to medium dense, fine SAND; wet, some silt to silty. Waterbearing at 6.5 feet.	∇
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/NW 15th Interchange: DR2 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-21

DATE DRILLED: 09/04/91
SURFACE ELEVATION: 54 ft.
TOTAL DEPTH: 7 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



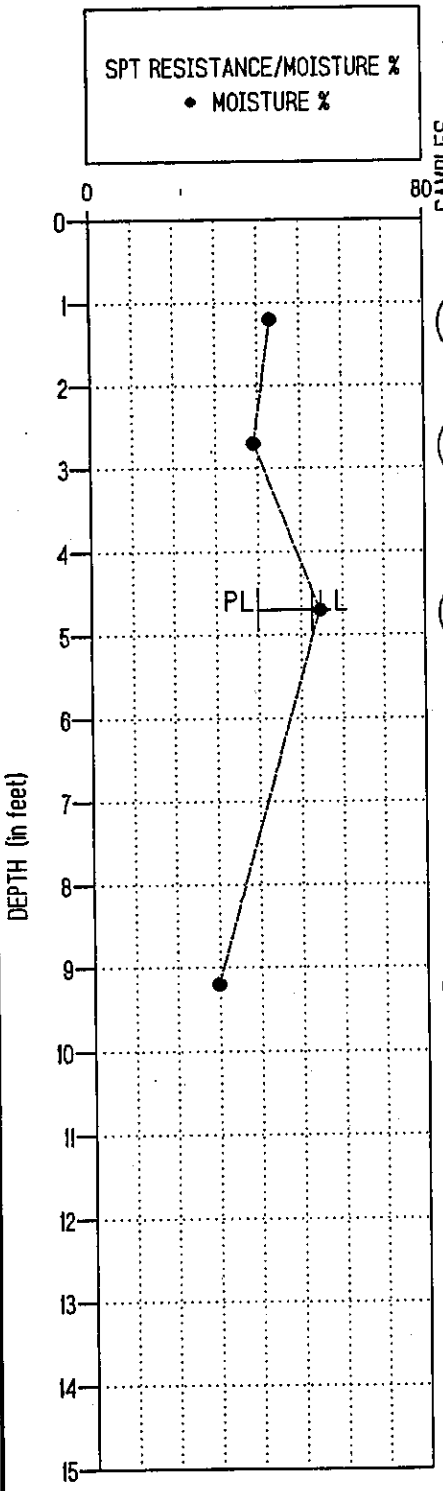
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Soft, brown, sandy SILT with rootlets and organics (Topsoil)	
		SM	Loose to soft, gray, very silty fine SAND; moist, slightly plastic, interbedded with fine gray sand and organic beds 2-3" thick	
		SM	Loose to medium dense, dark gray, very sity, fine to medium SAND. Wet to waterbearing.	∇
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/NW 15th Interchange: DR2 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-22

DATE DRILLED: 09/04/91
SURFACE ELEVATION: 54 ft.
TOTAL DEPTH: 5 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



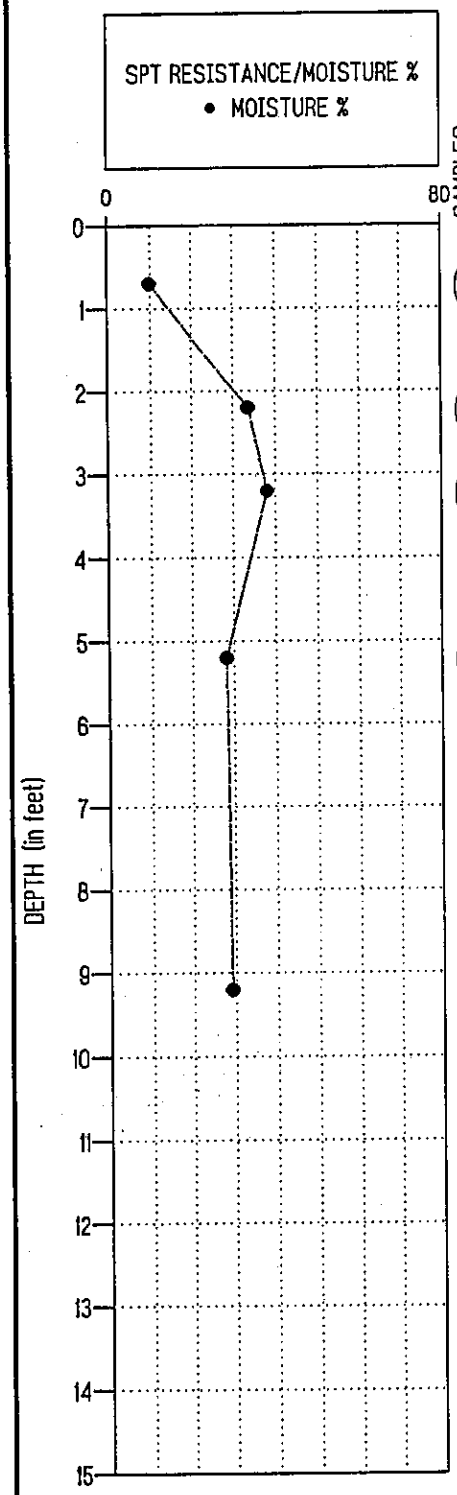
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Soft, brown, sandy SILT: slightly plastic, rootlets and organics, moist (Topsoil)	
			loose to medium dense, dark gray, silty, fine SAND; moist, seepage at interface with silt below	
		OH	Soft, gray, clayey silt with trace sand and organic fragments; plastic, interbedded with fine gray sand and purpleish gray silt; becomes sandier and less plastic with depth	
			Medium dense, dark gray, silty, fine SAND; wet.	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/S. 277th Street Interchange: DR1 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-23

DATE DRILLED: 09/05/91
SURFACE ELEVATION: 39 ft.
TOTAL DEPTH: 10 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



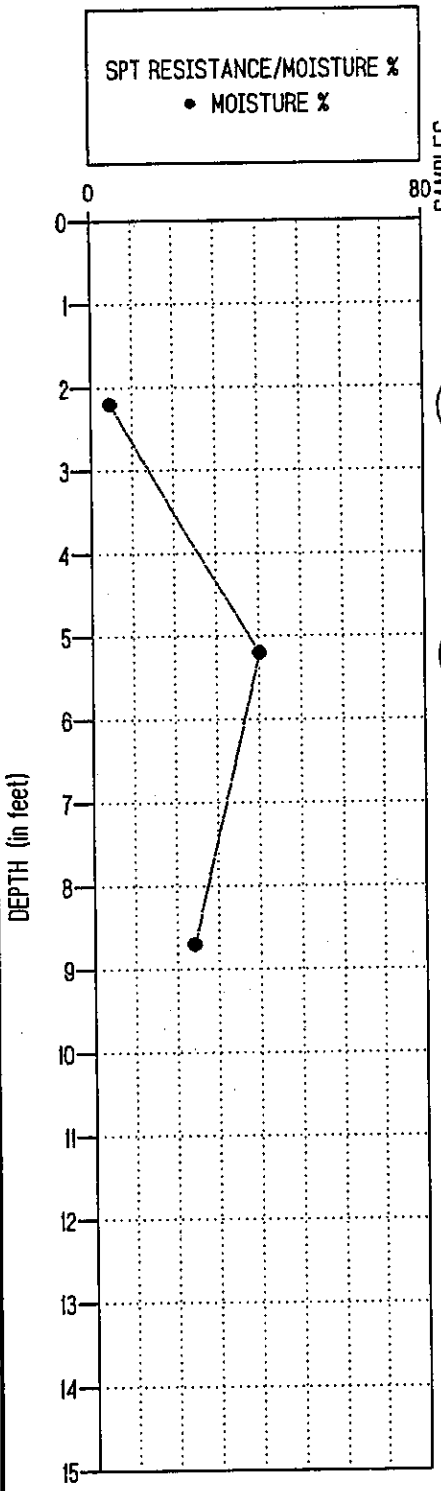
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			loose, silty SAND and GRAVEL; brown and weathered, wet (FILL)	
			Loose to medium dense, gray, fine sandy SILT with trace organics; moist. lower 1 foot contains reddish weathering. Vane shear value at 3'=0.5 ksf	
		ML	medium dense, gray, very sandy SILT; wet, interbedded and laminated	
			grades to silty, fine to medium sand below 8' depth	∇
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/S. 277th Street Interchange: DR1 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-24

DATE EXCAVATED: 09/05/91
SURFACE ELEVATION: 38 ft.
TOTAL DEPTH: 10 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



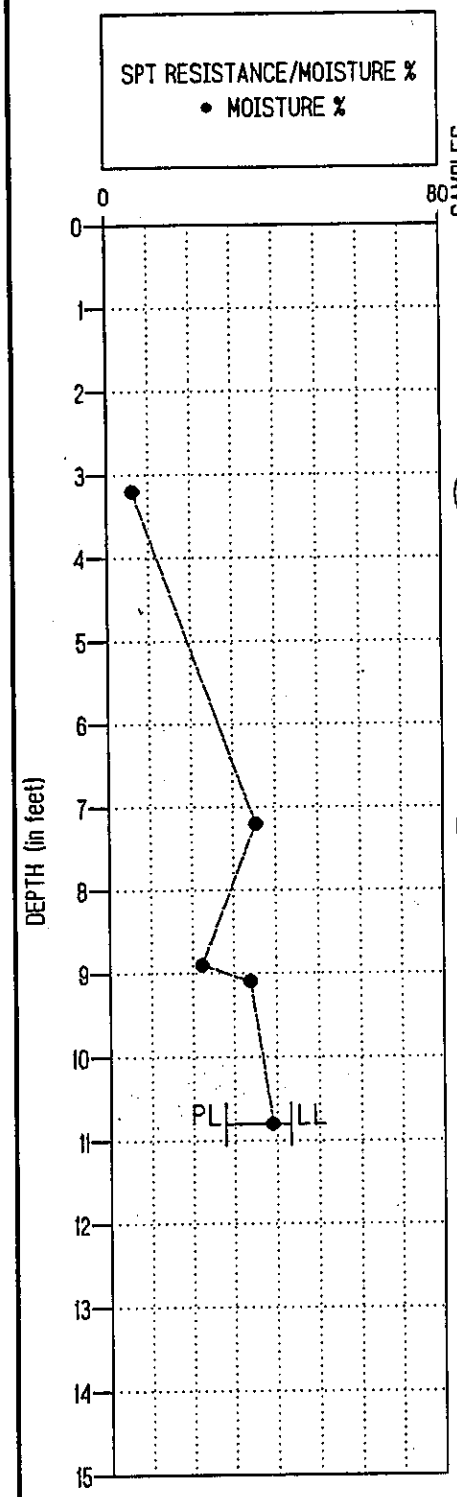
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, SAND and GRAVEL; moist to damp becomes gray, clean sand and gravel at 3' depth	
			Stiff, gray, SILT with some sand to sandy; damp, plastic with trace organic fragments, very little perceptible moisture	
			Found stump or wood debris at 8' depth	
			medium dense, dark gray, silty, fine SAND; water seeps into trench at 8' depth	∇
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/S. 277th Street Interchange: DR1 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-25

DATE DRILLED: 09/05/91
SURFACE ELEVATION: 40 ft.
TOTAL DEPTH: 9 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



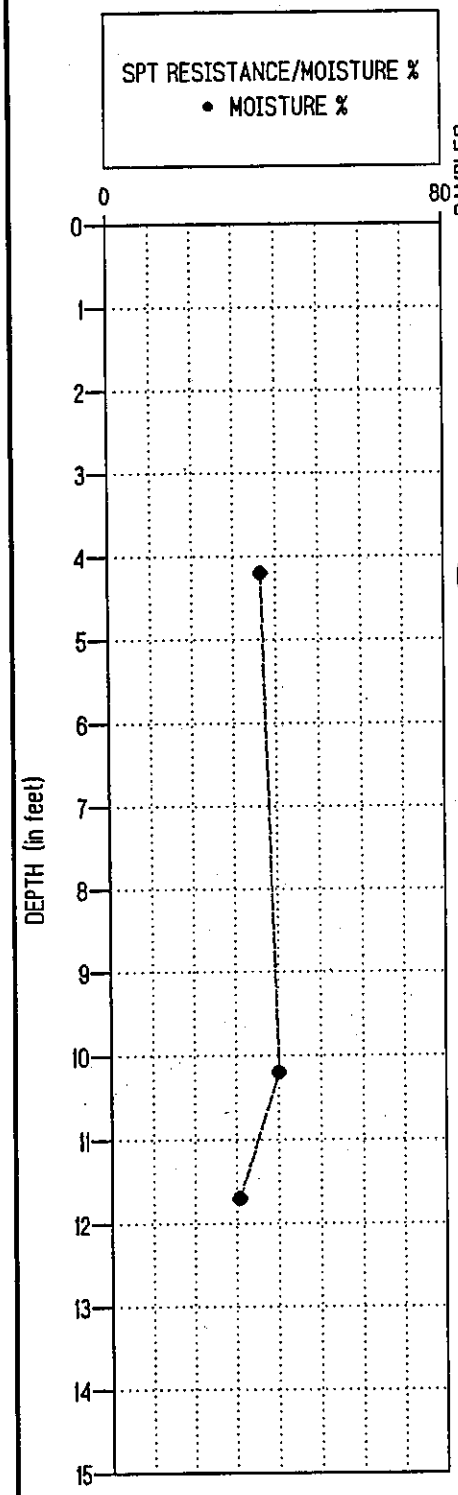
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			dense, brown, SAND and GRAVEL; damp, (FILL)	
			becomes gray at 3.5' depth	
			medium dense, dark brown, silty fine SAND; found bricks, bottle, wire, and organic debris (Original Soil and Fill)	
			Soft and loose, gray, Silt and fine sandy SILT with trace organics; moist; slightly plastic to plastic.	
			Medium dense, gray, fine SAND; moist to wet	
		ML	Soft, gray, plastic SILT; weathered, moist to wet but no seepage (alluvial or lacustrine deposits?)	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 516 Interchange: DR2 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-26

DATE DRILLED: 09/05/91
SURFACE ELEVATION: 40 ft.
TOTAL DEPTH: 12.5 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



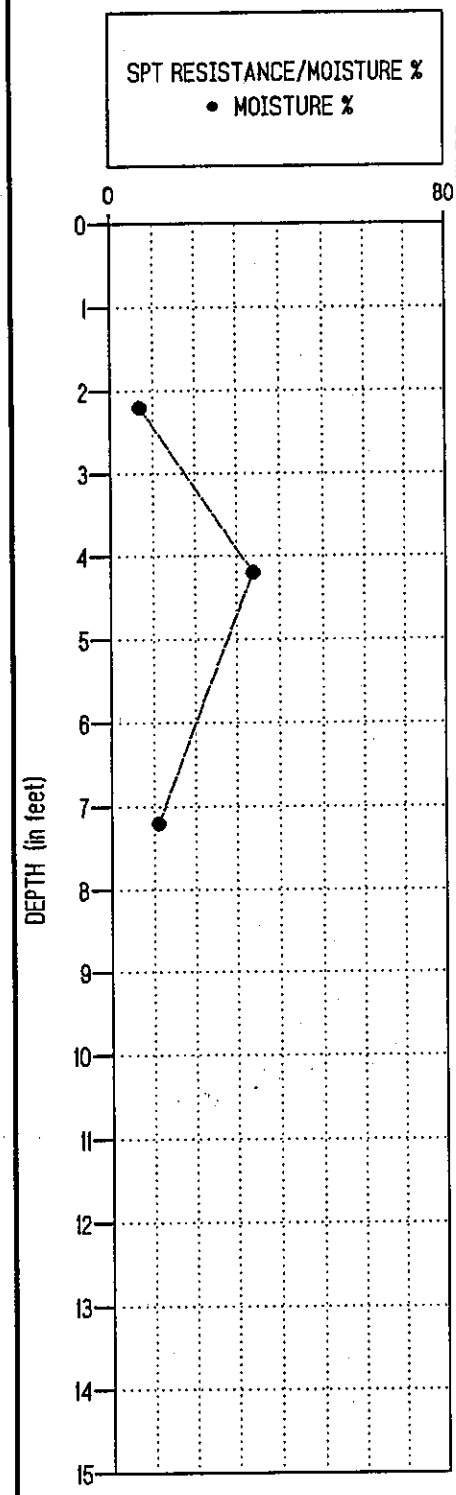
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Dense, brown, SAND and GRAVEL; damp, slightly weathered (FILL)	
			Loose and medium stiff, gray, sandy SILT and SILT with trace of fine sand. Becoming moist at 3.5'; plastic, trace of organics	
			becomes sandier with depth to sandy SILT; wet	
		SM	Medium dense, dark gray, silty, fine SAND; moist.	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 516 Interchange: DR2 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-27

DATE DRILLED: 09/05/91
SURFACE ELEVATION: 36 ft.
TOTAL DEPTH: 12 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



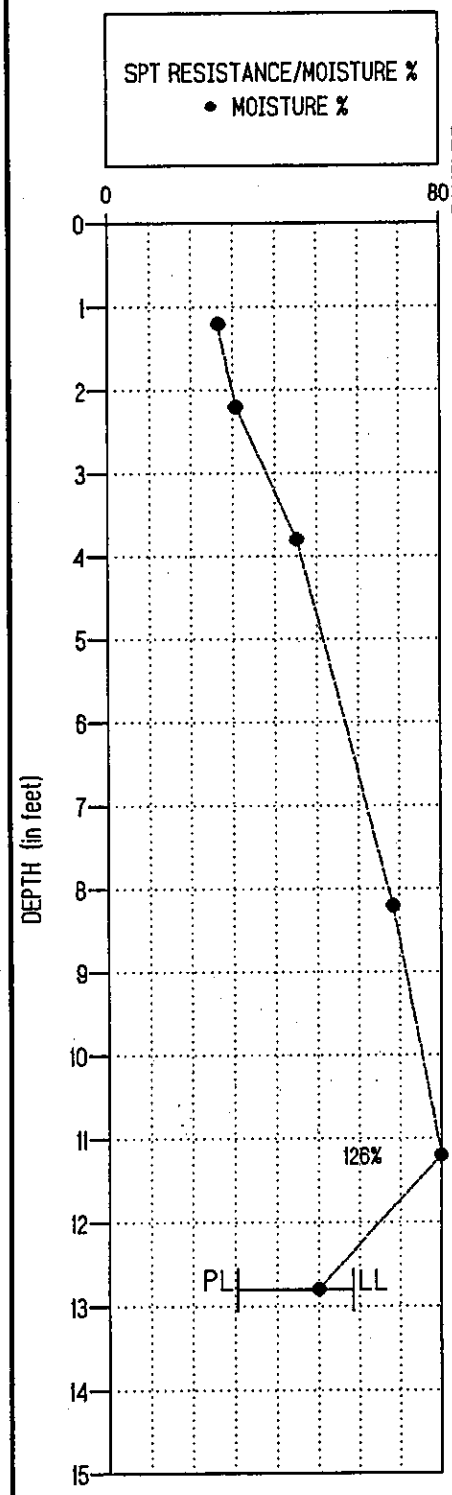
SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			medium dense, brown, SAND and GRAVEL; damp, (FILL)	
			becomes gray at 2' depth	
			medium stiff, gray, fine sandy SILT; damp, interbedded with fine sand and purple/gray silt	
			medium dense, gray, fine to medium SAND; damp, interbedded with silt	
			becomes more uniform fine sand at 8' depth becomes wet at 8'depth	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/SR 516 Interchange: DR2 Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-28

DATE DRILLED: 09/05/91
SURFACE ELEVATION: 35 ft.
TOTAL DEPTH: 11.5 ft.

HONG WEST & ASSOCIATES
TEST PIT LOG



SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			Loose, brown, silty fine SAND; weathered, wet, rootlets (Topsoil)	
			Loose to soft, gray, sandy SILT and SILT; moist to wet, weathered, trace organics	
			Loose to medium dense, gray, silty fine SAND; wet, interbedded and laminated with silt seams; slightly plastic. (Alluvium) waterbearing sand seam at 4'depth	
			loose, brown, organic debris and gray silt. Saturated, water seepage at 6.5 feet. (PEAT)	
		MH	Soft to very soft, gray, interbedded plastic SILT; trace to some fine sand, wet, sticky	
			End of Test Pit	

PROJECT NAME: SR-167: 15th Street SW to S. Grady Way
LOCATION: SR-167/84th Avenue So.: DRI Ramp
PROJECT NUMBER: 91101
LOGGED BY: pls

TEST PIT TP-29

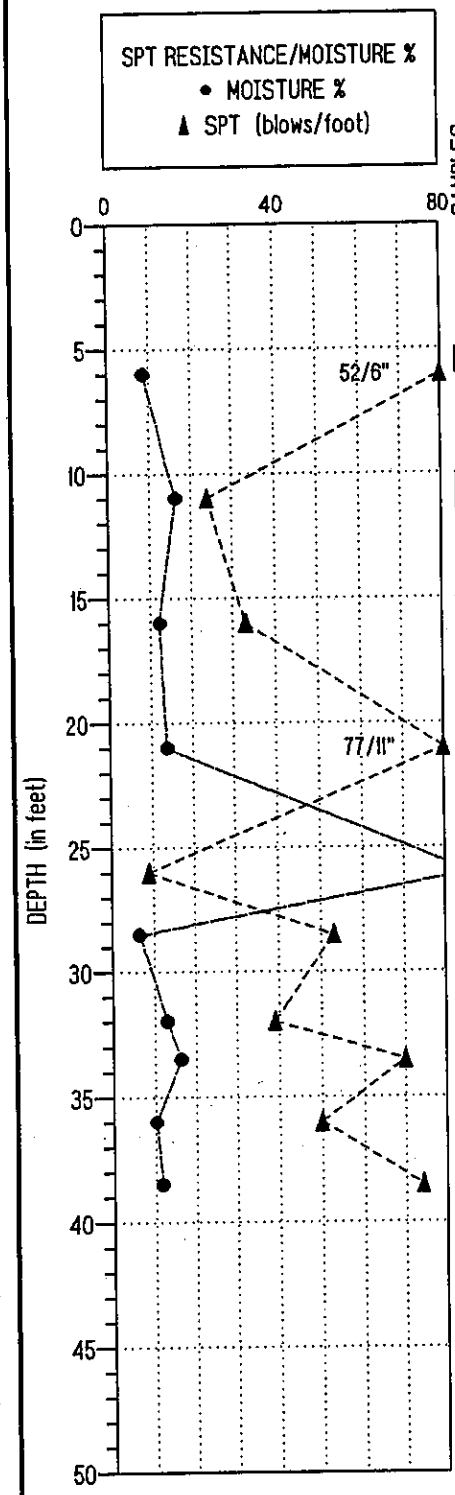
DATE DRILLED: 09/06/91
SURFACE ELEVATION: 31 ft.
TOTAL DEPTH: 13 ft.

APPENDIX C

LOGS OF EXPLORATORY BORINGS

HONG WEST & ASSOCIATES

HONG WEST & ASSOCIATES
BORING LOG



SAMPLES | SYMBOLS | GROUP SYM (UNC) | DESCRIPTION | PIEZOMETER

Approximately 3" asphalt concrete pavement on shoulder

Loose to dense, brown and gray to mottled, silty/clayey, SAND and GRAVEL, and possibly cobbles. Trace of organic debris. Moist to wet. (Embankment Fill)

Medium stiff, dark brown, organic, fiberous SILT. Some sand. Wet. (Peat)

Dense to very dense, gray, interbedded, silty, fine to coarse SAND and fine to medium SAND. A trace of gravel to gravelly; gravel fraction decreases with depth. Water bearing. (Alluvium)

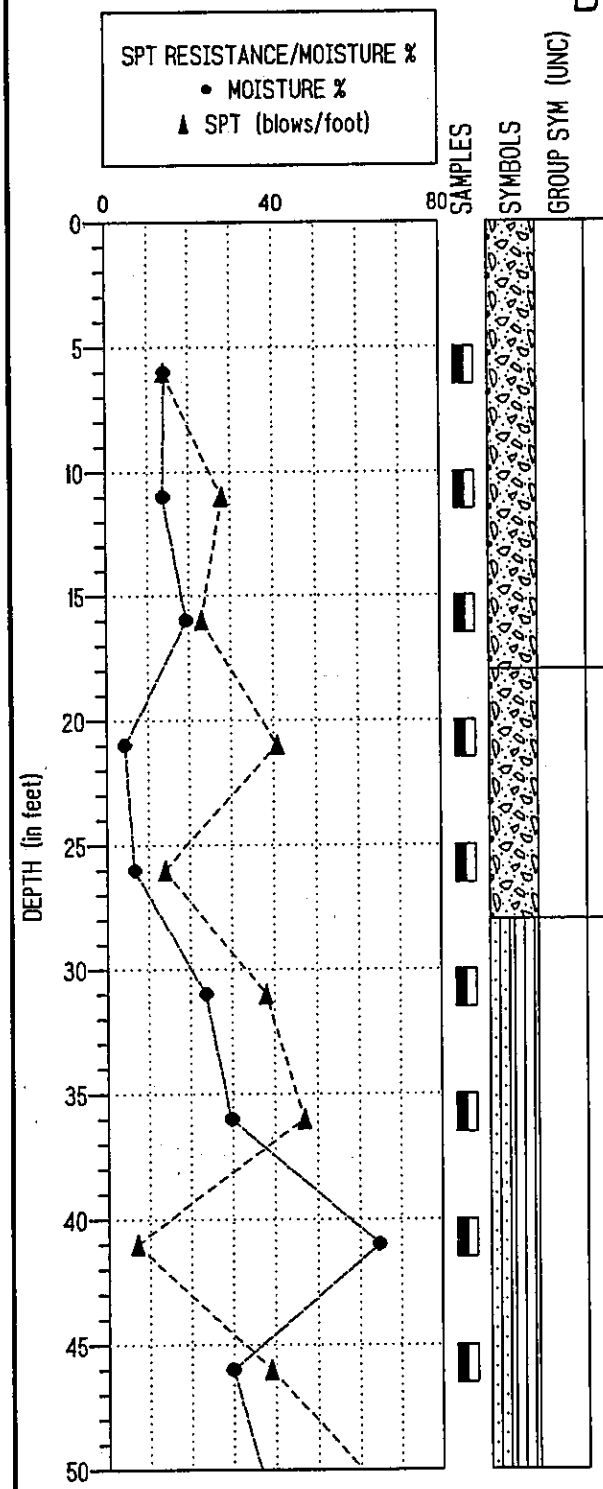
End of boring

PROJECT NAME: SR-167: 15th St. SW to S. Grady Way
LOCATION: SR-18 Interchange EN Ramp
PROJECT NUMBER: 91101
LOGGED BY: slt

BORING BH-1

DATE DRILLED: 09/10/91
SURFACE ELEVATION: 87 ft.
TOTAL DEPTH: 39 ft.

HONG WEST & ASSOCIATES
BORING LOG



DESCRIPTION	PIEZOMETER
Medium dense, brown and gray to mottled, silty, fine to medium SAND and fine sandy SILT. A trace to some gravel. Moist to wet. (Embankment Fill)	
Grades to fine to coarse SAND with some gravel.	∇
Medium dense to dense, light blueish grey, sandy GRAVEL and possible cobbles. Trace silt. (Fill ???)	
Dense to very dense, gray, silty, fine to medium SAND and fine sandy Silt. Trace fine gravel and organic matter. Water bearing. (Alluvium)	
Approximately 5 feet thick of loose, dark brown, organic, silty, fine SAND and some brown sawdust.	
Grades to fine to medium SAND. Trace silt and organic matter.	

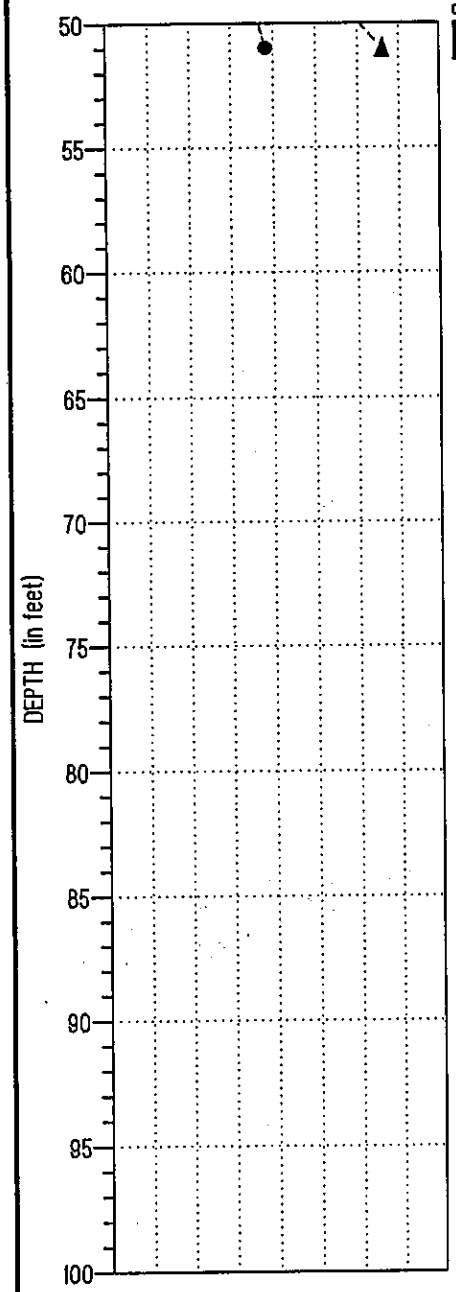
PROJECT NAME: SR-167: 15th St. SW to S. Grady Way
LOCATION: SR-18 Interchange ES Ramp
PROJECT NUMBER: 91101
LOGGED BY: slt

BORING BH-2

DATE DRILLED: 09/10/91
SURFACE ELEVATION: 88 ft.
TOTAL DEPTH: 51.5 ft.

HONG WEST & ASSOCIATES
BORING LOG

SPT RESISTANCE/MOISTURE %
● MOISTURE %
▲ SPT (blows/foot)

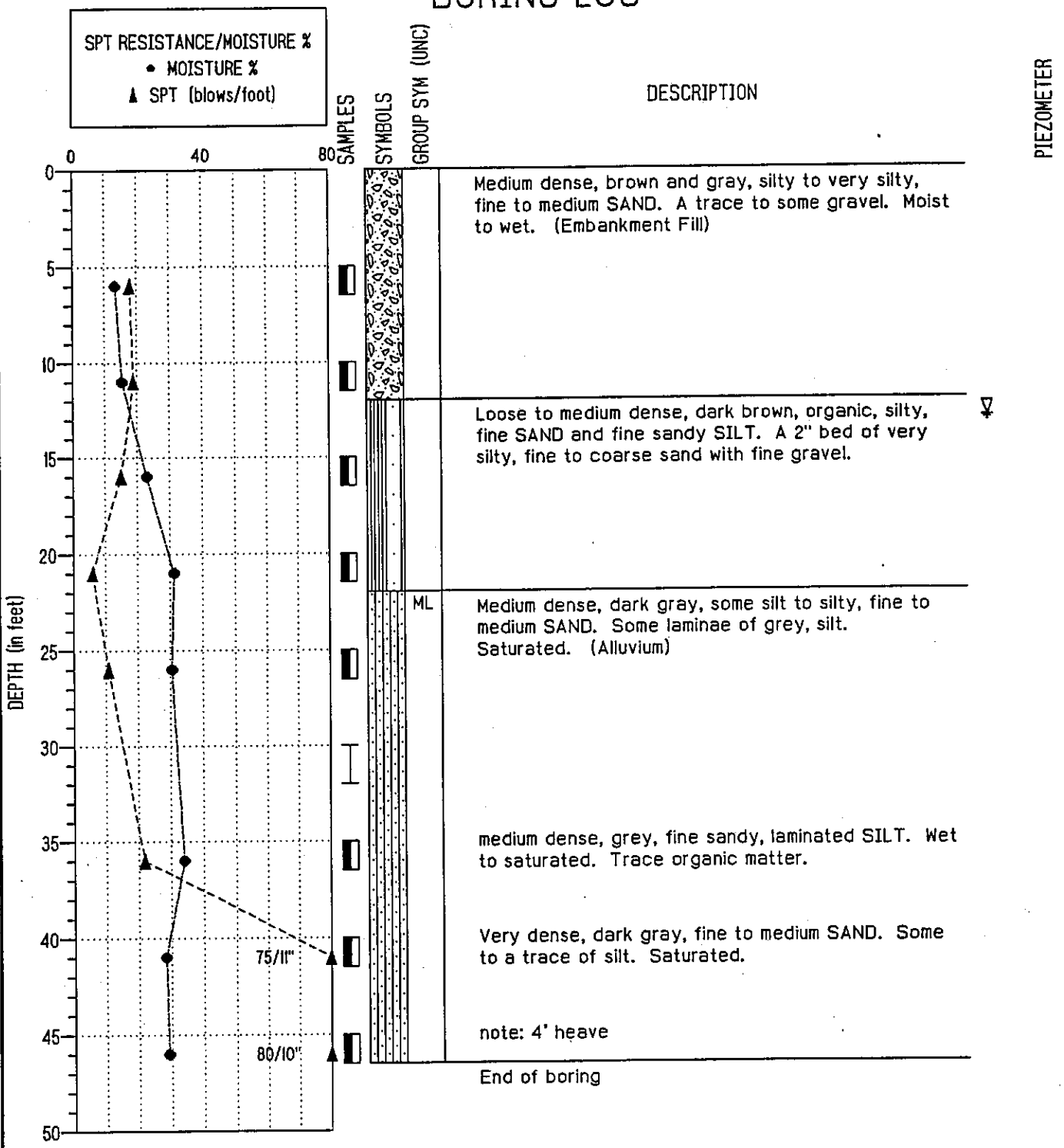


SAMPLES	SYMBOLS	GROUP SYM (UNC)	DESCRIPTION	PIEZOMETER
			End of boring at 51.5 feet	

PROJECT NAME: SR-167: 15th St. SW to S. Grady Way
LOCATION: SR-18 Interchange ES Ramp
PROJECT NUMBER: 91101
LOGGED BY: slt

BORING BH-2
DATE DRILLED: 09/10/91
SURFACE ELEVATION: 88 ft.
TOTAL DEPTH: 51.5 ft.

HONG WEST & ASSOCIATES
BORING LOG

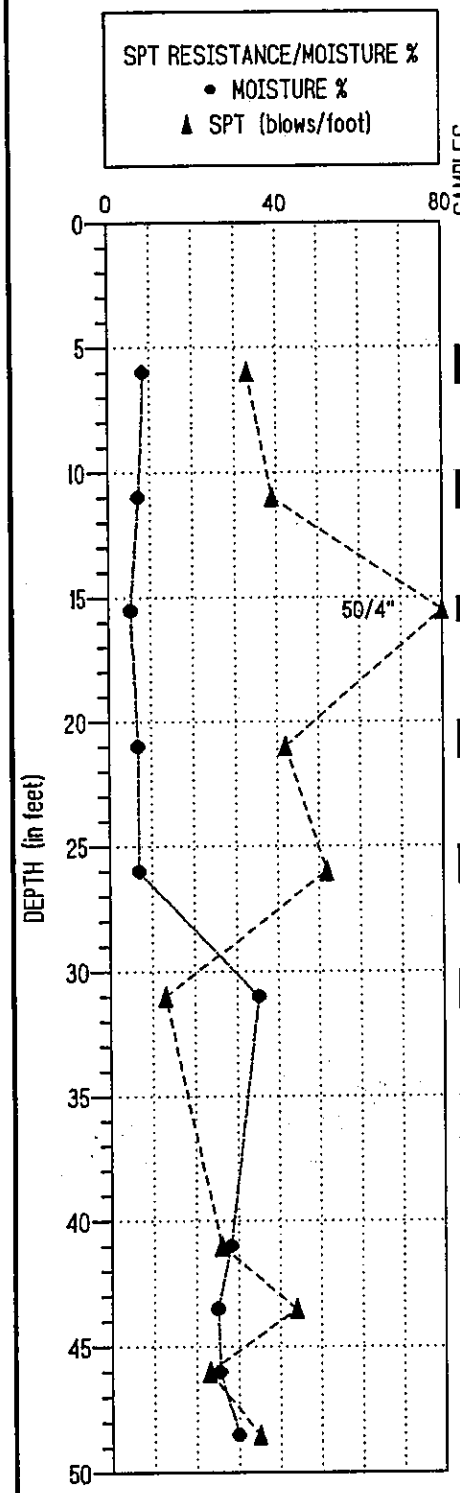


PROJECT NAME: SR-167: 15th St. SW to S. Grady Way
LOCATION: SR-18 Interchange EN Ramp
PROJECT NUMBER: 91101
LOGGED BY: slt

BORING BH-3

DATE DRILLED: 09/10/91
SURFACE ELEVATION: 82 ft.
TOTAL DEPTH: 46.5 ft.

HONG WEST & ASSOCIATES
BORING LOG



SAMPLES | SYMBOLS | GROUP SYM (UNC) | DESCRIPTION | PIEZOMETER

14" asphalt concrete pavement on the shoulder.

Medium dense to very dense, grey and brown to mottled, silty, gravelly SAND. Moist. Some zone of silty, fine to medium sand. Trace organic matter. (Embankment Fill)

ML — Stiff, gray and brown mottled, plastic, SILT. Some fine sand. Moist to wet. Beds of grey, silty, fine sand. (Alluvium)

Medium dense to dense, dark gray, fine to medium SAND. Some to a trace of silt. SAturated.

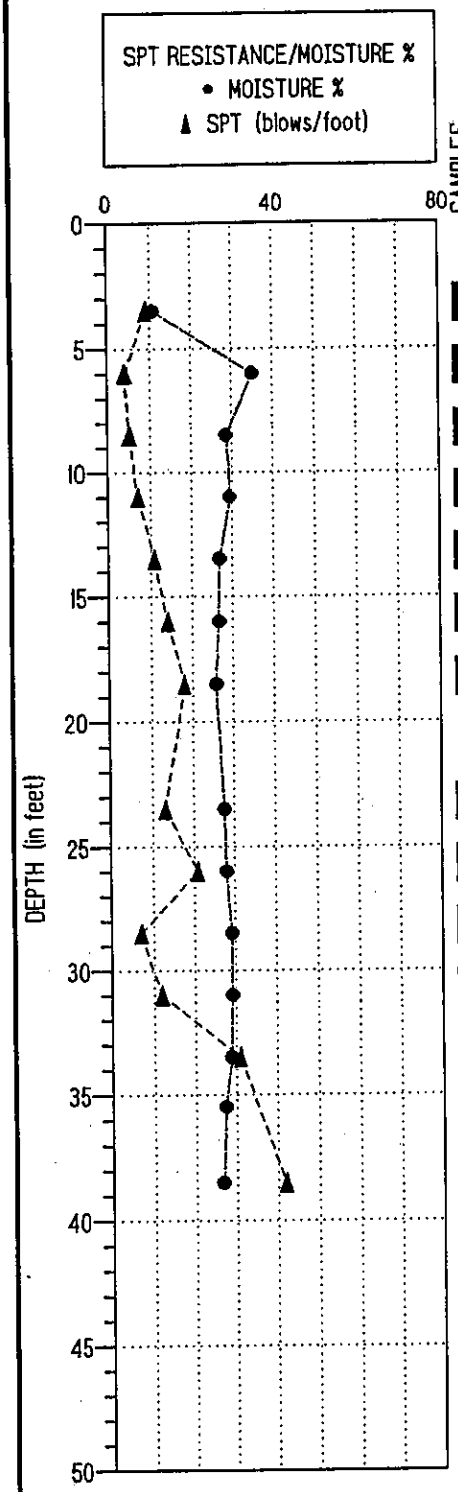
End of boring at 49 feet

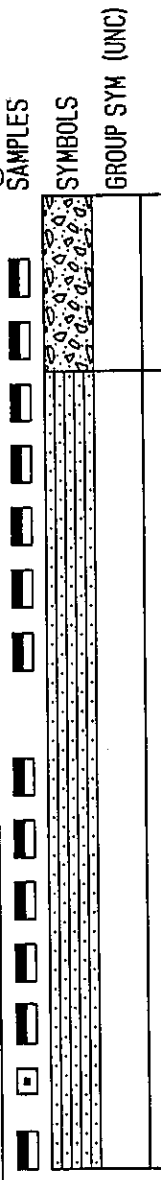
PROJECT NAME: SR-167: 15th St. SW to S. Grady Way
LOCATION: SR-516 Interchange DR2 Ramp
PROJECT NUMBER: 91101
LOGGED BY: slt

BORING BH-4

DATE DRILLED: 09/11/91
SURFACE ELEVATION: 50 ft.
TOTAL DEPTH: 49 ft.

HONG WEST & ASSOCIATES
BORING LOG





DESCRIPTION	PIEZOMETER
Loose to very loose, grey and brown to mottled, very silty, fine SAND and fine sandy SILT. Some roots to a depth of 4 – 5 feet. Moist to wet. (Embankment Fill)	
Loose to medium dense, dark grey, medium SAND. Trace silt. Some fine sand beds. Saturated. (Alluvium)	∇
Grades to medium to coarse grained SAND.	
Grades to silty, fine SAND. Some grey silt laminae. Trace organic matter. Saturated.	
End of boring	

PROJECT NAME: SR-167: 15th St. SW to S. Grady Way
LOCATION: 84th Avenue Interchange EN Ramp
PROJECT NUMBER: 91101
LOGGED BY: slt

BORING BH-5
DATE DRILLED: 09/11/91
SURFACE ELEVATION: 35 ft.
TOTAL DEPTH: 39 ft.

APPENDIX D

LABORATORY TEST RESULTS

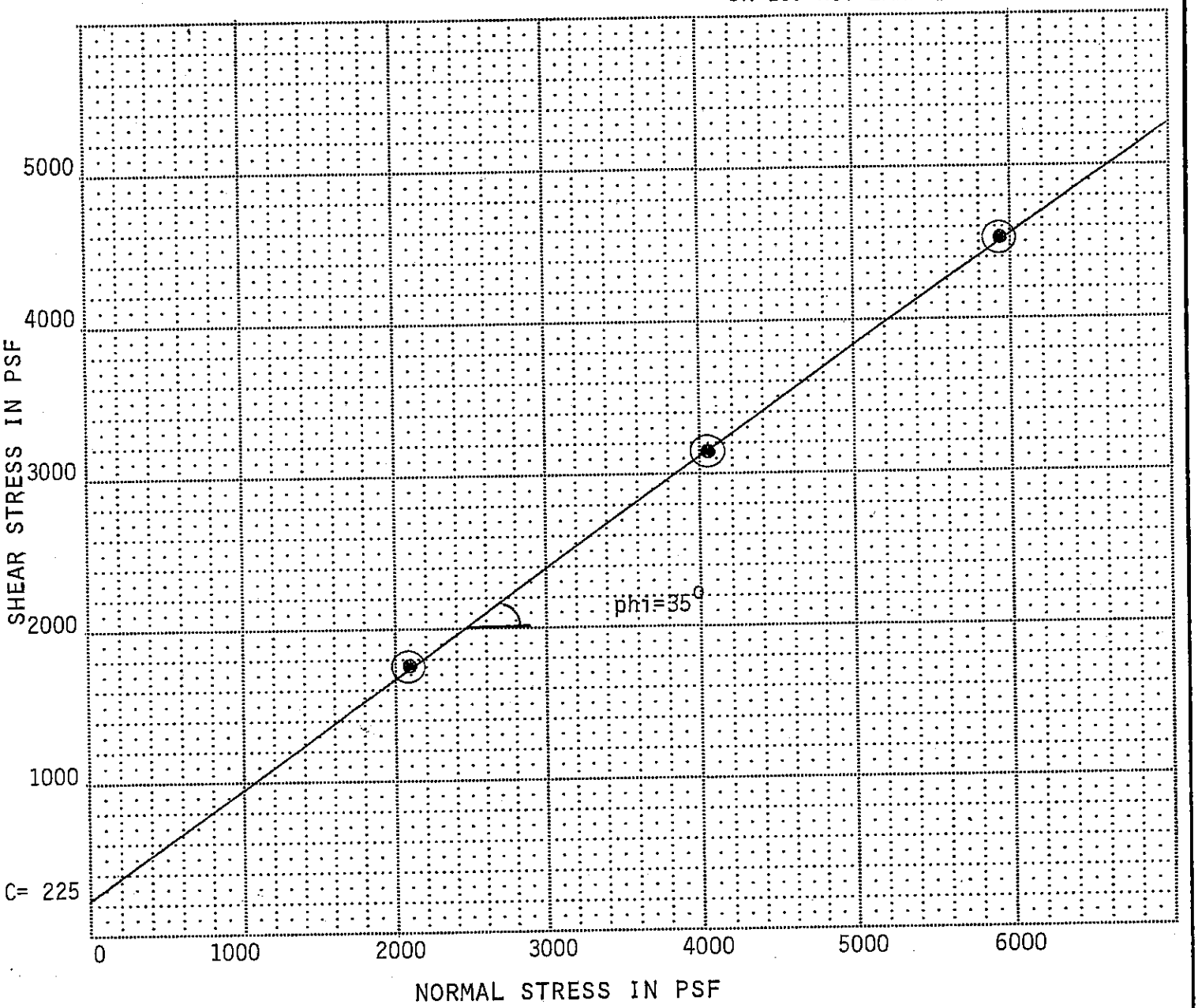
HONG WEST & ASSOCIATES

TABLE D-1. LABORATORY TEST RESULTS SUMMARY

Test Pit/Boring	Depth (feet)	L. L.	P.L.	P.I.	Nat. M.C.	Friction Angle	Cohesion	% Gravel	% Sand	% - 200	USCS
TP-1	4.5	42.8	31.6	11.2	53.8						ML
TP-2	5.5	39.5	30.6	8.9	31.5	21 deg.	585 psf				ML
TP-3	4	53	25	28	43.4						CH
TP-4	2				20.5			0.5	95.4	4.1	SP
TP-6	8				36.9			0	95.7	4.3	SP
TP-8	3				33.7			0	3.5	96.5	ML
TP-13	5	NP	NP	-	35.9						SM-ML
TP-16	6.5				27.3			0	87.5	12.5	SM
TP-20	5.5	66.9	42.9	24	60.7						OH
TP-20	9				36.2			0.1	60.7	39.2	SM
TP-22	2				37.2			0	62.2	37.8	SM
TP-22	4.5				29.1			0.1	65.2	34.7	SM
TP-23	4.5	52.7	39.8	12.9	54.6						OH
TP-24	5				28.2			0	34.9	65.1	ML
TP-26	10.5	43.2	27.7	15.5	33.8						ML
TP-27	11.5				30.7			0	81.1	18.9	SM
TP-29	13	58.4	30.6	27.8	50.1						MH
BH-3	30				31.8	35 deg.	225 psf	0	4.5	95.5	ML
BH-4	35				30.1	40 deg.	375 psf	0	46.3	53.7	ML
HB-1W	1				9.3			40.6	39.9	19.5	GM
HB-1C	2				6.9			66	28.6	5.4	GW-GM
HB-2E	1							43.3	38.2	18.5	GM
HB-3W	1				6.7			60.1	24.1	15.8	GM
HB-4E	1				4.6			45.7	36.5	17.8	GM
HB-6E	1				2.7			52.2	40.1	7.7	GP-GM
HB-7W	1				3.7			54.7	33.8	11.5	GP-GM
HB-12E	1				7.4			16.6	71	12.4	SM
HB-16E	2				4.5			49.1	43.6	7.3	GP-GM
HB-20E	0.5				6.7			30	57.5	12.5	SM
HB-24E	0.5				3.8			67.5	30.2	2.3	GW
HB-28E	2				5.3			46.3	48.8	4.9	SP
HB-32E	1				3.2			48.8	47.7	3.5	GP
HB-36E	1				5.5			50.5	45	4.5	GP
HB-40E	1				3.7			53.6	40.9	5.5	GP-GM
HB-44E	0.5				4.6			23	46.4	30.6	SM

DIRECT SHEAR TEST RESULTS

SR 167 HOV LANE #91101

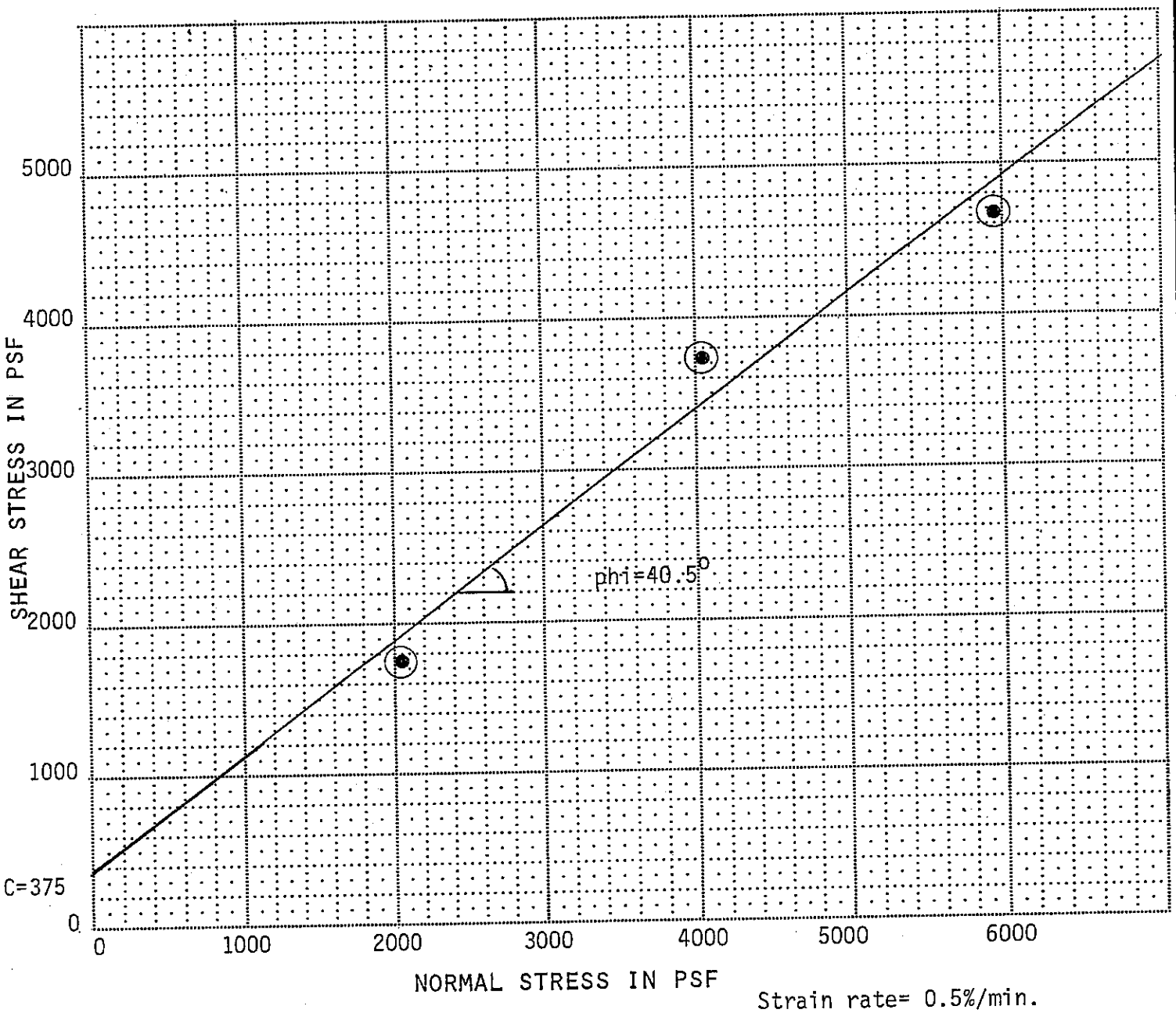


Strain rate= 0.5%/Min.

HOLE NO.	DEPTH (FT)	WATER CONTENT%	DRY (PCF) DENSITY	NORMAL PSF PRESSURE	YIELD PSF STRESS	PEAK PSF STRESS	SOIL CLASSIFICATION
BH-3	30.0-	31.8	86.6	2096		1766	ML
"	32.5'	31.7	85.9	4035		3130	
"		32.8	86.7	5961		4522	

Hong West and Associates

DIRECT SHEAR TEST RESULTS SR 167 HOV LANE #91101



Strain rate= 0.5%/min.

HOLE NO.	DEPTH (FT)	WATER CONTENT%	DRY (PCF) DENSITY	NORMAL PSF PRESSURE	YIELD PSF STRESS	PEAK PSF STRESS	SOIL CLASSIFICATION
BH-4	35.0-	30.1	86.3	2096		1763	SM/ML
"	36.5'	29.2	87.2	4035		3759	
"		29.4	89.6	5961		4676	

Hong West and Associates

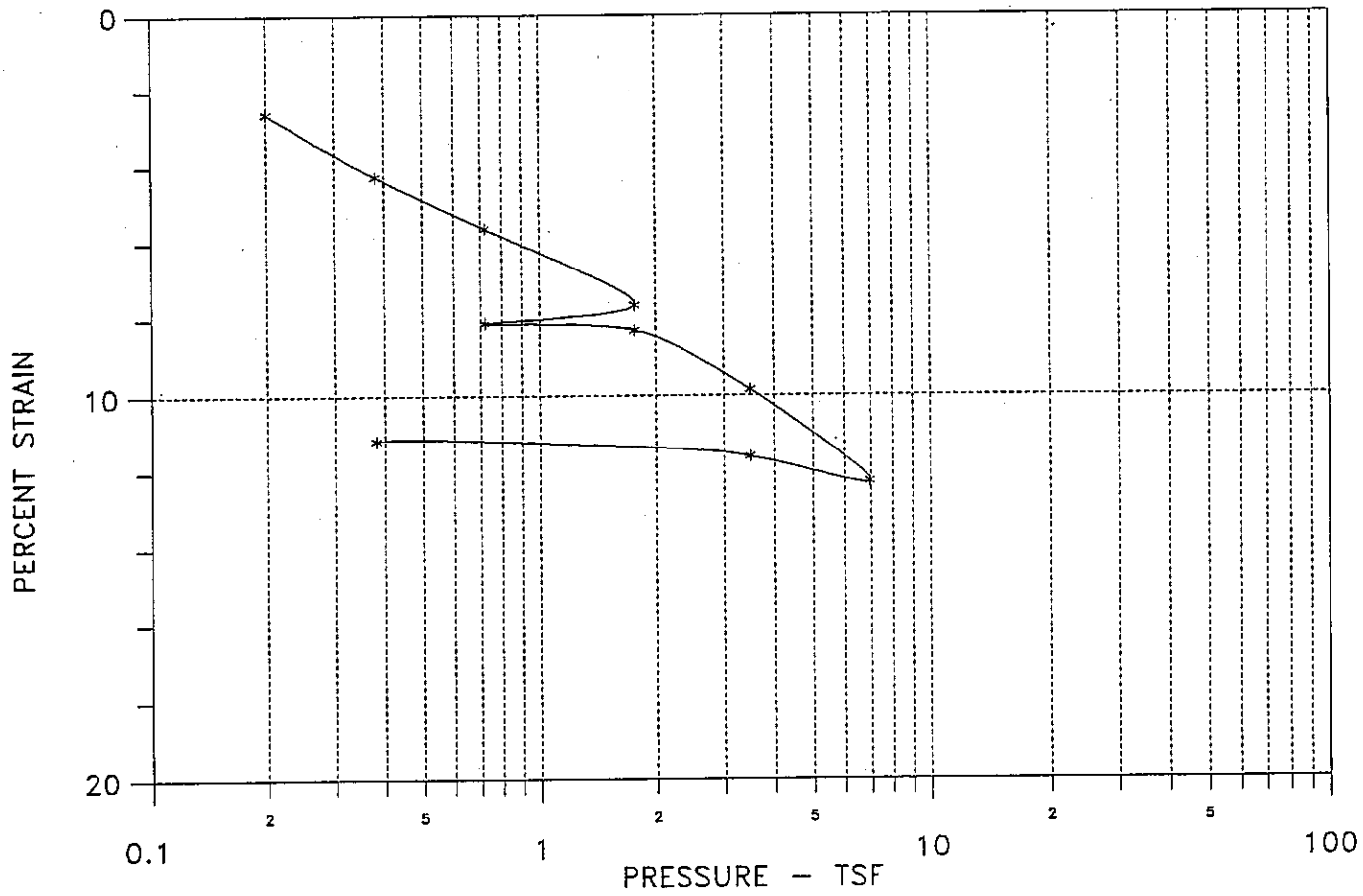
HONG WEST & ASSOCIATES
CONSOLIDATION TEST RESULTS

Project: SR 167 HOV LANE Project
Address: King County, Washington

Sample Description: Gray, SILT (ML)

	Initial	Final
Height (in.):	1.00	0.887
Water Content (%):	34.2	28.2
Wet Density (PCF):	116.7	131.6
Dry Density (PCF):	87.0	102.6

Project Number: 91101
Test Hole Number: TP-2
Depth Ft.: 5.5-7.0 feet
Test Number: 1
Date Tested: 9-17-91
Tested By: SEG/ST
Diameter (in.): 2.416
Assumed Sp. Gravity: 2.65
Void Ratio: Initial: .907
Final: .611



Reviewed By: _____

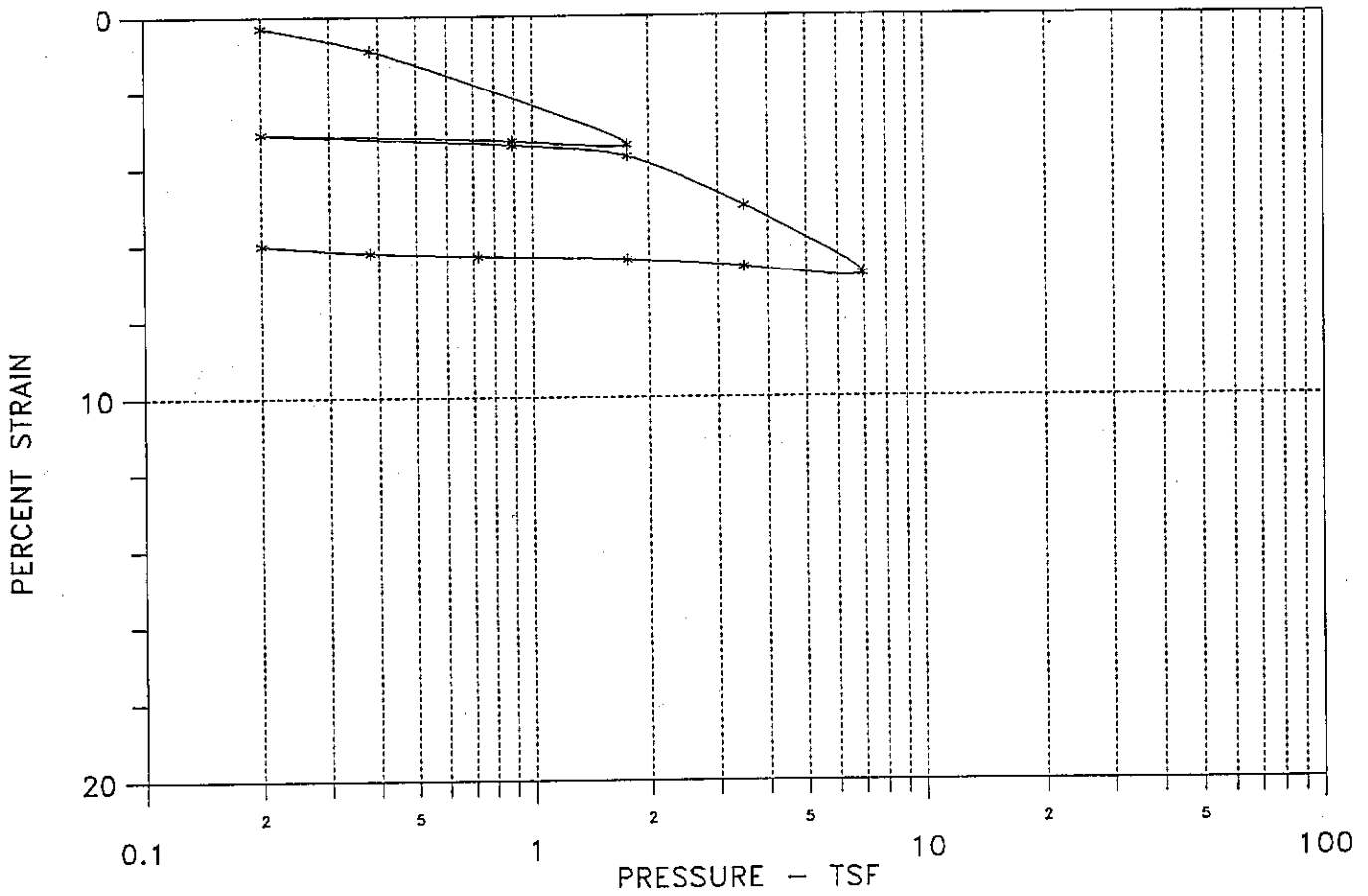
HONG WEST & ASSOCIATES
CONSOLIDATION TEST RESULTS

Project: SR-167 HOV LANE Project
Address: King County, Washington

Sample Description: Gray, silty SAND (SM)

	Initial	Final
Height (in.):	1.00	0.932
Water Content (%):	37.1	33.1
Wet Density (PCF):	115.7	124.1
Dry Density (PCF):	84.2	93.3

Project Number: 91101
Test Hole Number: TP-22
Depth Ft.: 2.0-3.5 feet
Test Number: 1
Date Tested: 9-26-91
Tested By: SEG
Diameter (in.): 2.416
Assumed Sp. Gravity: 2.65
Void Ratio: Initial: .9641
Final: .7723

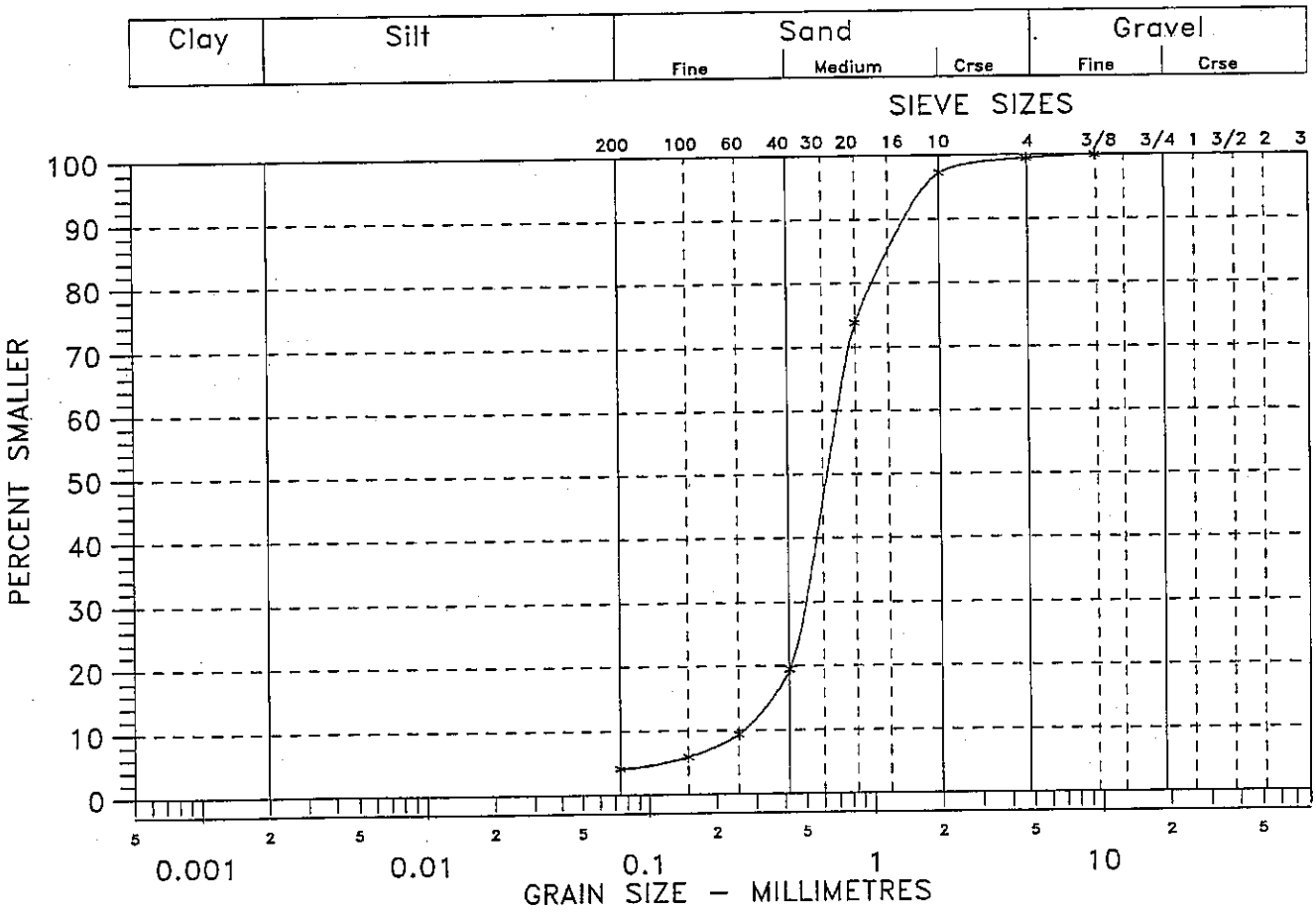


Reviewed By: _____

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Brown, Medium to fine SAND;trace silt (SP)

Test Hole Number: TP-4
Sample Number: S-1
Depth: 2.0 feet
Sample Description:
Gravel: 0.5
Sand: 95.4
Silt: 4.1
Clay:

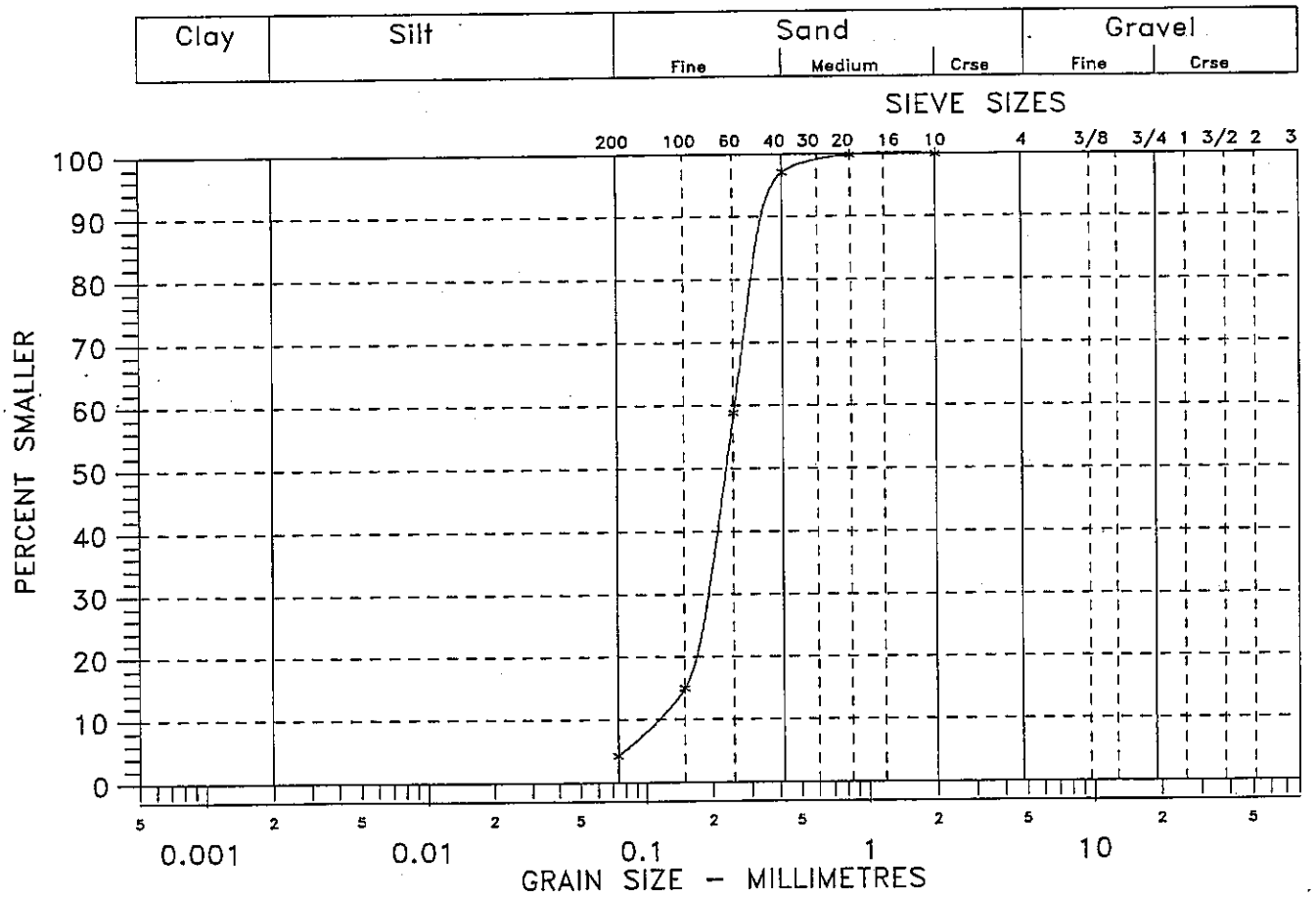


Reviewed By:

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Gray, Fine SAND; trace silt (SP)

Test Hole Number: TP-6
Sample Number: S-1
Depth: 8.0-8.5 feet
Sample Description:
Gravel: 0.0
Sand: 95.7
Silt: 4.3
Clay:

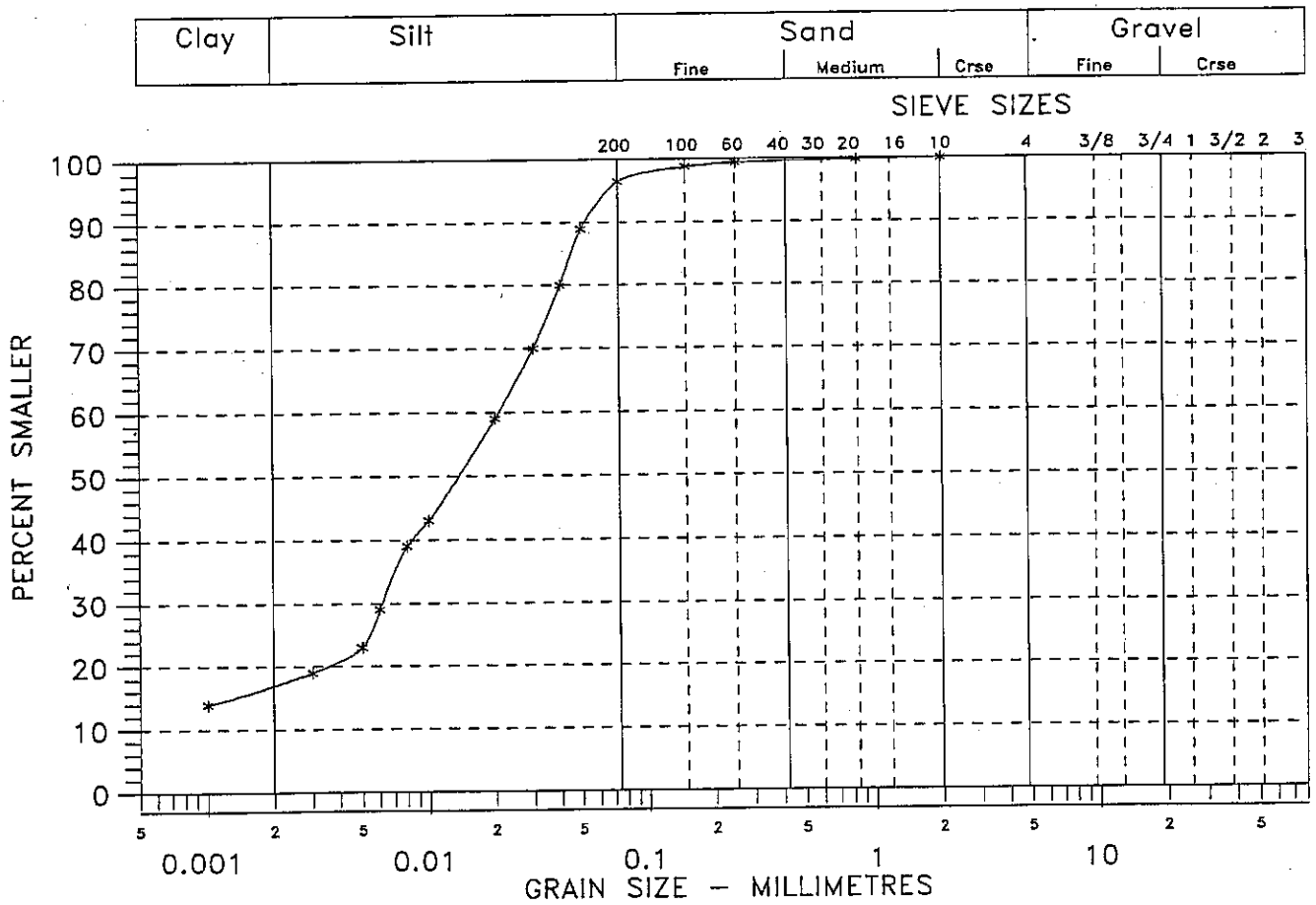


Reviewed By: _____

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Light brown, SILT; trace sand (ML)

Test Hole Number: TP-8
Sample Number: S-1
Depth: 3.0-3.5 feet
Sample Description:
Gravel: 0.0
Sand: 3.5
Silt: 96.5
Clay:

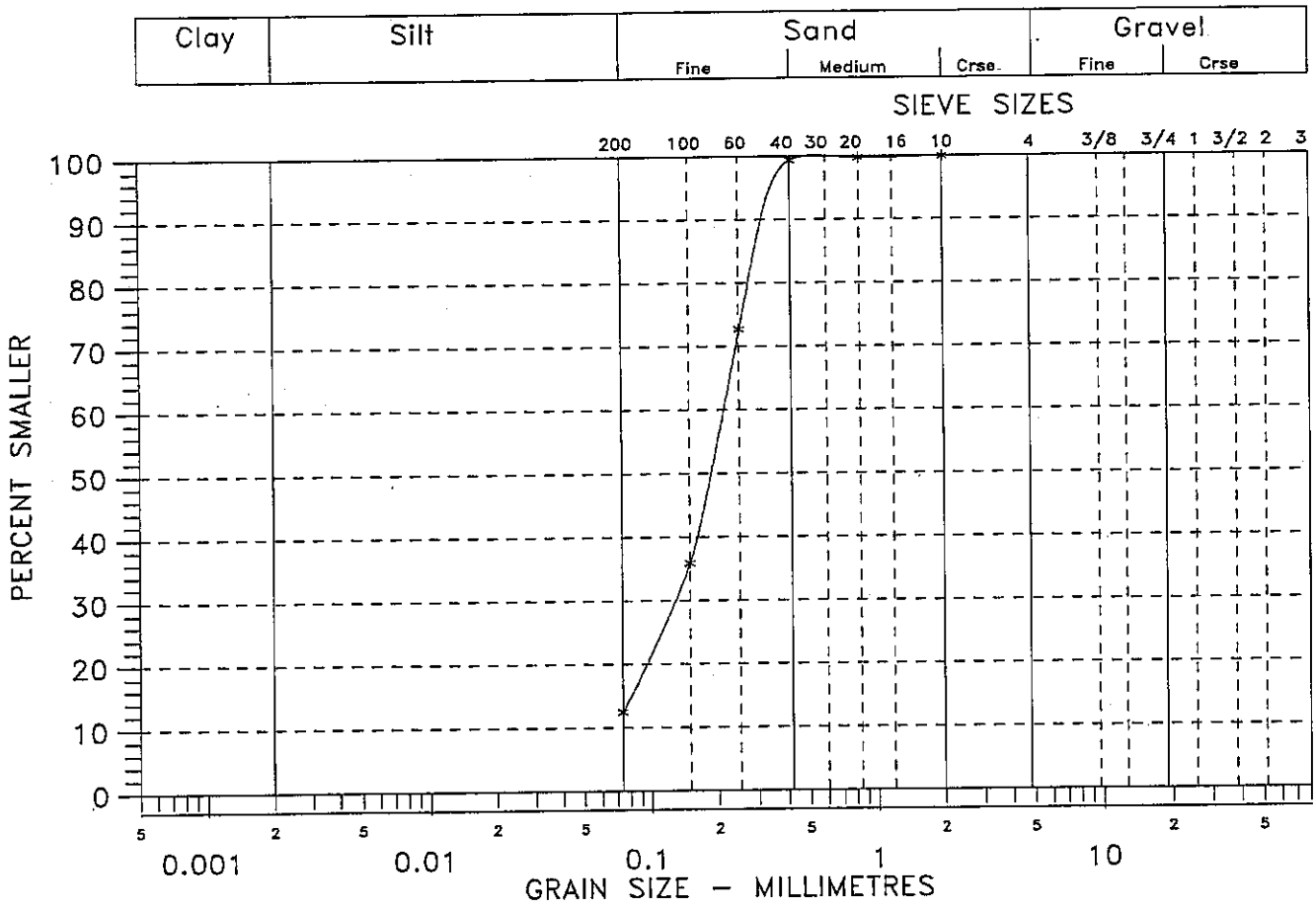


Reviewed By:

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Gray brown, silty SAND (SM)

Test Hole Number: TP-16
Sample Number: S-3
Depth: 6.5-7.0 feet
Sample Description:
Gravel: 0.0
Sand: 87.5
Silt: 12.5
Clay:

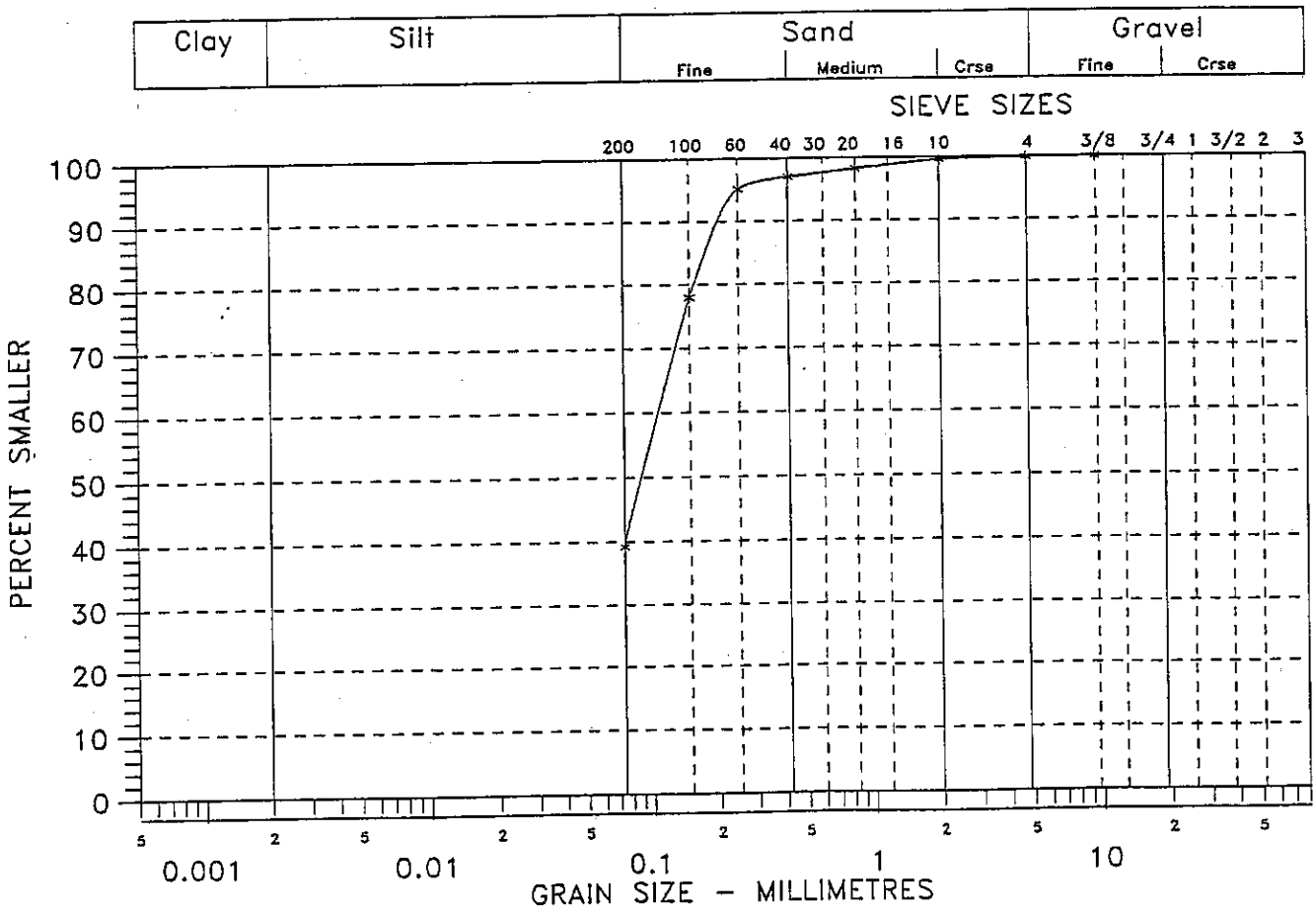


Reviewed By:

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Gray, very silty fine SAND (SM)

Test Hole Number: TP-20
Sample Number: S-3
Depth: 9.0-9.5 feet
Sample Description:
Gravel: 0.1
Sand: 60.7
Silt: 39.2
Clay:

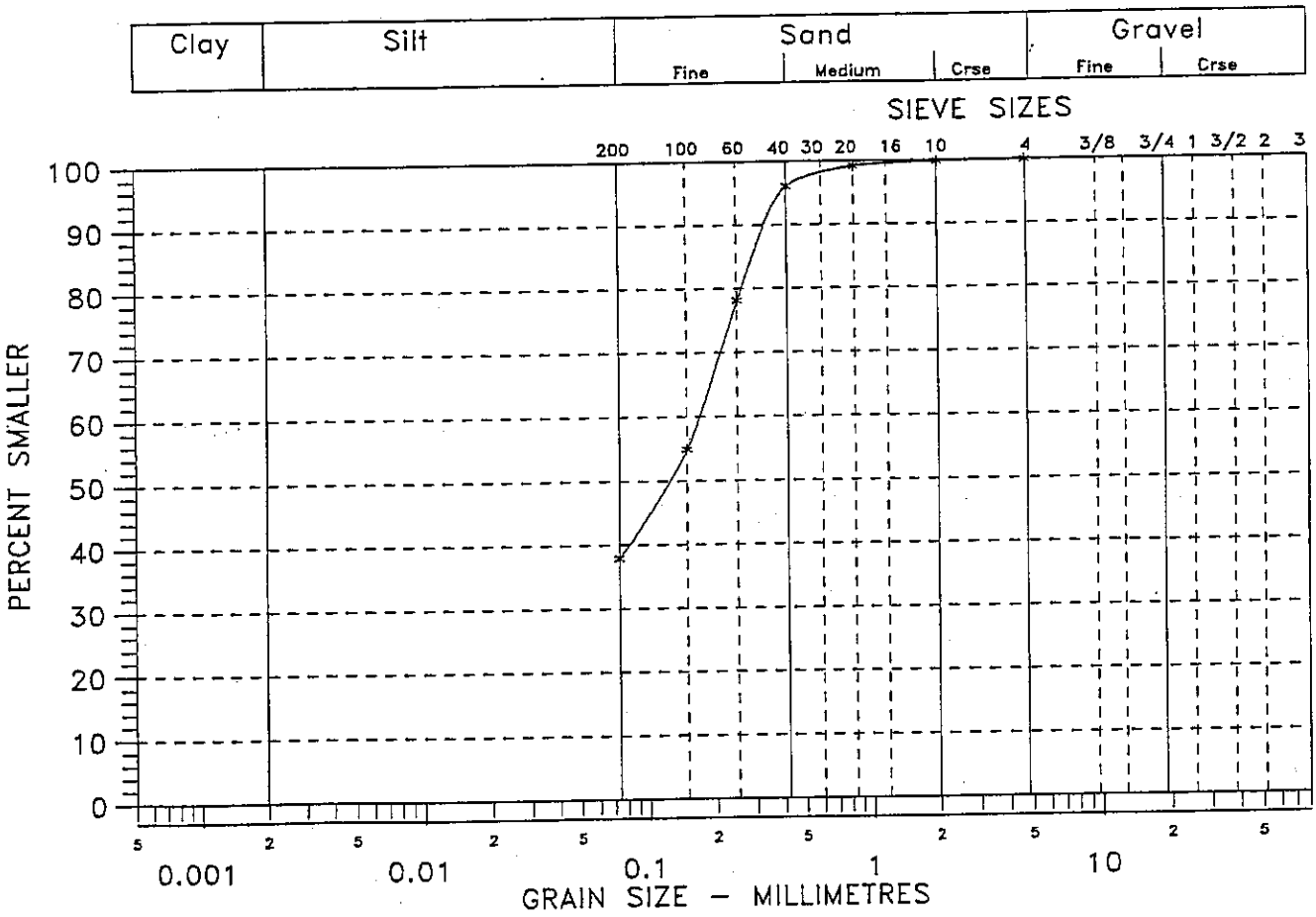


Reviewed By:

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Gray, very silty fine SAND (SM)

Test Hole Number: TP-22
Sample Number: S-2
Depth: 3.0-3.5 feet
Sample Description:
Gravel: 0.0
Sand: 62.2
Silt: 37.8
Clay:



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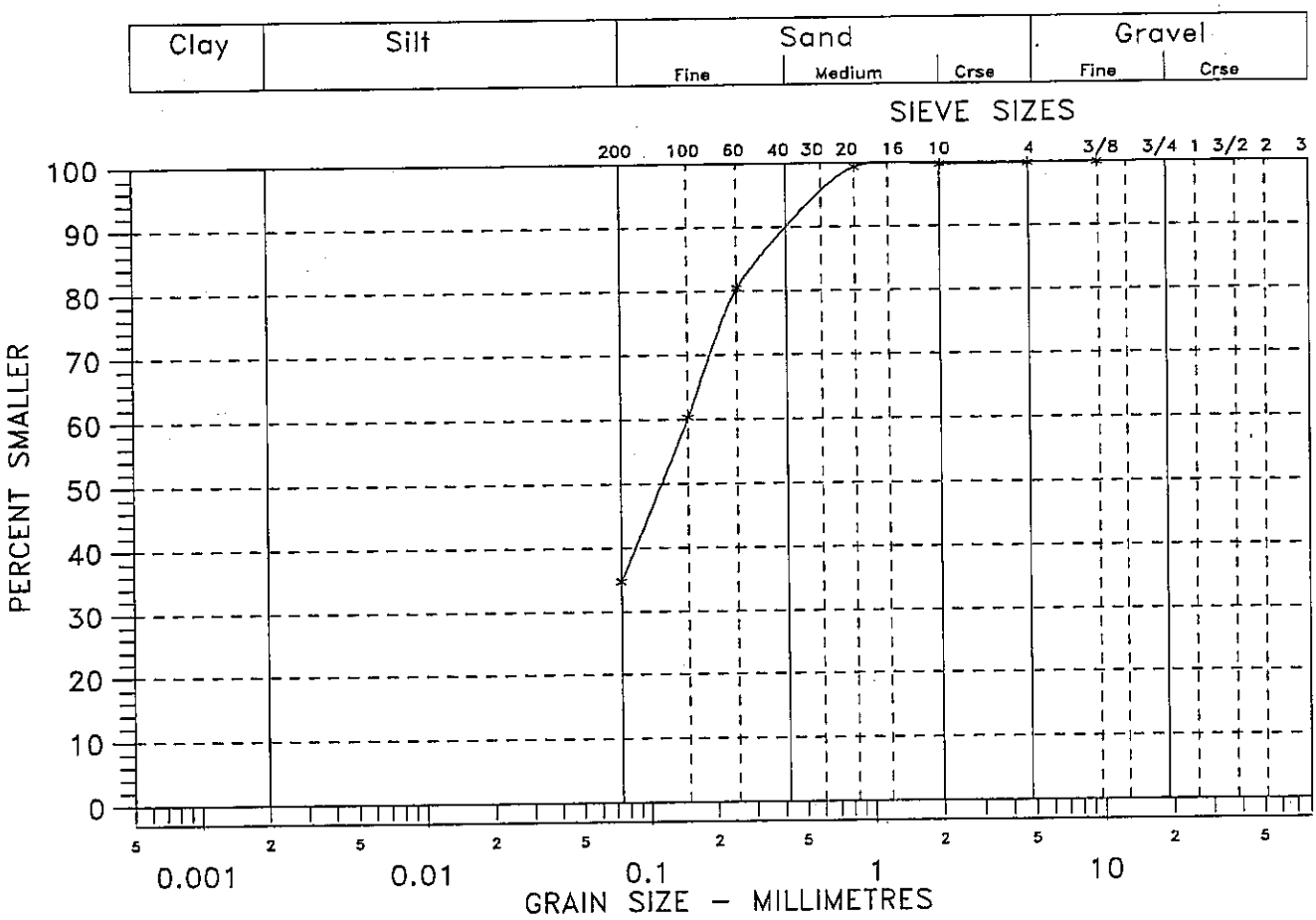
HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Gray, very silty fine SAND (SM)

Test Hole Number: TP-22
Sample Number: S-3
Depth: 4.5-5.0 feet
Sample Description:
Gravel: 0.1
Sand: 65.2
Silt: 34.7
Clay:

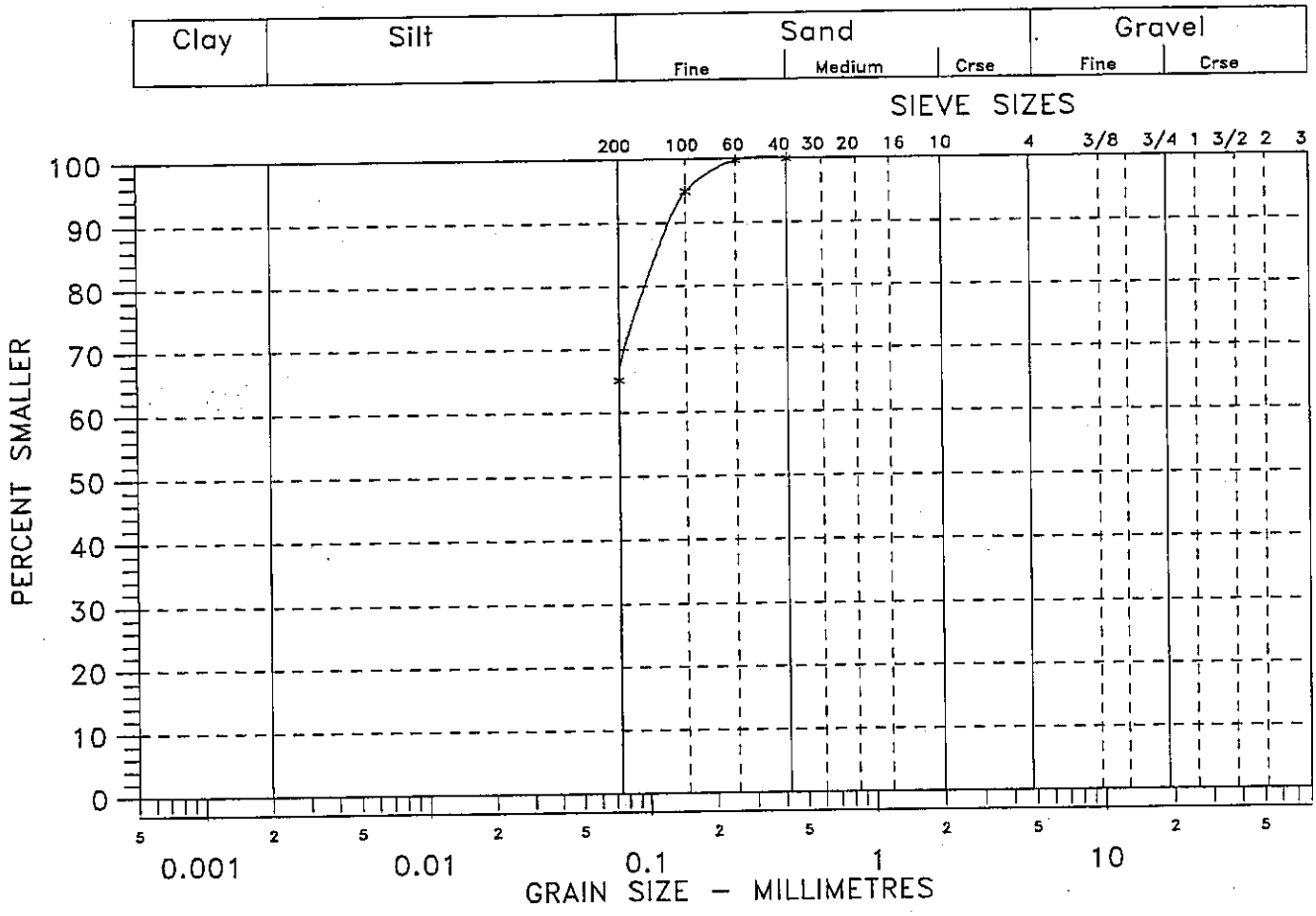


Reviewed By:

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Gray, very sandy SILT (ML)

Test Hole Number: TP-24
Sample Number: S-4
Depth: 5.0-5.5 feet
Sample Description:
Gravel: 0.0
Sand: 34.9
Silt: 65.1
Clay:

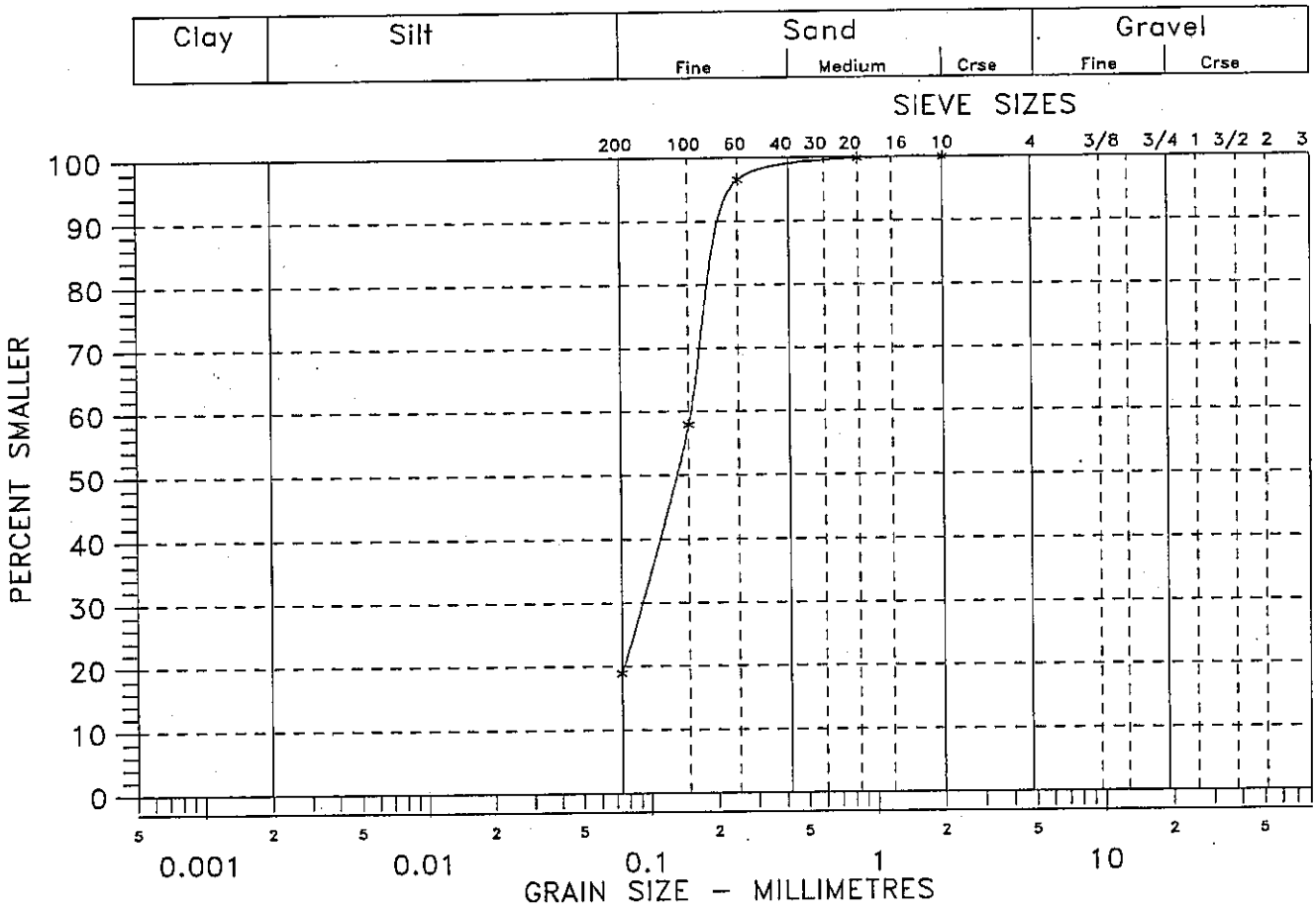


Reviewed By:

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Gray, silty fine SAND (SM)

Test Hole Number: TP-27
Sample Number: S-3
Depth: 11.5-12.0 feet
Sample Description:
Gravel: 0.0
Sand: 81.1
Silt: 18.9
Clay:

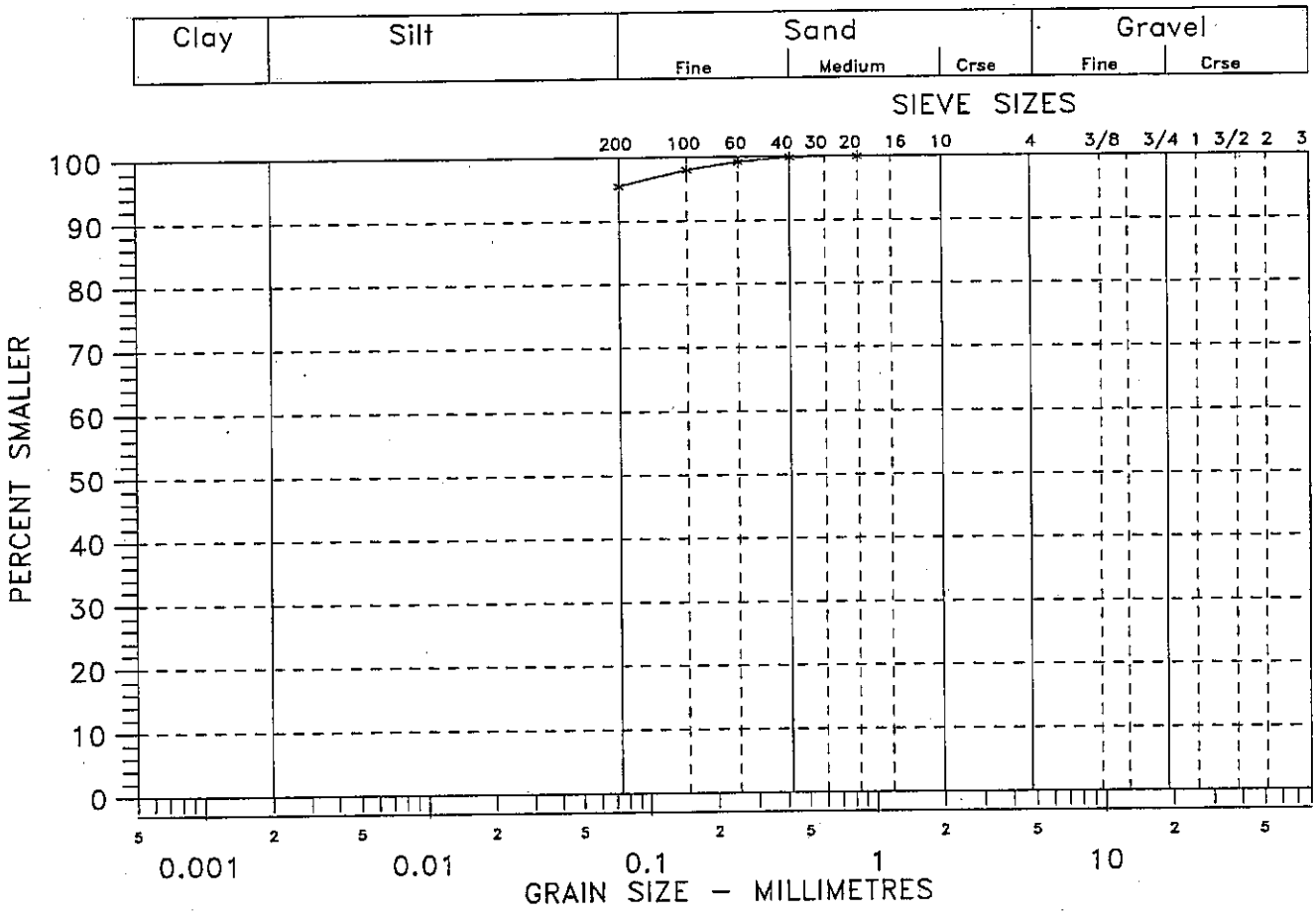


Reviewed By:

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Gray, SILT; trace sand (ML)

Test Hole Number: BH-3
Sample Number: S-3
Depth: 30.0-32.5 feet
Sample Description:
Gravel: 0.0
Sand: 4.5
Silt: 95.5
Clay:

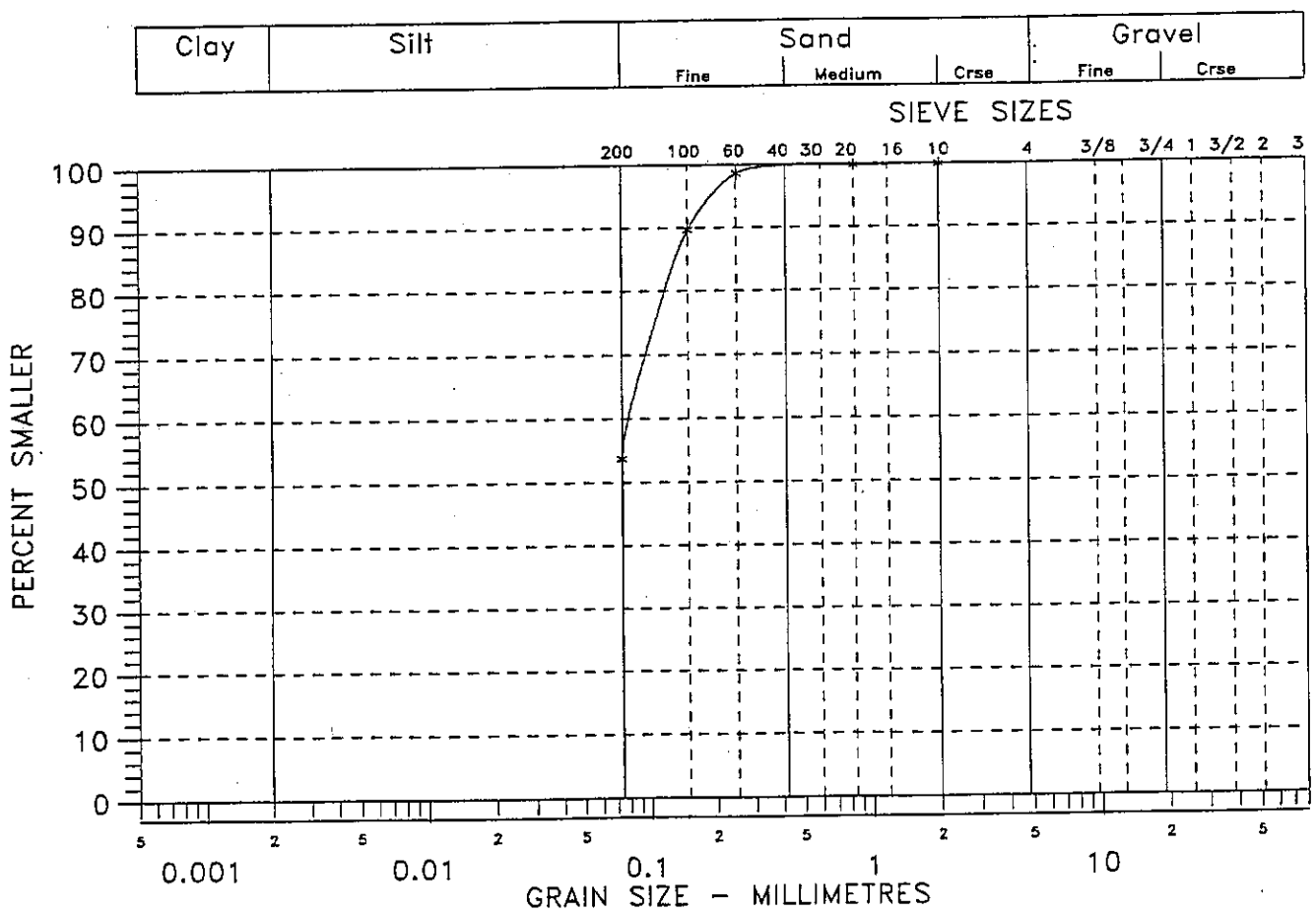


Reviewed By: _____

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Gray, very sandy SILT (ML)

Test Hole Number: BH-4
Sample Number: S-3
Depth: 35-36.5 feet
Sample Description:
Gravel: 0.0
Sand: 46.3
Silt: 53.7
Clay:

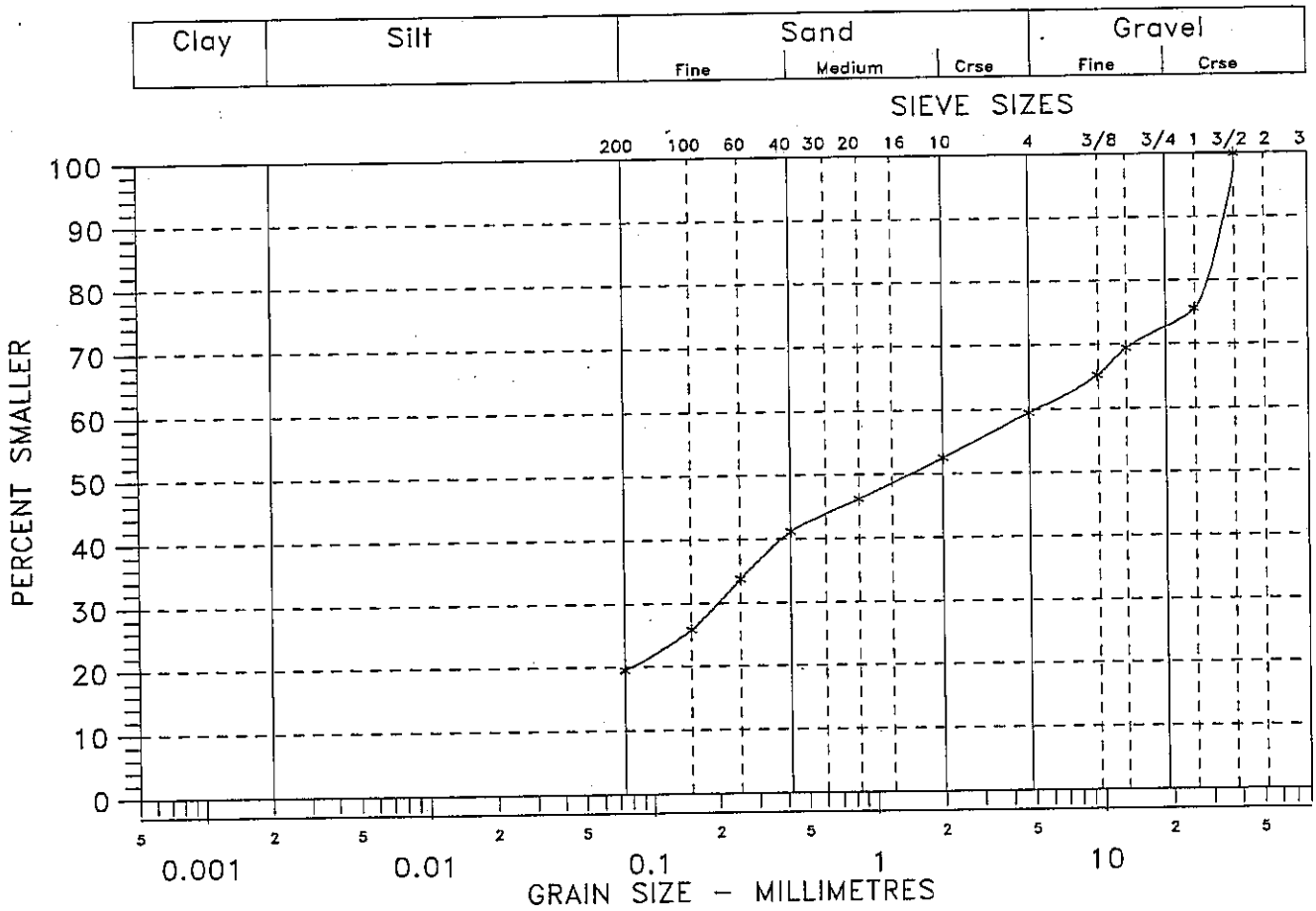


Reviewed By:

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-21-91
Remarks: Dark gray, silty, sandy GRAVEL, GM

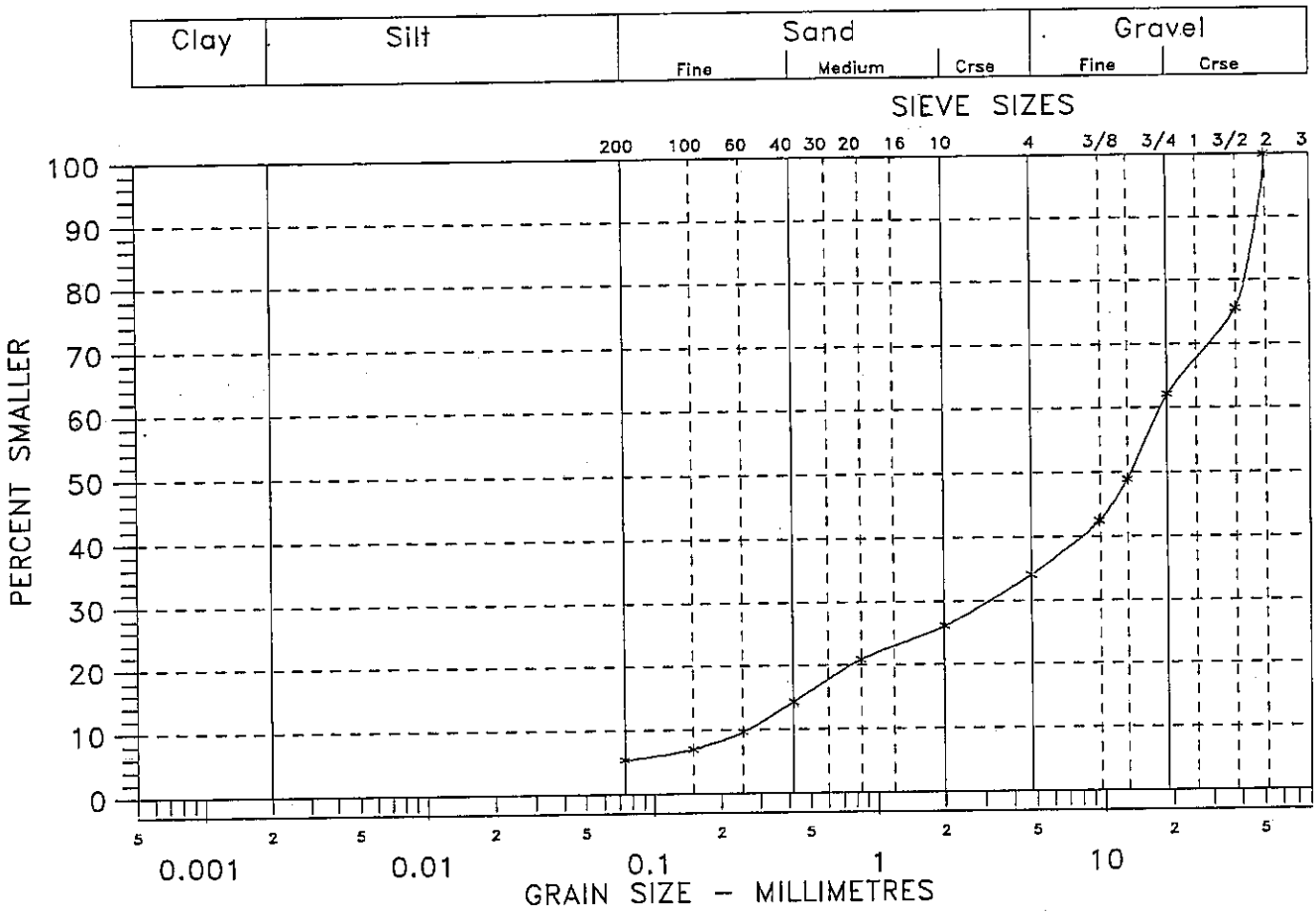
Test Hole Number: HB-1W
Sample Number: S-1
Depth: 12-15 inches
Sample Description:
Gravel: 40.6
Sand: 39.9
Silt: 19.5
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-21-91
Remarks: Dark grayish brown, sandy GRAVEL, some silt, GW-GM

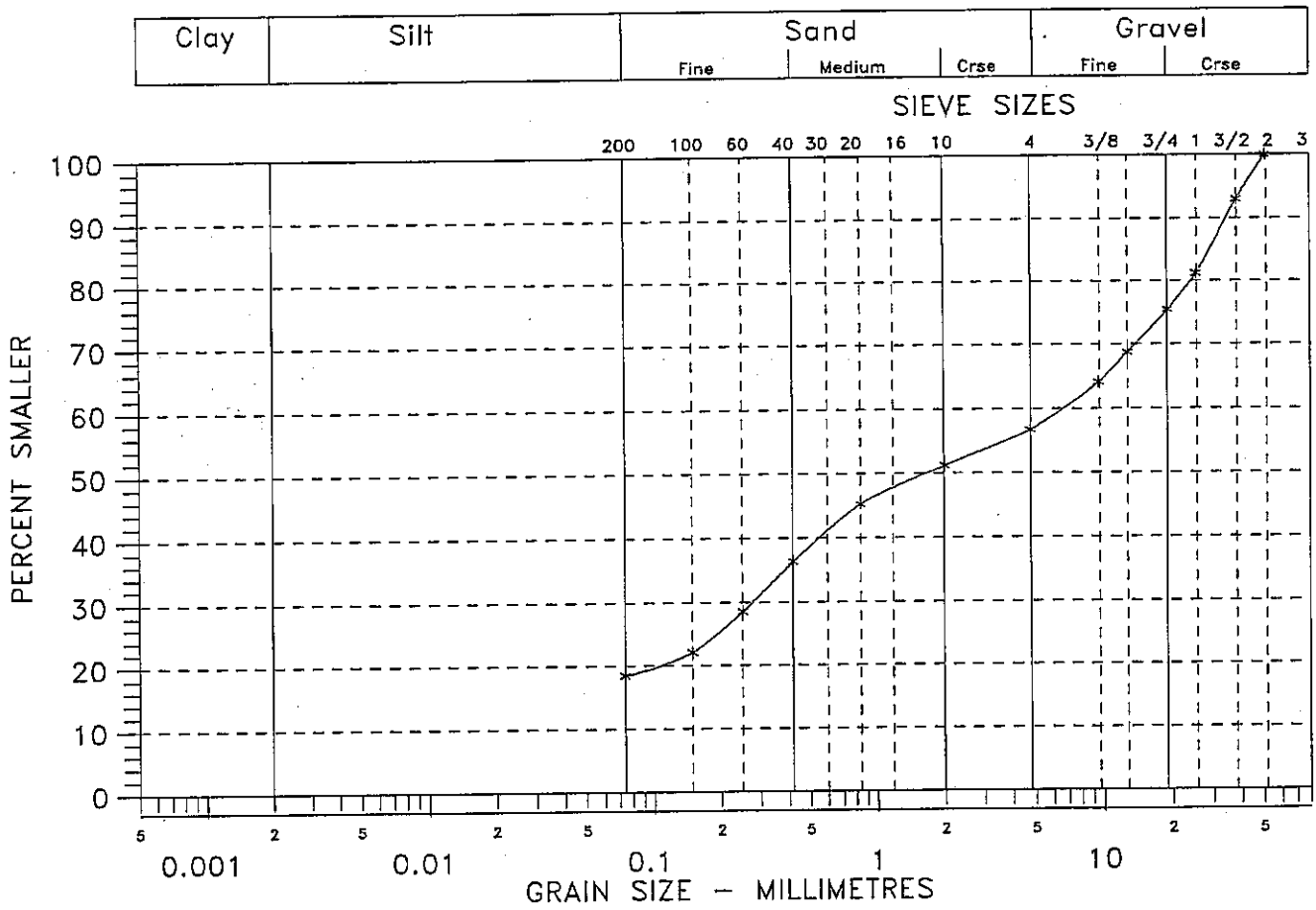
Test Hole Number: HB-1C
Sample Number: S-1
Depth: 27 inches
Sample Description:
Gravel: 66.0
Sand: 28.6
Silt: 5.4
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Silty, sandy GRAVEL, GM

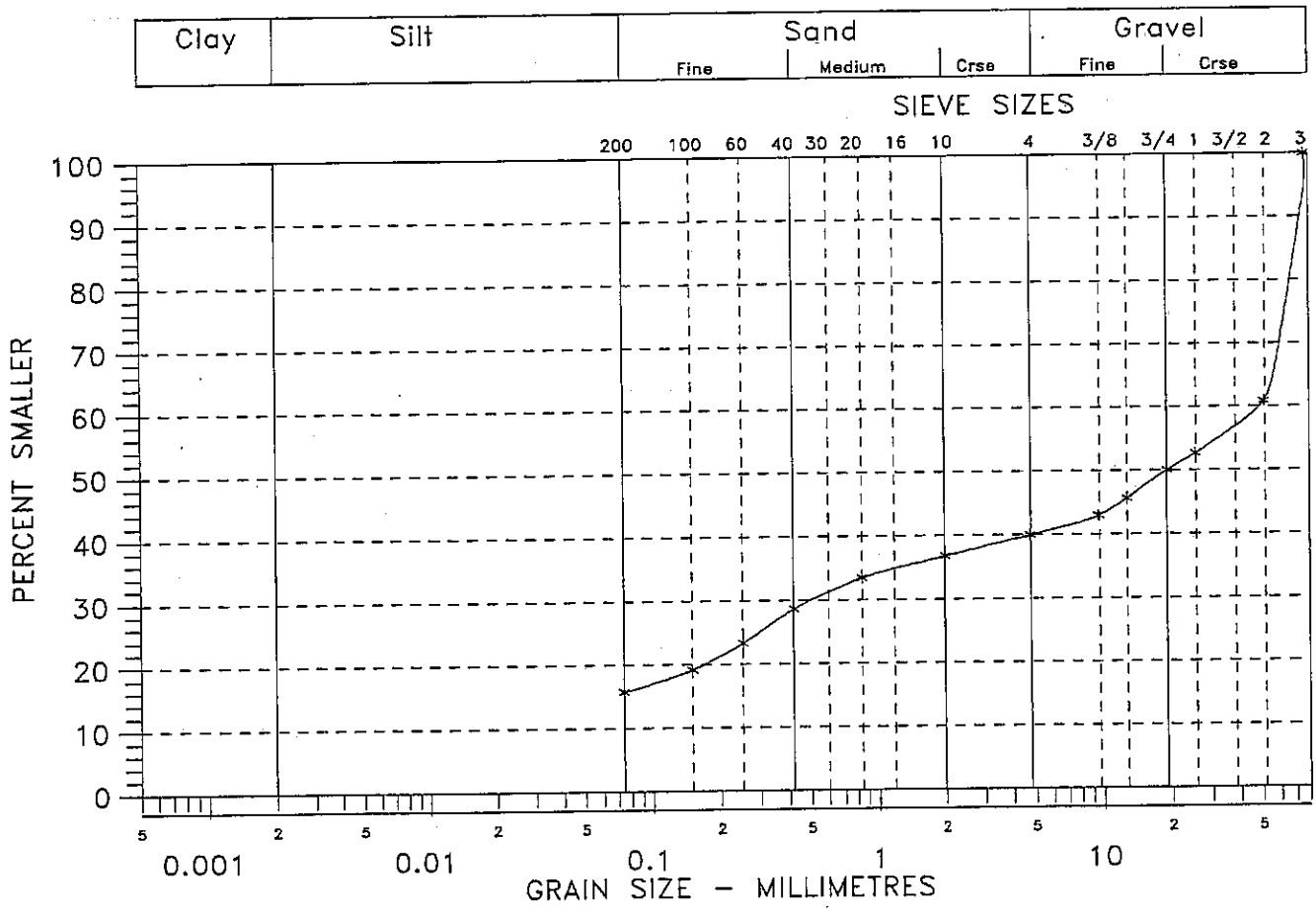
Test Hole Number: HB-2E
Sample Number: S-1
Depth: 0-2 feet
Sample Description:
Gravel: 43.3
Sand: 38.2
Silt: 18.5
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-21-91
Remarks: Grayish brown, silty GRAVEL, some sand, GM

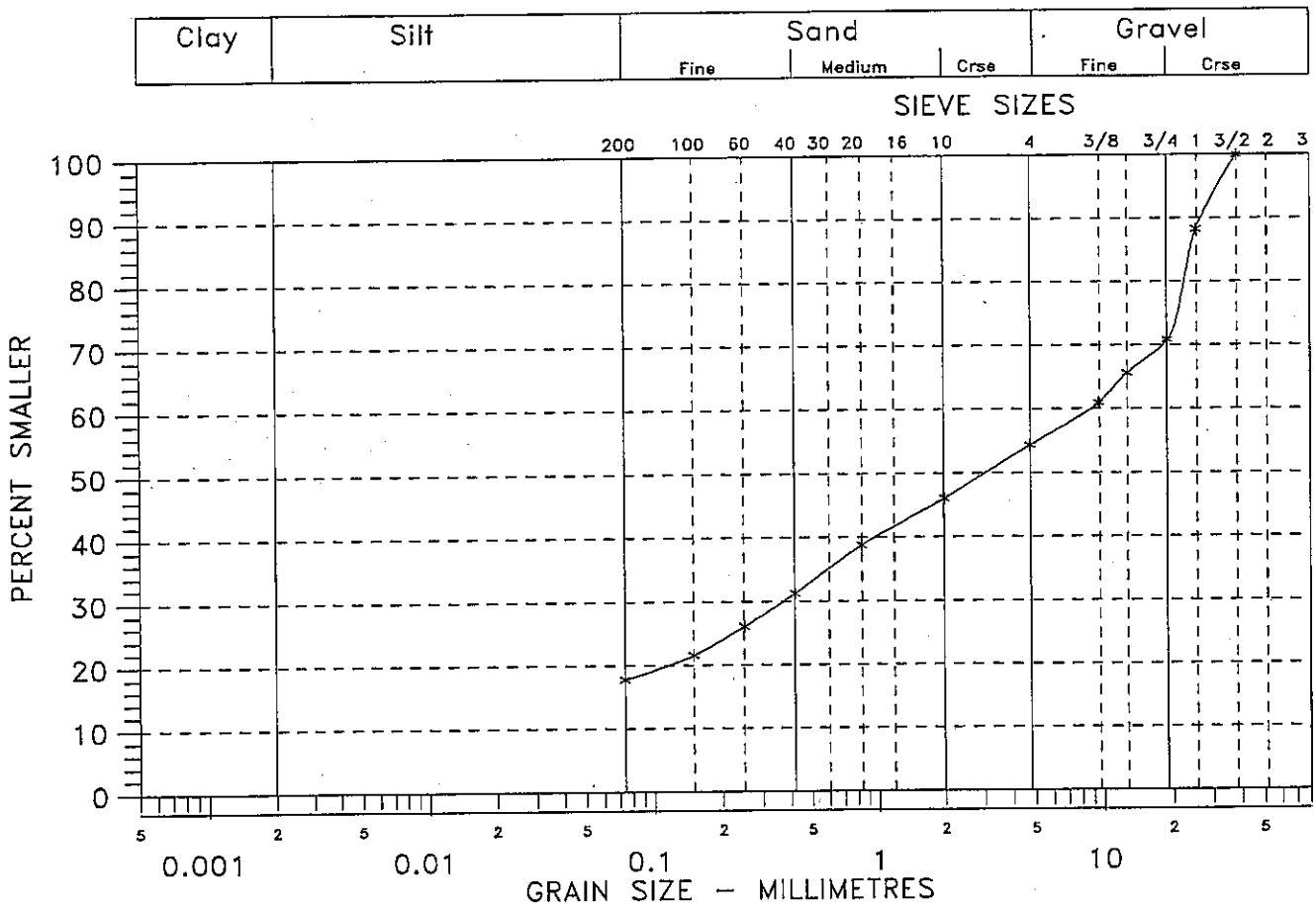
Test Hole Number: HB-3W
Sample Number: S-1
Depth: 10-12 inches
Sample Description:
Gravel: 60.1
Sand: 24.1
Silt: 15.8
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-21-91
Remarks: Grayish brown, silty, sandy gravel, GM

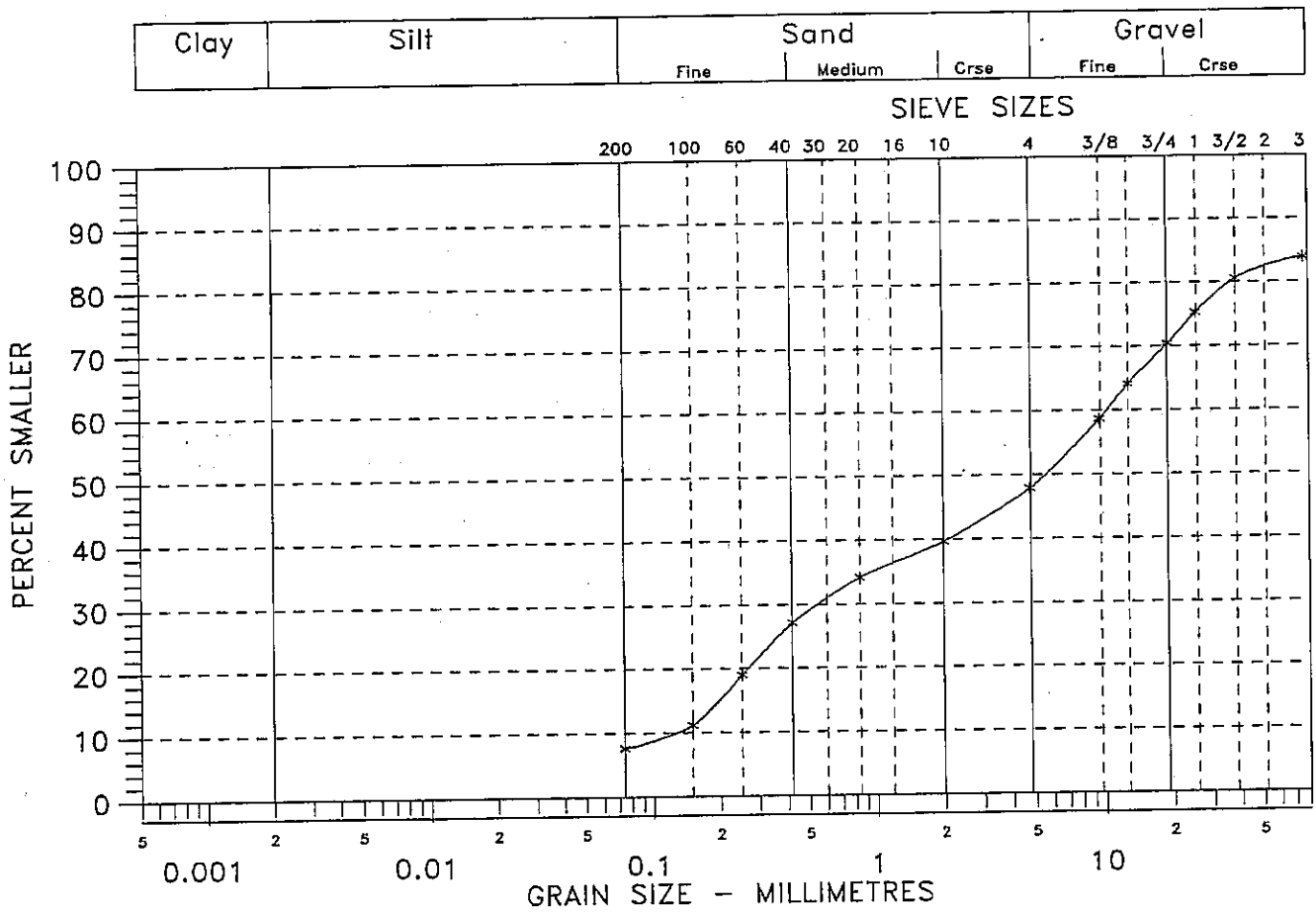
Test Hole Number: HB-4E
Sample Number: S-1
Depth: 10-12 inches
Sample Description:
Gravel: 45.7
Sand: 36.5
Silt: 17.8
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-23-91
Remarks: Sandy GRAVEL, with silt, GP-GM

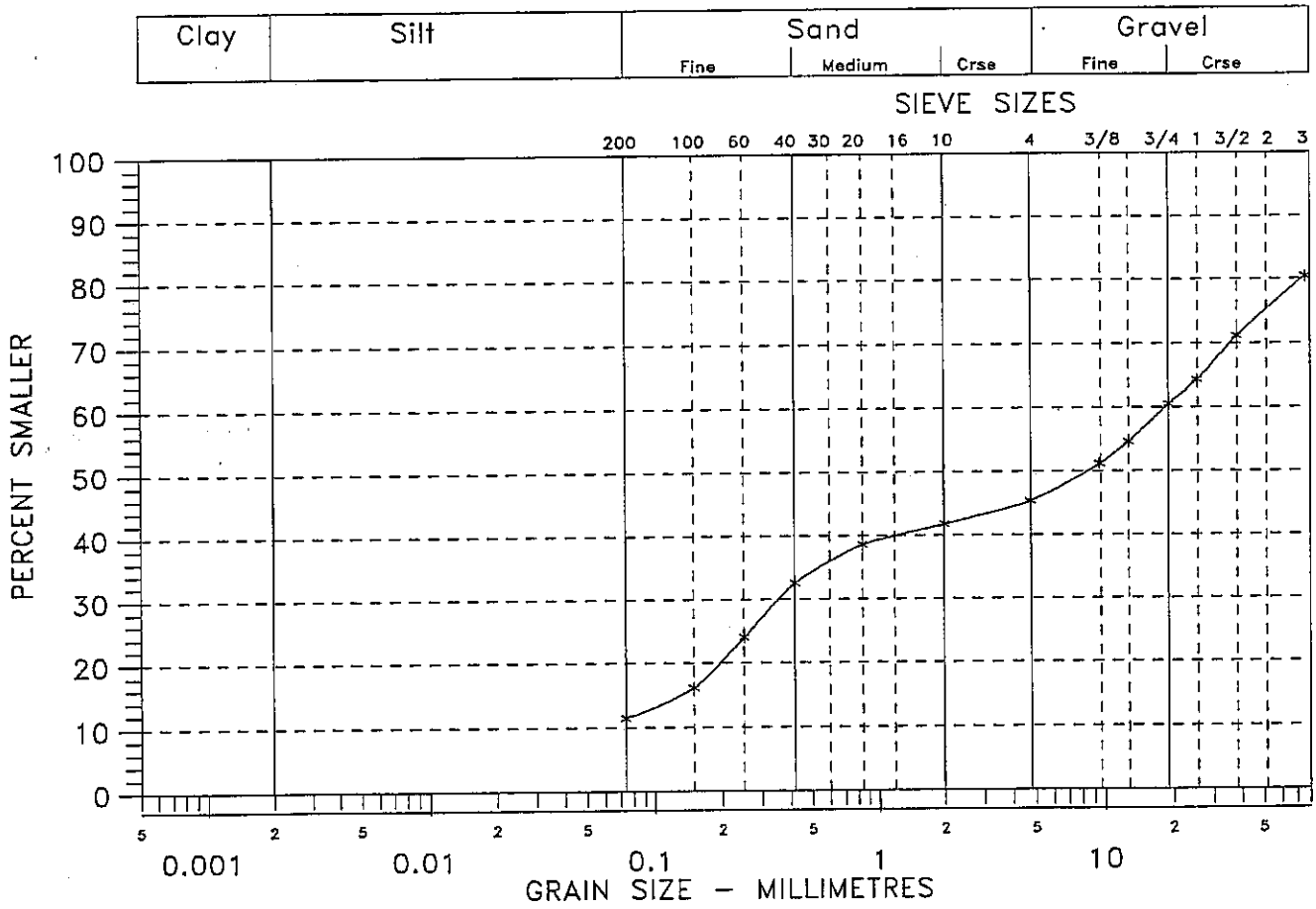
Test Hole Number: HB-6E
Sample Number: S-1
Depth: 0-12 inches
Sample Description:
Gravel: 52.2
Sand: 40.1
Silt: 7.7
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-21-91
Remarks: Sandy GRAVEL with silt, GP-GM

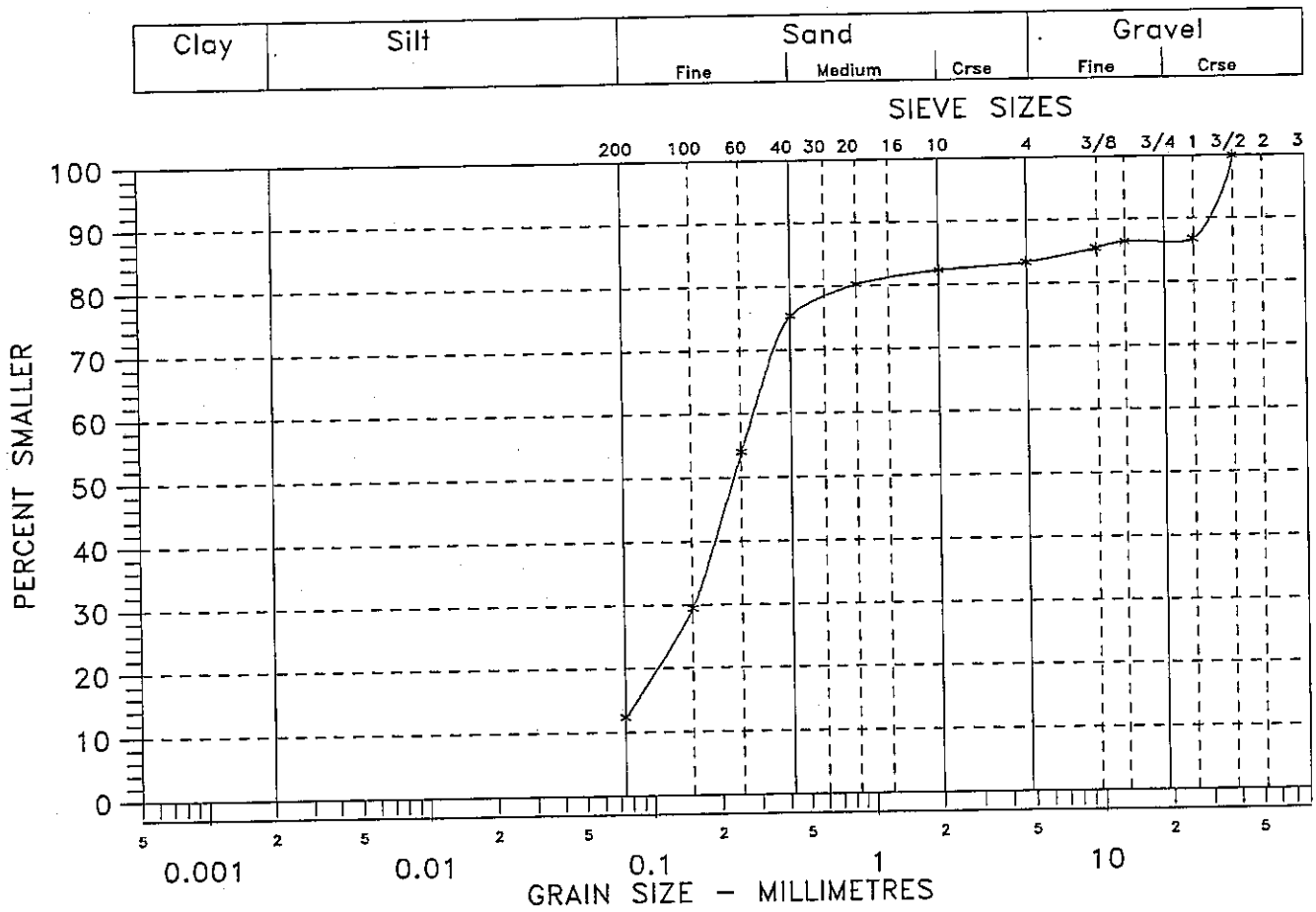
Test Hole Number: HB-7W
Sample Number: S-1
Depth: 0-24 inches
Sample Description:
Gravel: 54.7
Sand: 33.8
Silt: 11.5
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-25-91
Remarks: Brown, silty Sand; some gravel (SM)

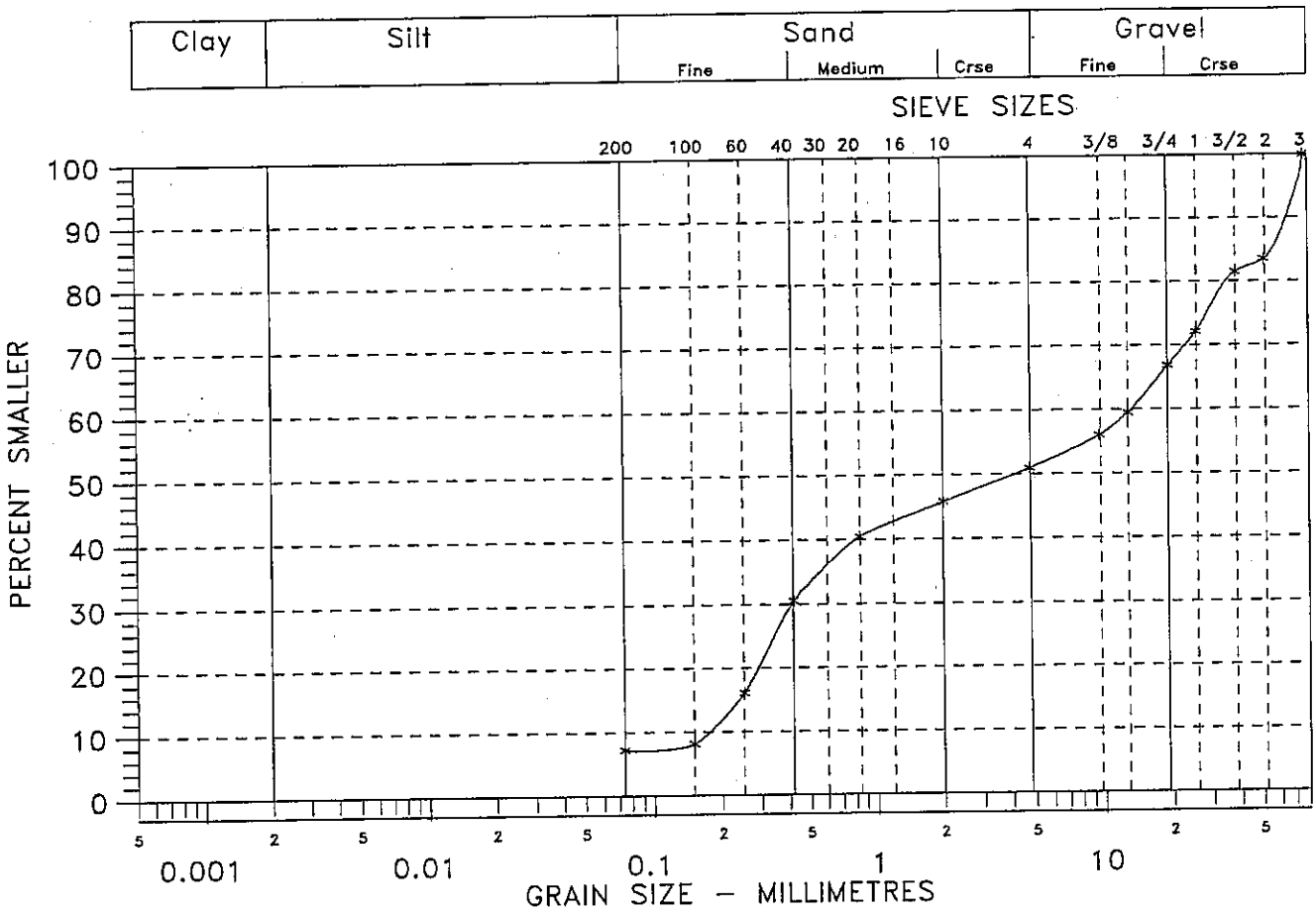
Test Hole Number: HB-12E
Sample Number: S-1
Depth: 0-3 feet
Sample Description:
Gravel: 16.6
Sand: 71.0
Silt: 12.4
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Brown sandy GRAVEL; some silt (GP-GM)

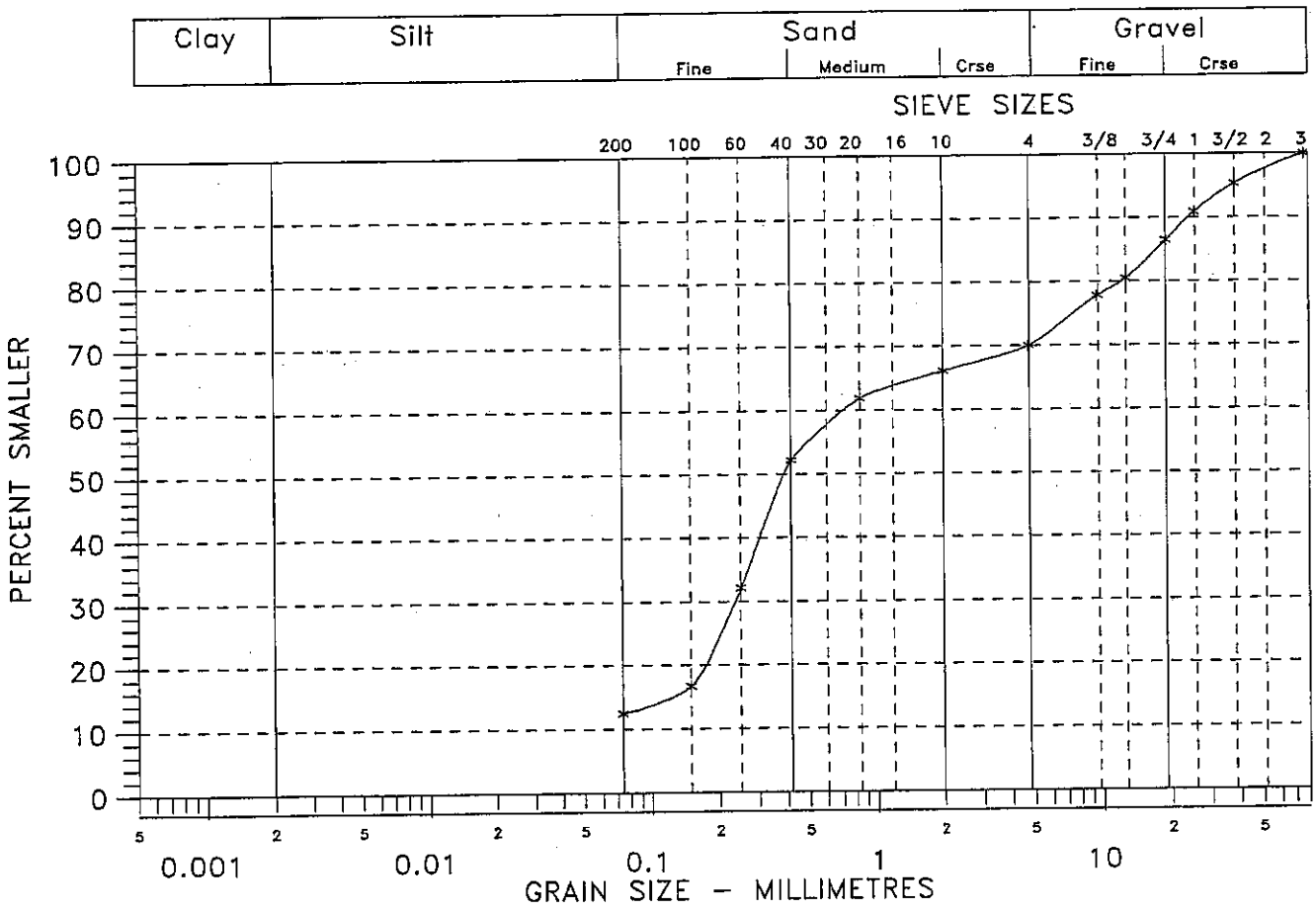
Test Hole Number: HB-16E
Sample Number: S-1
Depth: 0-2 feet
Sample Description:
Gravel: 49.1
Sand: 43.6
Silt: 7.3
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-28-91
Remarks: Brown, silty SAND with gravel (SM)

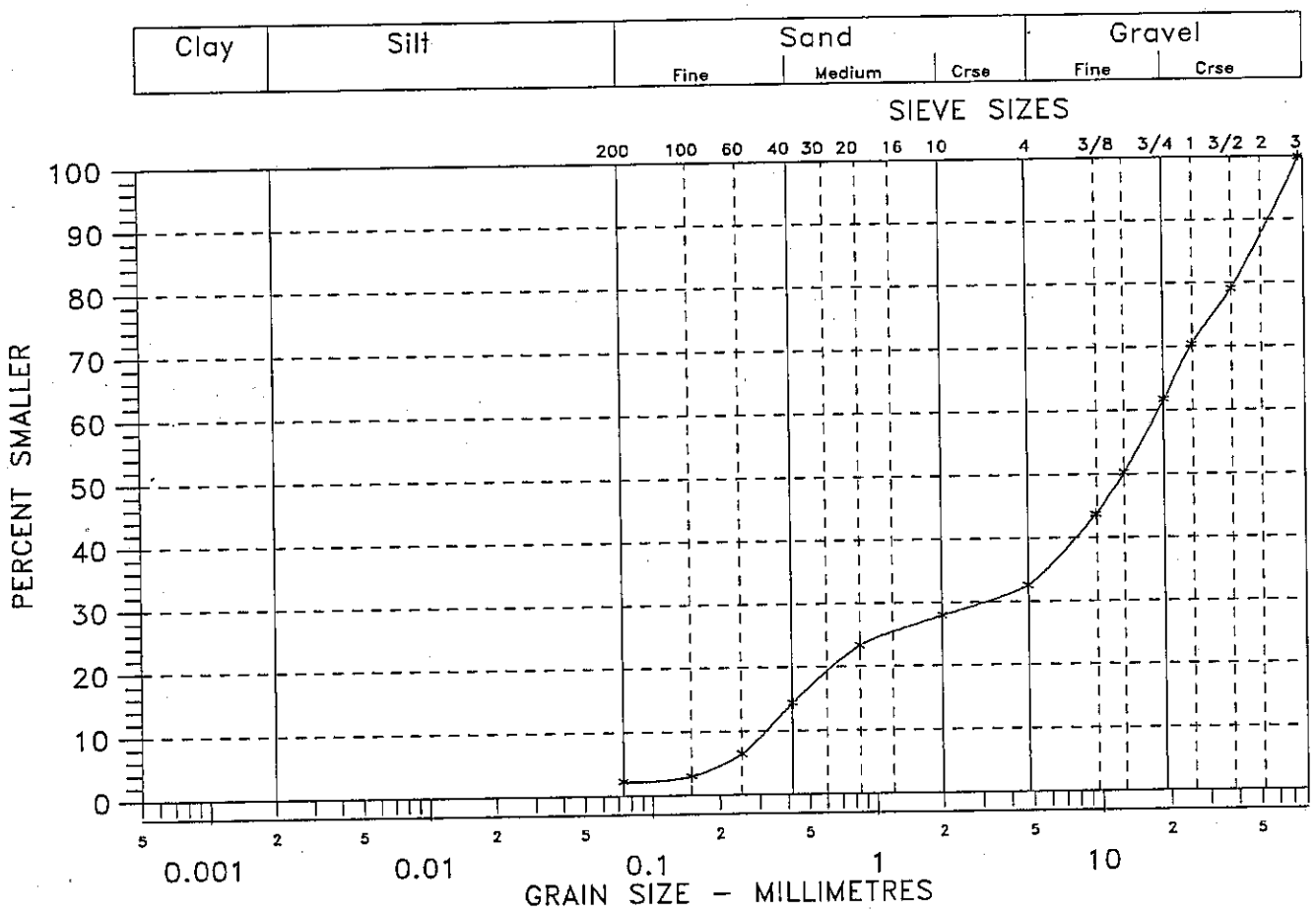
Test Hole Number: HB-20E
Sample Number: S-1
Depth: 0-12 inches
Sample Description:
Gravel: 30.0
Sand: 57.5
Silt: 12.5
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Brown, sandy GRAVEL; trace silt (GW)

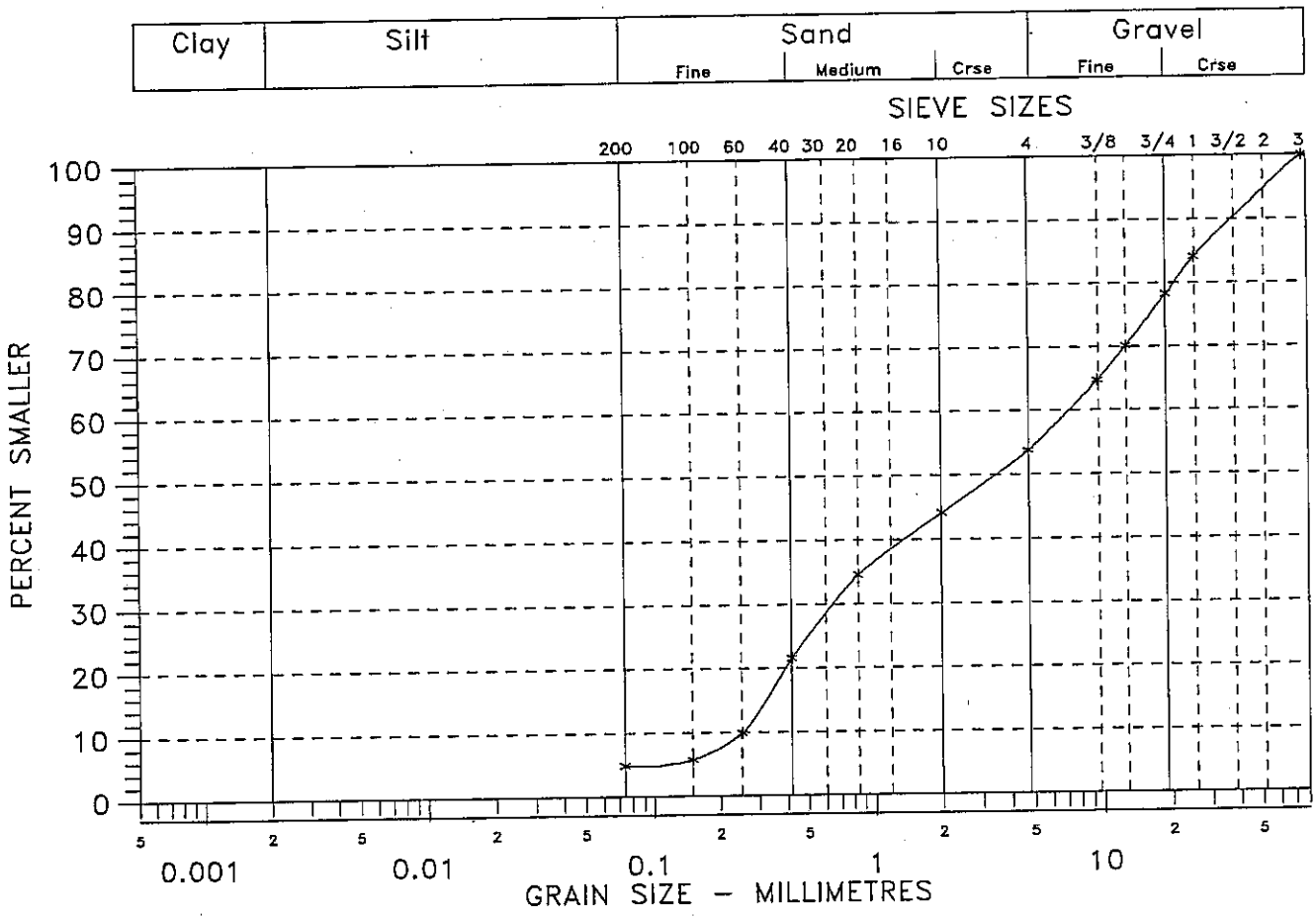
Test Hole Number: HB-24E
Sample Number: S-1
Depth: 0-12 inches
Sample Description:
Gravel: 67.5
Sand: 30.2
Silt: 2.3
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-28-91
Remarks: Brown, gravelly SAND; trace silt (SP)

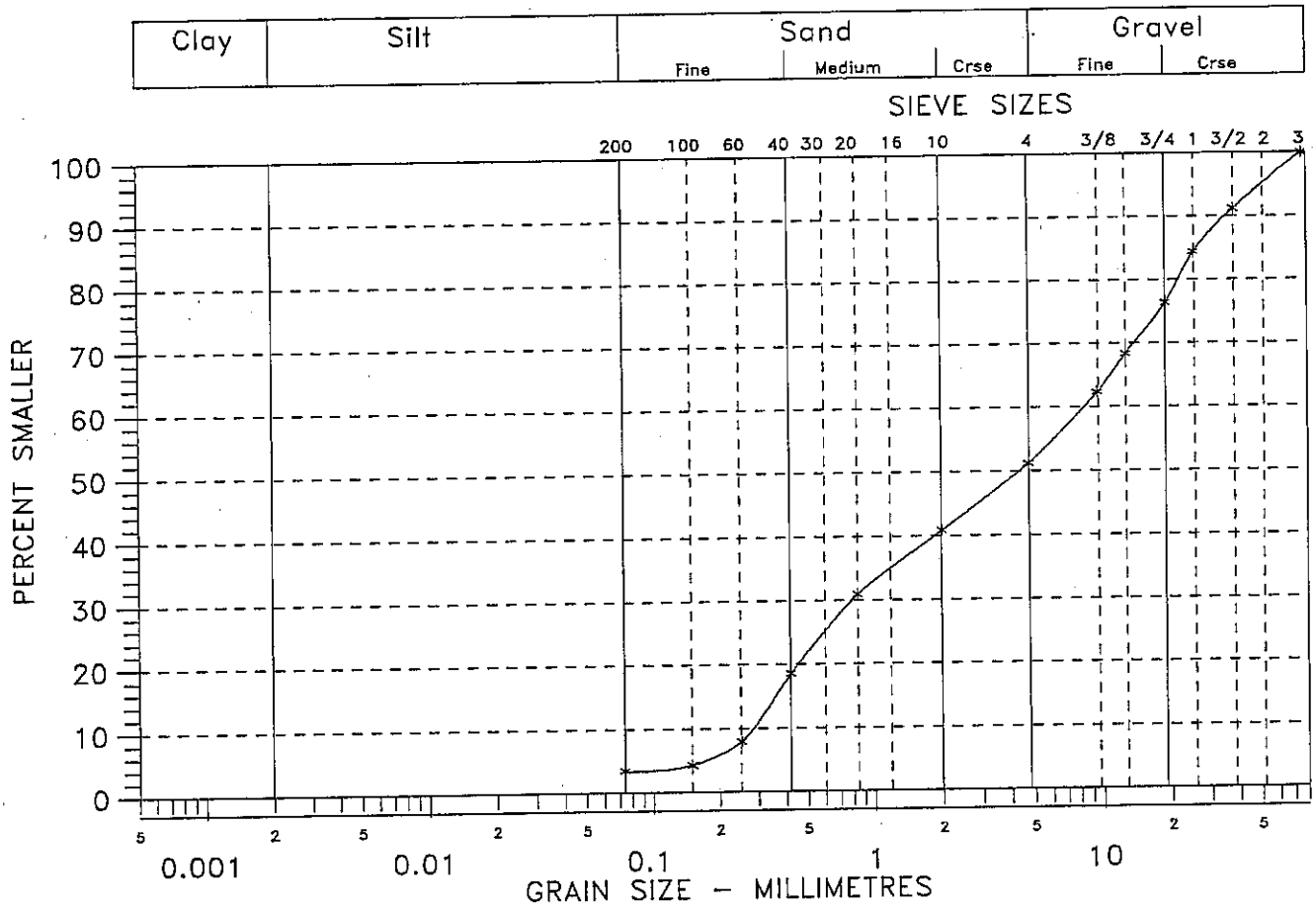
Test Hole Number: HB-28E
Sample Number: S-1
Depth: 0-2 feet
Sample Description:
Gravel: 46.3
Sand: 48.8
Silt: 4.9
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Brown sandy Gravel; trace silt (GP)

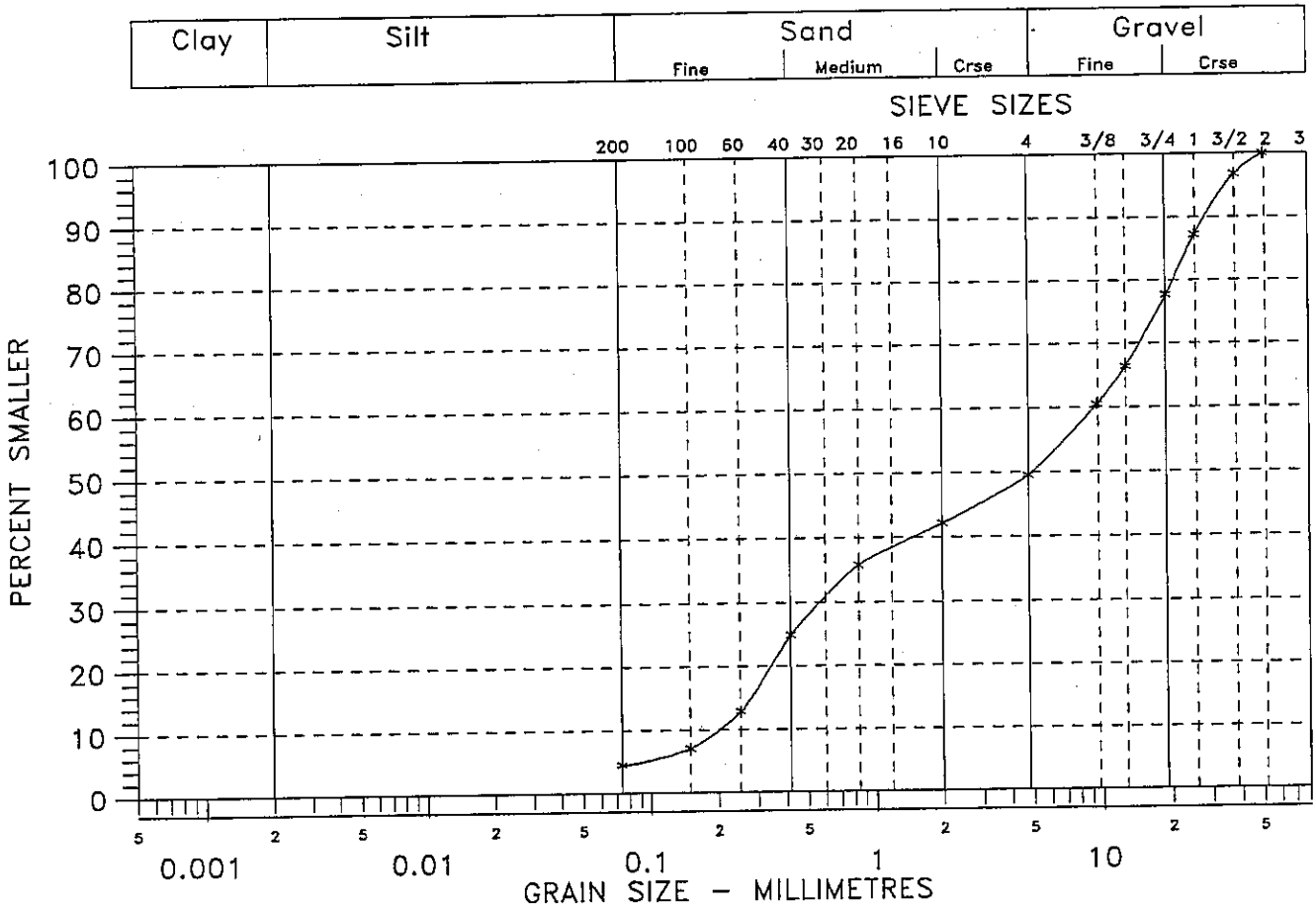
Test Hole Number: HB-32E
Sample Number: S-1
Depth: 0-2 feet
Sample Description:
Gravel: 48.8
Sand: 47.7
Silt: 3.5
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Brown, sandy GRAVEL; trace silt (GP)

Test Hole Number: HB-36E
Sample Number: S-1
Depth: 0-2.5 feet
Sample Description:
Gravel: 50.5
Sand: 45.0
Silt: 4.5
Clay:

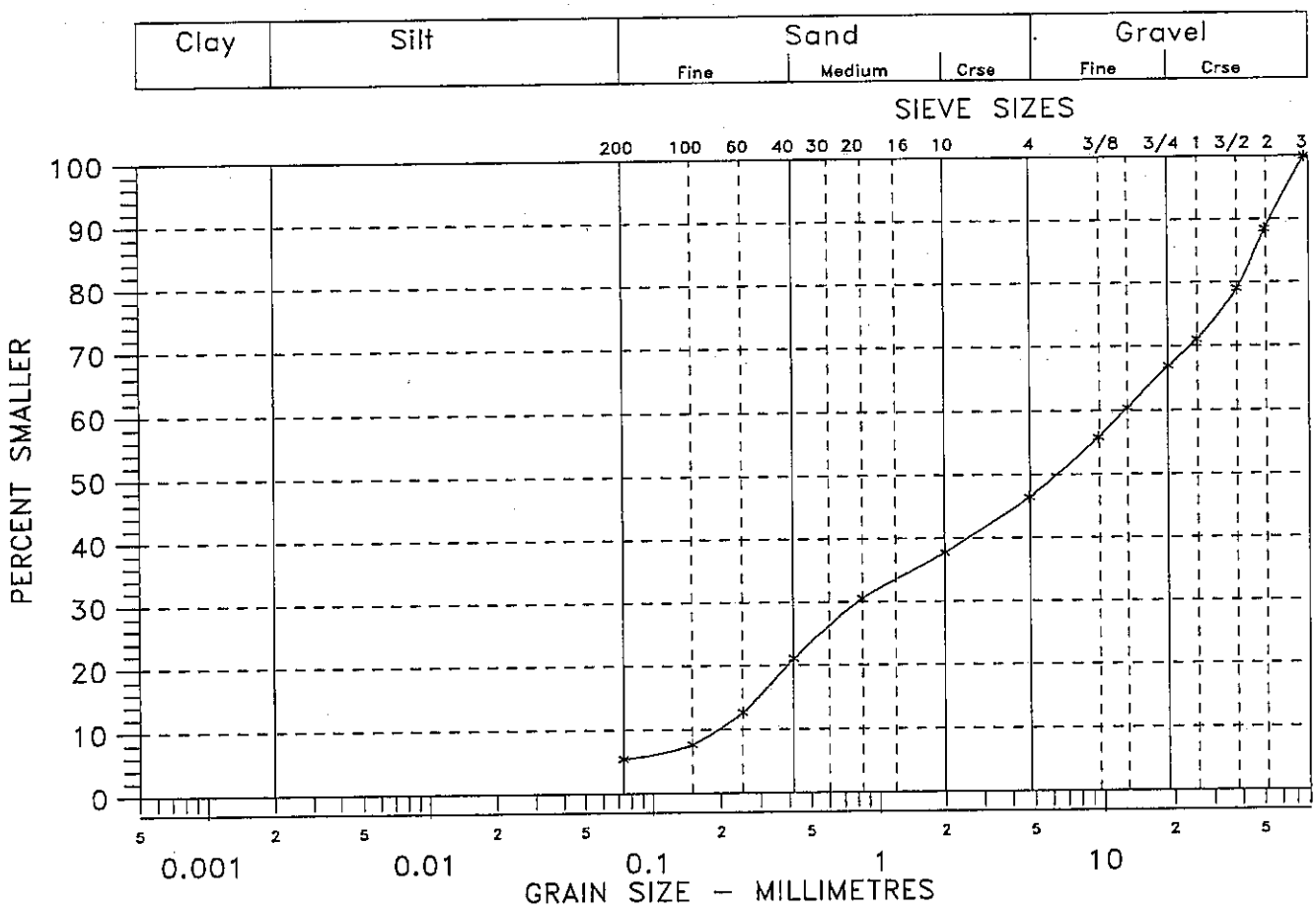


Reviewed By:

HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Brown sandy GRAVEL,some silt (GP-GM)

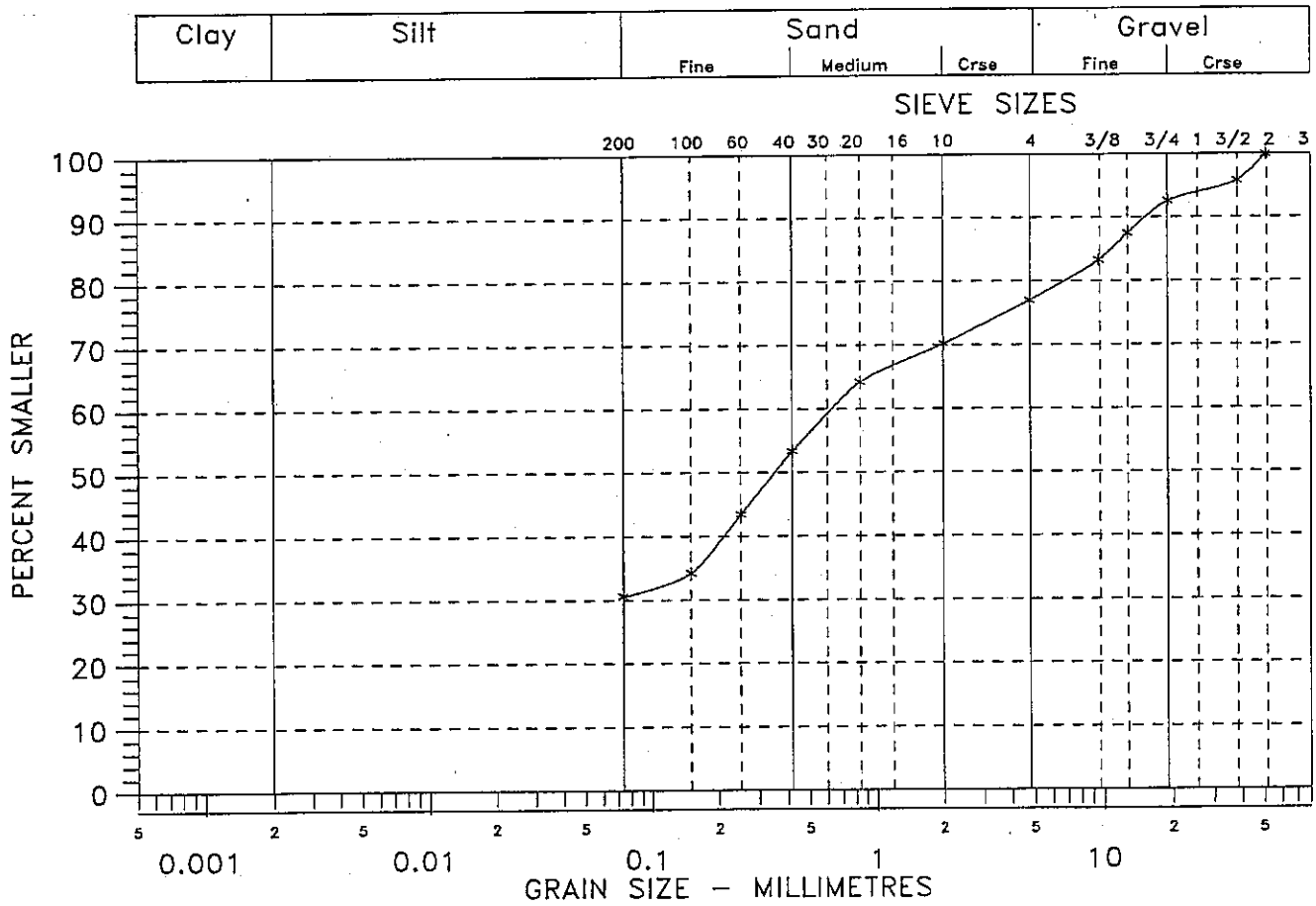
Test Hole Number: HB-40E
Sample Number: S-1
Depth: 0-2 feet
Sample Description:
Gravel: 53.6
Sand: 40.9
Silt: 5.5
Clay:



HONG WEST & ASSOCIATES
GRAIN SIZE DISTRIBUTION

Project: SR-167 HOV Lane Project
King County, Washington
Project Number: 91101
Date Tested: 8-26-91
Remarks: Brown, silty SAND; with some gravel (SM)

Test Hole Number: HB-44E
Sample Number: S-1
Depth: 0-1.0 feet
Sample Description:
Gravel: 23.0
Sand: 46.4
Silt: 30.6
Clay:



Reviewed By: