Final Geotechnical Data Report
Tri-City Water Pollution Control Plant
Phase 1 Expansion
Clackamas County, Oregon

May, 2008

SHANNON & WILSON, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

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24-1-03420-002

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FINAL GEOTECHNICAL DATA REPORT FOR TRI-CITY WATER POLLUTION CONTROL PLANT PHASE ONE EXPANSION CLACKAMAS COUNTY, OREGON

1.0 INTRODUCTION

1.1 Background

This Geotechnical Data Report presents a summary of the geotechnical data that was obtained and compiled for site characterization and to support the design phase of the proposed Tri-City Water Pollution Control Plant (WPCP) Interim Expansion, which includes upgrades to the existing facility and the construction of a new Membrane Bioreactor treatment facility. This expansion will provide capacity to handle growth from both the Tri-City Service District (TCSD) and Clackamas County Service District No. 1 (CCSD#1). Water Environment Services (WES, a department of Clackamas County) has contracted the MWH team to provide engineering services for the design of the Interim Expansion.

The project elements, as Shannon & Wilson (S&W) currently understands, are as described in the following section:

- Storm water control- WES is investing systems that reduce the amount of storm water that leaves both the existing and proposed plant site.
- Meet future treatment demands- Increased treatment capacity will be obtained though the construction of a new Membrane Bioreactor Process.
- Integrating future expansion- MWH is developing a master plan that will allow future expansion of the proposed facility.

1.2 Site Location

The WPCP is located at 15951 S. Agnes Ave in Clackamas County near the confluence of the Clackamas and the Willamette Rivers. The legal location description is the SE Quarter of the SW Quarter of Section 20 in Township 2 South and Range 2 East. Figure 1, Vicinity Map shows the project location in relation to nearby landmarks. The proposed plant expansion area will be

immediately to the south of the existing plant. Preliminary locations of each of the interim expansion structures in relation to the existing plant are shown on Figure 2.

2.0 SCOPE OF WORK

The purpose of this report is to summarize the data collected to provide additional site characterization and to support of the design efforts of MWH for the Tri-City WPCP Phase One Expansion. Also, we understand that the data contained in this report will be used as reference information for preparation of construction documents for the project.

For additional reference information, this report contains a collection of subsurface data gathered from previous projects at the WPCP Site, and are listed in the following section. The subsurface data, which includes boring logs, laboratory test data, and exploration location drawings, were collected by other consultants during a number of different projects for WES.

3.0 REVIEW OF EXISTING INFORMATION

The data collected by others, which S&W reviewed and included in this data report are from the following documents.

"Geotechnical Design Recommendations, Tri-City WPCP Liquids Expansion" by CH2M Hill, Inc, 2002, prepared for the Tri-City Service District.

"Geotechnical Data Report, Tri-City WPCP Liquids Expansion" by CH2M Hill, Inc, 2002, prepared for the Tri-City Service District.

"Soils Report, Tri-City Sewerage Treatment Plant" by CH2M Hill, Inc, 1982, prepared for the Tri-City Service District.

"Seismic Vulnerability Assessment, Tri-City Wastewater Treatment Plant" by URS Corporation, 2002, prepared for Water Environment Services.

"Phase I and Phase II Environmental Site Assessment, Tax Lot 502" by URS Corporation, 2001, prepared for Tri-City Service District.

"Remedial Action Work Plan, Unpermitted Rossman Landfill" by URS Corporation, 2000, prepared for Tri-City Service District.

4.0 SITE GEOLOGY AND SEISMIC SETTING

4.1 Site Topography

The WPCP is located approximately 4500 feet to east / northeast of the confluence of the Willamette and Clackamas River, as shown on Figue 1. The project site is bordered on the north by the Clackamas River and by Clackamette Cove to the southwest, both of which are at approximately elevation 15 ft above mean sea level. To the north and west of the site the ground is relatively flat for approximately 2000 feet before giving rise to steep terrace formations. On-site, the ground surface near the planned facilities is generally flat, but varies from elevation 44 to 46 feet.

4.2 Site Geology

The project site is underlain by three significant geologic units. The youngest unit is found below the relatively shallow site fill and is composed of catastrophic flood deposits laid down during the outwashing of glacial Lake Missoula some 15,000 years ago. Soils found in the flood deposits are generally silts with sand interbeds. The unit found below the flood deposits is known as the Troutdale formation. This unit is made up of many different soil types throughout the Portland area, but locally consists of very dense gravel and cobbles. A geologic unit named Sandy River Mudstone is found below the Troutdale gravels and locally observed along the banks of the Clackamas River. The Sandy River Mudstone Unit is generally composed of Pliocene-aged sedimentary rock beds. When encountered during our explorations the Sandy river mudstone was identified as very soft siltstone/very hard clayey silt.

4.3 Seismic Setting

Within the present understanding of the regional tectonic framework and historical seismicity, three broad seismogenic sources have been identified:

- A mega-thrust source at in interface between the North American and Juan de Fuca plates in the Cascadia Subduction Zone (CSZ).
- A deep subcrustal zone (intra-slab) in the subducted Juan de Fuca Plate and Gorda plates in the CSZ.
- A shallow crustal zone within the forearc of North American Plate.

For the general area of the WPCP, the seismogenic sources that contribute significantly to the ground motion hazard include both megathrust earthquakes on the CSZ (located about 95 miles west of the site) and shallow crustal earthquakes on nearby faults. The nearest mapped shallow crustal faults are the Portland Hills Fault and the Oatfield Fault. According to the United States Geological Survey (USGS) Quaternary Fault Database, the Oatfield fault has been traced to within less than a mile of the WPCP site. The Portland hills fault has been traced to within 2 miles of the WPCP site.

Table 1 illustrates the different properties or parameters for the earthquakes that contribute to the ground motion hazard levels. We used these earthquake parameters in evaluating the seismic hazards at the Tri-City WPCP site. The magnitudes and distances of earthquakes were obtained from the USGS web site, Probabilistic Seismic Hazard Deaggregation, based upon the project site location (Longitude = -122.590, and Latitude = 45.375). Peak ground accelerations (PGA) shown on Table 1 were obtained from the 2002 USGS Seismic Hazard Maps (Frankel et al., 2002) and USGS Ground Motion Parameter Tool (Version 5.0.7) for the Pacific Northwest Region. The relative contribution of seismogenic sources to the ground motion hazard levels were calculated from the USGS PSHA. As shown on this table shallow crustal and CSZ megathrust earthquakes contribute the most to the seismic hazard at the WPCP site.

TABLE 1

Earthquake Characterization by Seismogenic Source

Exceedance Probability	Bedrock PGA (g)	Seismogenic Source	Contribution to Seismic Hazard	Modal Distance from Site (km)	Modal Magnitude (M_w)
2 % in 50 yr	0.389	Shallow Crustal	80 %	10	6.0
		CSZ Intra-slab	N/A	N/A	N/A
		CSZ Megathrust	20 %	95	8.5

5.0 FIELD EXPLORATIONS, IN-SITU AND LABORATORY TESTING

5.1 Shannon & Wilson Explorations

Shannon & Wilson planned and executed a subsurface exploration program to characterize the subsurface conditions at the WPCP project site. The program consisted of three individual exploration Stages. Stage One efforts focused on developing a general subsurface model across the project site. Stage Two explorations were specifically directed at refining a subsurface anomaly that was detected during the Stage One explorations. Stage Three explorations focused on gathering specific subsurface data that is required for the facility design. The locations of S&W's explorations, in addition to locations of pertinent previous subsurface explorations by others, are illustrated on Figure 2. The relative locations of S&W explorations were established by the use of field methods, including hand taping and laser range finding to known on-site features. The locations of S&W's explorations should be considered approximate. We cannot verify the location of the previous exploration locations and they too should be considered approximate. A full description of S&W exploration program and logs of the borings are contained in Appendix A. For reference, boring logs from previous reports in the plant area are contained in Appendix D.

5.2 Shannon & Wilson Laboratory Testing

A laboratory testing program was developed and implemented in order to evaluate physical and engineering characteristics of the subsurface soils. Laboratory tests on selected soil samples included standard classification tests, which consisted of visual examination, moisture/density tests, Atterberg limits, grain-size analysis, hydrometers, and grain-size wash analysis, i.e., percent finer than the No. 200 sieve. In addition, in-place density tests, in-situ shear strength and unconfined compressive strength tests were conducted on selected undisturbed thin-walled samples. Appendix B contains results from S&W laboratory testing program, in addition to Figure B1, which summarizes all laboratory testing performed on samples collected on-site (this includes the laboratory results from previous work done by others).

5.3 Shannon & Wilson In-Situ Testing

5.3.1 Falling Head Test On Borehole Piezometers

In order to obtain estimates of the soil hydraulic conductivity, an in-place falling head test was conducted on borings IB-12 and IB-13. A description of these tests results are contained in Appendix C.

5.4 Previous Explorations and Laboratory Testing by Others

Contained in Appendix D is information from previous explorations and laboratory tests by others. Only data portions of the reports are included with information we believe is pertinent to the project; however, with most of the references noted, the complete report is available for additional information as needed. The included data from previous work is generally plan of explorations and boring logs and laboratory test results. As noted previously in this report, laboratory results from done by others is summarized together with S&W generated data on Figure B1 in Appendix B; the boring numbers indicate which tests were done by others.

Contained in Appendix D is information from previous explorations and laboratory tests by others. Only data portions of the reports are included with information we believe is pertinent to the project; however, with most of the references noted, the complete report is available for additional information as needed. The data from previous work is generally the subsurface conditions, plan of explorations, boring logs, and laboratory testing.

6.0 DISCUSSION OF SUBSURFACE CONDITIONS

6.1 Subsurface Soil Conditions

The subsurface soils encountered in the field explorations have been grouped, for discussion purposes, into units, from the ground surface downward, as follows:

- **Site Fill**
- **Alluvial silt, sandy silt and silty sand**
- **Alluvial gravelly sand and sandy gravel**
- **Siltstone**

A detailed discussion of the soil units is presented in the following paragraphs.

6.1.1 Site Fill

During the explorations S&W has identified several types and locations of fill at this site. We identified three different fill groups. One is on the property to west of the plant site, which we believe is deep (~43 feet) and was part of the backfill for a historic gravel pit. The second type is the fill related to the historic trolley grade, and the third is site fill related to the construction of the original WPCP.

The WPCP fill ranges in thickness from 4 to 7 feet. This fill was part of the original plant construction; therefore, it appears to be made up of excess select fine-grained native soil fill and remnants of the coarse-grained preload fill soils and graveled surface areas. The fine-grained fill is non- to low plasticity medium stiff silt with scatted organics. Thickness of the fine-grained soils was typically between 2 to 3 feet. Below the fine-grained fill, the coarse-grained soils were very dense and consisted of a combination of silt, gravel and cobbles. The coarse-grained soils were typically between 3 to 4 feet thick.

6.1.2 Alluvial silt, sandy silt and silty sand

This layer is quite variable across the site in both composition and relative thickness. This layer is largely made up of silts and silty sands. In some areas, primarily closer to the river, the soil is more sandy. These materials are flood-deposited and fine-grained with low to non-plastic characteristics. Thickness of the deposit ranges from 22 to 37 feet, on average the upper 20 feet of the unit is soft to stiff silt and the lower portion is a 2 to 4 feet thick bed of loose silty sand. The thickness range of this layer in the vicinity of the planned interim structures is 25 to 30 feet.

TABLE 8

Alluvial Silt and Sand Standard Penetration Resistance

Soil	N-values		
	Average	High	Low
Silt	4.5	12	0
Sandy Silt	3.5	15	0
Silty Sand	6	25	0

6.1.3 Alluvial gravelly sand, sandy gravel

This material is flood deposited and primarily coarse-grained material with fines in the matrices between gravel particles. This material is non-plastic and dense to very dense. This unit is encountered fairly regularly across the site at an elevation of approximately 20 ft msl with the exception being the anomaly area beneath the proposed fine-screening building where the top of the gravel was significantly lower and was encountered at an elevation of 7 ft msl.

TABLE 9

Alluvial Sand and Gravel Standard Penetration Resistance

Soil	N-values		
	Average	High	Low
Gravel, sandy gravel, gravel with cobbles	>50 bpf	50 blows-1"	18

6.1.4 Siltstone

Below the gravel unit is a siltstone layer that appears to be quite uniform in depth below the ground surface. Based on the borings that encountered the siltstone unit, we estimate the top of the unit is at a depth of 40 ft bgs (EL 5 ft msl). The siltstone is a very weak rock and shows signs of weathering and that remolds to a non-plastic silt or medium plasticity clayey silt depending on the degree of weathering.

TABLE 10
Siltstone Standard Penetration Resistance

Soil	N-values		
	Average	High	Low
Siltstone	31	43	18

6.2 Ground Water

Ground water beneath the site was noted during drilling and subsequently measured in piezometers installed in borings IB-6, IB-12, and IB-13. The measured ground water depths with the dates are presented on Table 11. S&W measured the ground water in all of the observation wells on-site that could be located. Additional historic ground water levels measurements by others are contained in Appendix D. The ground water table at this site generally fluctuates seasonally. The highest ground water level is during the late winter and spring periods (January through April) and lowest during the late summer and early fall (August through October). The maximum fluctuation is unknown. Perched ground water at shallow depths above the ground water may be present during all seasons of the year, but especially prevalent following periods of heavy rainfall.

TABLE 11
Ground Water Level Readings

Boring	Depth to ground water from ground surface (ft)		
	7/26/07	2/25/08	4/25/08
IB-6	22.5	33.0	32.6
IB-12	--	Below well (>15)	Below well (>15)
IB-13	--	Below well (>15)	Below well (>15)
B-101	--	32.9	32.2

7.0 LIMITATIONS

This work has been completed and report prepared for the exclusive use of MWH for specific application to the design of the Tri-City Water Pollution Control Plant, Phase 1 Expansion Project. The field explorations and water level measurements indicate subsurface conditions

only at the specific locations and times indicated. Soil and water level variations may exist between exploration and piezometer locations.

The data contained in this report are based upon site conditions as they now exist, and further assume that the explorations performed by others are representative of the subsurface conditions in those project areas. Within the limitations of the scope, schedule, and budget, the data presented in this report were collected and presented in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. This work was performed in accordance with generally accepted current local professional practices for the nature of work accomplished no other warranty, express or implied, is made.

If, during final design and construction, subsurface conditions different from those encountered in the field explorations are observed or appear to be present, we should be advised at once so that we can review these conditions and reconsider our data where necessary. If there is a substantial lapse of time between this report and the start of work at the site, or if conditions have changed because of modifications to project layout, natural forces or construction operations at or adjacent to the site, we recommend that this report be reviewed to determine the relevance of the data concerning the changed conditions or the time lapse.

This report is intended to include no interpretive information, and only the data in this report may be provided to prospective contractors as a basis for bidding. This report is not a warranty of subsurface conditions.

Unanticipated soil conditions are commonly encountered and cannot fully be determined by information from the explorations described in this report. Such unexpected conditions frequently require that additional expenditures be made to attain additional information to properly characterize the subsurface conditions. Therefore, some contingency fund is recommended to accommodate the potential for extra costs.

The scope of our geotechnical services did not include any environmental assessment or evaluation regarding the presence or absence of hazardous or toxic materials in the soil, surface

water, ground water, or air, on or below the site, or for evaluation or disposal of contaminated soils or ground water, should any be encountered, except as noted in this report.

Shannon & Wilson, Inc. has prepared a document, "Important Information About Your Geotechnical Report," to assist you and others in understanding the use and limitations of this document. This document is included in Appendix E.

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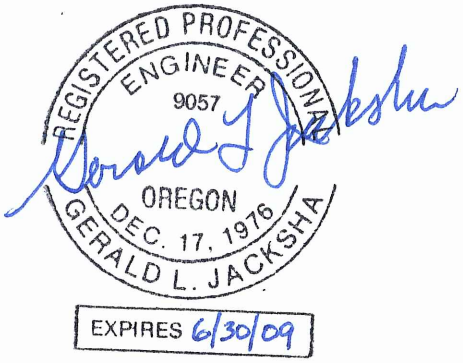
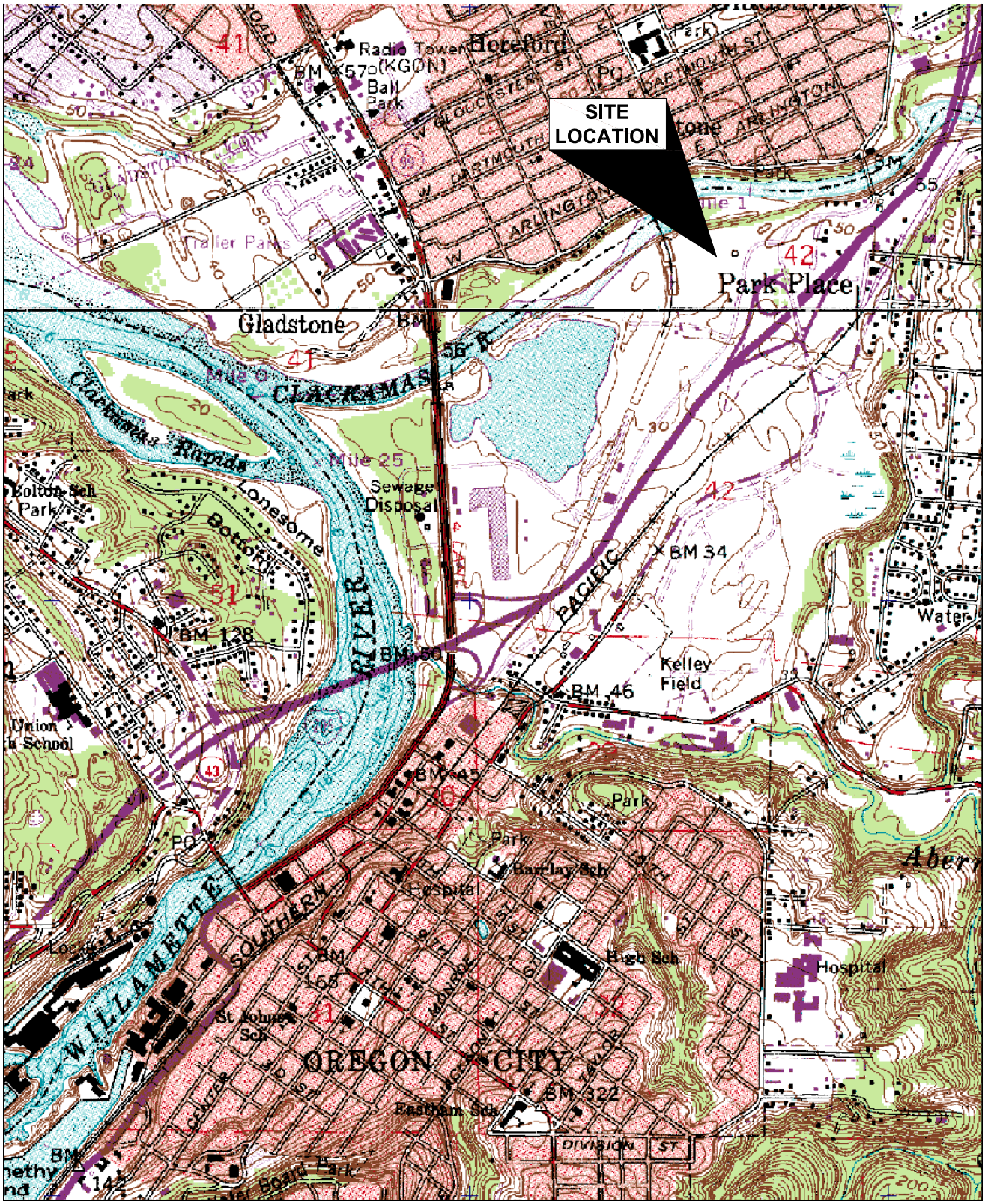
Derrick R. Hayes
Engineering Staff



Jerry L. Jacksha, PE
Senior Associate – Geotechnical Engineer

DRH/JLJ/kaw



Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

VICINITY MAP

May 2008 24-1-03420-001

NOTE: Map from Delorme 3-D TopoQuads software.

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FIG. 1

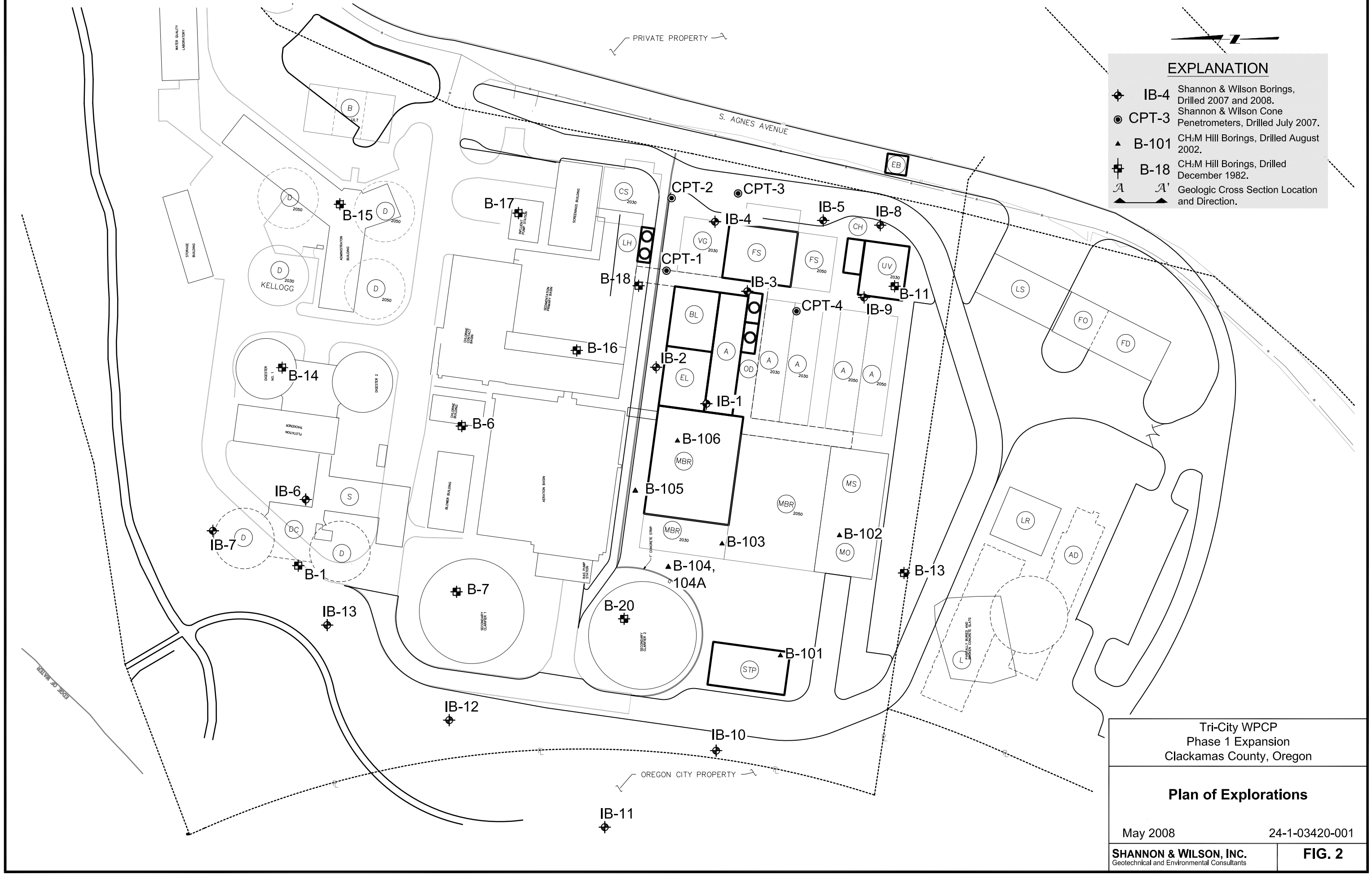
PRIVATE PROPERTY
S. AGNES AVENUE
OREGON CITY PROPERTY
EDGE OF WATER
WATER QUALITY LABORATORY
STORAGE BUILDING
ADMINISTRATION BUILDING
KELLOGG
DIGESTER NO. 1
DIGESTER 2
FLOTATION THICKENER
INFLUENT PUMP STATION
SCREENINGS BUILDING
GRIT CHAMBER BLDG.
SEDIMENTATION PRIMARY BLDG.
CHLORINE CONTACT BASIN
CHLORINE BUILDING
BLOWER BUILDING
AERATION BASIN
RAS PUMP STATION
1" CHAINLINK STRIP
SECONDARY CLARIFIER 1
SECONDARY CLARIFIER 2
PARTIALLY BURIED AND BERMED CONCRETE SLAB
B-15
B-17
B-18
B-16
B-14
B-6
B-7
B-20
B-1
B-13
B-101
B-106
B-105
B-103
B-102
B-104, 104A
CPT-1
CPT-2
CPT-3
CPT-4
IB-1
IB-2
IB-3
IB-4
IB-5
IB-6
IB-7
IB-8
IB-9
IB-10
IB-11
IB-12
IB-13
B-11
EXPLANATION
IB-4 Shannon & Wilson Borings, Drilled 2007 and 2008.
CPT-3 Shannon & Wilson Cone Penetrometers, Drilled July 2007.
B-101 CH2M Hill Borings, Drilled August 2002.
B-18 CH2M Hill Borings, Drilled December 1982.
A A' Geologic Cross Section Location and Direction.
Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon
Plan of Explorations
May 2008
24-1-03420-001
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FIG. 2

APPENDIX A
S&W FIELD EXPLORATIONS

APPENDIX A

S&W FIELD EXPLORATIONS

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APPENDIX A

S&W FIELD EXPLORATIONS

A.1 GENERAL

Shannon & Wilson planned and executed a subsurface exploration program to characterize the subsurface conditions at the WPCP project site. The program consisted of three individual exploration Stages. Stage One efforts focused on developing a general subsurface model across the project site. Stage Two explorations were specifically directed at refining a subsurface anomaly that was detected during the Stage One explorations. Stage Three explorations focused on gathering specific subsurface data that is required for the facility design. The locations of S&W's explorations, in addition to locations of pertinent previous subsurface explorations, are illustrated on Figure 2. The relative locations of S&W explorations were established by the use of field methods, including hand taping and laser range finding to known on-site features. The locations of S&W's explorations should be considered approximate. Table 2, below, describes the drilling method and depth below ground surface for all stages of S&W's subsurface explorations.

TABLE A1
Exploration Hole Details

Boring Label	Boring Type	Nearest Structure to Boring Location	Bottom	
			Depth, ft	Approximate Elevation, ft MSL
IB-1	Mud Rotary	Aeration Basin	31.5	13
IB-2	Mud Rotary	Blower/electrical	31.5	13
IB-3	Mud Rotary	Primary Gallery	31.5	13
IB-4	Mud Rotary	Fine Screening	46.5	-1
IB-5	Mud Rotary	Fine Screening/UV	30.6	14
IB-6	Mud Rotary	Future Digester	51.5	-6
IB-7	Mud Rotary	Future Digester	51.5	-6
IB-8	Mud Rotary	UV Building	26.5	18
IB-9	Mud Rotary	UV Building	34.2	11
IB-10	Mud Rotary	West of Plant	40.2	10
IB-11	Hollow Stem Auger	West of Plant	46.5	-6
IB-12	Hollow Stem Auger	Retention Basin	31.5	16
IB-13	Hollow Stem Auger	Retention Basin	17	29

CPT-1	Electric Cone Penetrometer	Primary Gallery	27.72	17
CPT-2	Electric Cone Penetrometer	Fine Screening	29.04	16
CPT-3	Electric Cone Penetrometer	Fine Screening	19.69	25
CPT-4	Electric Cone Penetrometer	Primary Gallery	33.14	12

Stage one and stage three subsurface explorations were performed by a drilling subcontractor hired by Shannon and Wilson. The subcontractor was Hardcore Drilling, Inc., of Dundee Oregon. Each of the borings were advanced using a truck-mounted CME-75 drill rig utilizing mud rotary drilling or hollow stem auger techniques. The drilling operations were directed by a representative from Shannon & Wilson who also logged the subsurface conditions during drilling and the logged and classified the soil samples that were collected during the operation. Soil sampling was performed using a standard split spoon sampler, Dames and Moore split spoon sampler and thin-walled Shelby tube sampler. Samples were sealed in containers and returned to our laboratory for further classification and index testing.

Stage One explorations, completed on the dates July 23rd through July 26th, 2007, consisted of seven mud rotary borings to depths ranging from 30 to 51.5 feet below the ground surface. Five borings, labeled IB-1 through IB-5, were located near of the Phase One Plant Expansion on the south side of the existing WPCP. Two borings, label IB-6 and IB-7, were located near the proposed digesters on the northwest corner of the WPCP site. A standpipe piezometer was installed in IB-6

Stage two explorations consisted of pushing four (CPT-1 through CPT-4) electric cone penetrometer test (CPT) holes on the August 14th, 2007. The work was performed by Vandehey Exploration, Inc. of Banks Oregon, who was a subcontractor to S&W. The CPT test holes were pushed to depths between 20 and 33 feet. The CPT probes were advanced to locate the top of the gravel layer near the Fine Screening Building. The CPT probes were stopped where they reached a refusal pushing force. No samples are collected during CPT exploration. The CPT logs provide a continuous record of soil resistance which includes tip resistance and side friction. Estimates of soil properties/classification can be made based on published correlations between tip and skin resistance. The estimated soil properties are based on analyses performed using published correlations and equations. The method used for estimating the properties listed above are:

a. Uncorrected N-Value (N_{60}) based on Robertson & Campanella. This Correlation of CPT data to ASTM International 1586 N-Value is interpretive and should not be considered factual or used as data on this project.
b. Soil Behavior Type based on University of British Columbia-1983. This correlation is interpretive, and should not be considered the actual soil type according to ASTM D2488.

Some of the logs have no data in the upper five feet of soil because the holes had to be predrilled to advance the CPT through the gravelly fill material.

Stage Three explorations consisted of six borings (IB-8 through IB-13), ranging in depth form 17 to 46.5 feet, and completed during the dates February 25th through February 27th 2008. Boring IB-8 and IB-9 were drilled near the proposed UV disinfection building and advanced to the top of the dense gravel layer. Borings IB-10 and IB-11 were drilled on the west side of the aid in the characterization of subsurface materials between the plant and the river. Borings IB-12 and IB-13 were drilled near the footprint of the proposed storm water retention basin. Standpipe piezometers were installed in borings IB-12 and IB-13. In-situ infiltration (permeability) tests were performed on boring IB-12 and IB-13, see Appendix C for detailed description of the in-situ testing.

Logs of the current exploration program are contained in this Appendix. For reference, boring logs from previous reports in the plant area are contained in Appendix D.

Shannon & Wilson, Inc. (S&W), uses a soil classification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following page. Soil descriptions are based on visual-manual procedures (ASTM D 2488-93) unless otherwise noted.

S&W CLASSIFICATION OF SOIL CONSTITUENTS

MAJOR constituents compose more than 50 percent, by weight, of the soil. Major consituents are capitalized (i.e., SAND).

Modifying (secondary) constituents compose 30 to 45 percent of the soil (i.e. sandy, silty, etc).

Minor constituents compose 12 to 50 percent of the soil and precede the major constituents (i.e., silty SAND). Minor constituents preceded by "slightly" compose 5 to 12 percent of the soil (i.e., slightly silty SAND).

Trace constituents compose 5 percent of the soil (i.e., slightly silty SAND, trace of gravel).

Dual symbols apply to coarse grained soils with 10 percent fines.

MOISTURE CONTENT DEFINITIONS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

ABBREVIATIONS

ATD	At Time of Drilling
Elev.	Elevation
ft	feet
FeO	Iron Oxide
MgO	Magnesium Oxide
HSA	Hollow Stem Auger
ID	Inside Diameter
in	inches
lbs	pounds
Mon.	Monument cover
N	Blows for last two 6-inch increments
NA	Not applicable or not available
NP	Non plastic
OD	Outside diameter
OVA	Organic vapor analyzer
PID	Photo-ionization detector
ppm	parts per million
PVC	Polyvinyl Chloride
SS	Split spoon sampler
SPT	Standard penetration test
USC	Unified soil classification
WLI	Water level indicator

GRAIN SIZE DEFINITION

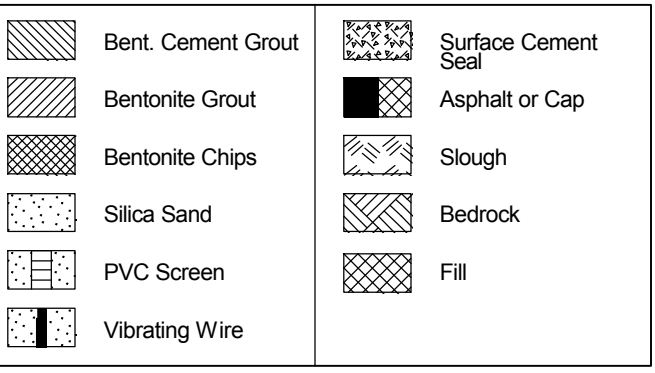
DESCRIPTION	SIEVE NUMBER AND/OR SIZE
FINES	< #200 (0.08 mm)
SAND* - Fine - Medium - Coarse	 #200 to #40 (0.08 to 0.4 mm) #40 to #10 (0.4 to 2 mm) #10 to #4 (2 to 5 mm)
GRAVEL* - Fine - Coarse	 #4 to 3/4 inch (5 to 19 mm) 3/4 to 3 inches (19 to 76 mm)
COBBLES	3 to 12 inches (76 to 305 mm)
BOULDERS	> 12 inches (305 mm)

* Unless otherwise noted, sand and gravel, when present, range from fine to coarse in grain size.

RELATIVE DENSITY / CONSISTENCY

COARSE-GRAINED SOILS		FINE-GRAINED SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
0 - 4	Very loose	Under 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
Over 50	Very dense	15 - 30	Very stiff
		Over 30	Hard

WELL AND OTHER SYMBOLS



Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

SOIL CLASSIFICATION AND LOG KEY

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FIG. A1
Sheet 1 of 2

BORING_CLASS1 TRI-CITY WWTP.GPJ SWNEW.GDT 8/7/08

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(From ASTM D 2487-98 & 2488-93)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL		TYPICAL DESCRIPTION
COARSE-GRAINED SOIL *(more than 50% retained on No. 200 sieve)*	Gravel *(more than 50% of coarse fraction retained on No. 4 sieve)*	Clean Gravel *(less than 5% fines)*	GW		Well-graded gravel, gravel, gravel/sand mixtures, little or no fines.
			GP		Poorly graded gravel, gravel-sand mixtures, little or no fines
		Gravel with Fines *(more than 12% fines)*	GM		Silty gravel, gravel-sand-silt mixtures
			GC		Clayey gravel, gravel-sand-clay mixtures
	Sand *(50% or more of coarse fraction passes the No. 4 sieve)*	Clean Sand *(less than 5% fines)*	SW		Well-graded sand, gravelly sand, little or no fines
			SP		Poorly graded sand, gravelly sand, little or no fines
		Sand with Fines *(more than 12% fines)*	SM		Silty sand, sand-silt mixtures
			SC		Clayey sand, sand-clay mixtures
FINE-GRAINED SOIL *(50% or more passes the No. 200 sieve)*	Silt and Clay *(liquid limit less than 50)*	Inorganic	ML		Inorganic silt of low to medium plasticity, rock flour, sandy silt, gravelly silt, or clayey silt with slight plasticity
			CL		Inorganic clay of low to medium plasticity, gravelly clay, sandy clay, silty clay
		Organic	OL		Organic silt and organic silty clay of low plasticity
	Silt and Clay *(liquid limit 50 or more)*	Inorganic	MH		Inorganic silt, micaceous or diatomaceous fine sand or silty soils, elastic silt
			CH		Inorganic clay or medium to high plasticity
		Organic	OH		Organic clay of medium to high plasticity, organic silt
HIGHLY-ORGANIC SOIL	Primarily organic matter, dark in color, and organic odor		PT		Peat, humus, swamp soils with high organic content (see ASTM D 4427)

NOTE: No. 4 size = 5 mm; No. 200 size = 0.075 mm

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND)* are used for soils with between 5% and 10% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, silty CLAY/clayey SILT; GW/SW, sandy GRAVEL/gravelly SAND)* indicate that the soil may fall into one of two possible basic groups.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

SOIL CLASSIFICATION AND LOG KEY

May 2008 24-1-03420-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A1
Sheet 2 of 2

BORING_CLASS2 TRI-CITY WWTP.GPJ SWNEW.GDT 8/7/08

Total Depth:	31.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. Depth (ft.)	Soil Description
43 / 2.0	SILT; with organics. (ML) **FILL**
	Gravelly SILT with cobbles (ML)
40 / 5.0	Soft to medium stiff brown SILT to SILT with sand; moist, non- to low plasticity, fine sand, micaceous. (ML)
	Grades to sandy SILT, moist, non-plastic at 10 ft. **ALLUVIUM**
	Grades to SILT with sand, moist, non-plastic at 15 ft.
	Grades to wet, low plasticity at 20 ft.
23 / 22.0	Brown silty SAND. (SM)
21 / 24.0	Dense to very dense dark grey sandy GRAVEL with silt; moist, non-plastic, fine to coarse sand and gravel, rounded gravel. (GP-GM) **ALLUVIUM**
13.5 / 31.5	Bottom of Boring - 24 July 2007

Symbol; Samples: S-1, S-2, S-3, S-4, S-5, S-6; Ground Water: During Drilling ▽

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

Depth, ft.: 0, 5, 10, 15, 20, 25, 30, 35

Blow counts: 5, 4, 3, 3, 39, 50/5"

0 20 40 60 80 100

LEGEND

* Sample Not Recovered

2.5" OD Split Spoon Sample

▽ Ground Water Level

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-1

May 2008 24-1-03420-001

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Geotechnical and Environmental Consultants

FIG. A2

Log: AAH Rev: DRH Typ: ECP

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

Total Depth:	31.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

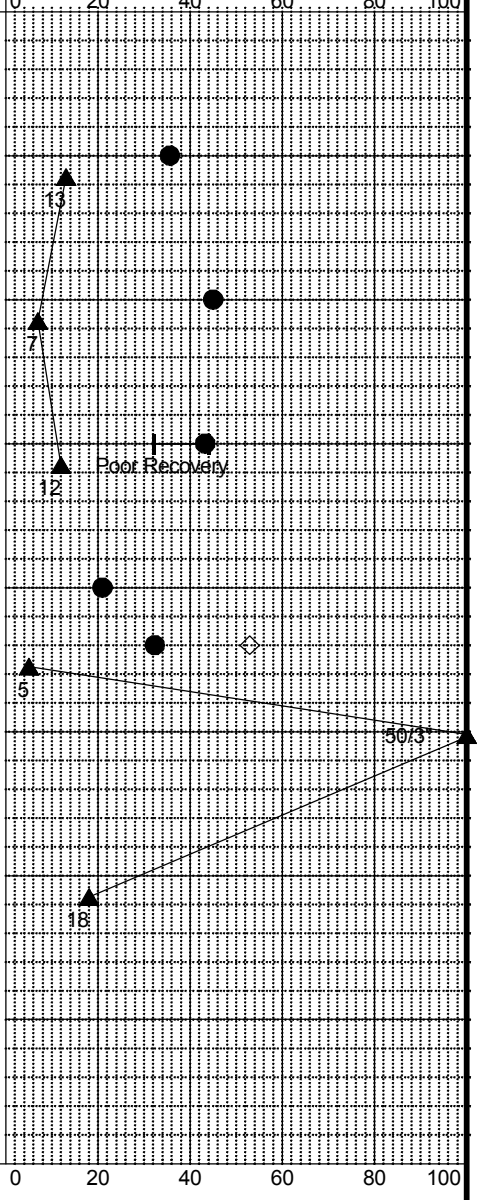
Elev. Depth (ft.)	Soil Description
43 / 2.0	SILT; with organics. (ML) **FILL**
	Gravelly SILT with cobbles. (ML)
40 / 5.0	Medium stiff to stiff brown SILT; moist, non- to low plasticity, micaceous, scattered iron staining at 5 ft. (ML)
	Grades to trace coarse sand.
	ALLUVIUM
	Grades to trace fine sand, medium plasticity.
25 / 20.0	Loose brown sandy SILT to silty SAND; moist to wet, non-plastic, fine sand, micaceous. (ML/SM)
20.5 / 24.5	Medium dense to very dense dark grey sandy GRAVEL. (GP) **ALLUVIUM**
13.5 / 31.5	Bottom of Boring - 23 July 2007

Samples: S-1, S-2, S-3, S-4, S-5, S-6, S-7

Ground Water: During Drilling

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



LEGEND

* Sample Not Recovered
2.5" OD Split Spoon Sample
3.25" O.D. Split Spoon Sample
3.0" O.D. Osterberg Sample
Ground Water Level

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit — Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-2

May 2008 24-1-03420-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A3

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08 Log: AAH Rev: DRH Typ: ECP

Total Depth:	31.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

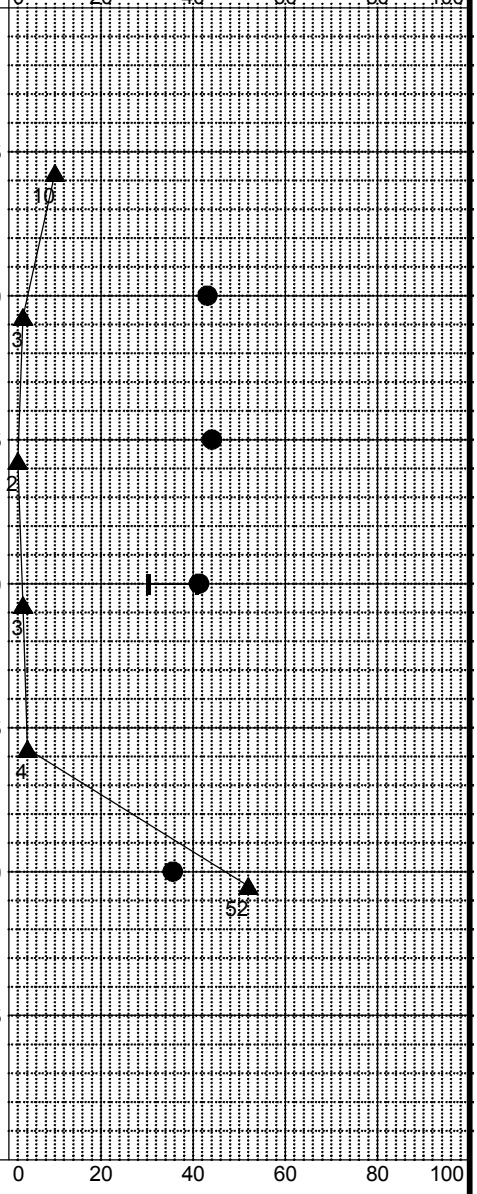
Soil Description	Elev. / Depth (ft.)
Dark brown SILT; moist,with organics. (ML)	43.5 / 1.5
FILL	
Gravelly SILT with cobbles. (ML)	42 / 3.0
Stiff brown SILT; moist, medium plasticity, micaceous, scattered iron oxide stains at 5 ft. (ML)	
Grades to soft at 10 ft.	
ALLUVIUM	
Grades to very soft to soft at 15 ft.	
Grades to soft to medium stiff at 25 ft.	
Grades to with sand at 28 ft.	
Very loose brown silty SAND; wet, non-plastic, fine sand. (SM)	14.8 / 30.2
Very dense dark grey sandy GRAVEL with silt; wet, non-plastic, fine to coarse sand and gravel. (GP-GM)	14 / 31.0 – 13.5 / 31.5
ALLUVIUM	
Bottom of Boring - 24 July 2007	

Symbol / Samples: S-1, S-2, S-3, S-4, S-5 *, S-6A, S-6B

Ground Water: During Drilling ▽

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



LEGEND

* Sample Not Recovered

2.5" OD Split Spoon Sample

▽ Ground Water Level

Plastic Limit — Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-3

May 2008 24-1-03420-001

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FIG. A4

Log: AAH Rev: DRH Typ: ECP

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

Total Depth:	46.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *lbs / inches*

140 lbs / 30 inches

Gravelly SILT to silty GRAVEL. (ML/GM)

FILL

40
5.0

Stiff to very stiff dark grey SILT; trace gravel, moist, low plasticity. (ML)

38.5
6.5

Medium stiff brown stratified SILT with sand to sandy SILT; moist, non- to low plasticity, fine sand, micaceous. (ML)

Grades to very soft at 15 ft.

ALLUVIUM

Grades to trace sand at 30 ft.

11
34.0

Very loose grey and brown silty SAND; wet, non-plastic, fine sand. (SM)

8
37.0

Sandy silty GRAVEL. (GM)

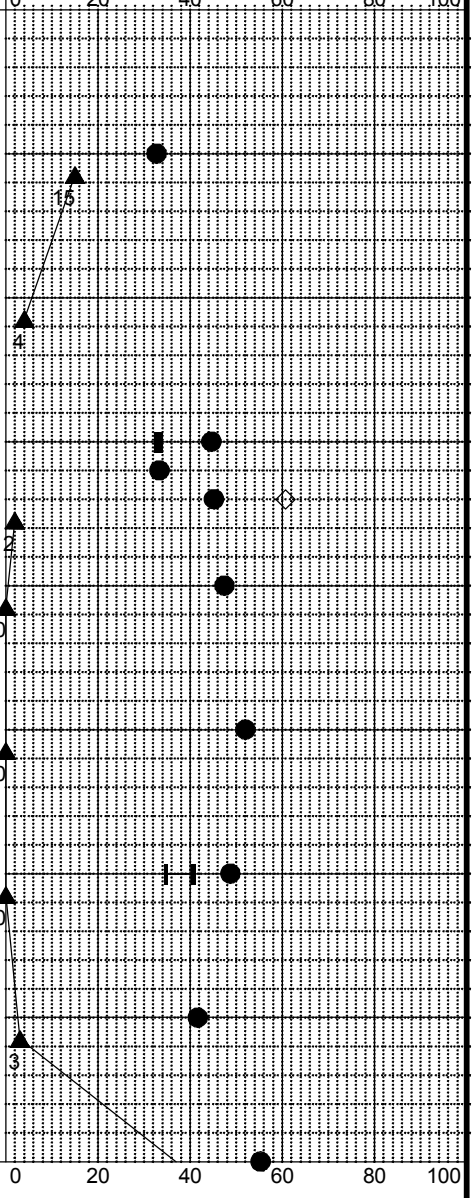
ALLUVIUM

6
39.0

CONTINUED NEXT SHEET

S-1 S-2 S-3 S-4 S-5 S-6 S-7 S-8

During Drilling ▽



LEGEND

* Sample Not Recovered

2.5" OD Split Spoon Sample

3.0" O.D. Osterberg Sample

▽ Ground Water Level

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-4

May 2008 24-1-03420-001

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FIG. A5
Sheet 1 of 2

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08 Log: AAH Rev: DRH Typ: ECP

Total Depth:	46.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *lbs / inches*

140 lbs / 30 inches

SILTSTONE; very low strength, grey, fresh, massive.

SILTSTONE

-1.5
46.5

Bottom of Boring - 24 July 2007

S-9

S-10

43

42

0 20 40 60 80 100

45 50 55 60 65 70 75

0 20 40 60 80 100

LEGEND

* Sample Not Recovered

2.5" OD Split Spoon Sample

3.0" O.D. Osterberg Sample

Ground Water Level

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-4

May 2008 24-1-03420-001

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FIG. A5
Sheet 2 of 2

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08 Log: AAH Rev: DRH Typ: ECP

Total Depth:	30.6 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. Depth (ft.)	Soil Description
	Silty GRAVEL to gravelly SILT. (ML/GM) **FILL**
41 / 4.0	Stiff brown SILT; moist, non- to low plasticity, micaceous. (ML)
	Grades to soft to medium stiff at 10 ft.
	ALLUVIUM
26 / 19.0	Medium dense brown SAND with silt to silty SAND; moist, non-plastic, fine to medium angular to subangular sand. (SP-SM/SM)
19.5 / 25.5	Very dense dark grey sandy silty GRAVEL; wet, non-plastic, fine to coarse subrounded to rounded gravel, fine to coarse sand. (GM)
	ALLUVIUM
14.4 / 30.6	Bottom of Boring - 25 July 2007

Symbol | Samples | Ground Water | Depth, ft.

S-1, S-2, S-3 *, S-4 $, S-5, S-6, S-7

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

0 20 40 60 80 100

5 10 15 20 25 30 35

10 4 4 12 50/5" 50/1"

0 20 40 60 80 100

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

LEGEND

* Sample Not Recovered

2.5" OD Split Spoon Sample

Shelby Tube Sample Portland Test Pit Log

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-5

May 2008 24-1-03420-001

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FIG. A6

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08 Log: AAH Rev: DRH Typ: ECP

Total Depth:	51.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	6 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

Soft to medium stiff brown SILT to sandy SILT; non- to low plasticity, moist to wet. (ML)

ALLUVIUM

24.1
20.9 Loose dark brown SAND; trace silt. (SP)

22.5
22.5 Very dense GRAVEL with cobbles and possible boulders; trace sand and silt. (GP)

ALLUVIUM

Grades to medium dense, caving at 29 ft.

Grades to very dense at 30.5 ft.

6.5
38.5 Sandy GRAVEL. (GP)

CONTINUED NEXT SHEET

S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-8

During Drilling ▽

Depth, ft.	Blows
5	2
10	3
15	4
20	5
25	50/6"
	75/3"
30	50/6"
35	50/3"

0 20 40 60 80 100

LEGEND

* Sample Not Recovered

2.5" OD Split Spoon Sample

3.25" O.D. Split Spoon Sample

▽ Ground Water Level

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-6

May 2008 24-1-03420-001

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FIG. A7
Sheet 1 of 2

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08 Log: DRH Rev: DRH Typ: ECP

Total Depth:	51.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	6 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

Continued:

Sandy GRAVEL. (GP)

0.5
44.5

Hard blue grey SILTSTONE; moist, medium plasticity, red brown mottling, remolds to very stiff clayey silt. (MH)

SILTSTONE

-6.5
51.5

Bottom of Boring - 26 July 2007

S-9, S-10, S-11

23, 18, 24

0 20 40 60 80 100

45 50 55 60 65 70 75

LEGEND

* Sample Not Recovered

2.5" OD Split Spoon Sample

3.25" O.D. Split Spoon Sample

Ground Water Level

Plastic Limit — Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-6

May 2008 24-1-03420-001

SHANNON & WILSON, INC.
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FIG. A7
Sheet 2 of 2

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08 Log: DRH Rev: DRH Typ: ECP

Total Depth:	51.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Very loose brown silty SAND to sandy SILT; moist, non-plastic, fine sand, micaceous. (SM/ML)

ALLUVIUM

35
10.0

Medium stiff brown SILT with sand; moist, fine sand, micaceous. (ML)

30
15.0

Loose to medium dense brown silty SAND; moist, non-plastic, fine sand. (SM)

21.5
23.5

Very dense grey to brown sandy silty GRAVEL with scattered cobbles and boulders; moist, non-plastic, fine to coarse sand and gravel. (GM)

ALLUVIUM

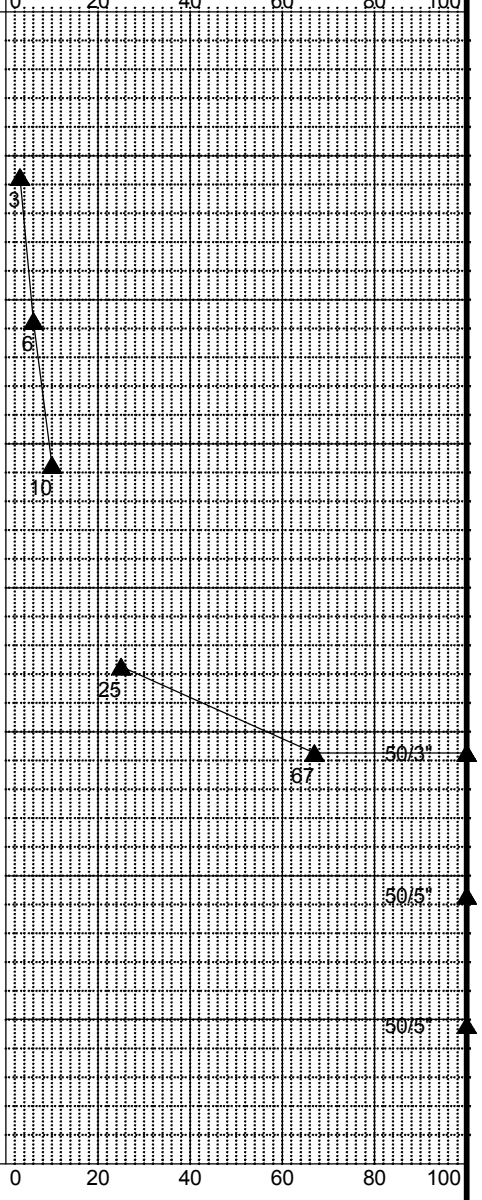
CONTINUED NEXT SHEET

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

S-1 S-2 S-3 S-4 S-5 S-6 S-7 S-8 S-9

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



LEGEND

* Sample Not Recovered
2.5" OD Split Spoon Sample
Shelby Tube Sample Portland Test Pit Log
3.25" O.D. Split Spoon Sample

Plastic Limit — Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-7

May 2008 24-1-03420-001

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FIG. A8
Sheet 1 of 2

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08 Log: AAH Rev: DRH Typ: ECP

Total Depth:	51.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Continued:

Very dense grey to brown sandy silty GRAVEL with scattered cobbles and boulders; moist, non-plastic, fine to coarse sand and gravel. (GM)

-1
46.0

Very stiff dark grey SILTSTONE; weathered, moist, low to medium plasticity, red orange staining.

SILTSTONE

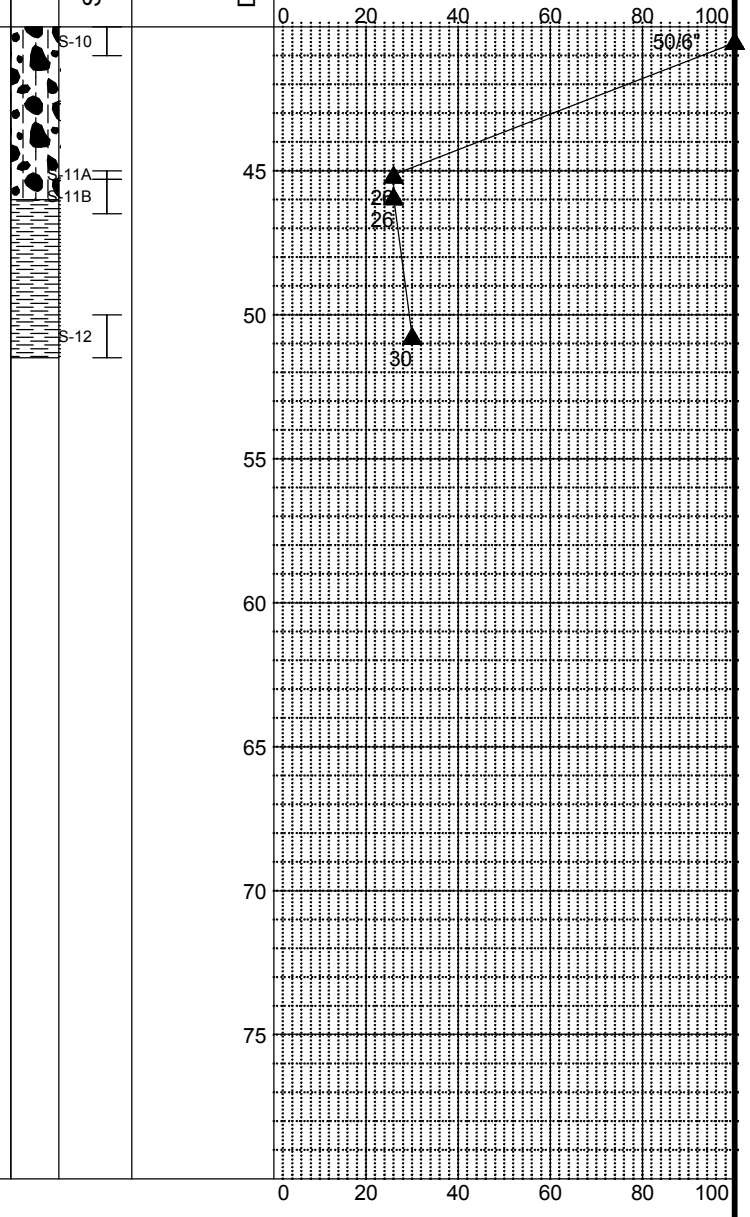
-6.5
51.5

Bottom of Boring - 25 July 2007

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



LEGEND

* Sample Not Recovered
2.5" OD Split Spoon Sample
Shelby Tube Sample Portland Test Pit Log
3.25" O.D. Split Spoon Sample

Plastic Limit — Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-7

May 2008 24-1-03420-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A8
Sheet 2 of 2

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08 Log: AAH Rev: DRH Typ: ECP

Total Depth:	26.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

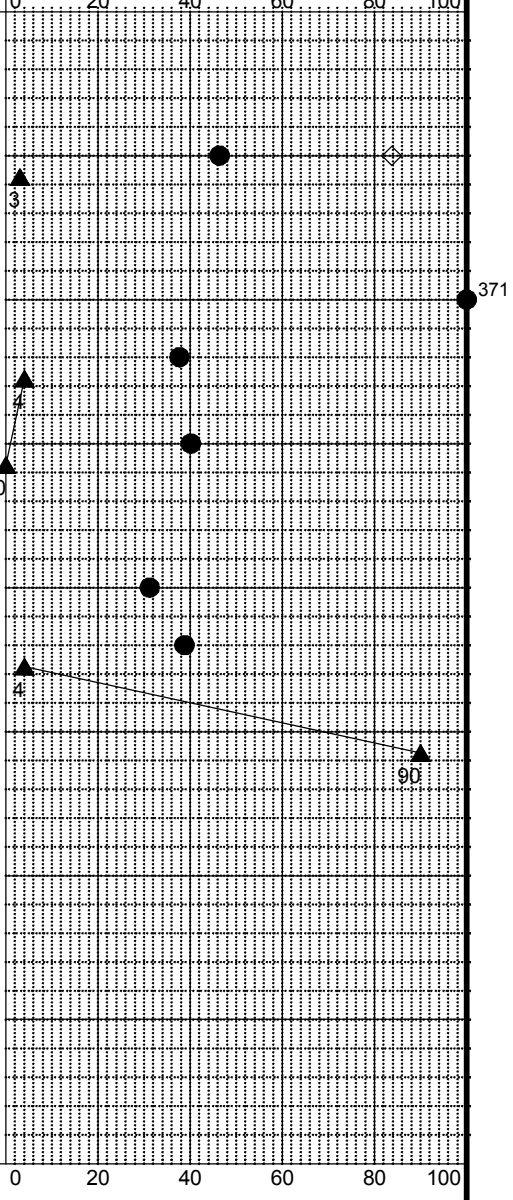
Soil Description	Elev. Depth (ft.)
Loose dark brown SILT, moist, numerous roots (Based on drill cuttings). (ML)	44 / 1.0
TOPSOIL	40.5 / 4.5
Brown silty GRAVEL, moist, rounded to subangular gravel (Based on drill cuttings). (GM)	
FILL	
Very loose brown silty SAND, moist, fine to medium sand, micaceous, no to low plasticity silt. (SM)	
	30 / 15.0
Very soft brown sandy SILT, moist, no plasticity, fine sand. (ML)	
ALLUVIUM	
	25 / 20.0
Very loose brown silty SAND, moist, fine to medium sand, micaceous, occasional seams of sandy GRAVEL with traceof silt. (SM)	
	21 / 24.0
Dense SAND layer approximately 12 inches thick of unknown silt content (According to driller). (SW/SM)	20 / 25.0
	18.5 / 26.5
Very dense gray and brown sandy GRAVELwith silt, moist, rounded to subrounded gravel, slight Fe-oxidation, granitic, quartzitic and basaltic clasts in a sand with silt matrix. (GW-GM)	
ALLUVIUM	
Bottom of Boring Completed 2/25/2008.	

Symbol / Samples: S-1, S-2, S-3, S-4, S-5, S-6, S-7

Ground Water Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



LEGEND

* Sample Not Recovered

Standard Penetration Test

3" O.D. Shelby Tube

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-8

May 2008 24-1-03420-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A9

Typ: CKS Rev: Log: CKS

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

Total Depth:	34.2 ft.	Northing:	~	Drilling Method:	Mud Roatary	Hole Diam.:	5 in.
Top Elevation:	45 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Loose dark brown SILT, moist, scattered roots and organics (Based on drill cuttings). (ML)

TOPSOIL

Brown silty GRAVEL, moist, rounded to subangular gravel (Based on drill cuttings and driller). (GM)

FILL

Soft Red-brown and gray mottled SILT trace of fine sand, moist, scattered wood debris, non to low plasticity silt. (ML)

Very loose brown silty SAND, moist to wet, fine to medium sand, non to low plasticity silt, micaceous, faintly stratified. (SM)

ALLUVIUM

Medium dense in upper to very dense lower gray to gray-brown sandy GRAVEL with silt, moist to wet, fine to coarse sand, rounded to subrounded gravel, scattered cobbly zones, driller losing circulation. (GW-GM)

ALLUVIUM

Bottom of Boring Completed 2/25/2008

Elev.	Depth (ft.)
43	2.0
41.5	3.5
38.5	6.5
14	31.0
10.8	34.2

Symbol | Samples: S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-8, S-9 | Ground Water: During Drilling

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

Depth, ft.: 0, 5, 10, 15, 20, 25, 30, 35

Penetration values: 3, 3, 0, 0, 2, 20, 50-3"

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

LEGEND

* Sample Not Recovered

Standard Penetration Test

3" O.D. Shelby Tube

▽ Ground Water Level

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-9

May 2008 24-1-03420-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A10

Typ: CKS Rev: Log: CKS

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

Total Depth:	40.2 ft.	Northing:	~	Drilling Method:	Mud Roatary	Hole Diam.:	5 in.
Top Elevation:	50 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. (ft.) / Depth (ft.)

Concrete- old building pad.
49.5 / 0.5

Cobbles and gravel/ Railroad Ballast Fill (According to driller).
48 / 2.0

Silty sandy GRAVEL (According to driller).
47 / 3.0

6 to 8-inch diameter cobble encountered (According to driller).
46 / 4.0

Concrete chunks encountered (According to driller and observed in drill cuttings).
45 / 5.0

Medium dense to very dense light gray and gray-brown to pinkish-gray sandy GRAVEL with silt, moist, rounded to angular fine to medium gravel up to 1.5-inch diameter, numerous lenses and pockets of bentonite or ash. (GW-GM)

FILL

Wood debris encountered.
32 / 18.0

Very soft to soft gray SILT trace of sand, trace of clay, moist, low to medium plasticity, fine sand, micaceous, occasional to scattered organics. (ML)

ALLUVIUM

Loose to medium dense gray-brown and brown interbedded silty SAND and SAND trace of silt, moist, silty SAND typically fine sand with low plasticity silt, SAND with trace of silt typically medium to coarse sand, trace of micas, rounded to subrounded medium gravels at 31.0 feet. (SW/SM)
22.5 / 27.5

Very dense gray-brown sandy GRAVEL with silt, moist, rounded to subangular gravel, occasional cobbles, slight Fe-oxidation. (GW-GM)
18 / 32.0

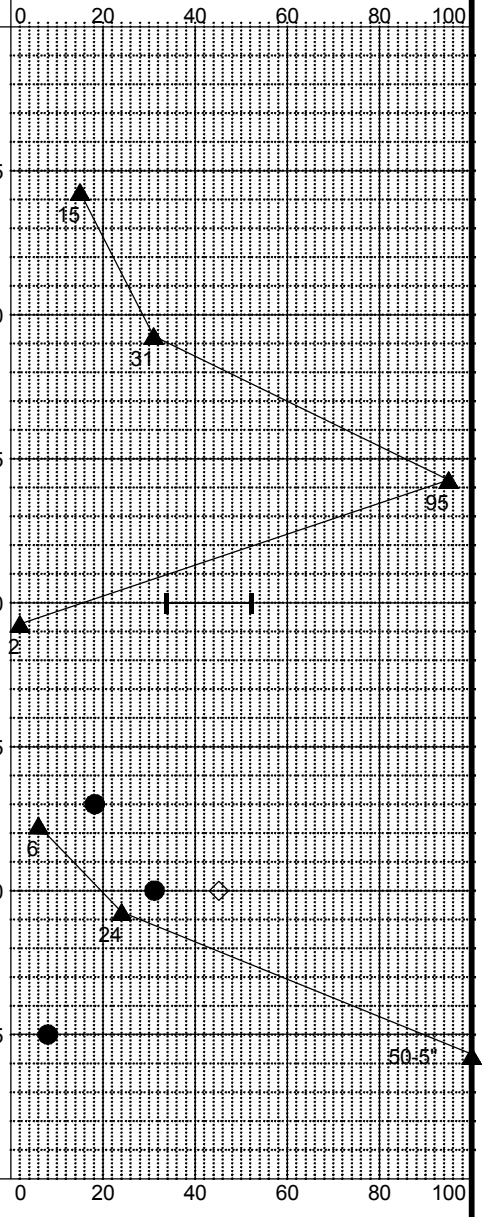
CONTINUED NEXT SHEET

Symbol / Samples / Ground Water / Depth, ft.

S-1, S-2, S-3, S-4, S-5 *, S-6, S-7, S-8

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

LEGEND

* Sample Not Recovered

Standard Penetration Test

3" O.D. Shelby Tube

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-10

May 2008 | 24-1-03420-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A11
Sheet 1 of 2

Typ: CKS Rev: Log: CKS MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

Total Depth:	*40.2 ft.*	Northing:	~	Drilling Method:	*Mud Roatary*	Hole Diam.:	*5 in.*
Top Elevation:	*50 ft.*	Easting:	~	Drilling Company:	*Hardcore Drilling*	Rod Type:	*NWJ*
Vert. Datum:		Station:	~	Drill Rig Equipment:	*CME-75*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

0 20 40 60 80 100

9.8
40.2

ALLUVIUM

S-9 50-4

Bottom of Boring Completed 2/26/2008.

45 50 55 60 65 70 75

0 20 40 60 80 100

LEGEND

* Sample Not Recovered

Standard Penetration Test

3" O.D. Shelby Tube

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-10

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SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A11
Sheet 2 of 2

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08 Log: CKS Rev: Typ: CKS

Total Depth:	46.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	40 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. / Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft. | PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

39.5
0.5

Dark brown SILT numerous roots and organics. (ML)

TOPSOIL

Very soft to soft red-brown SILT trace of sand and gravel, moist, fine subrounded to subangular gravel, slight Fe-oxidation. (ML)

FILL

30
10.0

Very soft dark gray-brown SILT trace of fine sand, wet, no plasticity silt, occasional to scattered seams to layers of fine sand with numerous organics and wood debris, trace of micas. (ML)

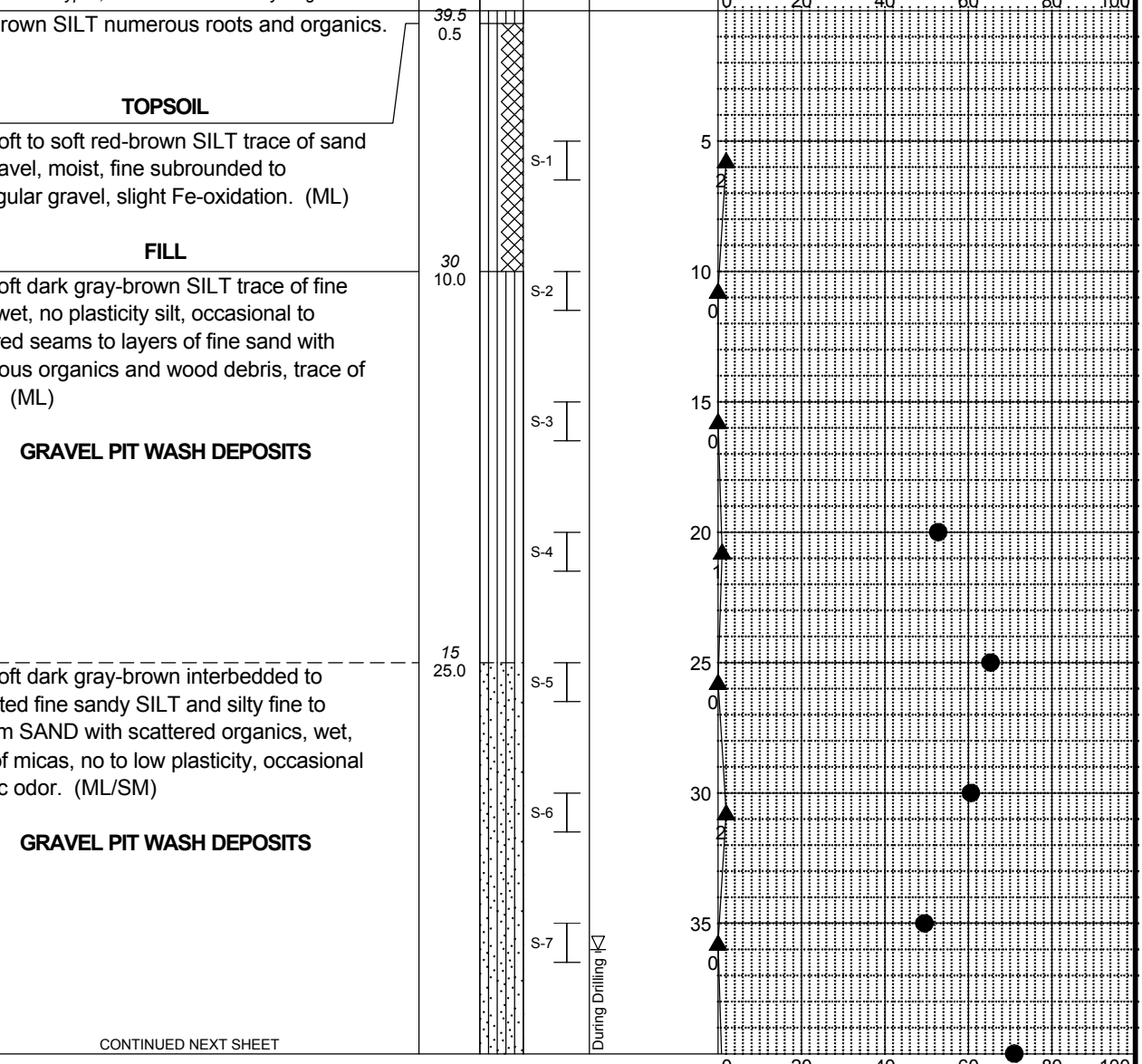
GRAVEL PIT WASH DEPOSITS

15
25.0

Very soft dark gray-brown interbedded to laminated fine sandy SILT and silty fine to medium SAND with scattered organics, wet, trace of micas, no to low plasticity, occasional organic odor. (ML/SM)

GRAVEL PIT WASH DEPOSITS

CONTINUED NEXT SHEET



LEGEND

* Sample Not Recovered
Standard Penetration Test
Ground Water Level

Plastic Limit — Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-11

May 2008 | 24-1-03420-001

SHANNON & WILSON, INC.
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FIG. A12
Sheet 1 of 2

Typ: CKS | Rev: | Log: CKS

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

Total Depth:	46.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	40 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

continued,
Very soft dark gray-brown interbedded to laminated fine sandy SILT and silty fine to medium SAND with scattered organics, wet, trace of micas, no to low plasticity, occasional organic odor. (ML/SM)

-3.5
43.5

S-8

-6
46.0

S-9

-6.5
46.5

GRAVEL PIT WASH DEPOSITS

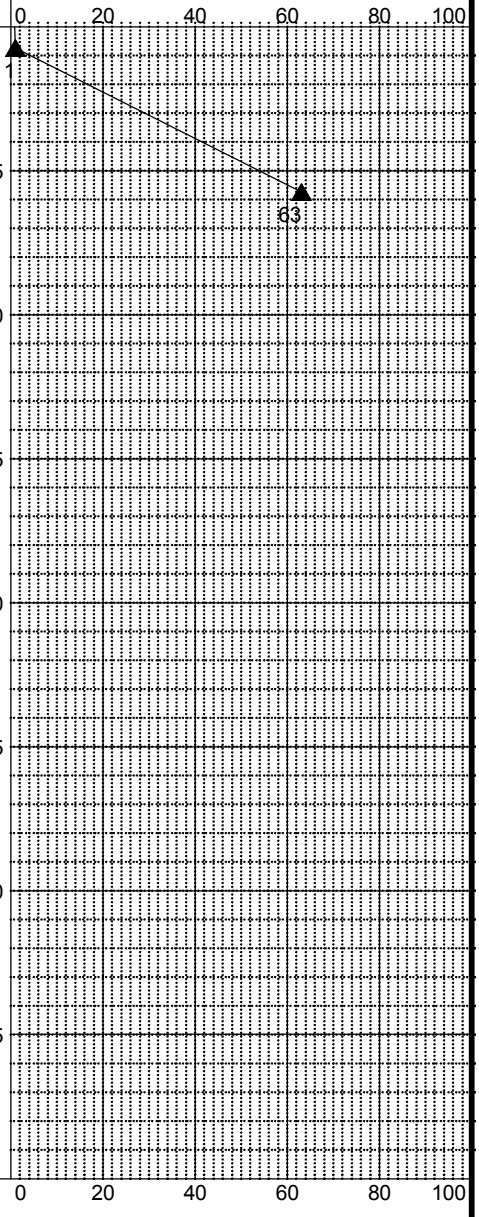
Very dense gray to reddish-brown sandy GRAVEL with silt, moist, ronded to subrounded gravel. (GM-GW)

ALLUVIUM

Very hard clayey SILT trace of sand, moist, moderate Fe-oxidation, relic conglomerate structure or relic siltstone, severely weathered gravel. (MH)

SILTSTONE

Bottom of Boring Completed 2/26/2008.



LEGEND

* Sample Not Recovered
Standard Penetration Test
Ground Water Level

Plastic Limit — Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-11

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SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A12
Sheet 2 of 2

Typ: CKS Rev: Log: CKS

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

Total Depth:	31.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	48 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Sandy GRAVEL with cobbles, moist, angular to subangular gravels and cobbles. (GM)

46
2.0

RAILROAD BALLAST FILL

Very loose to loose brown silty SAND, moist, fine to medium sand, no to low plasticity silt, occasional pockets of dark brown silt with scattered organic debris. (SM)

ALLUVIUM

33
15.0

Soft brown sandy SILT, moist, fine to medium sand, no to low plasticity silt, occasional organic debris. (ML)

28
20.0

Very loose to loose brown silty SAND, moist, fine to medium sand, no to low plasticity silt, micaceous. (SM)

18.5
29.5

Dense brown-gray sandy GRAVEL trace of silt, dry to moist, rounded to subangular gravel, fine to medium gravel up to 1.5-inch diameter. (GW)

16.5
31.5

ALLUVIUM

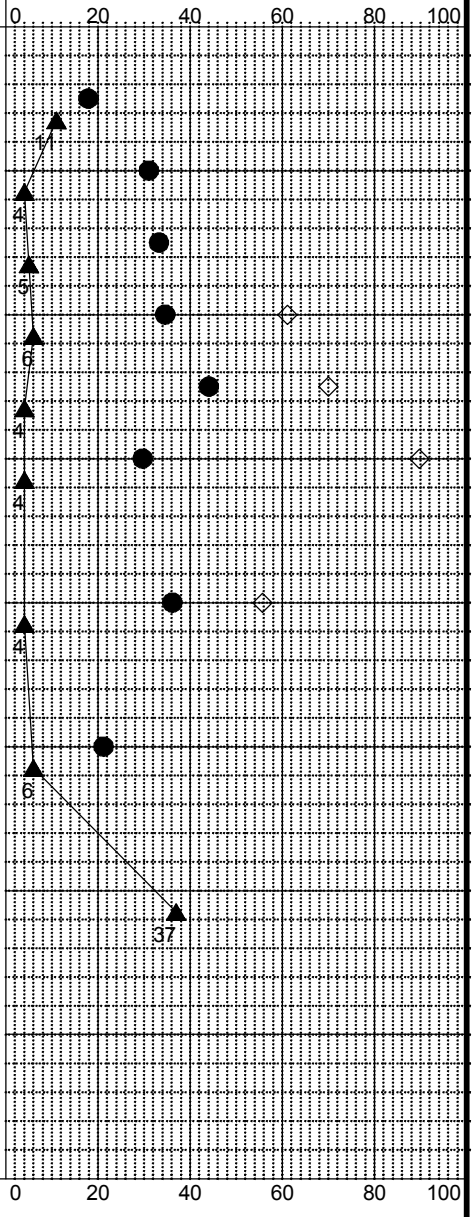
Bottom of Boring Completed 2/27/2008.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-8, S-9

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



LEGEND

* Sample Not Recovered

Standard Penetration Test

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit — Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-12

May 2008 | 24-1-03420-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A13

Typ: CKS | Rev: | Log: CKS

MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

Total Depth:	17 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	46 ft.	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Loose brown silty SAND, moist, fine to medium sand, low plasticity silt, occasional to scattered roots and organic debris, trace of subrounded gravels in upper 4.0 feet. (SM)

FILL

38.5
7.5

Soft brown sandy SILT, moist, fine sand, low plasticity silt, occasional roots and organic debris. (ML)

36
10.0

Very loose brown silty SAND, moist, fine to medium sand, low plasticity silt, occasional roots and organic debris. (SM)

ALLUVIUM

29
17.0

Bottom of Boring Completed 2/27/2008.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

S-1 (9), S-2 (6), S-3 (4), S-4 (4), S-5 (3), S-6 (3)

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

0 20 40 60 80 100

Depth, ft.: 0, 5, 10, 15, 20, 25, 30, 35

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

LEGEND

* Sample Not Recovered

⌶ Standard Penetration Test

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF BORING IB-13

May 2008 24-1-03420-001

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FIG. A14

Log: CKS Rev: Typ: CKS

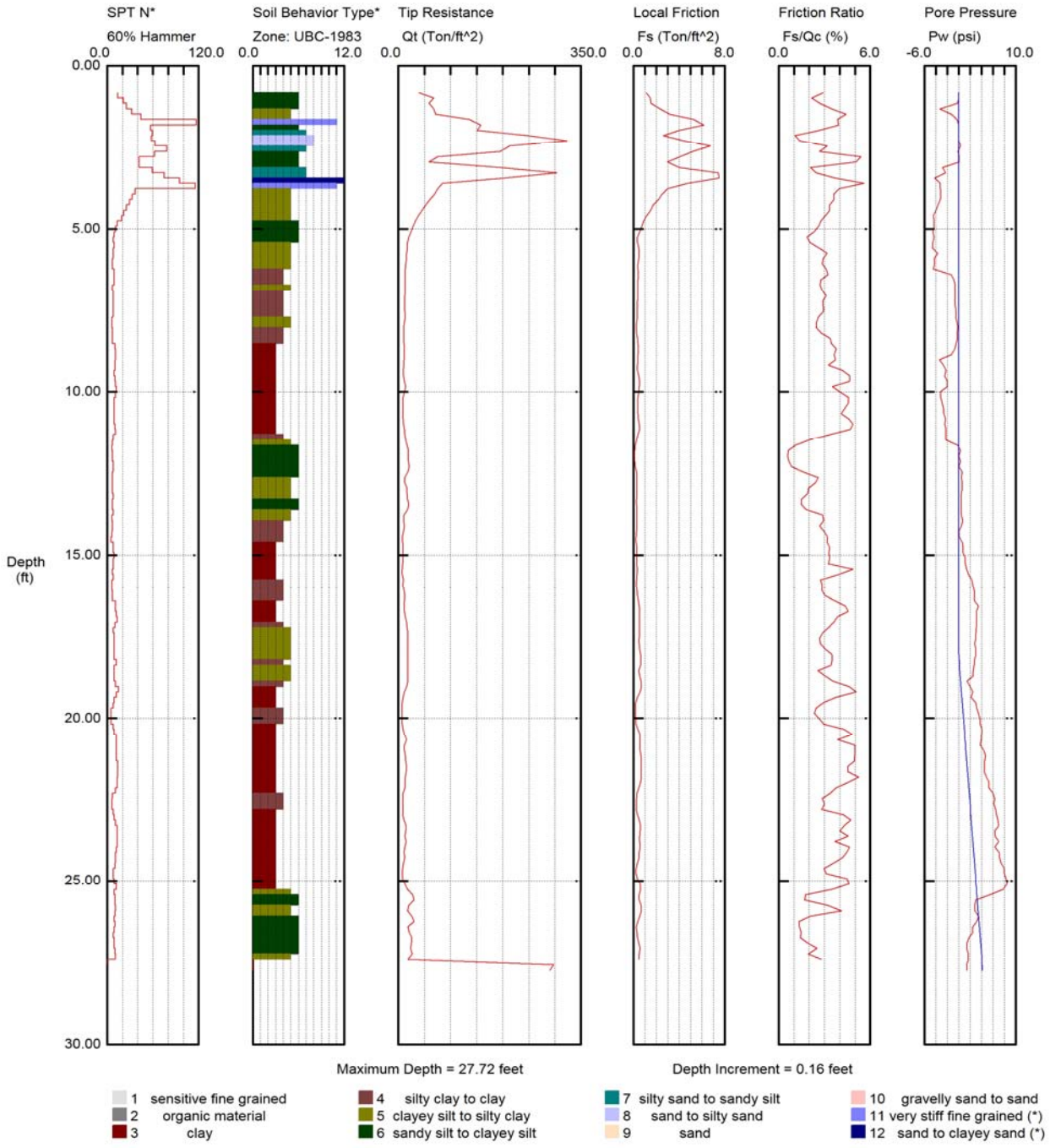
MASTER_LOG_E TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

*Soil behavior type and SPT based on data from UBC-1983

CPT-1

Operator: JSP/SVAN/VAN EXP
Sounding: FILO04
Cone Used: 4CH

CPT Date/Time: 08-14-07 08:49
Location: CP1 AGNESWWTP OC
Job Number: S&W/24-1-03420-1



NOTES:
1. A Log of probe is based on piezocone probe data provided by Vandehey Explorations.
2. The pore pressure was measured behind the tip of the penetrometer. Hydrostatic pore pressure based on an estimated groundwater depth.
3. The estimated soil properties are based on analyses performed using published correlations and equations. The method used for estimating the properties listed above are:
a. Uncorrected N-Value (N60) based on Robertson & Campanella.
b. Soil Behavior Type based on UBC-1983.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF CPT-1

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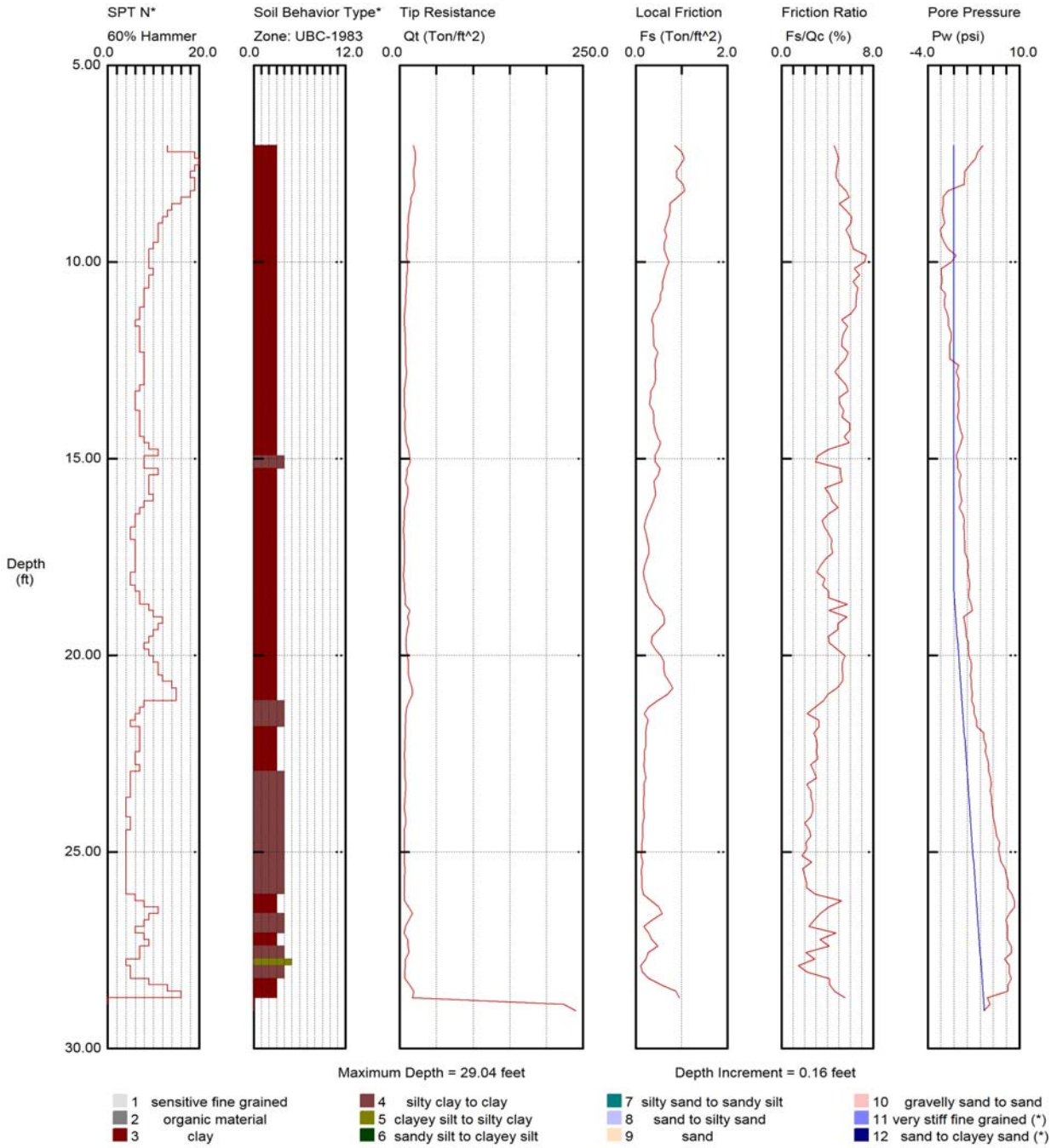
FIG. A15

*Soil behavior type and SPT based on data from UBC-1983

CPT-2

Operator: JSP/SVAN/VAN EXP
Sounding: FILO05
Cone Used: 4CH

CPT Date/Time: 08-14-07 11:04
Location: CP2 AGNESWWTP OC
Job Number: S&W/24-1-03420-1



NOTES:
1. A Log of probe is based on piezocone probe data provided by Vandehey Explorations.
2. The pore pressure was measured behind the tip of the penetrometer. Hydrostatic pore pressure based on an estimated groundwater depth.
3. The estimated soil properties are based on analyses performed using published correlations and equations. The method used for estimating the properties listed above are:
a. Uncorrected N-Value (N60) based on Robertson & Campanella.
b. Soil Behavior Type based on UBC-1983.

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

LOG OF CPT-2

May 2008 24-1-03420-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

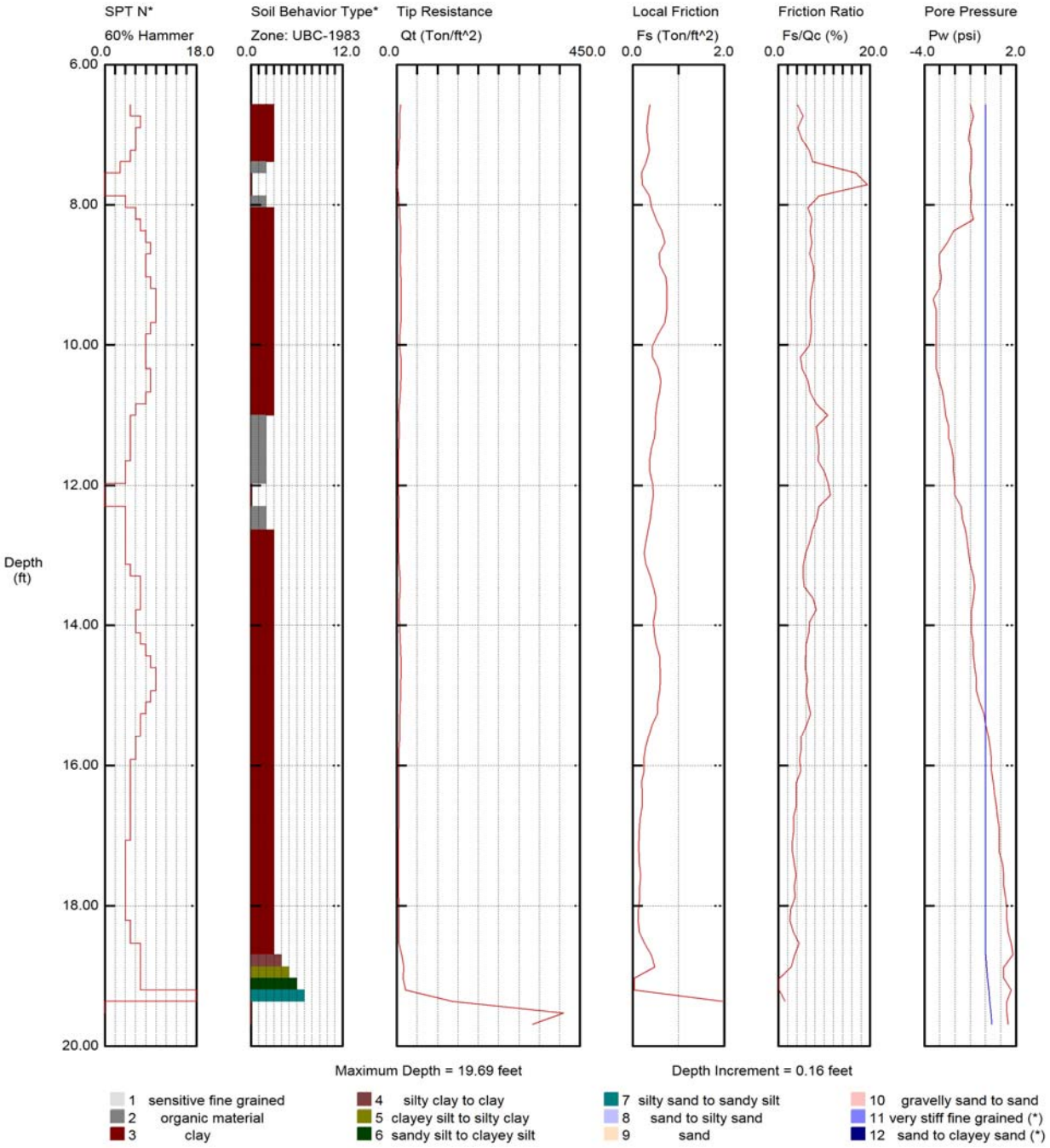
FIG. A16

*Soil behavior type and SPT based on data from UBC-1983

CPT-3

Operator: JSP/SVAN/VAN EXP
Sounding: FILO07
Cone Used: 4CH

CPT Date/Time: 08-14-07 11:40
Location: CP3 AGNESWWTP OC
Job Number: S&W/24-1-03420-1



NOTES:
1. A Log of probe is based on piezocone probe data provided by Vandehey Explorations.
2. The pore pressure was measured behind the tip of the penetrometer. Hydrostatic pore pressure based on an estimated groundwater depth.
3. The estimated soil properties are based on analyses performed using published correlations and equations. The method used for estimating the properties listed above are:
a. Uncorrected N-Value (N60) based on Robertson & Campanella.
b. Soil Behavior Type based on UBC-1983.

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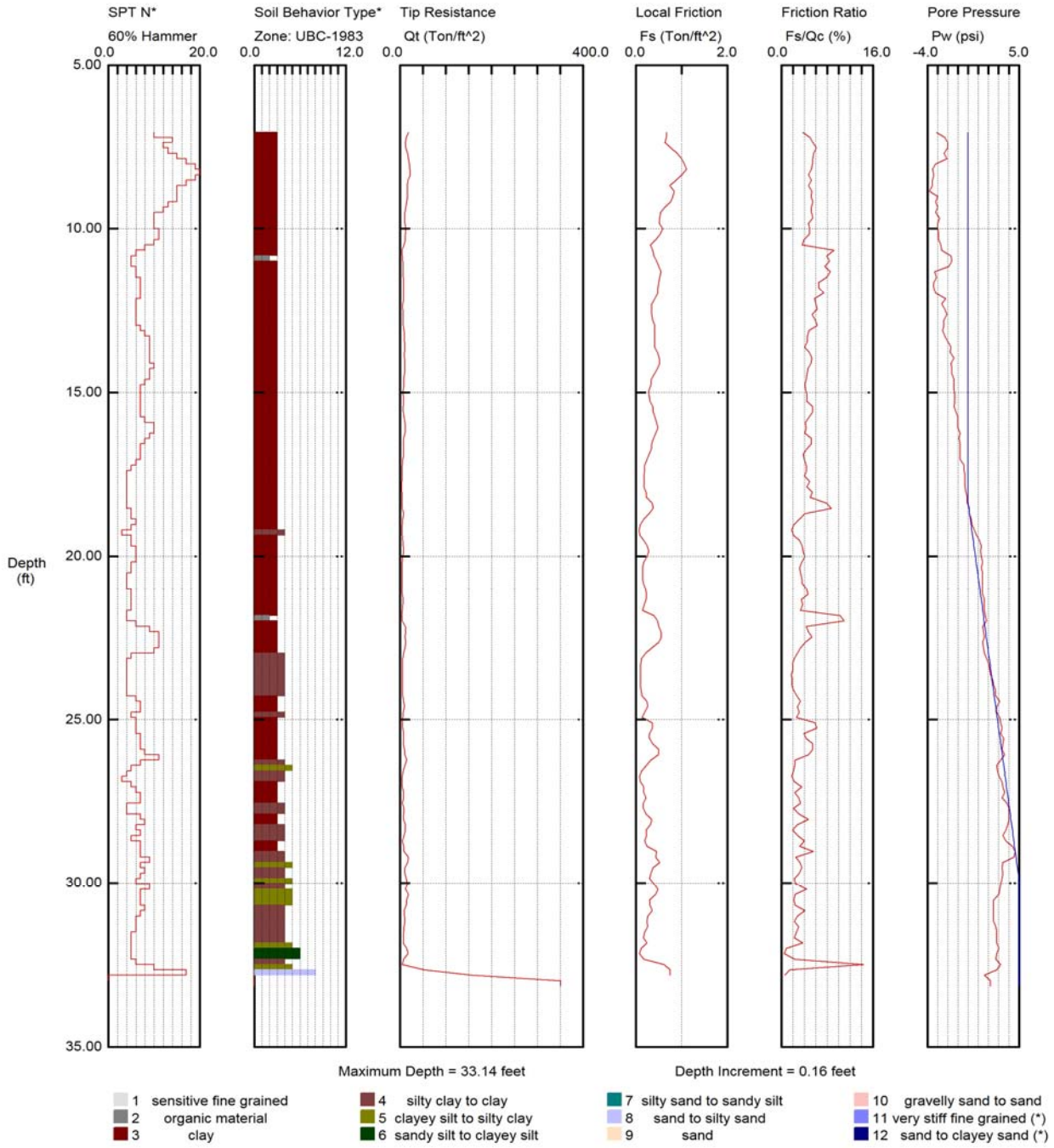
FIG. A17

*Soil behavior type and SPT based on data from UBC-1983

CPT-4

Operator: JSP/SVAN/VAN EXP
Sounding: FILO08
Cone Used: 4CH

CPT Date/Time: 08-14-07 13:00
Location: CP4 AGNESWWTP OC
Job Number: S&W/24-1-03420-1



NOTES:
1. A Log of probe is based on piezocone probe data provided by Vandehey Explorations.
2. The pore pressure was measured behind the tip of the penetrometer. Hydrostatic pore pressure based on an estimated groundwater depth.
3. The estimated soil properties are based on analyses performed using published correlations and equations. The method used for estimating the properties listed above are:
a. Uncorrected N-Value (N60) based on Robertson & Campanella.
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FIG. A18

APPENDIX B
S&W LABORATORY TESTING

APPENDIX B

S&W LABORATORY TESTING

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Figure No.

APPENDIX B

S&W LABORATORY TESTING

B.1 GENERAL

A laboratory testing program was developed and implemented in order to evaluate physical and engineering characteristics of the subsurface soils. Laboratory tests on selected soil samples included standard classification tests, which consisted of visual examination, moisture/density tests, Atterberg limits, grain-size analysis, hydrometers, and grain-size wash analysis, i.e., percent finer than the No. 200 sieve. In addition, in-place density tests, in-situ shear strength and unconfined compressive strength tests were conducted on selected undisturbed thin-walled samples. This Appendix contains the full lab results from S&W laboratory testing program, in addition to Figure B1, which summarizes all laboratory testing performed on samples collected on site (this includes the laboratory results from previous work done on-site by others). We cannot assure the completeness or accuracy of the data from other sources, but the information was used by Shannon & Wilson to supplement our interpretation of subsurface conditions and soil properties. The last column of Figure B1 indicates from which previous report the laboratory data was assembled.

B.1.1 Moisture (Natural Water) Content

Selected soil samples were evaluated to determine their in-situ water content. The moisture content is defined as the ratio of the weight of water to the dry weight of soil, expressed as a percentage. The results from our moisture testing are shown on Figure B-1. Additionally, the results of the moisture content determinations are presented on the logs of the borings in Appendix A.

B.1.2 Atterberg Limits

Atterberg Limits were determined on selected samples of fine-grained soils (that is, silts, clays and clayey silts) for the purpose of classifying fine-grained soils into groups based on plastic properties of the soil. Plastic properties of soils are used in a number of soil property correlations. Table 1 below shows the results of the Atterberg Limits tests that were performed by Shannon & Wilson. The results of the Atterberg Limits test are plotted on the plasticity chart on Figure B2 in this appendix.

TABLE 1
Atterberg Limits

Boring	Depth, ft	Liquid Limit	Plastic Limit	Plasticity Index	Classification
IB-2	15	44	32	12	ML
IB-3	20	41	30	11	ML
IB-4	15	34	33	1	ML
IB-4	30	41	35	6	ML
IB-9	20	NP	NP	NP	ML
IB-10	20	52	34	18	MH
IB-13	7.5	45	35	11	ML

B.1.3 Grain-Size Analyses

Grain-size analyses were conducted on selected soil samples to determine their particle size distribution. For most samples, a wet sieve analyses was performed to determine a percentage (by weight) of the sample passing the No. 200 (0.75 mm) sieve. For selected samples, a full grain size distribution curve was developed by testing the minus No. 10 material using a hydrometer, washing the full sample over a No. 200 sieve, and sieving the plus No. 200 material through a series of sieves to determine the distribution of the plus No. 200 material. The hydrometer plus sieving results were used to develop the particle-size distribution curves down to 0.002 mm. Table 2 below shows the tabular results of S&W grain size analysis. Figure B3 in this appendix presents the results of the Grain-Size Analysis.

TABLE 2
Grain-Size Analysis

Boring	Depth, ft	Percent Gravel	Percent Sand	Percent Fines	Classification
IB-1	10	--	--	60.8	ML
IB-1	20	--	--	87.2	ML
IB-2	22	0.0	52.2	47.8	SM
IB-4	17	--	--	60.7	ML
IB-4	35	--	--	42.0	SM
IB-5	22	0.0	43.2	56.8	ML
IB-8	5	--	--	83.8	ML
IB-9	15	0.0	17.9	82.1	ML
IB-9	22	--	--	76.8	ML
IB-10	30	--	--	45.2	SM
IB-12	10	--	--	61.1	ML
IB-12	12.5	--	--	70.0	ML

IB-12	15	0	10.3	89.7	
IB-12	20	--	--	55.6	ML
IB-13	10	--	--	58.4	ML
IB-13	12.5	0	44.9	32.0	
IB-13	15	--	--	40.6	SM

B.1.4 Unit Weight of Undisturbed Samples

The unit weights, or densities, from the thin-walled Shelby tube samples were determined in the laboratory. Results from S&W testing are below in Table 3. The results from all Unit weight measurements performed on-site are presented in this appendix.

TABLE 3
Unit Weight of Undisturbed Samples

Boring	Depth, ft	Dry Density pcf
IB-2	20	73.87
IB-4	15	84.37
IB-5	20	95.56
IB-8	20	91.0
IB-9	10	83.3

B.1.5 Consolidation Test

Shannon & Wilson performed one consolidation test on a sample from the Alluvial Silts at a depth of 20 ft, in the vicinity of the UV disinfection building. A consolidation test indicates the amount of deformation that a soil may undergo when subjected to a certain load. The consolidation test indicated that the soils at under the UV building have exhibit compressive characteristics as shown on Figure B4, in this appendix. The results from all consolidation tests performed on-site are presented on Figure B1, with the full lab results presented in Appendix D.

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FIGURE B1 - LAB TESTING SUMMARY

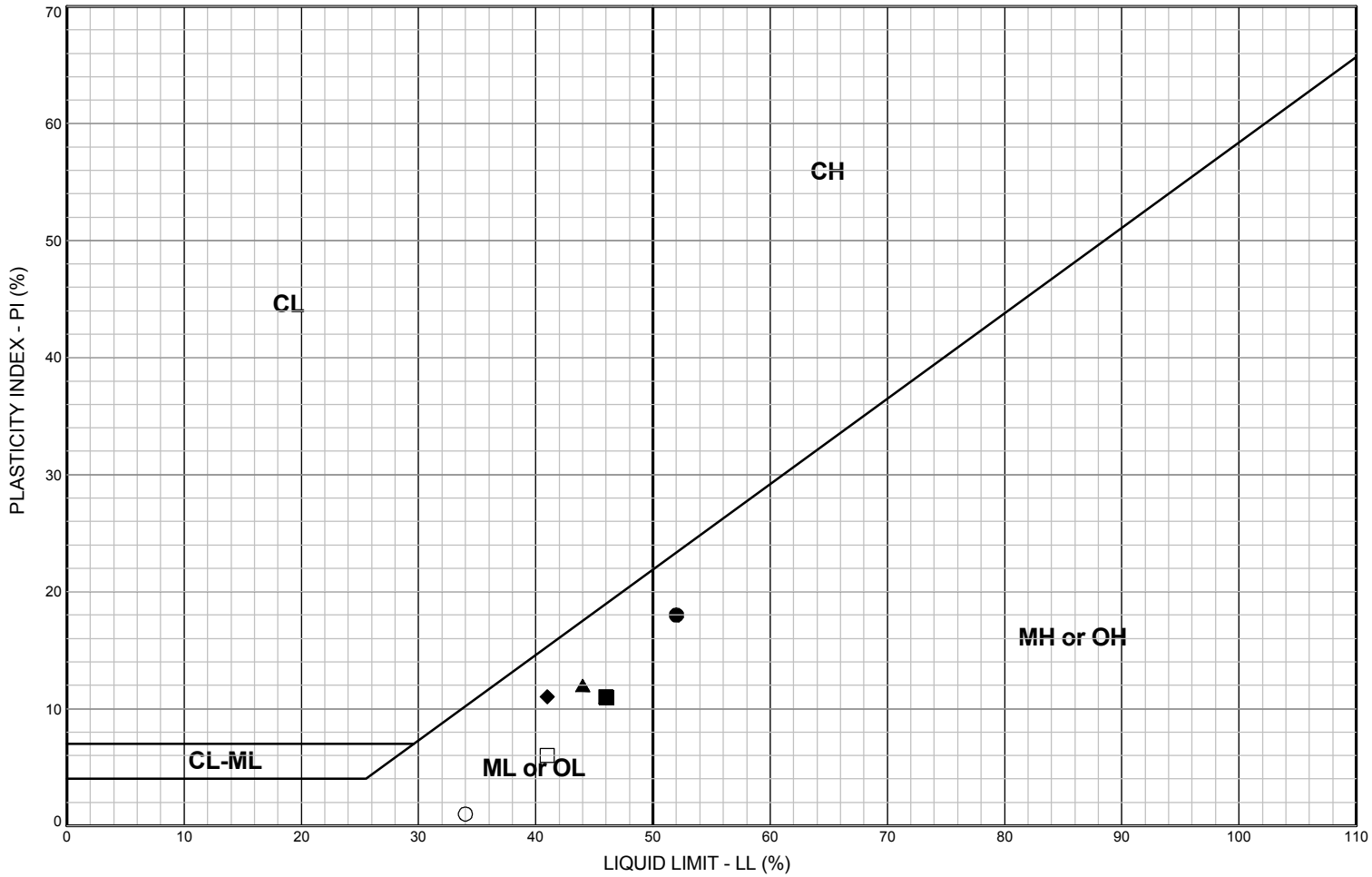
Tri-City WPCP Interim Expansion
24-1-03420-001

Boring	Sample Number	Sample Type	SPT N-value	Sample Depth (ft) Top	Bottom	Rec. (ft)	Geologic Unit	USCS	Classification	Water Content (%)	Atterberg Limits L.L	P.L.	P.I.	Grain Size Distribution Gravel (%)	Sand (%)	Fines (%)	C_C	C_U	Unit Weight (pcf) Wet	Dry	Direct Shear C' (psf)	ϕ (deg)	Laboratory Data Source, Date
B-101	SS-1	SPT	23	2.5	4		SILT	ML		30.0													CH_2M Hill, 2002
B-101	SS-8	SPT	7	27.5	29		SILT	ML		45.0	42	31	11										CH2M Hill, 2002
B-102	SS-3	SPT	11	10	11.5		SILT	ML		42.0													CH2M Hill, 2002
B-102	SO-6	Shelby	N/A	22.5	24.5		SILT	ML		43.0	48	32	26						110	77			CH2M Hill, 2002
B-102	SS-7	SPT	9	24.5	26		SILT	ML		45.0													CH2M Hill, 2002
B-102	SS-10	SPT	27	30.5	32		Silty SAND	SM								19.0							CH2M Hill, 2002
B-103	SS-4	SPT	2	15	16.5		SILT	ML		50.0	44	31	14										CH2M Hill, 2002
B-103	SS-6	SPT	4	22.5	24		SILT	ML		46.0													CH2M Hill, 2002
B-103	SS-8	SPT	15	27	28.5		Silty SAND	SM								29.0							CH2M Hill, 2002
B-103	SS-11	SPT	35	36	37.5		Silty GRAVEL	GM								6.0							CH2M Hill, 2002
B-104	SS-1	SPT	54-11"	5	5.92		SILT	ML		34.0													CH2M Hill, 2002
B-104	SS-4	SPT	9	26	27.5		Silty SAND	SM		37.0						47.0							CH2M Hill, 2002
B-105	SS-1	SPT	19	5	6.5		SILT	ML		32.0													CH2M Hill, 2002
B-105	SS-4	SPT	6	15	16.5		SILT	ML		35.0													CH2M Hill, 2002
B-105	SS-7	SPT	6	25	26.5		SILT	ML		47.0	42	36	6										CH2M Hill, 2002
B-106	SO-6	Shelby	N/A	23	24.5		SILT	ML		47.0	47	38	9						104	70.8			CH2M Hill, 2002
B-106	SS-8	SPT	12	27.5	29		Silty SAND	SM								35.0							CH2M Hill, 2002
B-6	SS-3	SPT	7	15	16.5		Silty SAND	SM								43.0	2	28					CH2M Hill, 1982
B-7	ST-3	Shelby	N/A	15	16.5		SILT	ML													200	32.3	CH2M Hill, 1982
B-15	SS-5	SPT	5	15	16.5		SILT	ML			NP	41	NP										CH2M Hill, 1982
B-16	ST-4	Shelby	N/A	10	12		Sandy SILT	ML		52.0	NP	50	NP			82.0	3	21	102	67			CH2M Hill, 1982
B-17	SS-1	SPT	4	5	6.5		SILT	MH		81.0	51	35	16										CH2M Hill, 1982
B-17	ST-3	Shelby	N/A	13	15		SILT	ML		54.0					6.0	94.0	5	33	107	69.4			CH2M Hill, 1982
B-18	ST-4	Shelby	N/A	10	12		Silty SAND	SM		30.0	NP	NP	NP		53.0	47.0	1	25			0	35.5	CH2M Hill, 1982
B-17	ST-3	Shelby	N/A	13	15		SILT	ML		54.0					2.0	98.0	2	6					CH2M Hill, 1982
B-17	ST-7	Shelby	N/A	23	25		Sandy SILT	ML		52.0					32.0	68.0	2	10	105	69			CH2M Hill, 1982
IB-1	S-1	SPT	5	5	6.5		SILT	ML		39.7													Shannon & Wilson, 2007
IB-1	S-2	SPT	4	10	11.5		Sandy SILT	ML		34.8						60.8							Shannon & Wilson, 2007
IB-1	S-3	SPT	3	15	16.5		Sandy SILT	ML		43.7													Shannon & Wilson, 2007
IB-1	S-4	SPT	3	20	21.5		Sandy SILT	ML		42.8						87.2							Shannon & Wilson, 2007
IB-1	S-5	SPT	39	25	26.5		Sandy GRAVEL	GM/GP															Shannon & Wilson, 2007
IB-2	S-1	SPT	13	5	6.5		SILT	ML		35.6													Shannon & Wilson, 2007
IB-2	S-2	SPT	7	10	11.5		SILT	ML		45.0													Shannon & Wilson, 2007
IB-2	S-3	SPT	12	15	16.5		SILT	ML		43.3	44	32	12										Shannon & Wilson, 2007
IB-2	S-4	Shelby	N/A	20	22		Silty SAND	SM		21.0									89.35	73.87			Shannon & Wilson, 2007
IB-2	S-5	SPT	5	22	23.5		Silty SAND	SM		32.3					52.2	47.8							Shannon & Wilson, 2007
IB-2	S-6	SPT	100	25	25.25		Sandy GRAVEL	GP															Shannon & Wilson, 2007
IB-3	S-2	SPT	3	10	11.5		SILT	ML		43.1													Shannon & Wilson, 2007
IB-3	S-3	SPT	2	15	16.5		SILT	ML		44.1													Shannon & Wilson, 2007
IB-3	S-4	SPT	3	20	21.5		SILT	ML		41.3	41	30	11										Shannon & Wilson, 2007
IB-3	S-5	SPT	4	25	26.5		SILT	ML															Shannon & Wilson, 2007
IB-3	S-6A	SPT	52	30	31		Silty SAND	SM		35.6													Shannon & Wilson, 2007
IB-4	S-1	SPT	15	5	6.5		SILT	ML		32.7													Shannon & Wilson, 2007
IB-4	S-3	Shelby	N/A	15	17		Sandy SILT	ML		33.3	34	33	1						112.5	84.37			Shannon & Wilson, 2007
IB-4	S-4	SPT	2	17	18.5		Sandy SILT	ML		45.2						60.7							Shannon & Wilson, 2007
IB-4	S-5	SPT	0	20	21.5		SILT	ML		47.4													Shannon & Wilson, 2007
IB-4	S-6	SPT	0	25	26.5		SILT	ML		52.0													Shannon & Wilson, 2007
IB-4	S-7	SPT	0	30	31.5		SILT	ML		48.8	41	35	6										Shannon & Wilson, 2007
IB-4	S-8	SPT	3	35	36.5		Silty SAND	SM		41.6						42.0							Shannon & Wilson, 2007
IB-4	S-9	SPT	43	40	41.5		SILTSTONE	SILTST.		55.3													Shannon & Wilson, 2007
IB-5	S-2	SPT	4	10	11.5		SILT	ML		36.9													Shannon & Wilson, 2007
IB-5	S-4	Shelby	N/A	20	22		Silty SAND	SM		23.0									117.6	95.56			Shannon & Wilson, 2007
IB-5	S-5	SPT	12	22	23.5		Silty SAND	SM		20.4					43.2	56.8							Shannon & Wilson, 2007
IB-5	S-6	SPT	100	25	26.4		Silty Sandy GRAVEL	GM		34.3													Shannon & Wilson, 2007
IB-8	S-1	SPT	3	5	6.5					46.4						83.8							Shannon & Wilson, 2008
IB-8	S-2	Shelby	N/A	10	12																		Shannon & Wilson, 2008
IB-8	S-3	SPT	4	12	13.5					37.7													Shannon & Wilson, 2008
IB-8	S-4	SPT	0	15	16.5					40.1													Shannon & Wilson, 2008
IB-8	S-5	Shelby	N/A	20	22					31.2									119.4	91			Shannon & Wilson, 2008
IB-8	S-6	SPT	4	22	23.5					38.8													Shannon & Wilson, 2008
IB-9	S-2	Shelby	N/A	10	12					44.3									120.2	83.3			Shannon & Wilson, 2008
IB-9	S-3	SPT	3	12	13.5					46.6													Shannon & Wilson, 2008
IB-9	S-4	SPT	0	15	16.5					50.7				0.0	17.9	82.1							Shannon & Wilson, 2008
IB-9	S-5	Shelby	N/A	20	22						NP	NP	NP										Shannon & Wilson, 2008
IB-9	S-6	SPT	0	22	23.5					50.2						76.8							Shannon & Wilson, 2008
IB-9	S-7	SPT	2	25	26.5					49.8													Shannon & Wilson, 2008
IB-10	S-4	SPT	2	20	21.5						52	34	18										Shannon & Wilson, 2008
IB-10	S-6	SPT	6	27	28.5					18.2													Shannon & Wilson, 2008
IB-10	S-7	SPT	24	30	31.5					31.2						45.2							Shannon & Wilson, 2008
IB-10	S-8	SPT	100	35	36.5					8.0													Shannon & Wilson, 2008
IB-11	S-4	SPT	1	20	21.5					52.7													Shannon & Wilson, 2008
IB-11	S-5	SPT	0	25	26.5					65.3													Shannon & Wilson, 2008

FIGURE B1 - LAB TESTING SUMMARY

Boring	Sample Number	Sample Type	SPT N-value	Sample Depth (ft) Top	Bottom	Rec. (ft)	Geologic Unit	USCS	Classification	Water Content (%)	Atterberg Limits L.L	P.L.	P.I.	Grain Size Distribution Gravel (%)	Sand (%)	Fines (%)	C_C	C_U	Unit Weight (pcf) Wet	Dry	Direct Shear C' (psf)	ϕ (deg)	Laboratory Data Source, Date
IB-11	S-6	SPT	2	30	31.5					60.6													Shannon & Wilson, 2008
IB-11	S-7	SPT	0	35	36.5					49.5													Shannon & Wilson, 2008
IB-11	S-8	SPT	1	40	41.5					71.0													Shannon & Wilson, 2008
IB-12	S-1	SPT	11	2.5	4					17.9													Shannon & Wilson, 2008
IB-12	S-2	SPT	4	5	6.5					31.0													Shannon & Wilson, 2008
IB-12	S-3	SPT	5	7.5	9					33.2													Shannon & Wilson, 2008
IB-12	S-4	SPT	6	10	11.5					34.6						61.1							Shannon & Wilson, 2008
IB-12	S-5	SPT	4	12.5	14					44.1						70.0							Shannon & Wilson, 2008
IB-12	S-6	SPT	4	15	16.5									0.0	10.3	89.7							Shannon & Wilson, 2008
IB-12	S-7	SPT	4	20	21.5					36.1						55.6							Shannon & Wilson, 2008
IB-12	S-8	SPT	6	25	26.5					21.2													Shannon & Wilson, 2008
IB-13	S-3	SPT	4	7.5	9						45	35	11										Shannon & Wilson, 2008
IB-13	S-4	SPT	4	10	11.5					30.3						58.4							Shannon & Wilson, 2008
IB-13	S-5	SPT	3	12.5	14									0.0	44.9	32.0							Shannon & Wilson, 2008
IB-13	S-6	SPT	3	15	16.5					37.5						40.6							Shannon & Wilson, 2008

*Split Sample, if two water contents were taken, the higher was reported.



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML or OL: Inorganic and organic silts and clayey silts of low plasticity

MH or OH: Inorganic and organic silts and clayey silts of high plasticity

CL-ML: Silty clays and clayey silts

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION	LL %	PL %	PI %	NAT. W.C. %	FINES %
● IB-10, S-4	20.0	MH	Brown sandy SILT	52	34	18		
■ IB-13, S-3	7.5	ML	Brown sandy SILT	46	35	11		
▲ IB-2, S-3	15.0	ML	Brown SILT, medium plasticity	44	32	12	43.3	
◆ IB-3, S-4	20.0	ML	Brown SILT, medium plasticity	41	30	11	41.3	
○ IB-4, S-3	15.0	ML	Brown SILT with sand to sandy SILT, non-plastic	34	33	1	44.6	
□ IB-4, S-7	30.0	ML	Brown SILT, low plasticity	41	35	6	48.7	
IB-9, S-5	20.0	ML	Brown SILT with sand	NP	NP	NP		

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ATTERBERG LIMITS RESULTS

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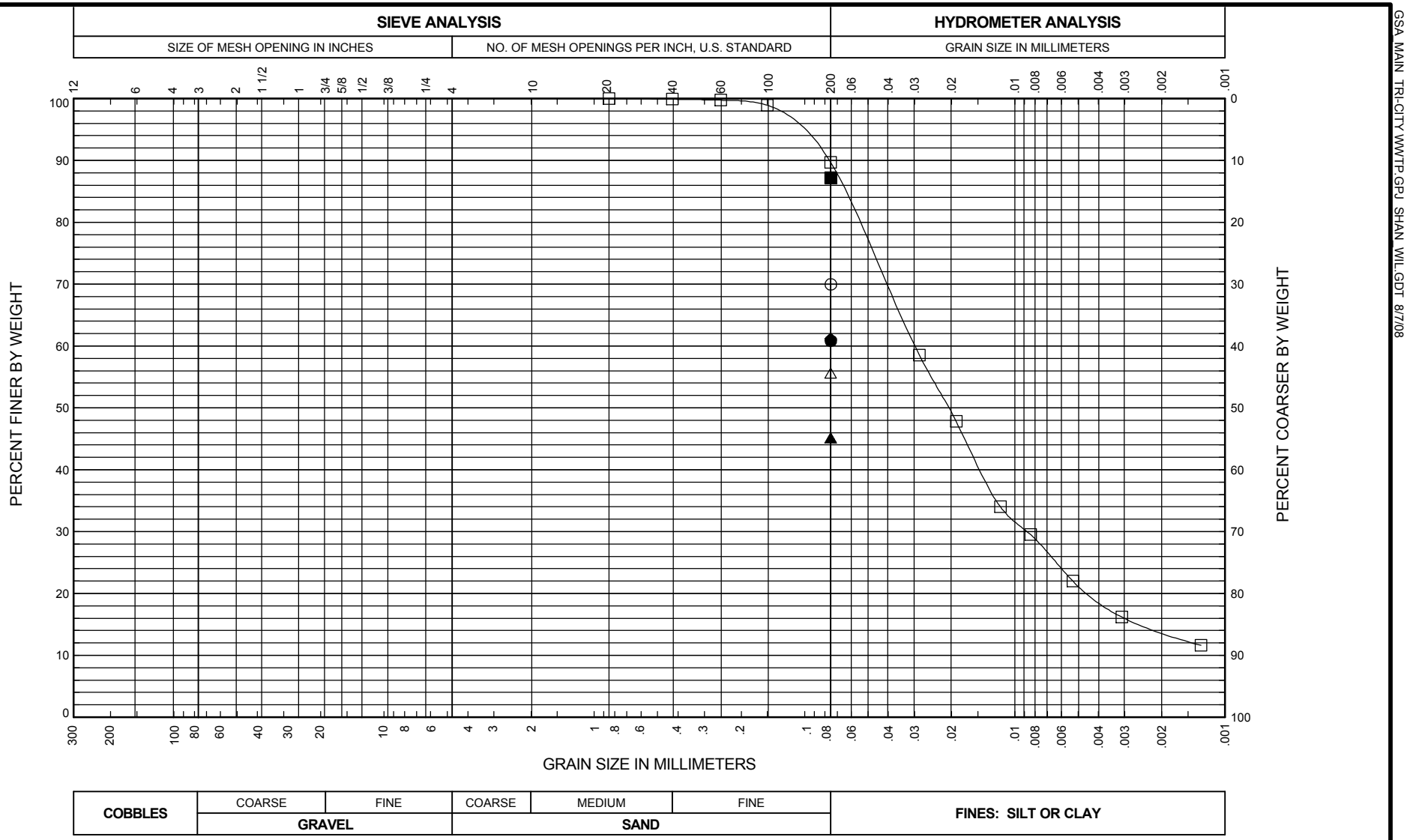
FIG. B1

FIG. B1



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	GRAVEL %	SAND %	FINES %	NAT. W.C. %	DRY DENSITY PCF
● IB-1, S-2	10.0	ML	Brown sandy SILT, non-plastic	0.0	0.0	60.8	34.8	
■ IB-1, S-4	20.0	ML	Brown SILT with sand, low plasticity	0.0	0.0	87.2	42.8	
▲ IB-10, S-7	30.0	ML	Brown sandy, gravelly SILT	0.0	0.0	45.2	31.2	
◆ IB-12, S-4	10.0	ML	Brown sandy SILT	0.0	0.0	61.1	34.6	
○ IB-12, S-5	12.5	ML	Brown sandy SILT	0.0	0.0	70.0	44.1	
□ IB-12, S-6	15.0	ML	Brown SILT with sand	0.0	10.3	89.7	29.7	
△ IB-12, S-7	20.0	ML	Brown sandy SILT	0.0	0.0	55.6	36.1	

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GRAIN SIZE DISTRIBUTION

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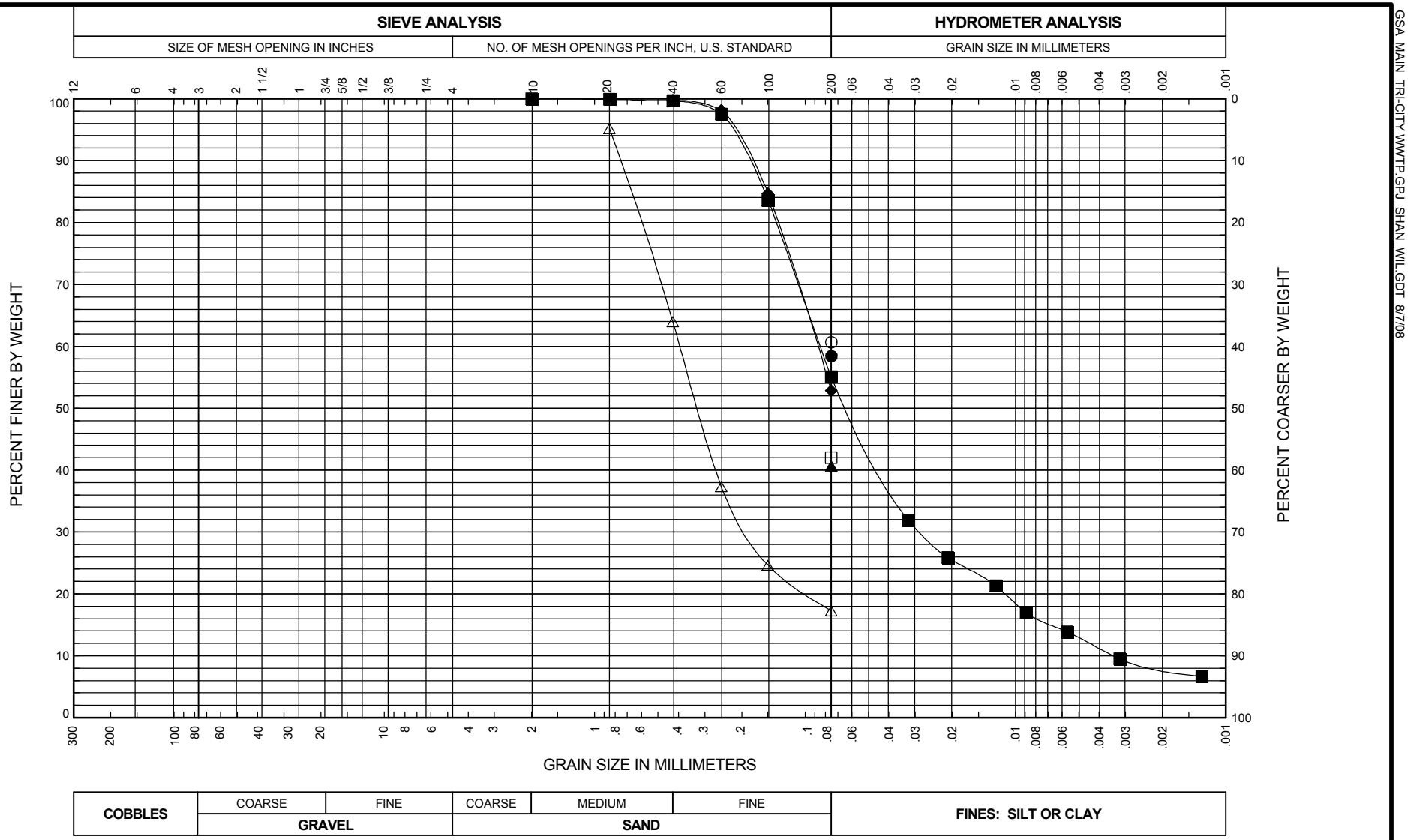
FIG. B2
Sheet 1 of 3

FIG. B2

GSA MAIN TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	GRAVEL %	SAND %	FINES %	NAT. W.C. %	DRY DENSITY PCF
● IB-13, S-4	10.0	ML	Brown sandy SILT	0.0	0.0	58.4	30.3	
■ IB-13, S-5	12.5	ML	Brown sandy SILT	0.0	44.9	55.1	32.0	
▲ IB-13, S-6	15.0	SM	Brown silty SAND	0.0	0.0	40.6	37.5	
◆ IB-2, S-5	22.0	ML/SM	Brown sandy SILT to silty SAND, non-plastic	0.0	46.9	52.9	32.3	
○ IB-4, S-4	17.0	ML	Brown sandy SILT, non-plastic	0.0	0.0	60.7	45.2	
□ IB-4, S-8	35.0	SM	Grey and brown silty SAND, non-plastic	0.0	0.0	42.0	41.6	
△ IB-5, S-5	22.0	SM	Brown silty SAND, non-plastic	0.0	77.9	17.3	20.4	

Tri-City WPCP
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GRAIN SIZE DISTRIBUTION

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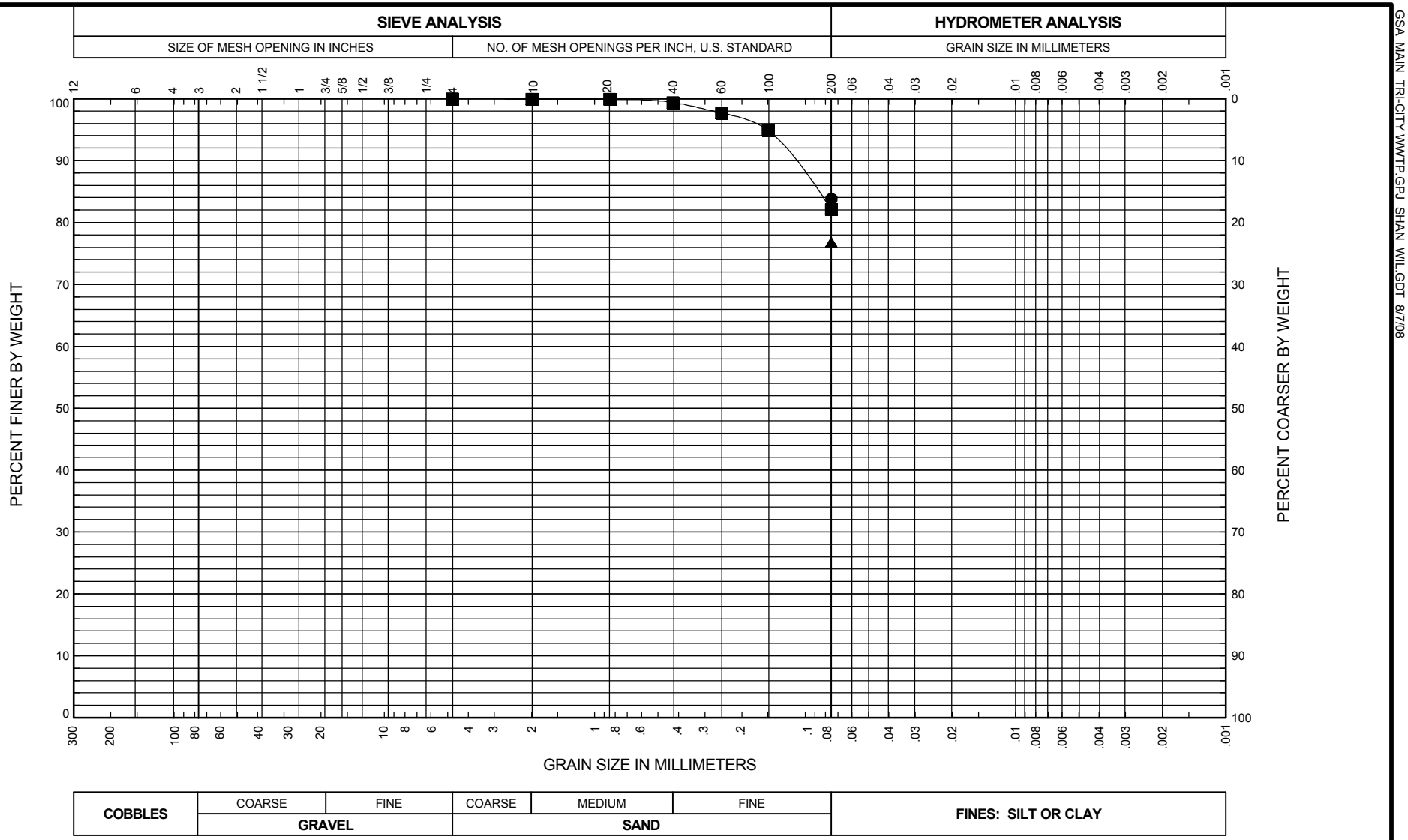
FIG. B2
Sheet 2 of 3

FIG. B2

GSA MAIN TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	GRAVEL %	SAND %	FINES %	NAT. W.C. %	DRY DENSITY PCF
● IB-8, S-1	5.0	ML	Brown SILT with sand	0.0	0.0	83.8	46.4	
■ IB-9, S-4	15.0	ML	Brown SILT with sand	0.0	17.9	82.1	50.7	
▲ IB-9, S-6	22.0	ML	Brown SILT with sand	0.0	0.0	76.8	50.2	

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

GRAIN SIZE DISTRIBUTION

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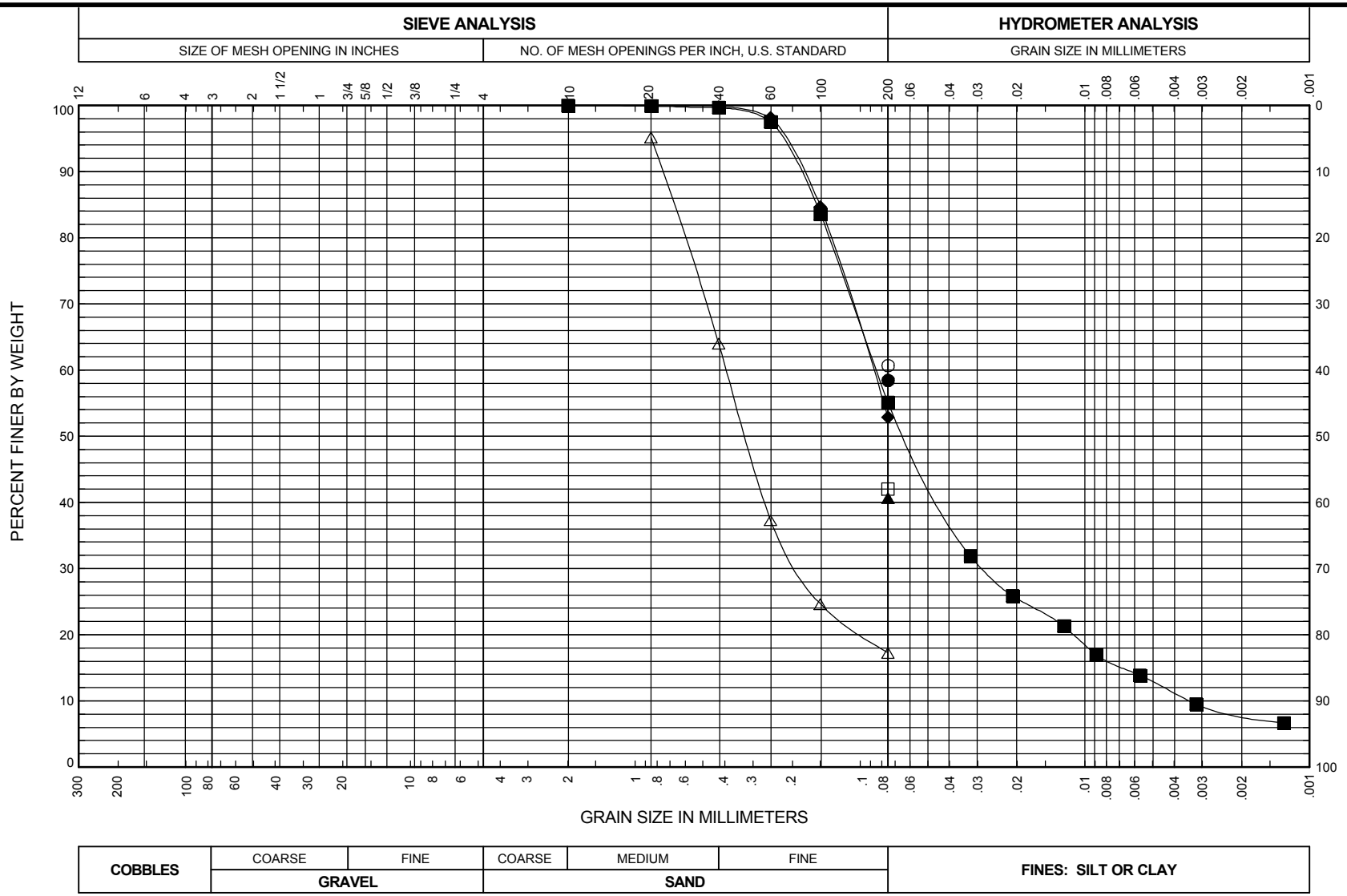
FIG. B2
Sheet 3 of 3

FIG. B2

GSA MAIN TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	GRAVEL %	SAND %	FINES %	NAT. W.C. %	DRY DENSITY PCF
● IB-13, S-4	10.0	ML	Brown sandy SILT	0.0	0.0	58.4	30.3	
■ IB-13, S-5	12.5	ML	Brown sandy SILT	0.0	44.9	55.1	32.0	
▲ IB-13, S-6	15.0	SM	Brown silty SAND	0.0	0.0	40.6	37.5	
◆ IB-2, S-5	22.0	ML/SM	Brown sandy SILT to silty SAND, non-plastic	0.0	46.9	52.9	32.3	
○ IB-4, S-4	17.0	ML	Brown sandy SILT, non-plastic	0.0	0.0	60.7	45.2	
□ IB-4, S-8	35.0	SM	Grey and brown silty SAND, non-plastic	0.0	0.0	42.0	41.6	
△ IB-8, S-5	22.0	SM	Brown silty SAND, non-plastic	0.0	77.9	17.3	20.4	

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

GRAIN SIZE DISTRIBUTION

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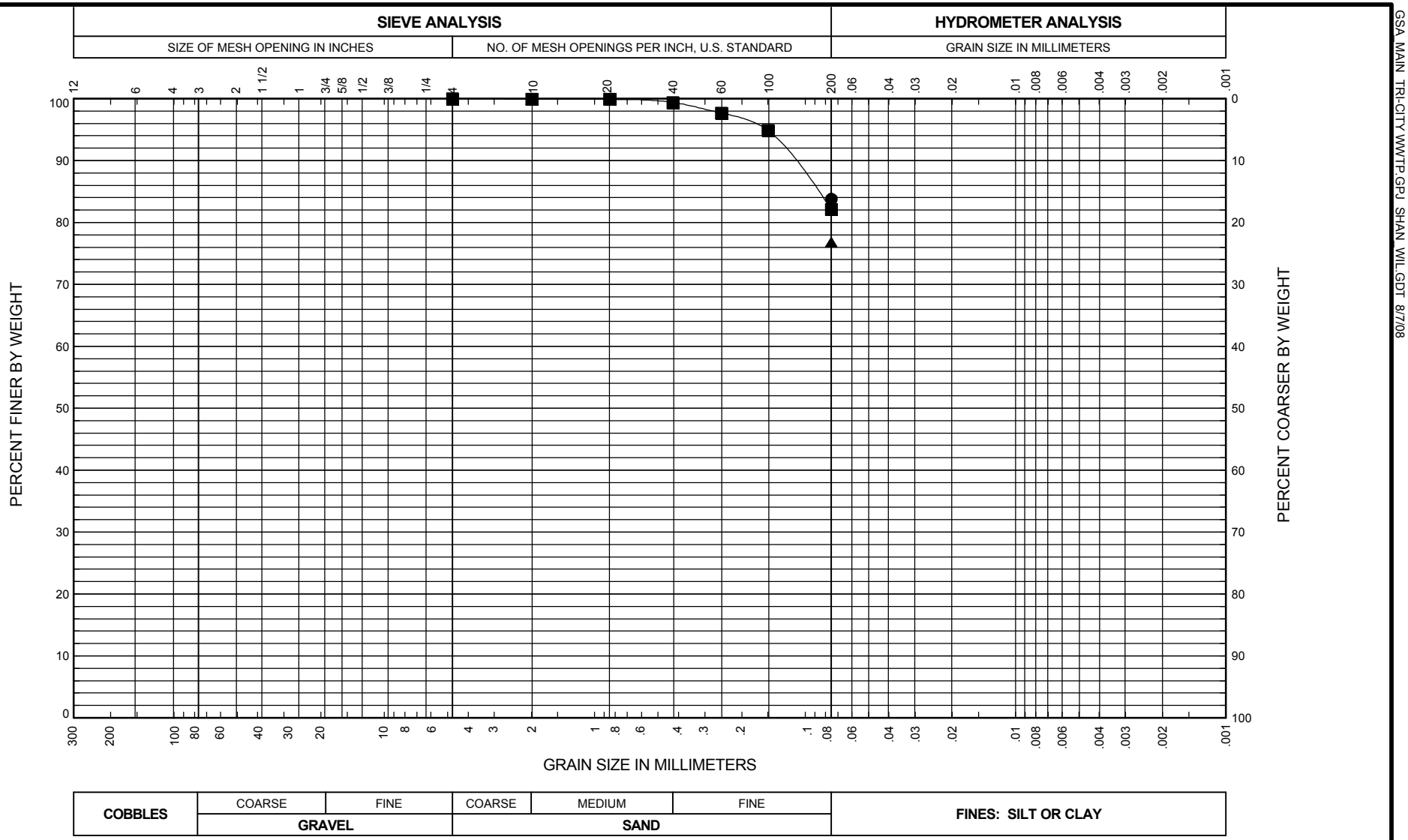
FIG. B2
Sheet 2 of 3

FIG. B2

GSA MAIN TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	GRAVEL %	SAND %	FINES %	NAT. W.C. %	DRY DENSITY PCF
● IB-8, S-1	5.0	ML	Brown SILT with sand	0.0	0.0	83.8	46.4	
■ IB-9, S-4	15.0	ML	Brown SILT with sand	0.0	17.9	82.1	50.7	
▲ IB-9, S-6	22.0	ML	Brown SILT with sand	0.0	0.0	76.8	50.2	

Tri-City WPCP
Phase 1 Expansion
Clackamas County, Oregon

GRAIN SIZE DISTRIBUTION

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FIG. B2
Sheet 3 of 3

FIG. B2

GSA MAIN TRI-CITY WWTP.GPJ SHAN_WIL.GDT 8/7/08

APPENDIX C

S&W IN-SITU TESTING

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APPENDIX C

S&W IN-SITU TESTING

B.1 GENERAL

We conducted falling head permeability tests in observation wells IB-12 and IB-13 in order to estimate the hydraulic conductivity of the formation in the proposed storm-water retention basin. The observation wells are each 15 feet deep and screened in the bottom 5 feet. The locations of these observation wells are shown on the Plan of Explorations, Figure 2. The soil logs of the observation well borings are presented in Appendix A, Figures A13 and A14.

B.2 FALLING HEAD TEST

Prior to testing, we saturated the soil in the test area by continuously filling the wells to the ground surface with potable water for more than 4 hours. We then performed two falling head permeability tests in each well. For each test:

- An acrylic plastic extension was temporarily affixed to the top of the standpipe.
- A Solinst Levelogger Gold Model 3001 electronic datalogging pressure transducer was placed in the bottom of the observation well.
- The well and acrylic plastic extension was filled with potable water to a level equivalent with a volume of seven liters over the top of the standpipe.
- The datalogger was set to record the water level in the well at 1 second intervals and all artificial flow to the well was stopped.
- The water level in the well was allowed to fall to less than 0.2 feet while the datalogger was recording.

The recorded change in head is plotted against time for each test in the semi-log plots presented in Figures C1 and C2. We made linear approximations of the portions of data which most likely represent the behavior of the target formation and used them to calculate soil hydraulic conductivity in general accordance with the procedures developed by Bower & Rice (1976). The term “general accordance” means that some assumptions and approximations were made to fit the conditions under which the tests were performed. The calculated hydraulic conductivities for each test are presented in Table 1, on the following page.

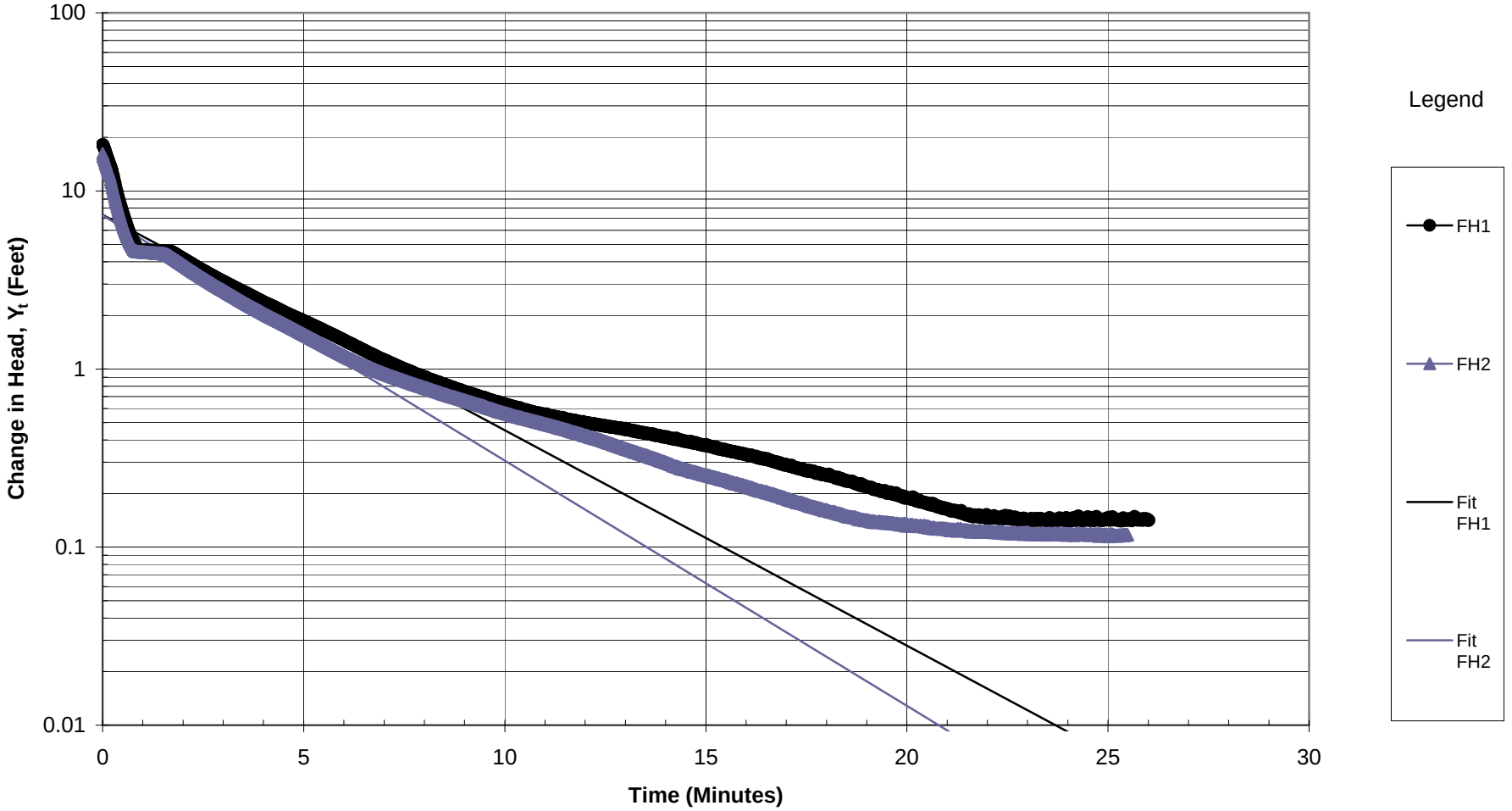
TABLE C1

Falling Head Test Results

BORING	TRIAL 1 K (cm/sec)	TRIAL 2 K (cm/sec)	AVERAGE K (cm/sec)
IB-12	8.1×10^{-4}	9.2×10^{-4}	8.7×10^{-4}
IB-13	2.1×10^{-4}	2.1×10^{-4}	2.1×10^{-4}

B.3 REFERENCE

Bower, H., and Rice, R.C., A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, *Water Resour. Res.*, 12(3), 423, 1976.



Notes:
1. In general accordance with the procedures developed by Bouwer & Rice (1976), "Fit" represents a linear approximation of the data used for calculation of soil hydraulic conductivity.

FIG. C1

Tri-City WWTP Phase 1 Expansion
Clackamas County, Oregon

FALLING HEAD TESTS
OBSERVATION WELL IB-12

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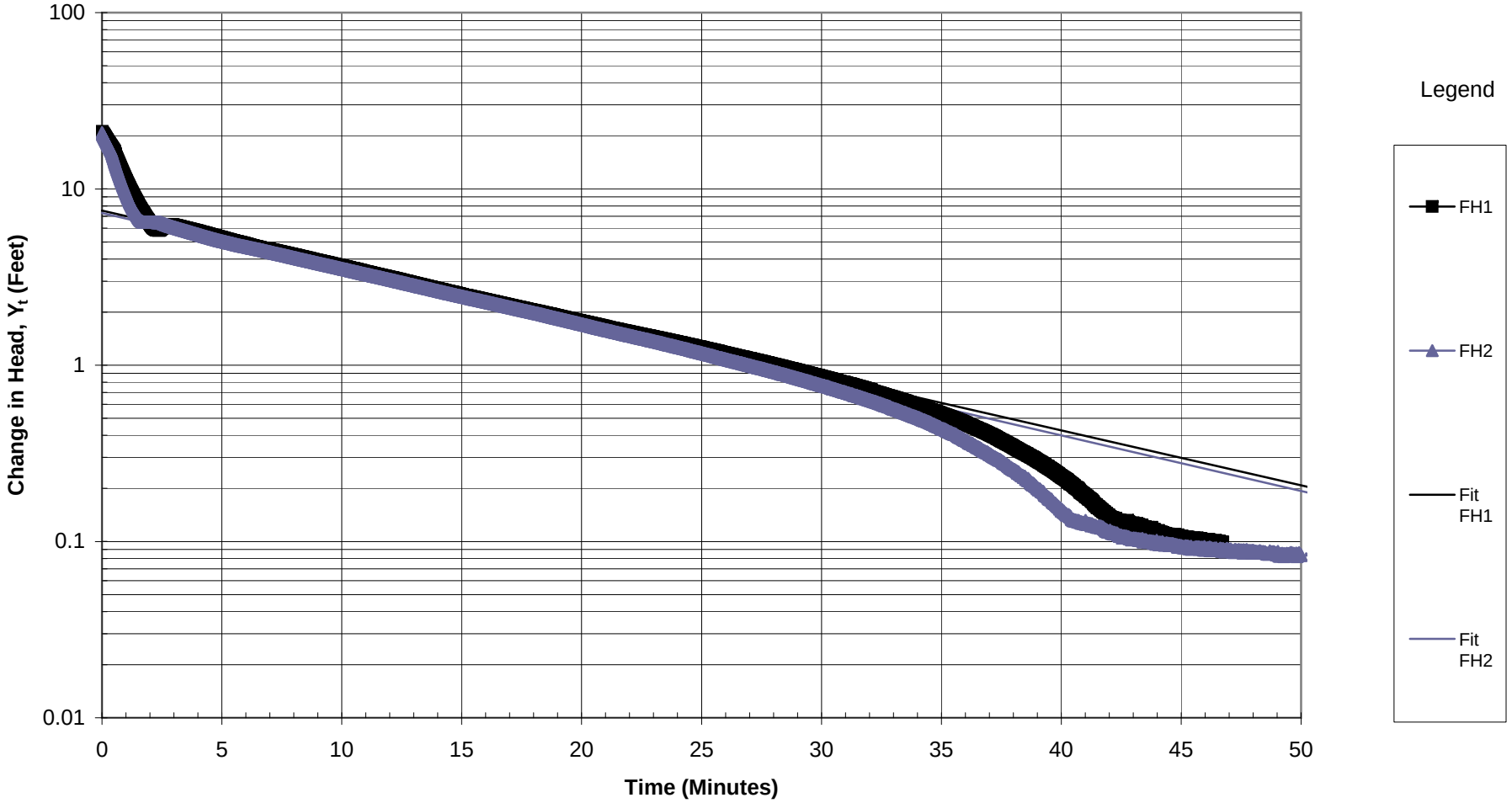
FIG. C1



Notes:
1. In general accordance with the procedures developed by Bouwer & Rice (1976), "Fit" represents a linear approximation of the data used for calculation of soil hydraulic conductivity.

Tri-City WWTP Phase 1 Expansion
Clackamas County, Oregon

FALLING HEAD TESTS
OBSERVATION WELL IB-13

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FIG. C2

FIG. C2

APPENDIX D
FIELD EXPLORATIONS AND LABORATORY TESTS BY OTHERS

APPENDIX D

FIELD EXPLORATIONS AND LABORATORY TESTS BY OTHERS

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D2–D70 Previous Boring Logs

APPENDIX D

PREVIOUS FIELD EXPLAORATIONS

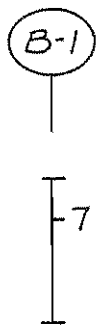
D.1 GENERAL

This appendix contains logs from previous exploratory borings on site and the original laboratory testing results. The lab data directly follows the boring logs for each individual source. Sources for the previous explorations are listed in the report text. The approximate location of the borings is shown on Figure 2, Plan of Explorations. Exploratory borings from adjacent properties are not included in this appendix.

NOTES:

1. THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE GENERALIZED FROM AND INTERPOLATED BETWEEN SOIL BORINGS. INFORMATION ON ACTUAL SUBSURFACE CONDITIONS EXISTS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THE BORING LOCATIONS. ALSO, THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS.
2. BORING LOCATIONS ARE SHOWN ON FIGURE 2.
3. BORINGS WERE LOGGED IN THE FIELD BY A CH2M HILL ENGINEERING GEOLOGIST.
4. BORINGS WERE DRILLED BY DON KENNER OF OREGON, INC. OF SHERWOOD, OREGON. BORINGS B-1 AND B-3 WERE DRILLED IN DECERMBER, 1981, USING A TRUCK-MOUNTED CME-55. THE REMAINDER OF THE BORINGS WERE DRILLED WITH A TRUCK MOUNTED CME-75 IN DECEMBER, 1981, AND IN JANUARY AND MAY, 1982.
5. TRANSITIONS BETWEEN SOIL TYPES MAY BE GRADUAL AND ARE APPROXIMATELY AT THE ELEVATIONS SHOWN.
6. SEE THE BORING LOGS FOR DETAILED DESCRIPTIONS OF THE SUBSURFACE CONDITIONS.

LEGEND



BORING NUMBER

SPLIT-SPOON SAMPLE (ASTM D1586), "N"-VALUE

STANDARD PENETRATION TEST:

BLOWS - THE NUMBER OF BLOWS FOR THREE 6-INCH INCREMENTS REQUIRED FROM A 140-LB HAMMER FALLING 30 INCHES TO DRIVE A STANDARD 2-INCH O.D. SPLIT-BARREL SAMPLER (ASTM D1586).

"N" - THE SUM OF BLOWS FOR THE SECOND AND THIRD 6- INCH INCREMENTS. IF THE SAMPLER IS DRIVEN LESS THAN 18-INCHES, THEN "N" IS THE NUMBER OF BLOWS FOR THE FRACTION OF THE LAST 2 6-INCH INCREMENTS.

FIGURE C-6
LEGEND AND NOTES
Tri-City Sewage Treatment Plant

BORING LOG LEGEND:

SAMPLE TYPE:

- S - SPLIT-BARREL (ASTM D1586 UNLESS OTHERWISE NOTED)
- ST - SHELBY TUBE
- W - WASH SAMPLE
- OT - OSTERBERG TUBE
- NX - DIAMOND CORE BARREL

STANDARD PENETRATION TEST:

BLOWS - THE NUMBER OF BLOWS FOR THREE 6-INCH INCREMENTS REQUIRED FROM A 140-LB HAMMER FALLING 30 INCHES TO DRIVE A STANDARD 2-INCH O.D. SPLIT-BARREL SAMPLER (ASTM D1586).

"N" - THE SUM OF BLOWS FOR THE SECOND AND THIRD 6-INCH INCREMENTS. IF THE SAMPLER IS DRIVEN LESS THAN 18 INCHES, THEN "N" IS THE NUMBER OF BLOWS FOR THE LAST TWO 6-INCH INCREMENTS.

UNIFIED SOIL CLASSIFICATION SYMBOL:

GROUP SYMBOL AS PER ASTM D 2487

NOTES:

1. BORINGS WERE DRILLED BY DON KENNER OF OREGON, INC. OF SHERWOOD, OREGON. BORINGS B-1 AND B-3 WERE DRILLED IN DECEMBER, 1981, USING A TRUCK-MOUNTED CME-55. THE REMAINDER OF THE BORINGS WERE DRILLED WITH A TRUCK-MOUNTED CME-75 IN DECEMBER, 1981, AND IN JANUARY AND MAY, 1982.

2. ENGINEERING PROPERITES OF SUBSURFACE MATERIALS ARE OPINION OF THE ENGINEERING GEOLOGIST, EXCEPT WHERE LABORATORY TESTING WAS CONDUCTED.

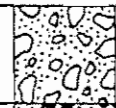
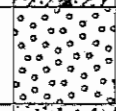
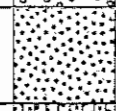
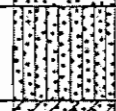
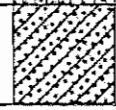
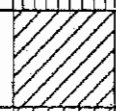
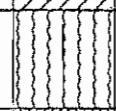
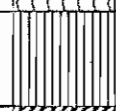
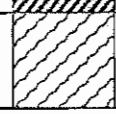
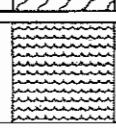
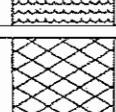
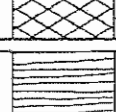
3. THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS. ALSO, THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS.

4. TRANSITIONS BETWEEN SOIL TYPES MAY BE GRADUAL AND ARE APPROXIMATELY AT THE ELEVATIONS SHOWN.

5. STANDARD PENETRATION TESTS WERE TAKEN IN APPROXIMATE ACCORDANCE WITH ASTM D1586.

6. SAMPLES WERE EXAMINED IN THE FIELD AND VISUALLY CLASSIFIED IN APPROXIMATE ACCORDANCE WITH ASTM 2488.

7. OPEN STANDPIPE PIEZOMETERS WERE INSTALLED IN BORINGS B-1, 3, 5, 7, 11, 13, 14, AND 21. ALL PIEZOMETERS CONSISTED OF A PERVIOUS PVC TIP THAT IS 18-INCHES LONG, 1.5-INCH INSIDE DIAMETER, AND HAS NOMINAL 0.010-INCH SLOTTED OPENINGS WITH 1/4-INCH SPACINGS. ALL TIPS WERE PACKED WITH 3/8-INCH PEA GRAVEL. RISER PIPE CONSISTS OF 3/4-INCH PVC PIPE, WITH APPROXIMATELY 0.5-FEET OF STANDPIPE ABOVE THE GROUND SURFACE. SEE INDIVIDUAL BORING LOGS FOR POSITION OF PERVIOUS TIP, ZONE OF GRAVEL-PACKING, AND LOCATION OF BENTONITE SEAL(S).

MAJOR DIVISION		LETTER DESIGNATION	GRAPHIC SYMBOL	DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOIL	GW		Well-graded gravel or gravel-sand mixtures, little or no fines
		GP		Poorly-graded gravel or gravel-sand mixtures, little or no fines
		GM		Silty gravel, gravel-sand-silt mixtures
		GC		Clayey gravel, gravel-sand-clay mixtures
	SAND AND SANDY SOIL	SW		Well-graded sand or gravelly sand, little or no fines
		SP		Poorly graded sand or gravelly sand, little or no fines
		SM		Silty sand, sand-silt mixtures
		SC		Clayey sand, sand-silt mixtures
FINE-GRAINED SOILS	SILTS AND CLAYS OF LOW PLASTICITY	ML		Inorganic silt of low to medium plasticity, gravelly silt, sandy silt, clayey silt
		CL		Inorganic clay of low to medium plasticity, gravelly clay, sandy clay, silty clay
		OL		Organic silts of low plasticity
	SILTS AND CLAYS OF HIGH PLASTICITY	MH		Inorganic silts of high plasticity
		CH		Inorganic clays of high plasticity
		OH		Organic clay and silt of medium to high plasticity
	HIGHLY ORGANIC SOILS	PT		Peat and other highly organic soils
	FILL			Fill, variable composition
	ROCK			Siltstone

GRAPHIC COLUMN LEGEND

CH2M HILL

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD, CME-55 DRILLERS & EQUIPMENT D. KENNER OF OREGON, INC.

ELEVATION 42.51 FEET BORE HOLE: B-1

WATER LEVEL SEE TEXT DATE: START: 12/21/81 FINISH: 12/22/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
									START DRILLING AT 11:25 LANDOWNER NOTES FILL MIGHT HAVE BEEN DUMPED ON SITE DURING CONSTRUCTION OF I-205
5	5.0								
	7.0	ST-1	21	- - -	-	SAND, SIMILAR TO S-1 (SEE BELOW)			BEGIN WITH DRAG BIT CHANGE TO ROLLER BIT AT 24.9 FT.
	8.5	S-1	7	2-2-2	4	SAND, FINE SAND WITH LESS THAN 5% NON-PLASTIC FINES, BROWN, MOIST, VERY LOOSE.		SP	
10	10.0								
	11.5	S-2	7	2-1-2	3	SAND, SAME AS S-1		SP	
15	15.0								
	16.5	S-3	7	2-3-5	8	SAND, SAME AS S-1		SP	
20	20.0								
	21.5	S-4	17	2-2-2	4	SILTY SAND, SIMILAR TO S-1 EXCEPT 20-25% NON-PLASTIC FINES		SM	
EL 17.5 25	25.0								DRILLER NOTES HARD DRILLING AT 24.9 FT, MIXMORE MUD AT 25 FT.
	26.5	S-5	14	26-46-46	92	SANDY GRAVEL, POORLY GRADED, WELL ROUNDED GRAVEL AT LEAST TO 1¼ INCH, 20% FINE-TO-COARSE SAND, MOSTLY MEDIUM, ABOUT 5% NON-PLASTIC FINES, WET, BROWN AND BLACK, VERY DENSE.		GP	SLOW ROUGH DRILLING TO 46 FT.

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY, CME-55 DRILLERS & EQUIPMENT DON KENNER OF OREGON, INC.

ELEVATION 42.51 FEET BORE HOLE: B-1

WATER LEVEL SEE TEXT DATE: START: 12/21/81 FINISH: 12/22/81 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
30	30								
	31.5	S-6	8	55-60/6"	105/12"	SANDY GRAVEL, SIMILAR TO S-5, WITH ABOUT 30% GRAVEL		GP	LOST CIRCULATION AT 31.5 FT, 32 AND 35 FT, REQUIRED MIXING MORE MUD.
35	35.0								
	35.5	S-7	0	60/5"	60/5"	NO RECOVERY			SAME COARSE, ANGULAR SAND CUTTINGS IN SAMPLE TUB. DRILLER NOTES SAND LENS AT 37-38 FT.
40	40.0								
	41.5	S-8	0	60/3"	60/3"	NO RECOVERY			SAMPLER BOUNCED DURING SPT. LOSE CIRCULATION AT 43 FT. VERY HARD, SLOW DRILLING, ADD NEW TRI CONE BIT AT 43 FT.
45	45.0								
	46.5	S-9	0	60/4"	60/4"	NO RECOVERY			DRILLER NOTES CHANGE IN DRILLING RATE (U.P) AT 46 FT, SAMPLE SS-6 PROBABLY FELL OUT OF TUBE ON TRIP UP, SILTY SAND CAKED ON SAMPLER
50	50.0								
	51.5	S-10	18	7-11-16	27	SILTSTONE, HIGHLY WEATHERED PLASTICITY, 5-10% FINE-TO-MEDIUM SAND IN UPPER 9 INCHES, DARK GRAYISH-GREEN WITH ORANGE BROWN AND YELLOWISH MOTTLING, MOIST, VERY STIFF.		ML	
55	55.0								
	57.0	ST-2	12	— —	—				
	58.5	SS-11	18	5-11-16	27	SILT, SAME AS S-10		ML	
60						END BORING AT 58.5 FEET			FINISHED DRILLING AT 1:00

CH2M HILL

PROJECT NUMBER P15600. A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY, CME-55 DRILLERS & EQUIPMENT D. KENNER OF OREGON. INC.

ELEVATION 42.51 FT. BORE HOLE: B-1

WATER LEVEL SEE TEXT DATE: START: 12/21/81 FINISH: 12/22/81 INSPECTOR CWH

DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
						PIEZOMETER INSTALLATION (SEE NOTES, BORING LOG LEGEND)			
						PLACEMENT OF PERVIOUS TIP: TOP AT 38.5 FT, BOTTOM AT 40.0 FT.			
						GRAVEL PACK: FROM 58.5 FT TO 24.9 FT.			
						BENTONITE SEAL: FROM 22.9 TO 24.9 FT.			
						RISER PIPE LENGTH: 40 FEET.			

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY, CME-55 DRILLERS & EQUIPMENT DON KENNER OF OREGON, INC

ELEVATION 46.13 FT. BORE HOLE: B-3

WATER LEVEL SEE TEXT DATE: START: 12/22/81 FINISH: 12/23/81 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
5	5.0								START DRILLING AT 2:35
	6.5	S-1	8	1/12" -2	2	SANDY SILT, NON TO SLIGHTLY PLASTIC FINES, ABOUT 25% FINE SAND, BROWN, MOIST, VERY SOFT.		ML	BEGIN WITH DRAG BIT, CHANGE TO ROLLER BIT AT 25.3 FT.
	7.0								
	9.0	ST-1	21	- - -	-				
10	10.0								
	11.5	S-2	8	2-2-2	4	SANDY SILT, SIMILAR TO S-1, WITH 30-40% FINE SAND.		ML	
15	15.0								
	17.0	ST-2	19	- - -	-	SILTY SAND: FINE SAND WITH 15-20% NON TO SLIGHTLY PLASTIC FINES, BROWN, WET, VERY SOFT TO FIRM.		SM	
20	20.0								
	21.5	S-3	2	3-4-5	9	SILTY SAND: SIMILAR TO ST-2, WITH 10-15% FINES.		SM	
	24.5								DRILLER NOTES GRAVEL AT 23.5 FT.
25	26.0	S-4	2	19-28-32	60	SANDY GRAVEL: POORLY-GRADED ROUNDED GRAVEL TO AT LEAST 1¼ INCH MAXIMUM SIZE, 5-10% NON PLASTIC FINES, BROWN TO BLACK, WET, VERY DENSE.		GP-GM	SLOW, ROUGH DRILLING TO 485 FT.
30									

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY WWTP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY; CME-55 DRILLERS & EQUIPMENT D. KENNER OF OREGON, INC.

ELEVATION 46.13 FEET BORE HOLE: B-3

WATER LEVEL SEE TEXT DATE: START: 12/22/81 FINISH: 12/23/81 INSPECTOR CWH

(FEET) DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE NUMBER	RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
30	30.0								
	31.5	S-5	3	24-28-16	44	SANDY GRAVEL, SAME AS S-4.		GP-GM	LAST 6" OF DRIVE FOR SS-5 MIGHT BE A SAND LENS.
35	35.0								
	35.2	S-6	0	60/2"	60/2"	NO RECOVERY			
40	40.0								
	41.3	S-7	3	60/4"	60/4"	SANDY GRAVEL, SAME AS S-4		GP-GM	
45	45.0								
	45.2	S-8	0	60/2"	60/2"	NO RECOVERY			DRILLER NOTES CHANGE IN DRILLING RATE (UP) AT 48.5 FT.
50	50.0								
	51.5	S-9	14	26-54-60/3"	114/9"	SILTSTONE: HIGHLY WEATHERED, 10-15% FINE TO MEDIUM SAND, MEDIUM HARD, GRAY WITH BLUE-GREEN AND WHITISH MOTTLING, SLIGHTLY MOIST, VERY DENSE.			
55	55.0								
	56.0	S-10	14	25-60/4"	85/10"	SILTSTONE, SAME AS S-9.			
						END BORING AT 56.0 FEET			FINISH DRILLING AT 1:00

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY WTP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD; CME-75 DRILLERS & EQUIPMENT D. KENNER OF OREGON, INC

ELEVATION 44.75 FEET BORE HOLE: B-5

WATER LEVEL SEE TEXT DATE: START: 1/12/82 FINISH: 1/13/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
									START DRILLING AT 2:10
5	5.0								
	6.5	S-1	9	1-1-1	2	SANDY SILT, NON PLASTIC, ABOUT 35% FINE SAND, BROWN, MOIST, VERY SOFT TO SOFT.		ML	
	8.0								
	10.0	ST-1	24	---	—				
10	11.5	S-2	12	1-1-1	2	SANDY SILT, SAME AS S-1.		ML	
	15.0								
15	16.5	S-3	9	1-2-1	3	SANDY SILT, SIMILAR TO S-1, WITH ABOUT 40% FINE SANDS		ML	
	18.0								
	20	ST-2	24	---	—				
20	21.5	S-4	14	1-1-3	4	SANDY SILT, SAME AS S-1		ML	
	25.0								
25	26.5	S-5	3	5-3-7	10	SAND, POORLY GRADED FINE SAND, 5-10% NON PLASTIC FINES, BROWN, MOIST, LOOSE		SP-SM	DRILLER NOTES GRAVEL AT 27 FEET
30									

CH2M HILL

PROJECT NUMBER P156600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY, CME-75 DRILLERS & EQUIPMENT D. KENNER OF OREGON, INC.

ELEVATION 44.75 FT BORE HOLE: B-5

WATER LEVEL SEE TEXT DATE: START: 1/12/82 FINISH: 1/13/82 INSPECTOR CWH

DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
60									DRILLER NOTICES NO CHANGE IN DRILLING RATES TO 65 FT.
65	65.0								
	65.8	S-12	9	28-60/3½	88/9½"	SILTSTONE, SIMILAR TO S-11, EXCEPT FOR LOCAL BLUE-GREEN AND ORANGE-BROWN MOTTLING			
70									DRILLER NOTES UNIFORM DRILLING TO 75 FT, EXCEPT FOR OCCASSIONAL lenses of harder material, possibly gravel
75	75.0								
	75.5	S-13	5	60/5	60/5"	SILTSTONE, SIMILAR TO S-11, EXCEPT FOR BLUE-GREEN AND ORANGE-PINK MOTTLING.			
						END BORING AT 75.5 FT			
						PIEZOMETER INSTALLATION: (see notes on Boring Log Legend) PLACEMENT OF PERVIOUS TIP: TOP AT 38.5 FT, BOTTOM AT 40.0 FT. GRAVEL PACK: FROM 76.5 FT TO GROUND SURFACE. BENTONITE SEAL: FROM 12-14 FT RISER PIPE LENGTH: 40 FT.			

CH2M HILL

PROJECT NUMBER P1S600-AS

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY; CME-75 DRILLERS & EQUIPMENT D. KENNER OF OREGON, INC

ELEVATION 42.14 feet BORE HOLE: B-6

WATER LEVEL NOT MEASURED DATE: START: 1/11/82 FINISH: 1/12/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
						SILTY TOPSOIL AT SURFACE			START DRILLING AT 3:30
5	5.0								
	6.5	S-1	9	2-1-1	3	SANDY SILT, LOW PLASTICITY, 30-40% FINE SAND, BROWN, MOIST, VERY SOFT, TRACE OF ORGANIC MATERIAL		ML	
	8.0								
	10.0	ST-1	20	- - -	-	SILT, LOW PLASTICITY, ABOUT 10% FINE SAND, BROWN, MOIST, VERY SOFT		ML	
10	11.5	S-2	14	2-2-4	6	SILT, SAME AS S-1.		ML	
	15.0								
15	16.5	S-3	9	3-3-4	7	SILTY SAND, LOW PLASTICITY, 58% FINE SAND, 32% SILT, 10% CLAY, BROWN, WET, LOOSE.		SM	
	20.0								
20	22.0	ST-2	13	- - -	-				ENCOUNTERED GRAVEL AT 21 FT, SHELBY TUBE BENT
	22.8	S-4	6	32-60/4½"	92/10½"	SANDY GRAVEL, ROUNDED GRAVEL TO AT LEAST 1¼" ABOUT 25% FINE TO COARSE SAND, 5-10% NON PLASTIC FINES, BROWN, VERY DENSE.		GP-GM	LOSE CIRCULATION AT 23 FT, MIX MORE MUD, SOFTER DRILLING 23-25 FT.
25	25.0								
	26.5	S-5	0	14-20-5	25	NO RECOVERY			POSS. SAND LENS FROM 23-26 FT? LOSE CIRCULATION AT 26 FT, MIX MORE MUD, SLOW ROUGH DRILLING TO 50 FT.

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY DRILLERS & EQUIPMENT D.KENNER OF OREGON, INC

ELEVATION 42.14 FEET BORE HOLE: B-6

WATER LEVEL NOT MEASURED DATE: START: 1/11/82 FINISH: 1/12/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
30	30.4	S-6	0	60/5"	60/5"	NO RECOVERY			SAMPLER BOUNCED DURING SS-6 SPT MIX MORE MUD AT 30 AND 33FT.
35	35.0 35.2	S-7	0	60/3"	60/3"	NO RECOVERY			SAMPLER BOUNCES DURING SS-7 SPT DRILLER NOTES LARGE ROCKS IN HOLE
40	40.0 41.5	S-8	6	48-45-60/3"	105/9"	SANDY GRAVEL, POORLY GRADED ROUNDED GRAVEL TO ATLEAST 1¼ INCH, ABOUT 25% FINE TO COARSE SAND, 5-10% NON PLASTIC FINES, BROWN, WET, VERY DENSE		GP-GM	SAMPLER BOUNCES DURING SS-8 SPT
45	45.0 45.2	S-9	0	60/2½	60/2½"	NO RECOVERY			MIX MORE MUD AT 45FT. DRILLER NOTES CHANGE IN DRILLING rate (up) at 50 FT.
50	50.5 52.0	S-10	12	14-26-47	73	SILTSTONE, HIGHLY WEATHERED TO SILT AND CLAY SIZED PARTICLES, ABOUT 10% ROUNDED FINE TO MEDIUM SAND, GRAY, MOIST, END BORING AT 52.0 FEET			FINISH DRILLING AT 1:15
55									

CH2M HILL

PROJECT NUMBER P156004A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY, CME-55 DRILLERS & EQUIPMENT D. KENNER OF OREGON, INC.

ELEVATION 41.33 FEET BORE HOLE: B-7

WATER LEVEL SEE TEXT DATE: START: 1/11/81 FINISH: 1/11/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
									START DRILLING AT 8:55
5	5.0								
	6.5	S-1	5	1-2-1	3	SANDY SILT, LOW PLASTICITY, ABOUT 40% FINE SAND, BROWN, MOIST, SOFT.		ML	
	8.0								
	10.0	ST-1	24	— — —	—	SILT, SIMILAR TO S-1, EXCEPT NO FINE SAND.		ML	
10	11.5	S-2	7	1-3-2	5	SILTY SAND, FINE SAND WITH ABOUT 40% NON PLASTIC FINES, BROWN, MOIST, LOOSE.		SM	
	15.0								
15	16.5	S-3	6	2-2-2	4	SILTY SAND, SIMILAR TO S-2 EXCEPT ABOUT 65% FINE SAND		SM	
	20.0								
20	22.0	ST-2	18	— — —	—	SILTY SAND, SIMILAR TO S-3		SM	HIT ROCK OR STONE AT BOTTOM OF ST-2
	21.5	S-4	6	12-13-17	30	SANDY GRAVEL, POORLY GRADED, ROUNDED GRAVEL TO AT LEAST 1/4 INCH, 20-30% FINE SAND, ABOUT 5% NON PLASTIC FINES, BROWN, WET, COMPACT.		GP-GM	DRILLER NOTES GRAVEL AT 22 FT.
25	25.0								
	26.5	S-5	6	30-49-60/5	109/11"	SANDY GRAVEL, SIMILAR TO S-4, EXCEPT ABOUT 15% FINE SAND		GP-GM	SAMPLER BOUNCES DURING S-5 SPT.
									MIX MORE MUD; SLOW, ROUGH DRILLING TO 44.9 FT.
30									

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY, CME-75 DRILLERS & EQUIPMENT D. KENNER OF OREGON, INC

ELEVATION 41.33 FEET BORE HOLE: B-7

WATER LEVEL SEE TEXT DATE: START: 1/11/82 FINISH: 1/11/82 INSPECTOR WH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
30	30.0								
	31.5	S-6	2	24-39-46	85	SANDY GRAVEL, SAME AS S-4		GP-GM	DRILLER NOTES TEMPORARY SMOOTH DRILLING FROM 33.5-34.5 FT, POSSIBLE SAND LENS.
35	35.0								
	35.4	S-7	0	60/4½	60/4½"	NO RECOVERY			
40	40.0								
	40.2	S-8	0	60/2½	60/2½"	NO RECOVERY			CAVING IN HOLE TO 33 FT, HAD TO RE-DRILL TO 40 TO TAKE SS-8. SAMPLER BOUNCES DURING SS-8 SPT. DRILLER NOTES CHANGE IN DRILLING RATE (UP) AT 44.9 FT.
45	45.0								
	46.5	S-9	18	11-30-60/4	90/8"	SILTSTONE, HIGHLY WEATHERED AND OXIDIZED, PARTICLES COMPOSED OF SILT AND CLAY SIZED MATERIAL, SLIGHTLY PLASTIC, LIGHT BLUE-GREY, ORANGE, AND DARK GRAY, MOIST, RELICT TEXTURE OF MORE COARSE-GRAINED ROCK APPARENT			
50	50.0								
	51.5	S-10	12	15-28-42	70	SILTSTONE, SAME AS S-9 EXCEPT FOR UNIFORM LIGHT BLUE-GREY COLOR			
						END BORING AT 51.5 FT			FINISH DRILLING AT 1:45
						PIEZOMETER INSTALLATION: (See notes on Boring Log Legend)			AT 37.5 FT
						PLACEMENT OF PERVIOUS TIP: TOP AT 35 FT, BOTTOM AT 51.5 FT TO SURFACE			
						GRAVEL PACK: FROM 18 TO 20 FEET			
						BENTONITE SEAL:			
						RISER PIPE LENGTH: 37.5 FT.			

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY, CME-55 DRILLERS & EQUIPMENT D. KENNER OF OREGON, INC

ELEVATION 42.50 FEET BORE HOLE: B-11

WATER LEVEL SEE TEXT DATE: START: 12/28/81 FINISH: 12/28/81 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
									START DRILLING AT 10:00
5	5.0								
	6.5	S-1	6	1-1-2	3	SILT, LOW TO MEDIUM PLASTICITY, ABOUT 5% FINE SAND, BROWN, VERY MOIST, SOFT.		ML	
10	10.0								
	11.5	S-2	10	1-2-2	4	SILT, LOW TO MEDIUM PLASTICITY, 10-15% FINE SAND, BROWN, MOIST, SOFT, TRACE OF ORGANIC MATERIAL.		ML	
	13.0								
	15.0	ST-1	24	— — —	—				
15	16.5	S-3	18	1-1/12"	1	SILT, SAME AS S-2		ML	
	20.0								
20	21.5	S-4	18	1-1-1	2	SANDY SILT, SIMILAR TO S-2 EXCEPT FOR 20-30% FINE TO MEDIUM SAND, MOSTLY FINE		ML	EL ... @ 18 FT
	25.0								DRILLER NOTES GRAVEL AT 24.5 FT
25	25.9	S-5	6	28-60/4"	88/10"	SANDY GRAVEL, POORLY GRADED, ROUNDED GRAVEL TO AT LEAST 1/4 INCH, 20-25% FINE TO MEDIUM SAND, 5-10% FINES WITH LOW TO MEDIUM PLASTICITY, BROWN, WET, VERY DENSE		GP-GM	SLOW, ROUGH DRILLING TO 30 FT.
									LOSE CIRCULATION AT 28 FT.

CH2M HILL

PROJECT NUMBER P15600.A5.00

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD MUD ROTARY DRILLERS & EQUIPMENT D. KENNER DF OREGON, INC

ELEVATION 42.50 FT BORE HOLE: B-11

WATER LEVEL SEE TEXT DATE: START: 12/28/81 FINISH: 12/28/81 INSPECTOR C.W.H.L

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
	30.0 30.9	S-6	4	20-60/5"	80/11"	SANDY GRAVEL, POORLY GRADED, ROUNDED GRAVEL TO AT LEAST 1 INCH, 20-30% FINE TO COARSE SAND, 5-10% NONPLASTIC FINES, BROWN, WET, VERY DENSE.		GP-GM	SLOW, ROUGH DRILLING TO 35 FT.
35	35.0 35.8	S-7	4	45-60/3"	105/9"	SANDY GRAVEL, SAME AS S-6		GP-GM	SAMPLER BOUNCES DURING SPT FOR SS-7
									DRILLER NOTES CHANGE IN DRILLING RATE (UP) AT 37.5 FT
40	40.0 41.5	S-8	12	13-50-60/3"	110/9"	SILTSTONE, HIGHLY WEATHERED TO SILT AND CLAY-SIZED PARTICLES WITH 5-10% FINE SAND, SOME SLIGHTLY BRITTLE, INTACT LAYERS + FRAGMENTS 1/8-1/4-INCH THICK, GRAY, SLIGHTLY MOIST.			
45	45.0 45.8	S-9	5	14-60/4	74/10"	SILTSTONE, SAME AS S-8			
						END BORING AT 45.8 FEET			FINISH DRILLING AT 1:40.
						PIEZOMETER INSTALLATION: (see notes on Boring Log Legend) PLACEMENT OF PERVIOUS TIP: TOP AT 33FT, BOTTOM AT 34.5FT GRAVEL PACK: FROM 46.5 FT TO GROUND SURFACE BENTONITE SEAL: FROM 18 TO 20 FEET RISER PIPE LENGTHS: 35 FEET			

CH2M HILL

PROJECT NUMBER P15600, A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD, CME-75 DRILLERS & EQUIPMENT D KENNER OF OREGON

ELEVATION 38.87 FEET BORE HOLE: B-13

WATER LEVEL SEE TEXT DATE: START: 12/28/81 FINISH: 12/29/81 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
									BEGIN DRILLING AT 1:55
5	5.0								
	6.5	S-1	10	1-2-2	4	SILT, LOW TO MEDIUM PLASTICITY ABOUT 5% FINE SAND, BROWN, MOIST, SOFT.		ML	
10	10.0								
	11.5	S-2	14	1-1-1	2	SANDY SILT, LOW TO MEDIUM PLASTICITY, 15-20% FINE SAND, BROWN, MOIST, SOFT		ML	
	13.0								
	15.0	ST-1	14	---	—	SANDY SILT, SIMILAR TO S-2			
15	16.5	S-3	12	1-1-1	2	SILT, LOW TO MEDIUM PLASTICITY, 5-10% FINE SAND, BROWN, MOIST, SOFT.		ML	
20	20.0								
	21.5	S-4	18	1-1-1	2	SILT, LOW TO MEDIUM PLASTICITY, ABOUT 5% FINE SAND, BROWN, MOIST, SOFT.		ML	
25	25.0							ML	
	26.5	S-5	10	2-11-28	39	UPPER 6 INCHES: SILT, SAME AS SS-4 LOWER 4 INCHES: SILTY SAND, FINE TO MEDIUM SAND, 20-25% SLIGHTLY PLASTIC FINES, BROWN, MOIST, DENSE.		SM	DRILLER NOTES GRAVEL AT 26FT, SLOW, ROUGH DRILLING TO 47.5 FT.
30									

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD, CME-75 DRILLERS & EQUIPMENT D. KENNER OF OREGON

ELEVATION 38.87 FEET BORE HOLE: B-13

WATER LEVEL SEE TEXT DATE: START: 12/28/81 FINISH: 12/29/81 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
30	30.0 30.6	S-6	4	41-60/4"	101/10"	SANDY GRAVEL, POORLY GRADED ROUNDED GRAVEL TO AT LEAST 1¼ INCH, 10-15% FINE TO MEDIUM SAND, 5-10% NON TO SLIGHTLY PLASTIC FINES, BROWN, VERY MOIST, VERY DENSE.		GP-GM	
35	35.0 35.5	S-7	4	56/6"	56/6"	SAME AS S-6		GP-GM	
40	40.0 40.4	S-8	1	60/4"	60/4"	SAME AS S-7		GP-GM	
45	45.0 45.3	S-9	0	60/3"	60/3"	NO RECOVERY			DRILLER NOTES END OF GRAVEL AT 47.5 FT.
50	50.0 50.8	S-10	6	43-60/2"	103/8"	SILTSTONE, HIGHLY WEATHERED TO SILT AND CLAY SIZED PARTICLES, WITH 10-15% FINE SAND AND GRAVEL, BLUE-GREEN WITH ORANGE-BROWN MOTTLING, SLIGHTLY MOIST.			1-2 INCH ROUNDED COBBLE WAS LODGED IN THE END OF SAMPLER FOR ST-10
55	55.0 56.5	S-11	15	25-46-60/3"	106/9"	SILTSTONE, HIGHLY WEATHERED TO SILT AND CLAY SIZED PARTICLES SOME BRITTLE, INTACT LAYERS AND FRAGMENTS, RELICT TEXTURE OF PARENT ROCK IS EVIDENT.			FINISH DRILLING AT 10:05

CH2M HILL

PROJECT NUMBER P15600. A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD, CME-75 DRILLERS & EQUIPMENT D.KENNER OF OREGON, INC.

ELEVATION 38.87 FEET BORE HOLE: B-13

WATER LEVEL SEE TEXT DATE: START: 12/28/81 FINISH: 12/29/81 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER	SAMPLE: RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS: BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS: BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
						PIEZOMETER INSTALLATION: (See notes on Boring Log Legend)			
						PLACEMENT OF PERVIOUS TIP; TOP AT 38.5 FT, BOTTOM AT 40.FT			
						GRAVEL PACK: FROM 56.5 FT TO GROUND SURFACE			
						BENTONITE SEAL: FROM 20 TO 22 FT.			
						RISER PIPE LENGTH: 40 FT.			

CH2M HILL

PROJECT NUMBER P15 600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD, FISHTALE & TRICONE BIT DRILLERS & EQUIPMENT D. KENNER CME -75

ELEVATION 44.70 FEET BORE HOLE: B-14

WATER LEVEL SEE TEXT DATE: 5/24/82 START: 5/18/82 FINISH: 5/18/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
									START DRILLING AT 9:45
	2.5								
	4.0	S-1	4	2-1-1	2	SILT, LOW PLASTICITY, ABOUT 5-10% FINE SAND, DARK BROWN, MOIST, SOFT		ML	
5	5.0								
	6.5	S-2	7	1-1-1	2	SANDY SILT, SIMILAR TO S-1, EXCEPT IT GRADES INTO A SILTY SAND WITH 30-50% FINE SAND TOWARD BOTTOM.		ML	DRILLER NOTES ALTERNATING SOFTER & FIRMER DRILLING 5-10 FT.
	7.5								
	9.0	S-3	5	2-3-4	7	SILTY SAND, FINE SAND, 20-25% FINES WITH LOW PLASTICITY, BROWN, WET, SOFT TO FIRM.		SM	
10	10.0								
	11.5	S-4	7	2-1-1	2	SILTY SAND, SIMILAR TO S-3, EXCEPT WITH 30-35% FINES WITH LOW PLASTICITY.		SM	
	13.5	ST-5	24	- - -	-	SILT, LOW PLASTICITY, ABOUT 10% FINE SAND, BROWN, WET, SOFT.		ML	ML IS AT VERY BOTTOM OF ST-5
15	15.0								
	16.5	S-6	5	3-2-4	6	SANDY SILT, LOW PLASTICITY, ABOUT 20% FINE SAND, DARK BROWN, MOIST, FIRM		ML	
	20.0								
20	21.5	S-7	6	3-22-22	44	UPPER 2": SILT LOW PLASTICITY, 5-10% FINE SAND, DARK BROWN, MOIST		ML	
						LOWER 4": SILTY SAND, FINE TO MEDIUM SAND, ABOUT 15% FINES, BROWN, WET, DENSE.		SM	DRILLER NOTES GRAVEL AT 21.5 FT.
	25.0								
25	25.5	S-8	4	60/5½"	60/5½"	GRAVELLY SAND, POORLY GRADED, 25-30% SUBROUNDED GRAVEL TO ATLEAST 1¼ INCH, FINE TO COARSE SAND, MOSTLY COARSE, 5-10% FINES, BROWN, WET, DENSE.		SP-SM	SAMPLER BOUNCED IN FIRST 6 INCHES OF S-8
									SLOW, ROUGH, DRILLING TO 30 FT.

CH2M HILL

PROJECT NUMBER P156600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD; FISHTAIL & TRICONE BIT DRILLERS & EQUIPMENT B KENNER OF OREGON

ELEVATION 44.70 FEET BORE HOLE: B-14

WATER LEVEL SEE TEXT DATE: 5/24/82 START: 5/18/82 FINISH: 5/18/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
30	30.0 30.9	S-9	5	32-60/5"	92/11"	SANDY GRAVEL, WELL GRADED ANGULAR AND SUBROUNDED GRAVEL TO ATLEAST 20-25% FINE TO COARSE SAND, LESS THAN 5% FINES, BROWN AND BLACK, WET DENSE.		GP	SLOW ROUGH DRILLING TO 35 FT.
35	35.0 35.8	S-10	2	35-60/4½	95/10½"	SANDY GRAVEL SIMILAR TO S-9, BUT TOO LITTLE RECOVERY TO PROVIDE A THOROUGH DESCRIPTION.		GP	DRILLER POUNDED SAMPLER DOWN 3FT. TO GET IT IN POSITION; SOME OF SAMPLE S-10 MIGHT BE CAVINGS LOSE CIRCULATION AT 35.5 FT; MIX MUD SLOW, ROUGH DRILLING TO 40FT
40	40.0 41.2	S-11	8	25-31-60/2½	91/8½"	SANDY GRAVEL, SAME AS S-9		GP	LOST CIRCULATION AT 42 FT, MIX MUD SLOW, ROUGH DRILLING TO 47 FT.
45	45.0 45.2	S-12	0	60/3"	60/3"	NO RECOVERY			SAMPLER BOUNCES IN FIRST 6INCH INTERVAL OF S-12. DRILLER NOTES END OF GRAVELLY MATERIAL AT 47 FT.
50	50.0 51.5	S-13	18	22-41-36	77	SILTSTONE, HIGHLY WEATHERED, FRACTURES INTO ANGULAR, BLOCKY PIECES ABOUT ¼" ON A SIDE; CONTAINS ABOUT 10% FINE SAND, AND LOCAL PIECES OF THOROUGHLY WEATHERED GRAVEL TO ~½ INCH; GRAY W/BLUE-GREEN MOTTLING AT TOP, MOIST. END BORING AT 51.5 FEET			FINISH DRILLING AT 2:20

PIEZO INSTALLATION: (see notes on Boring Log Legend)
PLACEMENT OF PERVIOUS TIP: TOP AT 38.5 FT, BOTTOM AT 40 FT.
GRAVEL PACK: FROM 51.5 FEET TO GROUND SURFACE
BENTONITE SEAL: FROM 15.5 to 17.5 FT, AND FROM ABOUT 7 TO 8 FEET
RISER PIPE DIMENSIONS: 40 FEET

CH2M HILL

PROJECT NUMBER P15600, A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD, FISH TAIL BIT DRILLERS & EQUIPMENT D. KENNER OF OREGON.

ELEVATION 46.69 FT. BORE HOLE: B-15

WATER LEVEL NOT MEASURED DATE: START: 5/18/82 FINISH: 5/18/82 INSPECTOR GWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
	2.5								START DRILLING AT 3:35
	4.0	S-1	5	2-2-2	4	SILT LOW PLASTICITY, 10-15% FINE SAND, BROWN, WET, SOFT.		ML	
5	5.0								
	6.5	S-2	8	1-2-2	4	SANDY SILT, LOW PLASTICITY, ABOUT 15% FINE SAND, BROWN, WET, LOOSE, SOME ROOTS PRESENT		ML	
	8.0								
	10.0	ST-3	24	---	—	SANDY SILT, SIMILAR TO S-2		ML	
10	11.5	S-4	5	2-2-3	5	SANDY SILT LOW PLASTICITY, ABOUT 15% FINE SAND, DARK BROWN, MOIST, SOFT TO FIRM.		ML	
	15.0								
15	16.5	S-5	7	2-2-3	5	SILT, LOW TO MEDIUM PLASTICITY, LESS THAN 5% FINE SAND BROWN, WET, SOFT TO FIRM		ML	
	20.0								
20	21.5	S-6	10	2-3-4	7	SANDY SILT, LOW PLASTICITY, 35-45% FINE SAND, DARK BROWN, MOIST, FIRM		ML	
	25.0								
25	26.5	S-7	12	8-19-58	77	UPPER 9": SAND, UNIFORMLY GRADED, FINE SAND, 5-12% FINE WITH LOW PLASTICITY, BROWN, WET		SP SM	
						LOWER 3": SANDY GRAVEL, WELL GRADED GRAVEL TO 1¼ INCH, 20-30% FINE TO COARSE SAND, LESS THAN 5% FINE.		GP	FINISH DRILLING AT 4:20
						END BORING AT 26.5 FT			

FORM D 1586 5/78

SHEET | OF |

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD, FISHTAIL BIT DRILLERS & EQUIPMENT D. KENNER OF OREGON

ELEVATION 40.20 FEET (NOT MEASURED) BORE HOLE: B-16

WATER LEVEL DATE: START: 5/19/82 FINISH: 5/19/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
									START DRILLING AT 11:10
	2.5								
	4.0	S-1	7	2-2-1	3	SILT, LOW TO MEDIUM PLASTICITY, DARK BROWN, MOIST, SOFT		ML	
5	5.0								
	6.5	S-2	9	1-1-2	3	SILT, SIMILAR TO S-1, EXCEPT WITH 5-10% FINE SAND		ML	
	7.5								
	9.0	S-3	12	1-1-1	2	SILT, LOW TO MEDIUM PLASTICITY, ABOUT 10% FINE SAND, DARK BROWN, MOIST, SOFT.		ML	
10	10.0								
	12.0	ST-4	24	- - -	—	SANDY SILT, LOW PLASTICITY, 18% FINE TO MEDIUM SAND, MOSTLY FINE 65% SILT, 17% CLAY, MOIST, SOFT.		ML	
	13.5	S-5	18	1-1-1	2	SILT, SIMILAR TO S-1, EXCEPT ABOUT 5% FINE SAND		ML	
	15.0								
15	16.5	S-6	18	1-1-2	3	SILT, LOW PLASTICITY, DARK BROWN, MOIST, SOFT		ML	
	20.0								
20	21.5	S-7	12	2-2-1	3	SANDY SILT, LOW PLASTICITY, 15-20% FINE SAND, BROWN, MOIST, SOFT.		ML	
	25.0								
25	26.5	S-8	5	7-7-8	15	SAND, UNIFORMLY GRADED, FINE TO MEDIUM SAND, MOSTLY FINE, 5-12% FINES, BROWN, MOIST, COMPACT		SP-SM	
	27.5								DRILLER NOTES GRAVEL AT 27.5FT
	29.5	S-9	2	41-60/6"	101/12"	SANDY GRAVEL, POORLY GRADED GRAVEL TO AT LEAST 1¼ INCH, 10-15%		GP-GM	
						FINE TO COARSE SAND, 5-12% FINES, WET, BROWN, DENSE, END BORING @ 29.0 FT			FINISH DRILLING AT 1:50

FORM D 1586 5/78

CH2M HILL

PROJECT NUMBER P156600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD, FISHTAIL & TRICONE BIT DRILLERS & EQUIPMENT D. KENNER OF OREGON

ELEVATION 40.52 FEET BORE HOLE: B-17

WATER LEVEL NOT MEASURED DATE: START: 5/20/82 FINISH: 5/20/82 INSPECTOR CWH

DEPTH BELOW SURFACE (Ft)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
									START DRILLING AT 8:45
5	5.0								
	6.5	S-1	5	1-2-2	4	SILT, LOW PLASTICITY, ABOUT 5% FINE SAND, BROWN, WET, SOFT TO FIRM.		ML	
10	10.0								
	11.5	S-2	12	1-1-1	2	SANDY SILT, LOW PLASTICITY, 25-30% FINE SAND, BROWN, WET, SOFT.		ML	
	13.0								
	15.0	ST-3	24	— — —	—	SILT, LOW TO MEDIUM PLASTICITY, 6% FINE SAND, 73% SILT, 21% CLAY, BROWN, SOFT.		ML	
15	16.5	S-4	18	1-1-1	2	SANDY SILT, SIMILAR TO S-2, EXCEPT WITH 20-25% FINE SAND.		ML	
	18.0								
	20.0	ST-5	24	— — —	—	SANDY SILT, SIMILAR TO S-2, EXCEPT WITH 10-15% FINE SAND.		ML	
20	21.5	S-6	15	1-1-1	2	SANDY SILT, SIMILAR TO S-2, EXCEPT WITH 10-15% FINE SAND.		ML	DRILLER NOTES SLIGHTLY FIRMER DRILLING 20-25 FT.
	23.0								
	25.0	ST-7	20	— — —	—	SANDY SILT, SIMILAR TO S-2, EXCEPT WITH 10-20% FINE SAND.		ML	
25	26.5	S-8	18	3-2-2	4	SANDY SILT, SIMILAR TO S-2, EXCEPT WITH 15-20% FINE SAND, AND ORANGE-BROWN MOTTLING IN LOWER 6 INCES		ML	
									DRILLER NOTES GRAVEL AT 29 FT.
30									

CH2M HILL

PROJECT NUMBER P156600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD, DRAG & ROLLER BITS DRILLERS & EQUIPMENT D. KENNER OF OREGON

ELEVATION 40.52 FEET BORE HOLE: B-17

WATER LEVEL NOT MEASURED DATE: START: 5/20/82 FINISH: 5/20/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
30	30.3	S-9	3	60/3"	60/3"	SANDY GRAVEL, POORLY GRADED, SUBANGULAR GRAVEL TO AT LEAST 1¼ INCH, 12-15% FINE TO COARSE SAND, 5-10% FINES, BROWN AND BLACK, WET, DENSE		GP-GM	SLOW, ROLLER DRILLING TO 46.5 FT.
	35.0								DRILLER NOTES SLIGHTLY SOFTER DRILLING AT 35 FT, PROBABLY A SAND LENS, HE THINKS
35	35.5	S-10	5	60/5½"	60/5½"	SANDY GRAVEL, SIMILAR TO S-9 EXCEPT FOR 35-40% FINE TO COARSE SAND.		GP-GM	
	40.0								LOSE CIRCULATION AT 38 FT, MIX MUD
40	40.5	S-11	5	56/6"	56/6"	SANDY GRAVEL, SIMILAR TO S-9, EXCEPT FOR 20-25% FINE TO COARSE SAND		GP-GM	LOSE CIRCULATION AT 42 FT, MIX MUD. DRILLER THINKS GROUNDWATER IS DILUTING MUD MIXTURE.
	45.0								
45	45.1	S-12	0	60/½"	60/1½"	NO RECOVERY			DRILLER NOTES BOTTOM OF GRAVEL AT 46.5 FT.
	47.5								
	48.5	S-13	11	29-60/5½"	89/11½"	SILTSTONE, WEATHERED, FRACTURES INTO BLOCKY, ANGULAR PIECES ALMOST ¼ INCH ON A SIDE, BLUE-GREEN, MOIST.			
50	52.5								
	53.5	S-14	11	16-50/6"	75/12"	SILTSTONE, SAME AS S-13 EXCEPT CONTAINS THOROUGHLY WEATHERED PEBBLES (COARSE SAND) WEATHERED TO BLUE GREEN, YELLOW AND REDDISH BROWN; SILTSTONE IS BLUE GREEN IN UPPER 4 INCHES, GRAY IN LOWER 7 INCHES			DM-15 IS A 2 INCH OD TUBE; 300 LB DOWN-HOLE HAMMER WAS USED, HAD TO END AFTER A 5 INCH DRIVE BECAUSE OF CAVING.
	57.5								
	58.0	DM-15	0	82/5"	82/5"	NO RECOVERY			
						END BORING AT 58.0 FT.			

SHEET | OF |

CH2M HILL

PROJECT NUMBER P156001.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY MUD DRILLERS & EQUIPMENT D. KENNER OF OREGON

ELEVATION 44.19 FEET BORE HOLE: B-18

WATER LEVEL NOT MEASURED DATE: START: 5/19/82 FINISH: 5/19/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
									START DRILLING AT 9:45
	2.5								
	4.0	S-1	6	2-2-2	4	SILT LOW PLASTICITY, 5-10% FINE SAND, DARK BROWN, MOIST, FIRM.		ML	
5	5.0								
	6.5	S-2	5	1-1-1	2	SANDY SILT, LOW PLASTICITY, 10-15% FINE SAND, BROWN, MOIST, SOFT.		ML	
	7.5								
	9.0	S-3	5	1-2-2	4	SILT, LOW PLASTICITY, ABOUT 5% FINE SAND, DARK BROWN, MOIST, FIRM.		ML	
10	10.0								
	12.0	ST-4	14	- - -	—	SILTY SAND, 53% FINE TO MEDIUM SAND, MOSTLY FINE, 35% SILT, 12% CLAY, BROWN, MOIST, LOOSE		SM	
	13.5	S-5	2	3-2-2	4	SILT, SAME AS S-3		ML	
	15.0								
15	16.5	S-6	8	2-2-3	5	SILT SIMILAR TO S-3, EXCEPT NO FINE SAND.		ML	
20	20.0								
	21.5	S-7	7	3-5-3	8	SILT, LOW PLASTICITY, ABOUT 5% FINE SAND, BROWN, MOIST, FIRM.		ML	DRILLER NOTES FIRMER DRILLING 20-25 FT.
25	25.0								
	26.5	S-8	6	3-3-5	8	UPPER 3 INCHES; SILT, SAME AS S-3		ML	
	27.5					LOWER 3 INCHES; SILTY SAND, FINE SAND, 5-12% FINES, DARK BROWN, MOIST, LOOSE.		SP-SM	DRILLER NOTES GRAVEL AT 27.5 FT.
	29.0	S-9	5	60/4.5"	60/4.5"	SILTY GRAVEL, POORLY GRADED GRAVEL TO AT LEAST 1 1/4 INCH, 10-15% SAND, 20-25% FINES WITH LOW PLASTICITY COMPACT		GM	
						END BORING AT 29.0 FT			FINISH DRILLING AT 10:45

D27

FORM D 1586 5/78

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY, WATER DRILLERS & EQUIPMENT D. KENNER OF OREGON - CME-75

ELEVATION 41.58 FEET BORE HOLE: B-21

WATER LEVEL SEE TEXT DATE: START: 5/24/82 FINISH: 5/24/82 INSPECTOR CWH

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
5									START DRILLING AT 9:00 DRILL TO 8 FT WITH WATER, CIRCULATED CUTTING OUT; LOSING SOME WATER INTO HOLE
									SET 5 IN I.D. CASING TO 8 FT, THEN DRILLED TO 10 FT
									FALLING HEAD PERMEABILITY TEST #1 PERFORMED WITH 8 TO 10 FT AS TEST INTERVAL
10	10.0								
	12.0	ST-1	24	- - -	—	SANDY SILT, SAME AS S-2 (SEE BELOW)		ML	
	13.5	S-2	15	1-1-1	2	SANDY SILT, LOW TO MEDIUM PLASTICITY, 20-25% FINE SAND, DARK BROWN, WET, SOFT.		ML	
15									DRILLED TO 18 FEET WITH WATER, SET CASING AT 18 FEET, THEN DRILLED TO 20 FT.
									FALLING HEAD PERMEABILITY TEST #2 PERFORMED WITH 18 TO 20 FT AS TEST INTERVAL
20	20.6								
	22.0	ST-3	24	- - -	—	UPPER PART: SAME AS S-2 LOWER PART: SAME AS S-4		ML	DRILLER NOTES ABOUT 5 INCHES OF SLOUGH SETTLED ON BOTTOM OF HOLE DURING TEST NO 2
	23.5	S-4	12	5-7-7	14	SILTY SAND, FINE SAND, 15-20% FINES WITH LOW PLASTICITY, MORE FINES TOWARD TOP OF SAMPLE, DARK BROWN, WET, COMPACT.		SM	
								SM	DRILLED TO 28 FT WITH WATER, NO LOST CIRCULATION AT 28 FT WHEN BIT ENCOUNTERED GRAVEL.
25									DRILLER NOTES VERY SOFT MATL 26.5 TO 28 FT.
								GP	DRILLER NOTES GRAVEL AT 28 FT, SET CASING TO 28 FT, PERMEABILITY TEST 3+4 FROM 28 TO 30 FT.
30									

CH2M HILL

PROJECT NUMBER P15600.A5

SOIL BORING LOG

PROJECT TRI CITY STP LOCATION OREGON CITY, OREGON

DRILLING METHOD ROTARY, WATER DRAG BIT DRILLERS & EQUIPMENT D. KENNER OF OREGON CME-75

ELEVATION 41.58 FEET BORE HOLE: B-21

WATER LEVEL SEE TEXT DATE: START: 5/24/82 FINISH: 5/24/82 INSPECTOR CWH.

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER	SAMPLE RECOVERY (INCHES)	STANDARD PENETRATION TEST RESULTS BLOWS 6"-6"-6"	STANDARD PENETRATION TEST RESULTS BPF "N"	SOIL DESCRIPTION (COLOR, RELATIVE DENSITY OR CONSISTENCY, MOISTURE, GRAIN SHAPE AND TYPE, STRUCTURE, CEMENTATION, ORGANICS, MATERIAL)	GRAPHIC LOG	UNIFIED SOIL CLASSIFICATION SYMBOL	COMMENTS (DRILLING PROGRESS, LOST CIRCULATION, TYPE OF DEPOSIT, PROBLEMS, ETC.)
30	30.0 / 30.2	S-5	0	60/3"	60/3"	NO RECOVERY		GP	
						END BORING 30.5 FT			FINISH DRILLING AT 1:20
						PIEZOMETER INSTALLATION:			
35						PLACEMENT OF PERVIOUS TIP: TOP AT 28.5 FT, BOTTOM AT 30. FT			
						GRAVEL PACK: FROM 31.5 FT TO GROUND SURFACE			
						BENTONITE SEAL: FROM 24.7 TO 26.7 FT			
						RISER PIPE LENGTH: 30 FT			

SUMMARY OF GROUNDWATER LEVELS
(ELEVATIONS IN FEET)

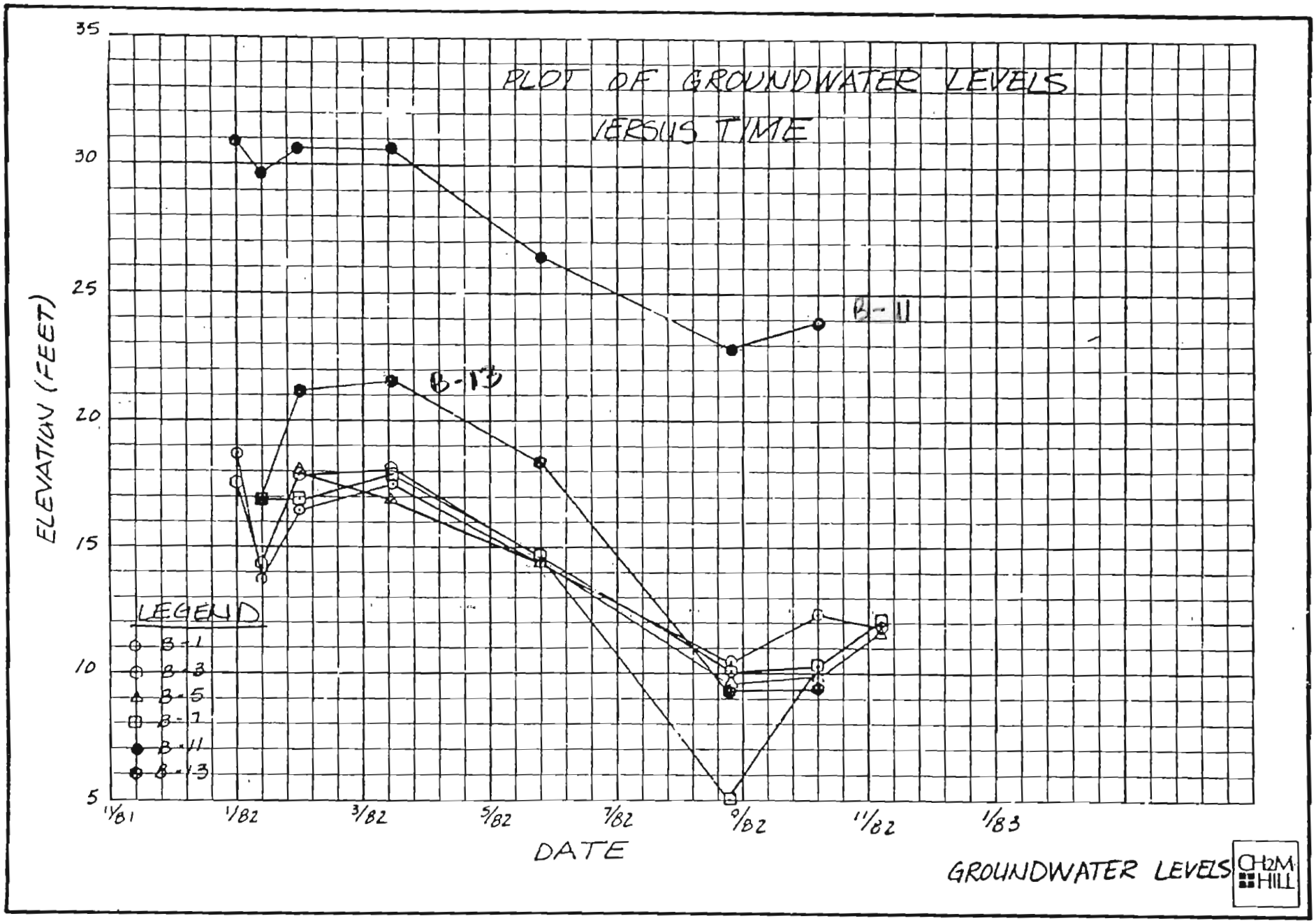
BORING NUMBER	DATE														
	12/23/81	12/28/81	12-29-81	1-11-82	1-12-82	1-13-82	2-2-82	3-12-82	5-24-82	8-26-82	10-7-82	11-8-82			
B-1	19.5[a]	18.6	18.7	13.6	13.7	13.7	16.5	17.5	14.4	10.4	12.4	11.9			
B-3	34.3[a]	17.8	17.4	13.6	14.4	14.3	17.8	18.1	14.6	10.1	10.3	12.0			
B-5	-	-	-	-	-	26.0[a]	17.9	16.9	14.4	9.6	9.9	11.7			
B-7	-	-	-	-	20.5[a]	16.9	16.5	17.9	14.6	5.0	10.3	12.0			
B-11	-	32.0[a]	30.8	29.5	30.0	29.7	30.7	30.7	26.4	22.8	23.8	c			
B-13	-	-	-	15.2	17.6	18.3	21.2	21.6	18.4	9.3	9.4	11.1			
B-14	-	-	-	-	-	-	-	-	14.9	b	b	b			
B-21	-	-	-	-	-	-	-	-	22.7[a]	b	b	b			

NOTE: [a] READINGS WERE TAKEN WITHIN 24 HOURS AFTER PIEZOMETER WAS INSTALLED.

[b] NO WATER LEVEL MEASURED IN PIEZOMETER.

[c] PIEZOMETER DESTROYED.

CH2M HILL


PLOT OF GROUNDWATER LEVELS
VERSUS TIME
ELEVATION (FEET)
35
30
25
20
15
10
5
B-11
B-13
LEGEND
B-1
B-3
B-5
B-7
B-11
B-13
11/81
1/82
3/82
5/82
7/82
9/82
11/82
1/83
DATE
GROUNDWATER LEVELS
CH2M HILL

Appendix B
LABORATORY TEST RESULTS

CH2M HILL

PROJECT NUMBER P156000.AS.10

SOILS CLASSIFICATION AND TEST SUMMARY

ASTM D2487

PROJECT DESCRIPTION: TRI CITIES

MATERIALS LABORATORY: CH2M HILL INC. TYPE OF SAMPLE:

SAMPLE LOCATION: AS NOTED SAMPLE NO:

SAMPLE LOCATION	SAMPLE NUMBER	DEPTH INTERVAL (FEET)	DESCRIPTION OF MATERIAL	ASTM CLASSIFICATION	MOISTURE P.L. (%)	MOISTURE ω (%)	MOISTURE L.L. (%)	GRADATION, % PASSING 3"	1½"	#4	#200	LABORATORY TESTS
B-1	SS-1	7.0-8.5	MED BROWN MED-F SAND	SP						*100	*≤5	
B-6	ST-1	8.0-10.0	MED. BROWN SILT W/F SAND	ML						*100	*90	
B-6	SS-3	15.0-16.5	MED BROWN SILTY F SAND	SM						100	43	Hydrometer
B-7	ST-1	8.0-10.0	MED. BROWN SILT	ML						*100	*100	Direct Shear
B-7	SS-3	15.0-16.5	MED BROWN SILTY F SAND	SM						*100	*35	
B-14	SS-6	15.0-16.5	MED. BROWN F SANDY SILT	ML						*100	*80	
B-15	SS-2	5.0-6.5	MED. BROWN F SANDY SILT	ML						*100	*85	
B-15	SS-5	15.0-16.5	MED. BROWN SILT	ML	NP	41	NP			*100	*95	Limits
B-15	SS-4	10.0-11.5	MED BROWN F SANDY SILT	ML						*100	*85	
B-16	SS-3	7.5-9.0	MED BOWN SILT W/F SAND	ML						*100	*90	
B-16	ST-4	10.0-12.0	MED. BROWN F SANDY SILT	ML	NP	50	NP			100	82	Hydrometer, Limits, Consolidation
B-16	SS-6	15.0-16.5	MED. BROWN SILT	ML						*100	*97	

REMARKS: * = ESTIMATED VALUE

D33

TESTED BY:	DATE:	COMPUTED BY:	DATE:	CHECKED BY:	DATE:
J RAMANDAN	14 JUNE 1982				

LAB FORM D2487P 2/78

CH2M HILL

PROJECT NU[illegible] P15600.A5.10

SOILS CLASSIFICATION AND TEST SUMMARY

ASTM D2487

PROJECT DESCRIPTION: TRI CITIES

MATERIALS LABORATORY: CH2M HILL INC. TYPE OF SAMPLE:

SAMPLE LOCATION: AS NOTED SAMPLE NO:

SAMPLE LOCATION	SAMPLE NUMBER	DEPTH INTERVAL (Feet)	DESCRIPTION OF MATERIAL	ASTM CLASSIFICATION	MOISTURE P.L. (%)	MOISTURE ω (%)	MOISTURE L.L. (%)	GRADATION, % PASSING 3"	1½"	#4	#200	LABORATORY TESTS
B-17	SS-1	5.0-6.5	MED. BROWN SILT	MH	35	81	51			*100	*100	LIMITS
B-17	ST-3	13.0-15.0	MED. BROWN SILT	ML						100	94	Hydrometer
B-18	ST-4	10.0-12.0	MED. BROWN SILTY F SAND	SM	NP	30	NP			100	47	Direct Shear, Hydrometer, Limits
B-18	SS-6	15.0-16.5	MED. BROWN SILT	ML						*100	*100	
B-18	SS-7	20.0-21.5	MED. BROWN SILT	ML						*100	*95	
B-20	SS-5	15.0-16.5	MED BROWN SILT	ML						*100	*100	
B-20	SS-6	20.0-21.5	MED. BROWN F SANDY SILT	ML						*100	*85	
BAG SAMPLE	CWH82-1		NEAR B-1 MED BROWN F SANDY SILT.	ML		29				*100	*75	Compaction D1557
B-17	ST-3	13.0-15.0	MED BROWN SILT	ML		54				100	98	Hydrometer, Consolidation
B-17	ST-7	23.0-25.0	MED. BROWN SANDY SILT	ML		52				100	68	Hydrometer, Consolidation

D84

REMARKS: * = ESTIMATED VALUE.

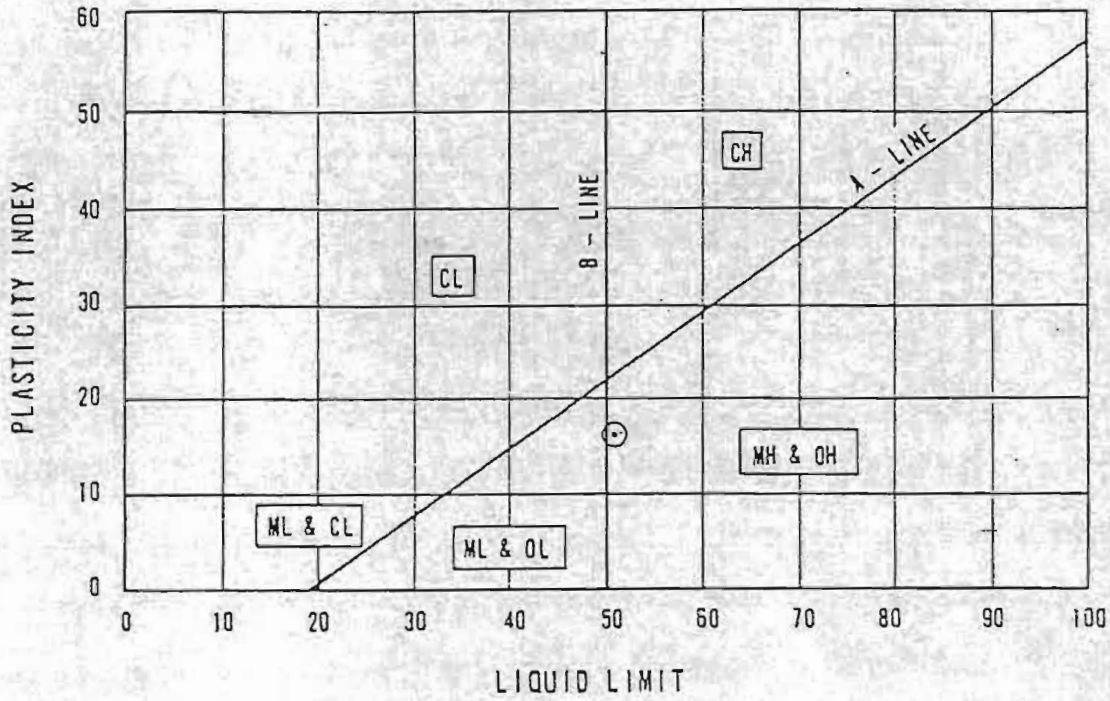
TESTED BY: J PLAMONDON DATE: 14 JUNE 1982

COMPUTED BY: DATE:

CHECKED BY: DATE:

LAB FORM D2487P 2/78

PLASTICITY CHART



SYMBOL	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	NATURAL MOISTURE
⊙	B-17, SS-1, 5.0-6.5'	51	16	81
	B-15, SS-5, 15.0-16.5'	NP*	—	41
	B-16, ST-4, 10.0-12.0'	NP*	—	50
	B-18, ST-4, 10.0-12.0'	NP*	—	30

NOTE: * NONPLASTIC

P15600 A5.10

PLASTICITY CHART
TRI-CITY SEWAGE
TREATMENT PLANT

CH2M HILL

SHEET ___ OF ___

CH2M HILL

PROJECT NUMBER
P15600.A5.10

PARTICLE-SIZE ANALYSIS

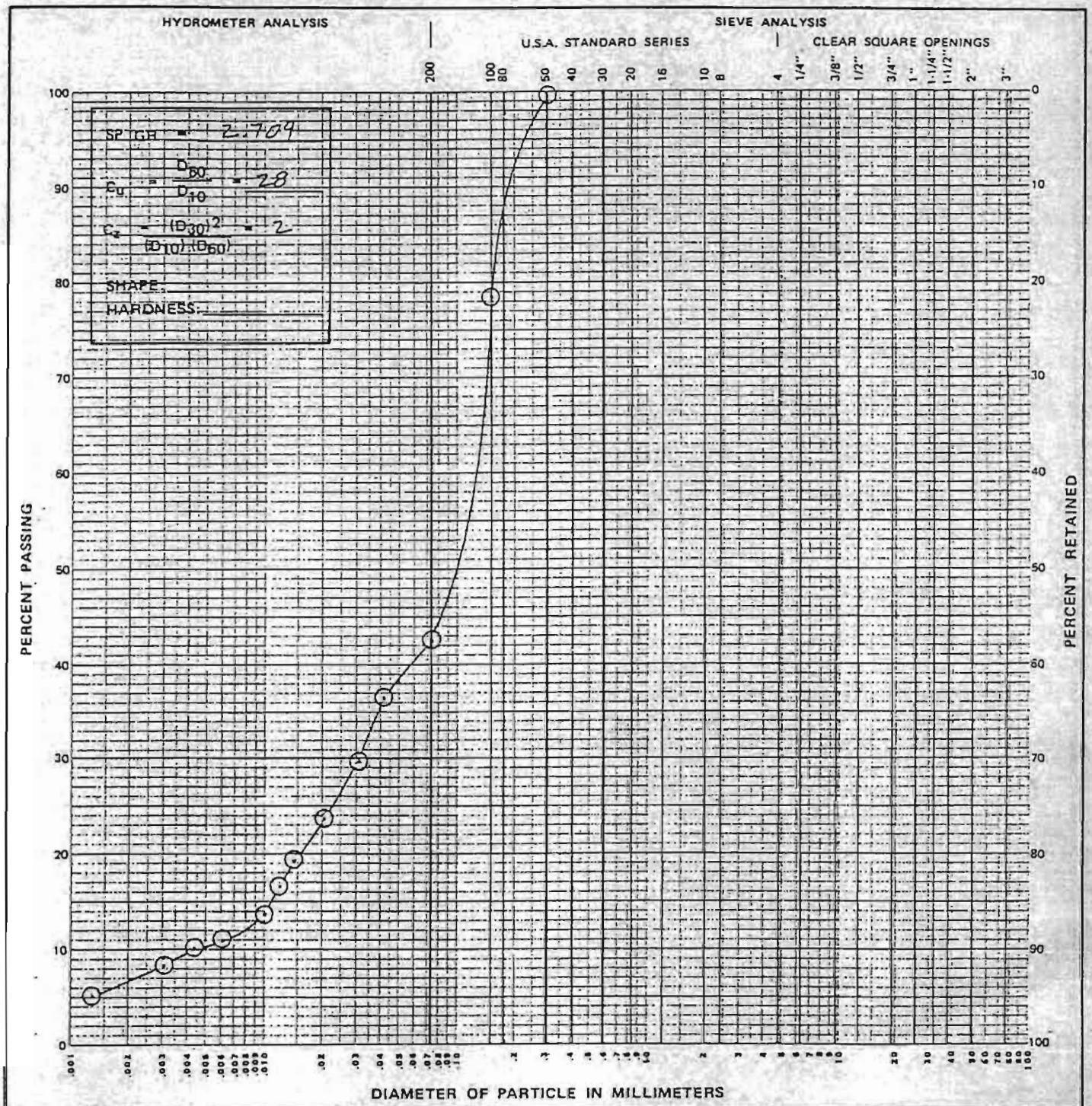
ASTM D422

PROJECT DESCRIPTION: TRI CITIES

MATERIALS LABORATORY: CH2M HILL INC.

SAMPLE LOCATION: B-6 15'-16.5' SAMPLE NO. SS-3

TYPE OF SAMPLE: MED. BROWN SILTY F SAND SM



COL-LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL.	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION ___

TESTED BY:	DATE:	COMPUTED BY:	DATE:	CHECKED BY:	DATE:
J RAMONDON	7 JUNE 1982	J RAMONDON	7 JUNE 1982		

D36

LAB FORM D422P –M 7/78

SHEET ___ OF ___

CH2M HILL

PROJECT NUMBER P15600.A5.10

PARTICLE-SIZE ANALYSIS

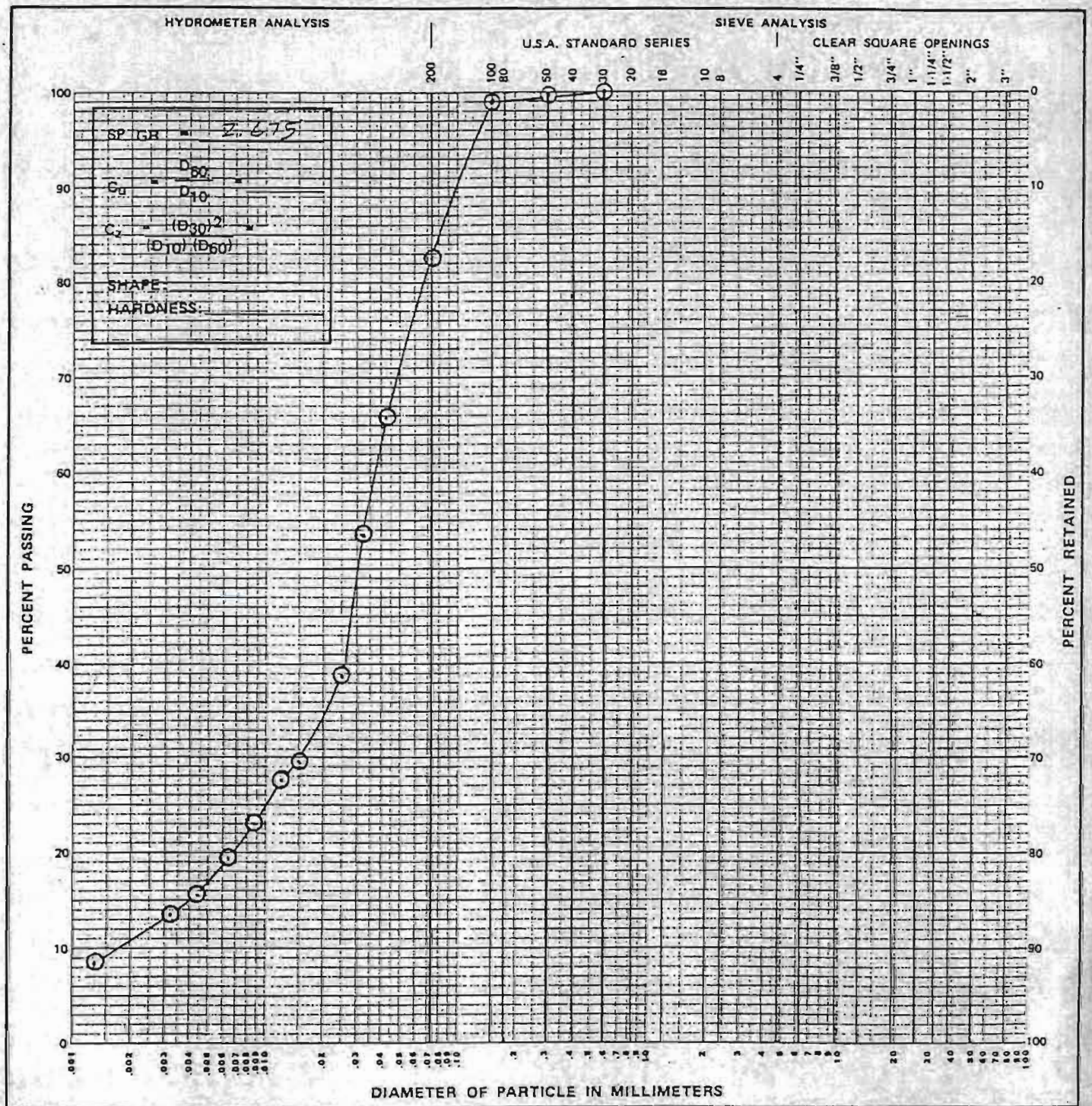
ASTM D422

PROJECT DESCRIPTION: TRI CITIES

MATERIALS LABORATORY: CH2M HILL INC

SAMPLE LOCATION: B-16 10'-12' SAMPLE NO. ST-4

TYPE OF SAMPLE: MED BROWN F SANDY SILT ML



COL-LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION ___

TESTED BY:	DATE:	COMPUTED BY:	DATE:	CHECKED BY:	DATE:
J RAMONDON	7 JUNE 1982	J RAMONDON	7 JUNE 1982		

LAB FORM D422P -M 7/78

SHEET ___ OF ___

CH2M HILL

PROJECT NUMBER P15600.AS.10

PARTICLE-SIZE ANALYSIS

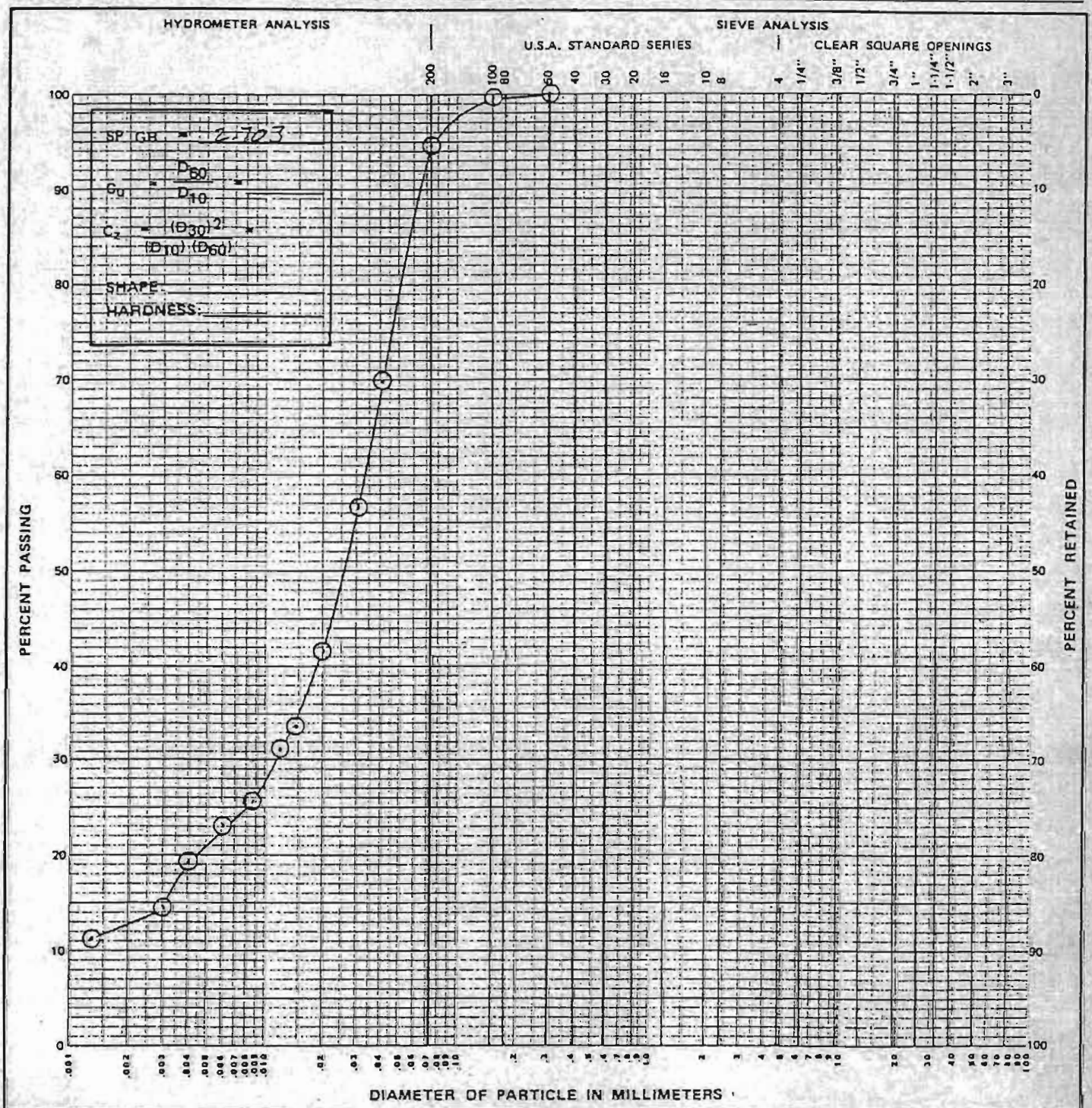
ASTM D422

PROJECT DESCRIPTION: TRI CITIES

MATERIALS LABORATORY: CH2M HILL INC.

SAMPLE LOCATION: B-17 13'-15' SAMPLE NO. ST-3

TYPE OF SAMPLE: MED. BROWN SILT ML



COL-LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION ___

TESTED BY:	DATE:	COMPUTED BY:	DATE:	CHECKED BY:	DATE:
J RAMONDON	7 JUNE 1982	J RAMONDON	7 JUNE 1982		

LAB FORM D422P –M 7/78

SHEET ___ OF ___

CH2M HILL

PROJECT NUMBER P15600.A5.10

PARTICLE-SIZE ANALYSIS

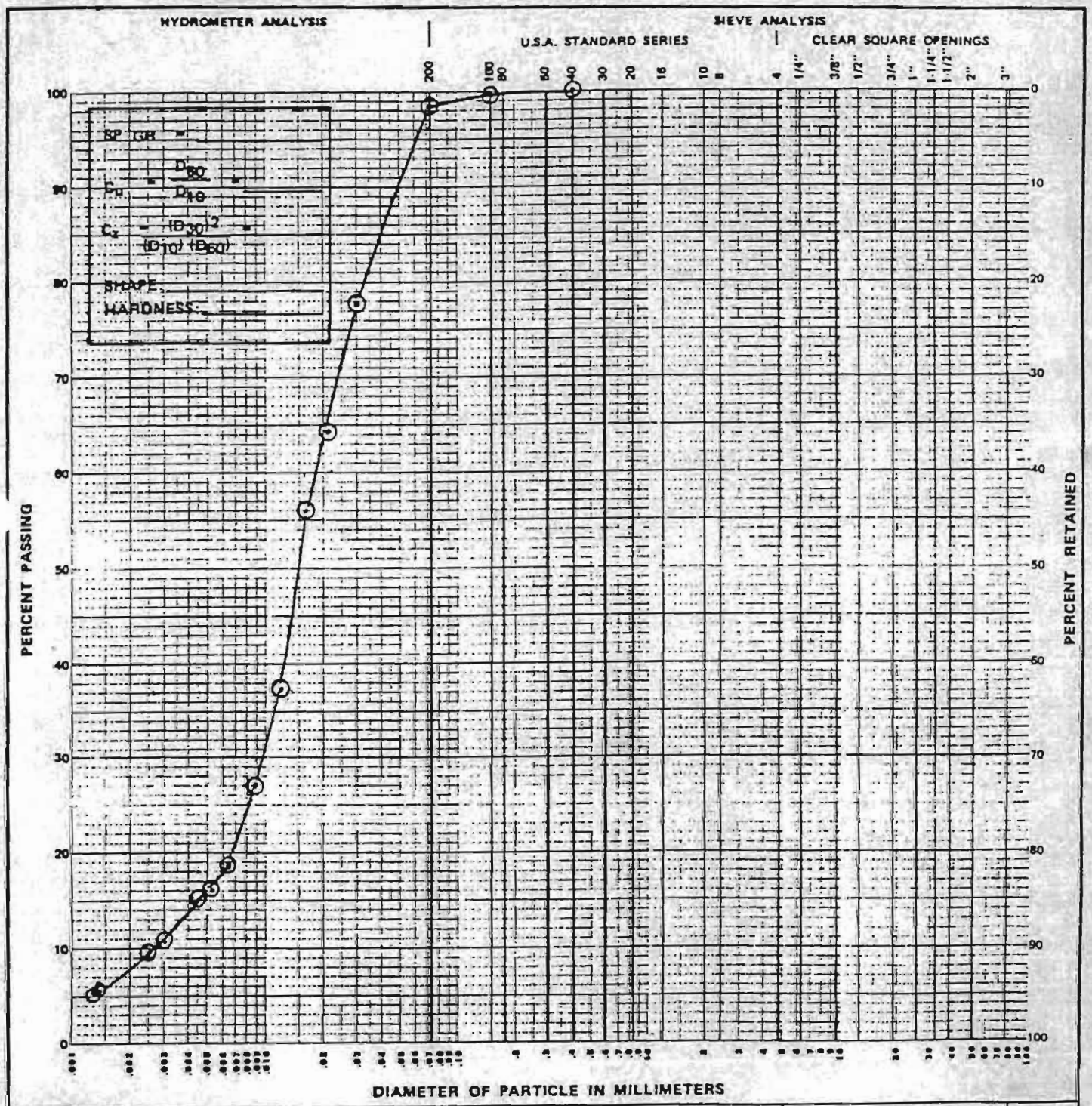
ASTM D422

PROJECT DESCRIPTION: TRICITY - WWTP

MATERIALS LABORATORY: PDX

SAMPLE LOCATION: B-17 S-3 D-13-15' SAMPLE NO. 2

TYPE OF SAMPLE: QUICK CONSOL. TEST



COL-LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION ___

TESTED BY:	DATE:	COMPUTED BY:	DATE:	CHECKED BY:	DATE:
A. Shah	09/14/82	A. Shah	09/16/82		

LAB FORM D422P -M 7/78

SHEET ___ OF ___

CH2M HILL

PROJECT NUMBER P15600.A5.10

PARTICLE-SIZE ANALYSIS

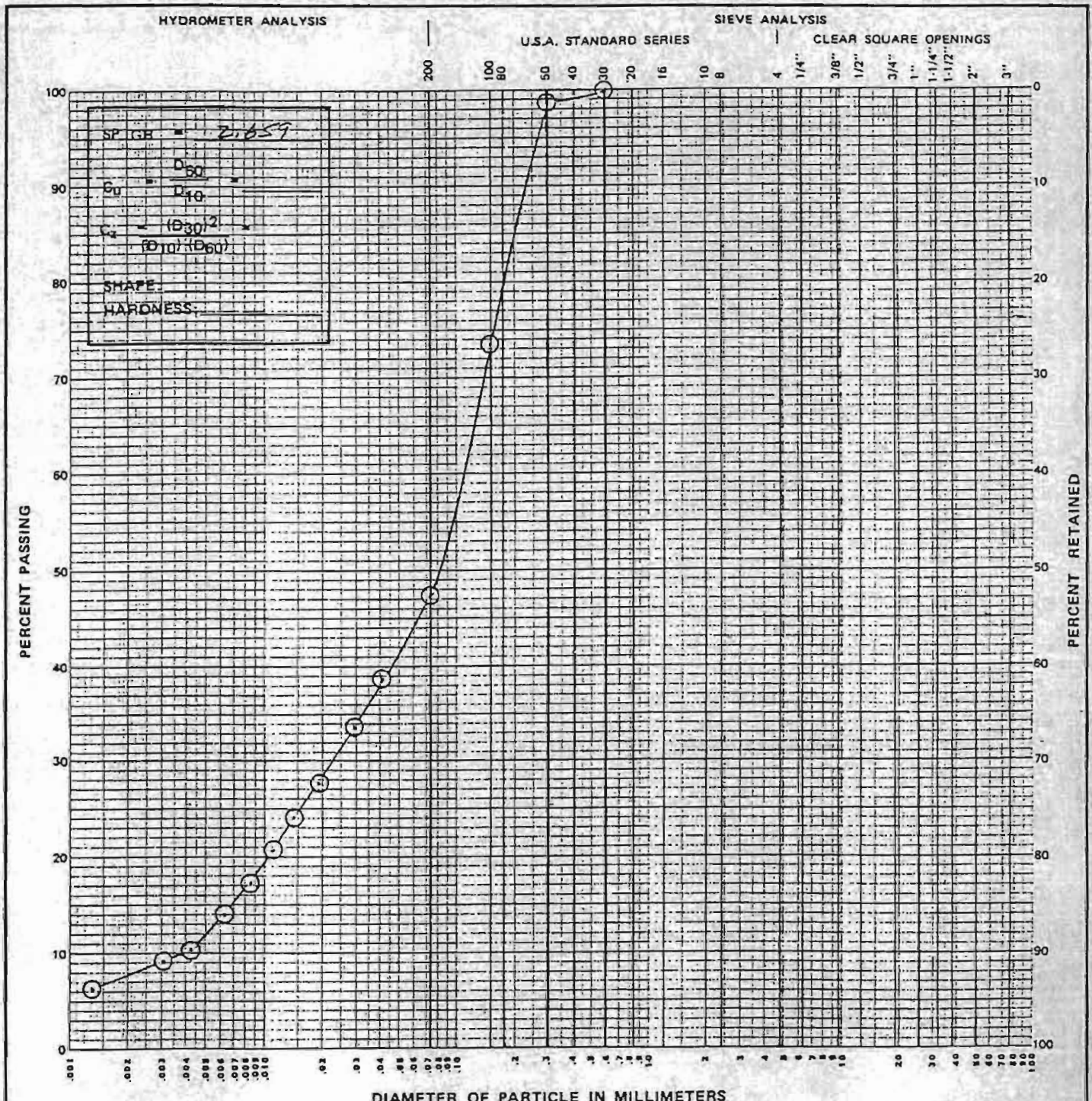
ASTM D422

PROJECT DESCRIPTION: TRI CITIES

MATERIALS LABORATORY: CH2M HILL INC.

SAMPLE LOCATION: B-18 10'-12' SAMPLE NO. ST-4

TYPE OF SAMPLE: MED. BROWN SILTY F SAND



COL-LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION ___

TESTED BY:	DATE:	COMPUTED BY:	DATE:	CHECKED BY:	DATE:
J RAMONDON	7 JUNE 1982	J RAMONDON	7 JUNE 1982		

LAB FORM D422P –M 7/78

CH2M HILL

PROJECT NUMBER P 15600. A5.10

PARTICLE-SIZE ANALYSIS

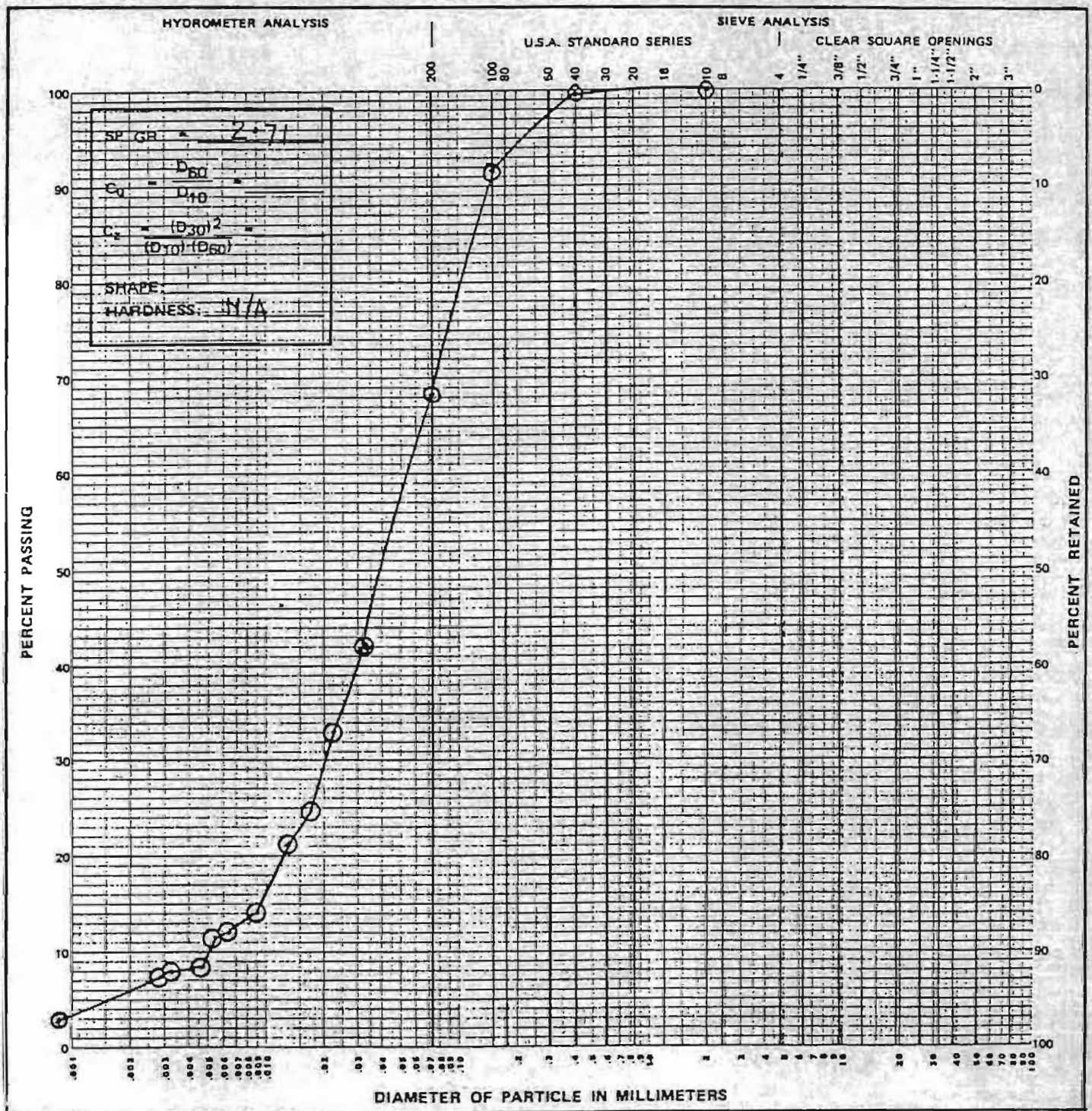
ASTM D422

PROJECT DESCRIPTION: TRICITY - WWTP

MATERIALS LABORATORY:

SAMPLE LOCATION: B-17, ST-7 D - 23-25' SAMPLE NO. ST-7

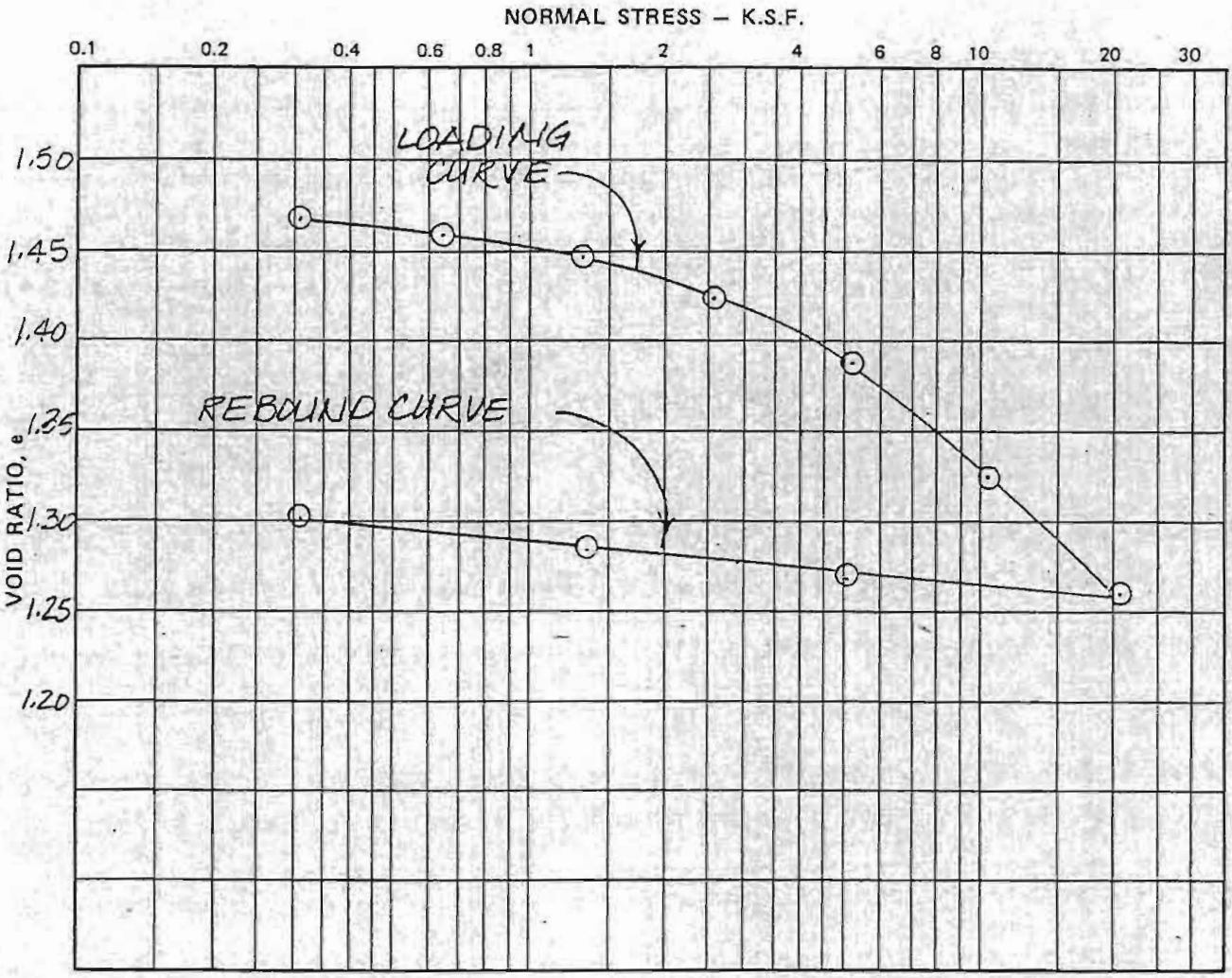
TYPE OF SAMPLE:



COL-LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION

TESTED BY:	DATE:	COMPUTED BY:	DATE:	CHECKED BY:	DATE:
A. Shah	09/09/82	A. Shah	09/13/82		



PLOT OF PRIMARY CONSOLIDATION

SAMPLE DATA:

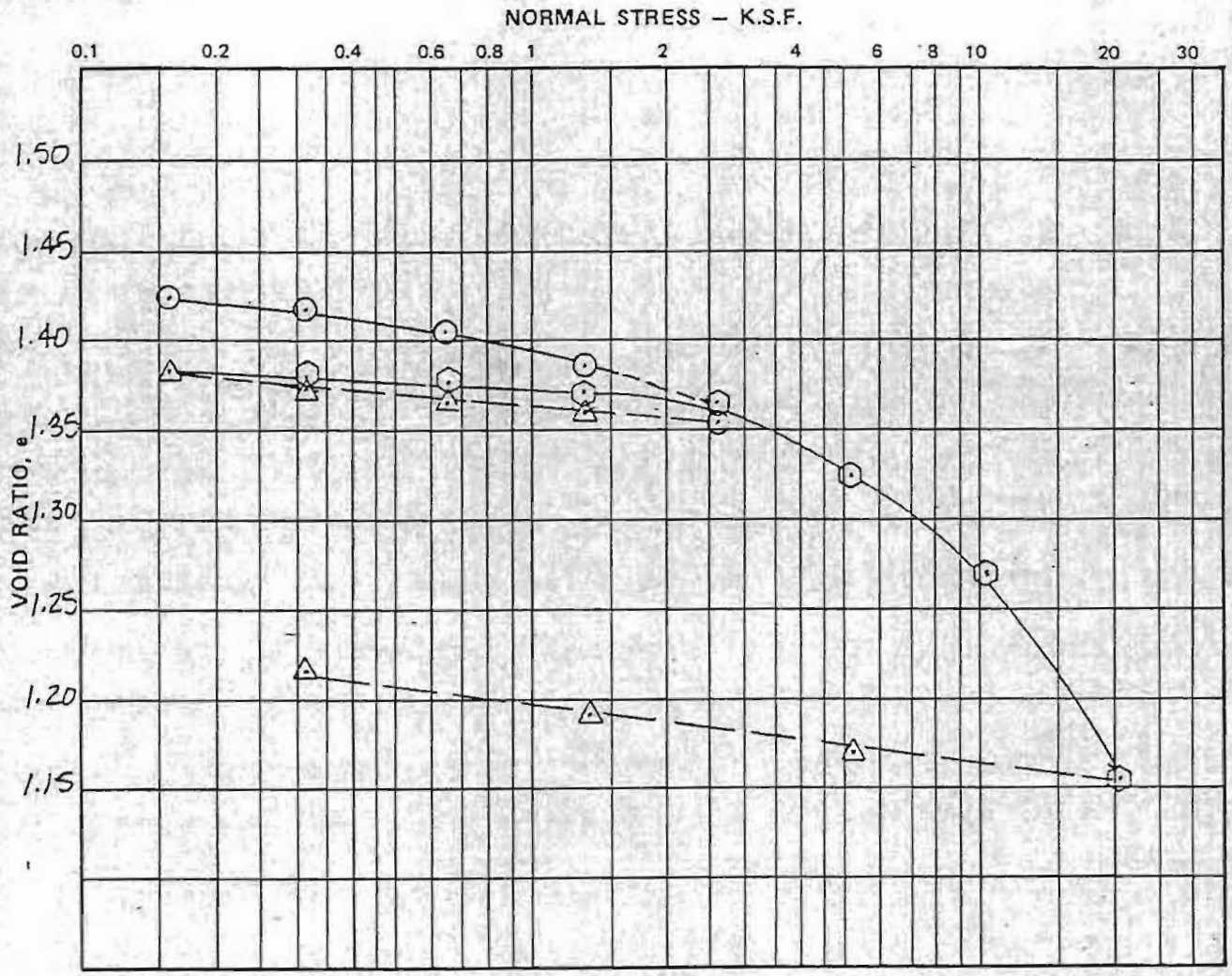
BROWN SANDY SILT (ML)
DEPTH 10.0-12.0 FT.
INITIAL DIAMETER = 2.50 IN.
INITIAL HEIGHT = 1.00 IN.
INITIAL VOID RATIO = 1.47
NATURAL MOISTURE CONTENT = 52 %
DRY DENSITY = 67PCF

B-16 ST-4
CONSOLIDATION TEST
TRI-CITY SEWAGE TREATMENT PLANT

CH2M HILL

P15600.A5

FORM 70



PLOT OF PRIMARY CONSOLIDATION

SAMPLE DATA:

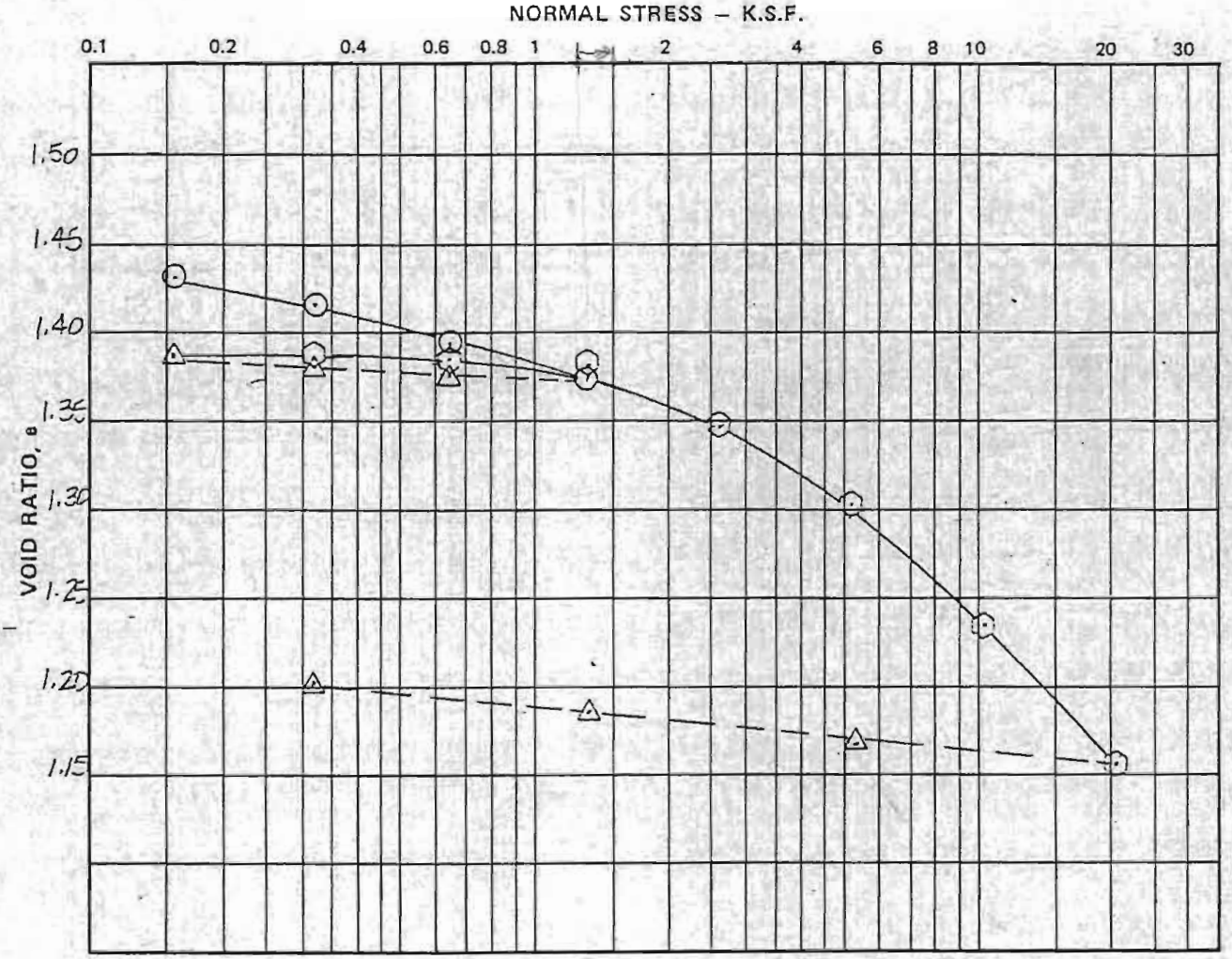
MEDIUM BROWN SILT (ML)
DEPTH 13-15 FT.
INITIAL DIAMETER = 2.50 IN.
INITIAL HEIGHT = 1.00 IN.
INITIAL VOID RATIO = 1.426
INITIAL MOISTURE CONTENT = 54%
DRY DENSITY = 69.4 PCF

B-17 ST-3
CONSOLIDATION TEST
TRI-CITY SEWAGE TREATMENT PLANT

CH2M HILL

P15600.A5.10

FORM 70



PLOT OF PRIMARY CONSOLIDATION

SAMPLE DATA:

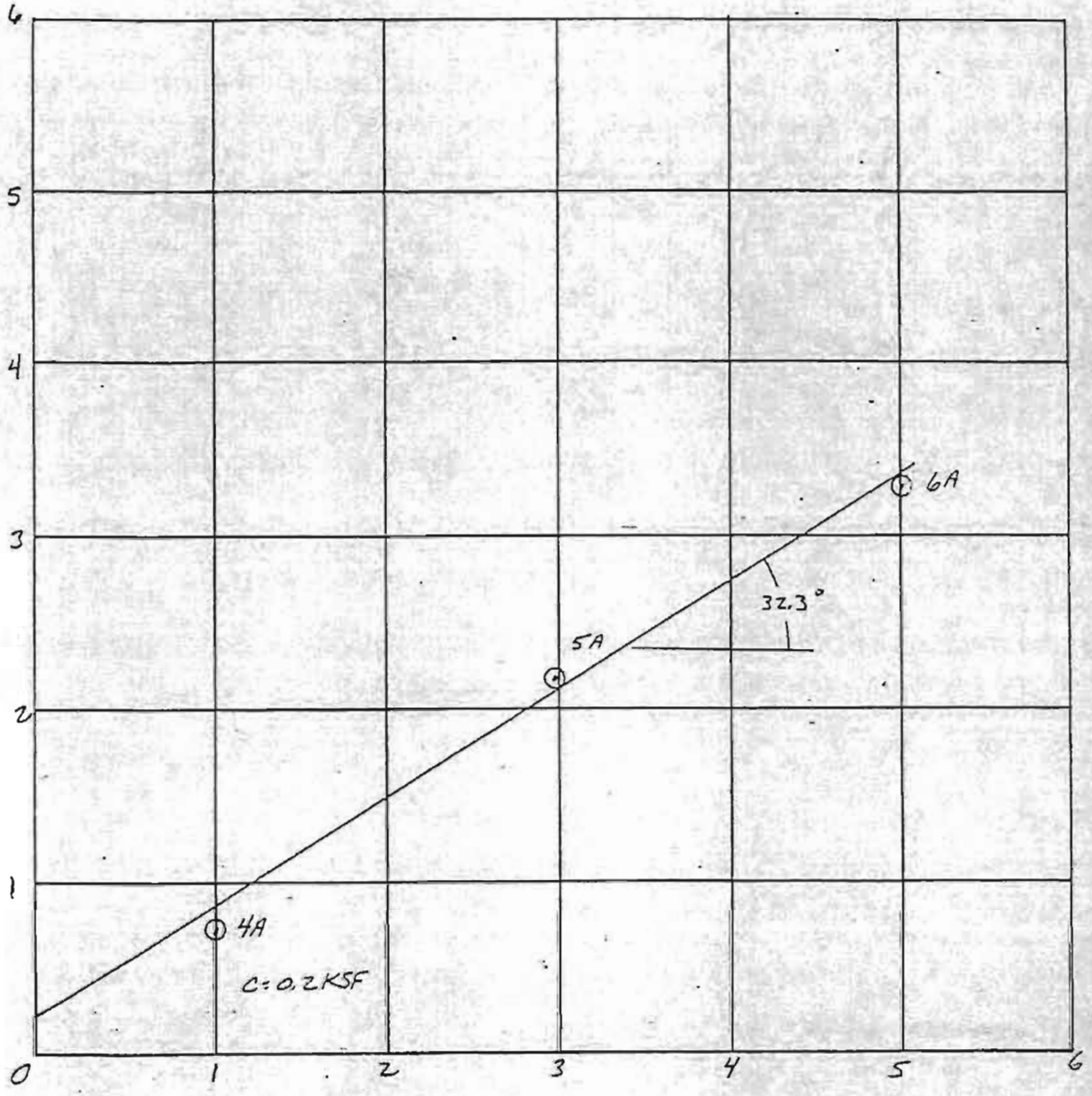
MEDIUM BROWN SANDY SILT (ML)
DEPTH 23-25 FT.
INITIAL DIAMETER = 2.501N.
INITIAL HEIGHT = 1.00 IN.
INITIAL VOID RATIO = 1.44
NATURAL MOISTURE CONTENT = 52%
DRY DENSITY = 69 PCF

B-17 ST-7
CONSOLIDATION TEST
TRI-CITY SEWAGE TREATMENT PLANT

P15600.A5,10

CH2M HILL

PROJECT TRI CITIES PROJECT NO. P15600.A5.10
SAMPLE NO. B-7 ST-1 DEPTH 8'-10'
MATERIAL TYPE MED. BROWN SILT

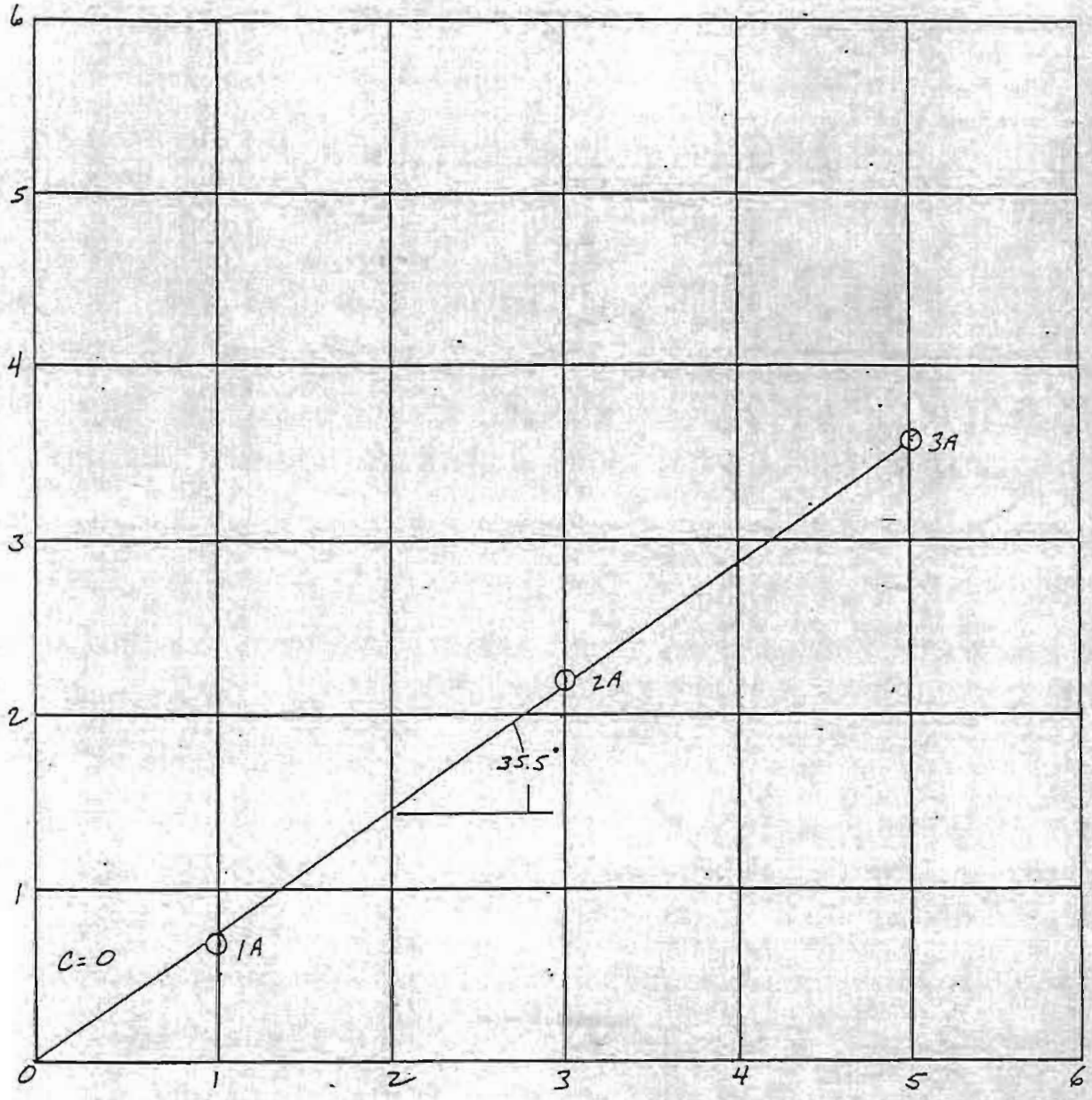


SPECIMEN	UNITS	4A	5A	6A
WET DENSITY	PCF	105.44	109.86	108.47
DRY DENSITY	PCF	70.72	75.20	74.04
MOISTURE	%	49.1	46.1	46.5
NORMAL STRESS	KSF	1.01	2.97	5.03
SHEAR STRESS	KSF	0.72	2.18	3.27
SHEAR RATE	0.005IN/MIN.			
SPECIMEN TYPE	UNDISTURBED			
REMARKS	SPECIMENS WERE INUNDATED DURING SHEAR			

CH2M HILL

Job No. P15600.A5.10 Date: 11 JUNE 1982 By: JRamsdell

PROJECT TRI CITIES PROJECT NO. P15600.A5.00
SAMPLE NO. B-18 ST-4 DEPTH 10'-12'
MATERIAL TYPE MED BROWN SILTY F SAND SM



SPECIMEN	UNITS	1A	2A	3A
WET DENSITY	PCF	100.48	104.70	102.73
DRY DENSITY	PCF	76.70	79.73	79.88
MOISTURE	%	31.0	30.7	28.6
NORMAL STRESS	KSF	1.01	2.97	5.03
SHEAR STRESS	KSF	0.69	2.17	3.62
SHEAR RATE	0.005 IN/MIN.			
SPECIMEN TYPE	UNDISTURBED			
REMARKS	SPECIMENS WERE INUNDATED DURING SHEAR.			

CH2M HILL

Job No. P15600.A5.00 Date: 11 June 1982 By: J Rasmussen

CH2M HILL

PROJECT NUMBER: P15600, A5

MOISTURE - DENSITY TEST RESULTS

PROJECT DESCRIPTION: TRI CITIES

MATERIALS LABORATORY: CH2M HILL INC. TYPE OF SAMPLE: BROWN SANDY SILT

SAMPLE LOCATION: SAMPLE NO:

TEST SPECIFICATIONS

- ☐ ASTM D698
- ☒ ASTM D1557

METHOD

- ☒ A ☐ C
- ☐ B ☐ D

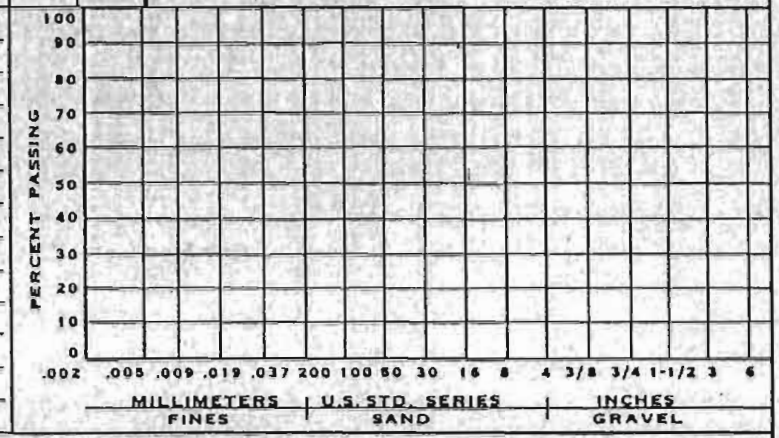
SYM	
LL	
PL	
G_s	

ASTM SOIL CLASSIFICATION: ML

GEOLOGICAL CLASSIFICATION:

COMMENTS:

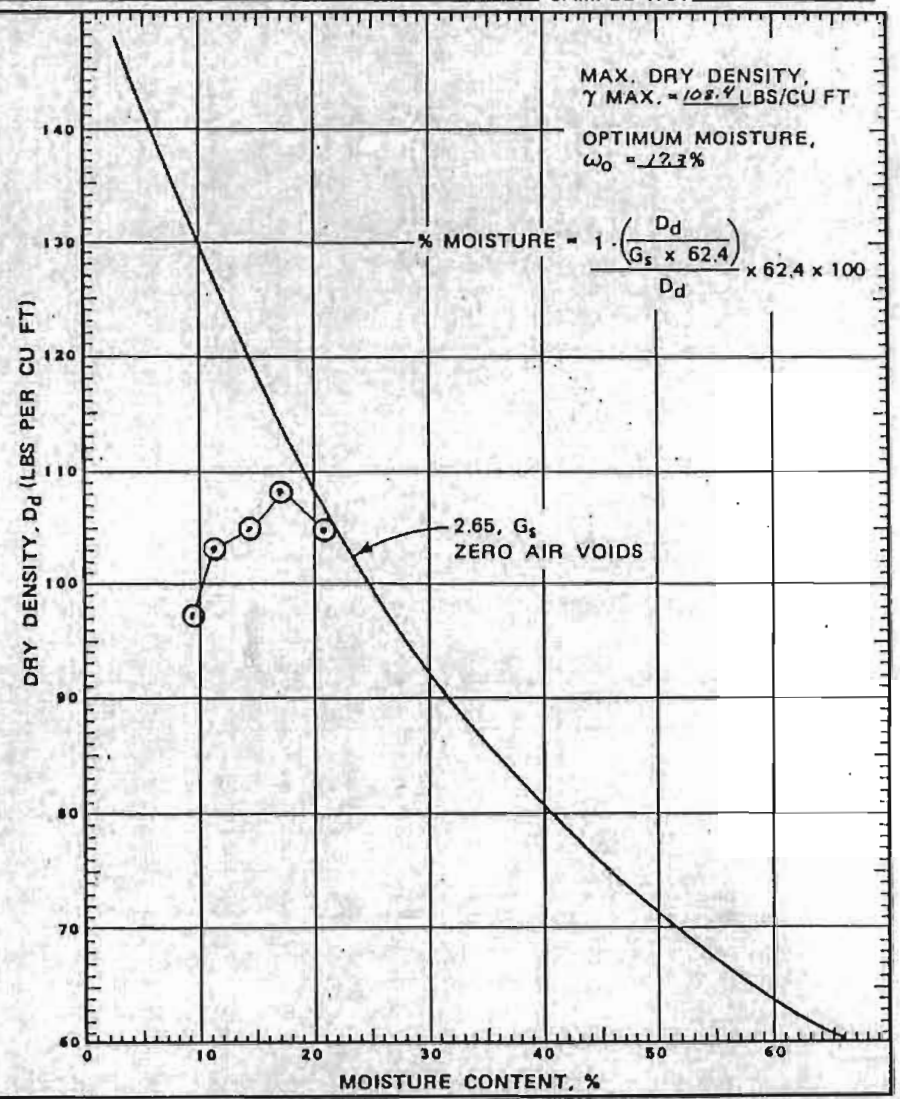
D47



FIELD TEST RESULTS

TEST NO.	(UNITS)					
FIELD DRY DENSITY	LB/FT^3					
FIELD MOISTURE CONTENT	%					
PERCENT COMPACTION	%					
TEST NO.	(UNITS)					
FIELD DRY DENSITY	LB/FT^3					
FIELD MOISTURE CONTENT	%					
PERCENT COMPACTION	%					

REMARKS:



TESTED BY:	DATE:	COMPUTED BY:	DATE:	CHECKED BY:	DATE:
S.B REYNOLDS	6-15-82	S.B REYNOLDS	6-16-82	J RAMONDON	16 JUNE 1982

LAB FORM D698P 2/78

N

0 20 40 60
Scale In Feet

B-20

SECONDARY
CLARIFIER NO. 2

B-105

AERATION
BASIN 5 & 6

B-106

B-104

B-104A

B-103

B-18

45

B-11

B-13

B-101

B-102

SECONDARY
CLARIFIER NO. 3

5' WALKWAY

JUNCTION
STRUCTURE

PARKING AREA

FENCE

ACCESS ROAD

CONSTRUCTION GATE

GATE

LEGEND

2002 SOIL BORINGS

1981-1982 SOIL BORINGS

FIGURE 2
SOIL BORING LOCATIONS

TRI-CITY WPCP LIQUIDS EXPANSION PROJECT

174016gt02.dlv

D48

CH2MHILL

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-101
Sheet: 1 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** SW of clarifier no. 3
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/5/02 **FINISH:** 8/5/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	140-pound safety hammer, rope and cathead with 1½ wraps around cathead
	2.5 4.0	SS-1	9	6-11-12 (23)	**SILT (ML)** dark brown and gray-brown, moist, very stiff, medium plasticity, one piece of 1" subangular gravel in shoe (FILL)	w = 30%
5	5.0 6.5	SS-2	2	17-18-32 (50)	Poor Recovery **POORLY GRADED GRAVEL (GP)** black, wet, very dense, fine to coarse angular and subangular gravel up to 1½" (FILL)	Native material at 8 ft
10	10.0 11.5	SS-3	3	6-5-6 (11)	**SILT (ML)** gray, wet, stiff, low to medium plasticity,one piece of 1" black gravel in shoe	Stiffer silt at 12 ft
15	15.0 16.5	SS-4	12	6-7-10 (17)	**SANDY SILT (ML)** mottled gray and red, moist, very stiff, low to medium plasticity, 15% very fine sand at top of sample grading to 40% at bottom of sample	Scattered gravel from 16.5-17.5 ft, then back into silt
20	20.0 21.5	SS-5	15	5-5-6 (11)	**SILT (ML)** reddish brown, moist, stiff, nonplastic to low plasticity, trace of very fine sand	
	23.0 25.0	SH-6	NR	PUSH	**No Recovery**	
25	25.0 26.5	SS-7	15	2-2-4 (6)	**SILT (ML)** reddish brown, moist, firm, nonplastic to low plasticity, 5-10% very fine sand	PP = 1.5, 2.0, 2.5 tsf
	27.5 29.0	SS-8	18	3-3-4 (7)	**SILT (ML)** Same as SS-7	LL, PL, PI = 42, 31, 11; w = 45%
30						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-101
Sheet: 2 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** SW of clarifier no. 3
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/5/02 **FINISH:** 8/5/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	30.0 31.5	SS-9	6	2-4-14 (18)	**SILT (ML)** reddish brown, wet, very stiff, 1 piece of black 1½" gravel in shoe	
35						Dense gravel at 32.8 ft Driller indicates cemented gravel (Troutdale formation?)
	35.0 35.5	SS-10	3	100/6"	**POORLY GRADED GRAVEL WITH SAND (GP)** black and red gravel, red sand, wet, very dense, fine gravel with one piece 1½" gravel, subangular and fractured, one piece of fine angular quartzite gravel	
	38.0 38.3	SS-11	NR	50/3"	**No Recovery**	End Boring at 38.3 ft Boring backfilled in accordance with OAR 690-240
40					BOTTOM OF BORING	
45						
50						
55						
60						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-102
Sheet: 1 of 3

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** SE of clarifier no. 3
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: 22.95' **START:** 8/6/02 **FINISH:** 8/7/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	140-pound safety hammer, rope and cathead with 1½ wraps around cathead
	2.5 4.0	SS-1	11	15-15-15 (30)	**SILTY GRAVEL (GM)** black gravel, brown silt, moist, medium dense, gravel up to 1", low to medium plasticity silt (FILL)	
5	5.0 6.5	SS-2	14	18-15-23 (38)	**GRAVELLY SILT (ML)** brown with black gravel, moist, hard, low plasticity silt, angular gravel up to 1", trace organics (FILL)	
						Native material at 8.5 ft
10	10.0 11.5	SS-3	12	7-5-6 (11)	**SILT (ML)** brown with gray and rust mottling, moist, stiff, low plasticity, trace very fine sand	PP = 2.0 tsf w = 42%
15	15.0 16.5	SS-4	15	3-7-5 (12)	**SANDY SILT (ML)** brown with gray mottling, moist, stiff, nonplastic, 15% very fine sand	
20	20.0 21.5	SS-5	18	2-3-6 (9)	**SILT (ML)** mottled brown and gray, moist, stiff, low plasticity, 5% very fine sand at top of sample grading to 10% at bottom of sample	
	22.5 24.5	SO-6	24	PUSH	**SILT (ML)**	Osterberg piston sampler TV = 0.35 tsf; PP = 2.0, 2.0, 1.5 tsf LL, PL, PI = 48, 32, 16; w = 43% Consolidation test
25						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-102
Sheet: 2 of 3

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** SE of clarifier no. 3
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: 22.95' **START:** 8/6/02 **FINISH:** 8/7/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	24.5 26.0	SS-7	18	4-4-5 (9)	**SILT (ML)** brown, moist, stiff, low plasticity	PP = 1.25, 1.25, tsf (SS-7) w = 45%
	27.5 29.0	SS-8	18	3-4-7 (11)	**SILT TO SANDY SILT (ML)** Upper 12": same as above; Lower 6": brown, wet, stiff, nonplastic to low plasticity, 15% very fine sand	Bagged upper 12" as sample SS-8A, lower as SS-8B
30	29.5 30.4	SO-9	12	PUSH	**SILTY SAND (SM)**	Push bottomed out at 30.4 ft Hit dense gravel at 30.4 ft; silty sand at bottom of SO-9
	30.5 32.0	SS-10	16	22-16-11 (27)	**SILTY SAND (SM)** black with some white and red grains, moist, medium dense, fine grained sand, 1" zone of cemented sand at top of sample, 15% silt, 2" sandy silt layer near bottom of sample	P200 = 19% Driller indicates silt and sand seams to 34 ft
35	35.0 35.8	SS-11	NR	42-50/4"	**POOR RECOVERY** one piece of 1½" black gravel wedged in shoe	
						Drilling rate increased from 39-40 ft; lost 10-15 gallons of mud
40	40.0 41.5	SS-12	5	23-20-20 (40)	**POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)** black gravel and sand, brown silt, wet, dense, fractured and angular gravel ¾" up to 1½", 10% sand, 10% silt	Reamed out hole and continued with 6" tri-cone bit
45	45.0 45.2	SS-13	NR	50/2"	**POOR RECOVERY** one piece of black 1½" angular gravel in shoe, black, wet, very dense	Slow drilling, approx. 20 min/ft
50						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-102
Sheet: 3 of 3

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** SE of clarifier no. 3
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: 22.95' **START:** 8/6/02 **FINISH:** 8/7/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	50.0 50.3	SS-14	NR	50/3"	**POOR RECOVERY** 1" slough in sampler	Bagged up slough to show gravel type; mostly black with 2-3 pieces of quartzite
55	54.5 55.9	SS-15	17	28-32-50/5"	**SILTSTONE** brown with 1" blue-green seam and blue and rust mottling, moist, hard	Hit siltstone at 53.5 ft Shut down at 4:30, start drilling on 8/7/02 at 6:00 PP = no penetration at 4.5 tsf End Boring at 55.9 ft Installed Piezometer in accordance with OAR 690-240 Finished piezo install at 7:00 moved to B-103 Took reading in piezo on 8/9/02 groundwater at 22.95 ft
					BOTTOM OF BORING	
60					Piezometer Materials: 2" OD schedule 40 PVC pipe 5' 20-slot machine-slotted screen with end cap 3/4 bentonite chips 8/12 Colorado silica sand Grout mix: 30 gal. water 70 lbs. portland cement 20 lbs. bentonite powder	
65					Piezometer Configuration: 54.5-53.5 bentonite chips 53.5-45.2 sand 52.5-47.5 screen 45.2-42.2 chips 42.2-1.5 grout (50-55 gallons used) 1.5-0 flush-mount monument set in concrete	
70						
75						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-103
Sheet: 1 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** N of clarifier no. 3
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/7/02 **FINISH:** 8/7/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	140-pound safety hammer, rope and cathead with 1½ wraps around cathead
	2.5 3.1	SS-1	4	29-12/1"	**SILTY GRAVEL (GM)** black gravel, brown silt, moist, very dense, fine angular gravel, 25-35% silt, 5-10% sand (FILL)	Big cobble pushing sampler to side, stopped SPT after 7"
5	5.0 6.5	SS-2	NR	17-18-19 (37)	**No Recovery**	Gravel fill Into native material at 7 ft
10	10.0 11.5	SS-3	13	2-2-1 (3)	**SILT (ML)** brown, moist, very soft, low plasticity	
15	15.0 16.5	SS-4	15	1-1-1 (2)	**SILT (ML)** Same as SS-3	LL, PL, PI = 44, 31, 14; w = 50%
20	20.0 21.5	SS-5	14	2-1-3 (4)	**SILT (ML)** same as SS-3	PP = 1.5, 1.25, 1.25 tsf
	22.5 24.0	SS-6	17	3-2-2 (4)	**SILT (ML)** same as SS-3	PP = 1.0, 1.75, 1.75 tsf w = 46%
25	25.0 27.0	SO-7	24	PUSH	**SILT (ML)** (top) **SILTY SAND (SM)** (bottom)	
	27.0 28.5	SS-8	14	3-5-10 (15)	**SILTY SAND (SM)** brown, moist, medium dense, fine sand, 45% silt at top of sample grading to 25% in shoe	P200 = 29%
30					D54	Hit gravel at 30 ft

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-103
Sheet: 2 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** N of clarifier no. 3
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/7/02 **FINISH:** 8/7/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	30.0 31.0	SS-9	3	34-50/6"	**POORLY GRADED GRAVEL WITH SILT (GP-GM)** black and red, wet, very dense, subrounded to subangular gravel, 10% silt, 5-10% sand	Smoother, faster drilling (5 ft/20 min) in gravel than in B-101 and 102; driller indicates smaller gravel size (<2")
35	35.0 35.4	SS-10	2	100/5"	**POORLY GRADED GRAVEL (GP)** black and red, wet, very dense, rounded to angular gravel up to 2"	Poor recovery in SS-10, so drilled out and went right back down with 3" splitspoon and 300-pound hammer to get SS-11
	36.0 37.5	SS-11	6	16-16-19 (35)	**SILTY GRAVEL WITH SAND (GM)** black and red, wet, dense, gravel up to 2½", 15% sand, 15% silt	P200 = 6% End Boring at 37.5 ft
40					BOTTOM OF BORING	Boring backfilled in accordance with OAR 690-240
45						
50						
55						
60						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-104
Sheet: 1 of 1

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** SW corner of aeration basins 5 and 6
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: **START:** 8/7/02 **FINISH:** 8/7/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	140-pound safety hammer, rope and cathead with 1½ wraps around cathead
	2.5 4.0	SS-1	14	10-8-7 (15)	**SILT (ML)** gray with brown mottling, moist, stiff, low to medium plasticity (FILL)	
5	5.0 6.5	SS-2	15	7-16-43 (59)	**SILT (ML)** brown with black mottling, low plasticity, black fractured gravel in shoe (FILL)	Very slow drilling in fill; drilling through backfill material at existing clarifier
10	10.0 10.8	SS-3	4	20-50/3"	**GRAVELLY SILT (ML)** brown with black gravel, moist, hard, gravel up to 1"	End Boring at 10.8 ft Boring backfilled in accordance with OAR 690-240 Moved 8' to the east and 6' to the south to get out of clarifier backfill zone (See boring 104A)
					BOTTOM OF BORING	
15						
20						
25						
30						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-104A
Sheet: 1 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** SW corner of aeration basins 5 and 6
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/7/02 **FINISH:** 8/7/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	140-pound safety hammer, rope and cathead with 2 wraps around cathead
5	5.0 5.9	SS-1	5	4-50/5"	**SILT (ML)** brown, moist, hard, one piece 1" angular gravel in shoe (FILL)	w = 34%
						Into native material at 9 ft
10	10.0 11.5	SS-2	10	2-3-3 (6)	**SILT (ML)** brown with gray and red mottling, moist, firm, low plasticity	Quick, easy drilling
15	15.0 16.5	SS-3	15	2-2-2 (4)	**SILT (ML)** brown , moist, soft, low plasticity, 5% very fine sand	
20	20.0 21.5	SS-4	13	2-3-4 (7)	**SILT (ML)** Same as SS-3	
	22.5 24.0	SS-5	14	3-3-3 (6)	**SILT (ML)** Same as SS-3	Osterberg sampler TV = 0.15 tsf
25	24.0 26.0	SO-6	24	PUSH	**SANDY SILT (ML)**	
	26.0 27.5	SS-7	16	3-4-5 (9)	**SANDY SILT (ML)** at top of sample grading to **SILTY SAND (SM)** at bottom of sample brown, wet, firm/loose, fine sand, low plasticity silt, 30% sand at top, 30-40% silt at bottom	P200 = 47%
30					D57	Gravel at 29.9 ft

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-104A
Sheet: 2 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** SW corner of aeration basins 5 and 6
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/7/02 **FINISH:** 8/7/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	30.0 31.0	SS-8	6	34-50/6"	**SILTY GRAVEL (GM)** black gravel, red silt, wet, very dense, angular gravel, 15% silt, 5-10% medium sand	
35	35.0 35.9	SS-9	8	46-50/5"	**SILTY GRAVEL (GM)** black and red gravel, reddish brown silt, wet, very dense, 15-20% silt, 10% sand	End Boring at 35.9 ft Boring backfilled in accordance with OAR 690-240
					BOTTOM OF BORING	
40						
45						
50						
55						
60						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-105
Sheet: 1 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** N edge of aeration basins 5 and 6
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/8/02 **FINISH:** 8/8/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	140-pound safety hammer, rope and cathead with 1½ wraps around cathead
5	5.0 6.5	SS-1	15	10-9-10 (19)	**SILT (ML)** brown, moist, very stiff, medium plasticity, trace very fine sand, one piece of 1" gravel at top of sample (FILL)	w = 32%
	7.5 9.0	SS-2	15	9-14-15 (29)	**GRAVELLY SILT (ML)** brown and black, moist, very stiff, medium plasticity, 30% black fractured gravel up to 1" (FILL)	Large cobble at 9.5 ft
10	10.0 11.5	SS-3	14	11-17-25 (42)	**GRAVELLY SILT (ML)** brown with black gravel, moist, hard, 30% rounded and angular gravel up to 1", 10% fine to coarse sand (FILL)	Hit rubble or boulder at 12.2 ft Into native material at 12.5 ft
15	15.0 16.5	SS-4	NR	3-3-3 (6)	**NO RECOVERY** went back down with 3" splitspoon sampler and recovered gravelly silt (ML), brown, moist, firm, low plasticity 15% black angular gravel up to 2-1/2"	Driller indicates no recovery because sampler was pushing a piece of coarse gravel; went right back down hole with 3" splitspoon sampler and recovered 8" on 1.5 ft push from 15-16.5 ft; w = 35%
20	20.0 21.5	SS-5	8	4-4-5 (9)	**SILT (ML)** brown, moist, stiff, low plasticity, trace very fine sand	
	23.0 25.0	SO-6	22	PUSH	**SANDY SILT (ML)**	TV = 0.15 tsf
25	25.0 26.5	SS-7	18	2-3-3 (6)	**SILT (ML)** brown, moist, firm, low plasticity	LL, PL, PI = 42, 36, 6; w = 47%
	27.5 28.0	SS-8	18	21-11-9 (20)	**SILTY SAND (SM)** brown silt, black, red and white sand grains, moist, medium stiff, fine sand, 25-30% silt	4" gravel seam at 27.5 ft
30						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-105
Sheet: 2 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** N edge of aeration basins 5 and 6
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/8/02 **FINISH:** 8/8/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	30.0 31.3	SS-9	12	8-45-50/3"	**SILTY SAND (SM)** same as above except some rust staining and ¾" rounded gravel in shoe	Gravel at 30.5 ft Slow, difficult drilling
35	35.0 36.5	SS-10	NR	21-15-7 (22)	**POOR RECOVERY** one piece of 1½" black angular gravel in shoe	Lost circulation, lost 30 gal. mud, faster drilling, driller indicates looser gravel from 35-38 ft Back into very dense gravel at 38 ft
40	40.0 40.5	SS-11	3	50/6"	**POORLY GRADED GRAVEL (GP)** black and red, wet, very dense, angular to rounded gravel up to 1½"	End Boring at 40.5 ft Boring backfilled in accordance with OAR 690-240
					BOTTOM OF BORING	
45						
50						
55						
60						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-106
Sheet: 1 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** near center of aeration basins 5 and 6
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/8/02 **FINISH:** 8/8/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	140-pound safety hammer, rope and cathead with 1½ wraps around cathead
5	5.0 6.5	SS-1	10	9-7-6 (13)	**SILT (ML)** gray with red staining, moist, stiff, medium plasticity (FILL), material in tip is low plasticity, brown native silt	Last 2" of SS-1 is native silt
	7.5 9.0	SS-2	10	2-4-6 (10)	**SILT (ML)** brown, moist, stiff, low plasticity, one piece of 1" black angular gravel	Scattered gravel at top of sample
10	10.0 11.5	SS-3	NR	2-2-2 (4)	**NO RECOVERY** some silt stuck to sample catcher	Driller indicates samples lost at SS-3 and SS-4 probably due to scattered coarse gravel in silt; sampler is probably pushing a piece of gravel
15	15.0 16.5	SS-4	NR	2-2-2 (4)	**NO RECOVERY** some silt stuck to sample catcher	
20	20.0 21.5	SS-5	15	2-3-3 (6)	**SILT TO SANDY SILT (ML)** brown, moist, firm, nonplastic, 10-20% very fine sand	
	23.0 25.0	SO-6	24	PUSH	**SILT (ML)** at top and bottom of shelby tube	Osterberg sampler TV = 0.2 tsf LL, PL, PI = 47, 38, 9; w = 47% Consolidation test
25	25.0 26.5	SS-7	18	1-2-2 (4)	**SILT (ML)** brown, moist, soft, low plasticity, trace very fine sand	
	27.5 29.0	SS-8	13	9-6-6 (12)	**SILTY SAND (SM)** red, black, brown, moist, medium dense, 25% nonplastic to low plasticity silt	Driller indicates sand at 27.5 ft P200 = 35%
30						

CH2MHILL

PROJECT NUMBER: 174016 **BORING NUMBER:** B-106
Sheet: 2 of 2

SOIL BORING LOG

PROJECT: Tri-City WPCP Liquids Expansion **LOCATION:** near center of aeration basins 5 and 6
ELEVATION: 45' **DRILLING CONTRACTOR:** Geo-Tech Explorations, Tualatin, Oregon
DRILLING METHOD AND EQUIPMENT: Mobile B-59 rubber-tire drill rig, mud rotary, 4-7/8" tri-cone bit
WATER LEVELS: N/A **START:** 8/8/02 **FINISH:** 8/8/02 **LOGGER:** R. Wilcock

DEPTH BELOW GROUND SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	30.0 31.5	SS-9	9	20-20-41 (61)	**SILTY SAND (SM)** black and red sand, brown silt, wet, very dense, 15% silt, 2" silt lens near top of sample, bottom 2" of sample is gravel	Gravel at 31.4 ft 30 gal. mud loss at 32 ft; lost circulation at 32.5 ft; added bentonite to thicken mud Slow, difficult drilling from 30-35 ft End Boring at 35.3 ft Boring backfilled in accordance with OAR 690-240
35	35.0 35.3	SS-10	NR	50/4"	**POOR RECOVERY** fractured black gravel in shoe	
					BOTTOM OF BORING	
40						
45						
50						
55						
60						

CH2M Hill
Tri-City WPCP Liquids Expansion
Project Number 174016

Moisture Contents
Table 1

Exploration Number	Sample Number	Sample Depth (ft)	Moisture Content %
B-101	S-1	2.5-4.0	30
B-101	SS-8	27.5-29.0	45
B-102	SS-3	10.0-11.5	42
B-102	SS-7	24.5-26.0	45
B-103	SS-4	15.0-16.5	50
B-103	SS-6	22.5-24.0	46
B-104	SS-1	5.0-6.5	34
B-104	SS-7	26.0-27.5	37
B-105	SS-1	5.0-6.5	32
B-105	SS-4	15.0-16.5	35
B-105	SS-7	25.0-26.5	47

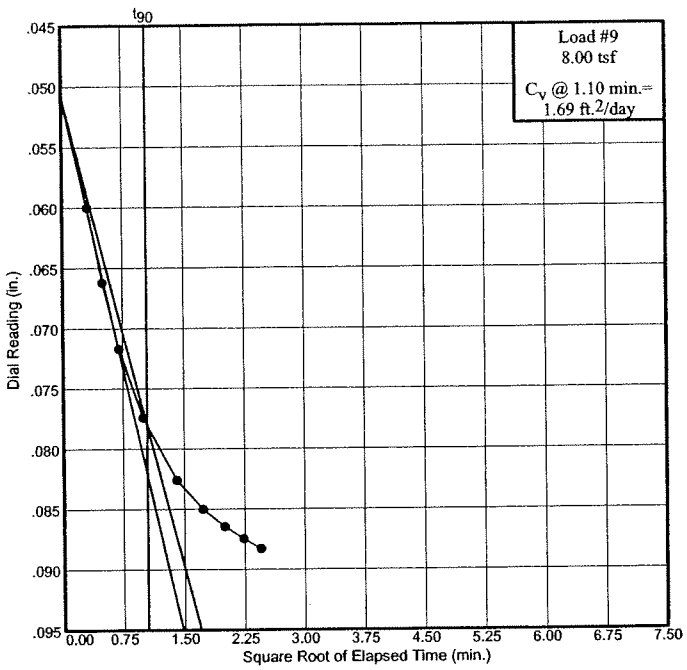
Percent Passing U.S. Sieve Number 200
Table 2

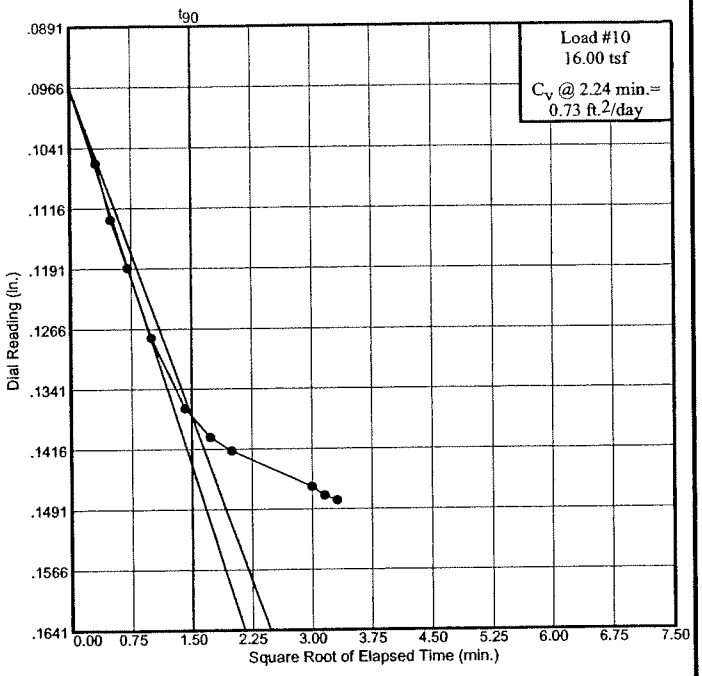
Exploration Number	Sample Number	Sample Depth (ft)	Percent Passing 75 micron
B-102	SS-10	30.5-32.0	19
B-103	SS-8	27.0-28.5	29
B-103	S-11	36.0-37.5	6
B-104	SS-7	26.0-27.5	47
B-106	SS-8	27.5-29.0	35

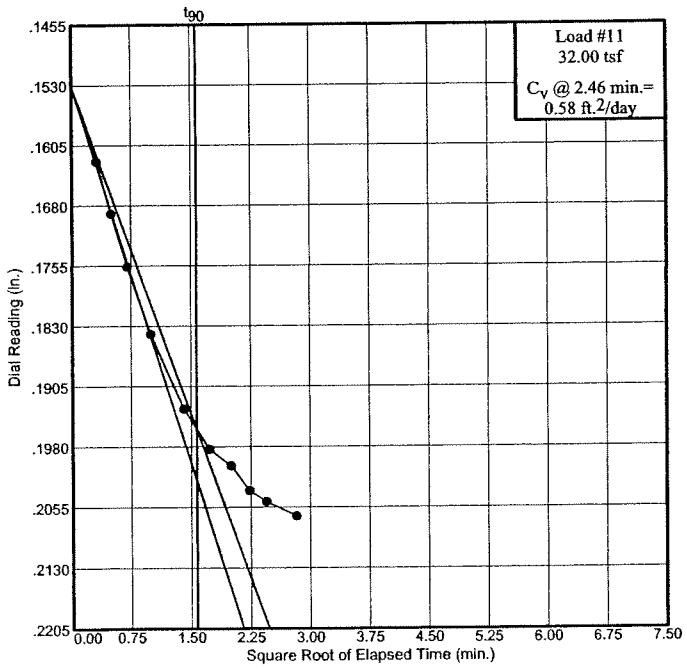
Dial Reading vs. Time

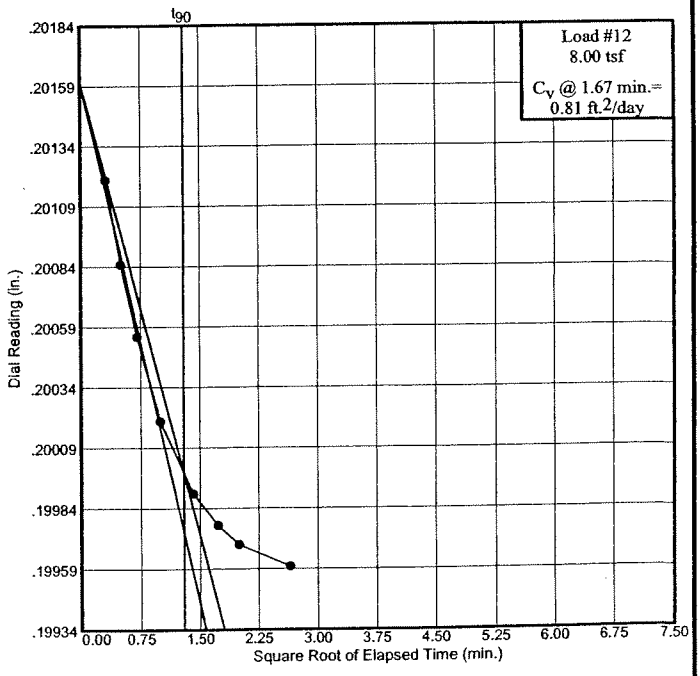
Project No.: J-1475
Project: Tri City

Source: B-102 Sample No.: SO-6 Elev./Depth: 23.6-23.8









Dial Reading vs. Time

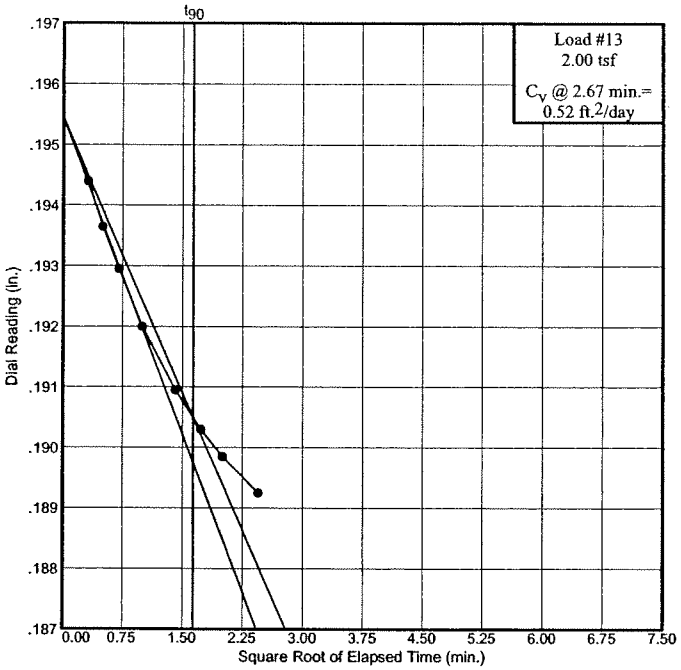
SOIL TECHNOLOGY, INC.

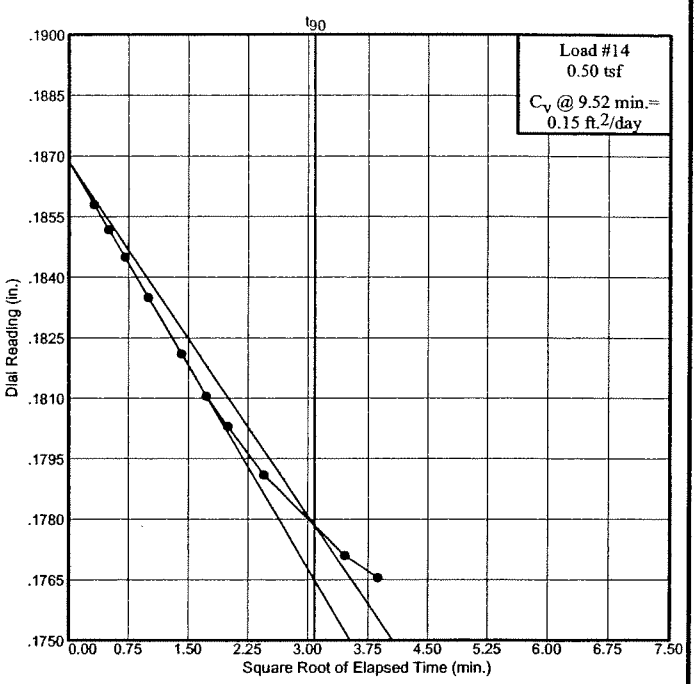
Consol Plot 4

Dial Reading vs. Time

Project No.: J-1475
Project: Tri City

Source: B-102 Sample No.: SO-6 Elev./Depth: 23.6-23.8



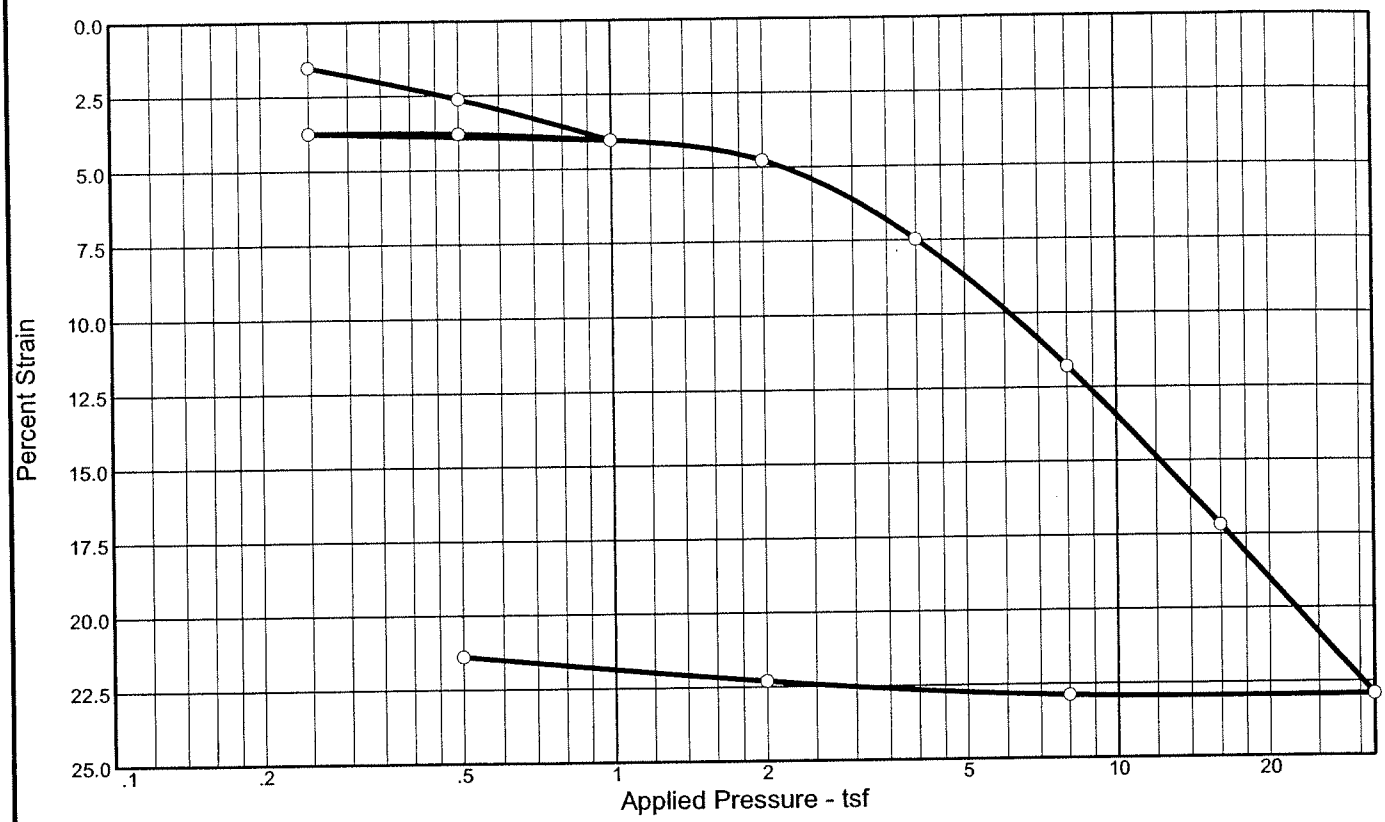


Dial Reading vs. Time

SOIL TECHNOLOGY, INC.

Consol Plot 5

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation

No.	Load (tsf)	C_v (ft.2/day)	C_α	No.	Load (tsf)	C_v (ft.2/day)	C_α	No.	Load (tsf)	C_v (ft.2/day)	C_α
1	0.25	4.84		11	32.00	3.02					
2	0.50	4.54		12	8.00	3.64					
3	1.00	0.72	0.001	13	2.00	2.02					
4	0.25	3.73		14	0.50	0.72					
5	0.50	0.61									
6	1.00	5.06									
7	2.00	3.40									
8	4.00	4.30									
9	8.00	4.23									
10	16.00	3.68									

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (tsf)	C_c	Initial Void Ratio
Saturation	Moisture							
91.1 %	46.6 %	70.8			2.7	3.90	0.45	1.381

MATERIAL DESCRIPTION	USCS	AASHTO

Project No. J-1475 **Client:** CH2M Hill

Project: Tri City

Source: B-106 **Sample No.:** SO6 **Elev./Depth:** 24.4-24.6

CONSOLIDATION TEST REPORT

SOIL TECHNOLOGY, INC.

Remarks:

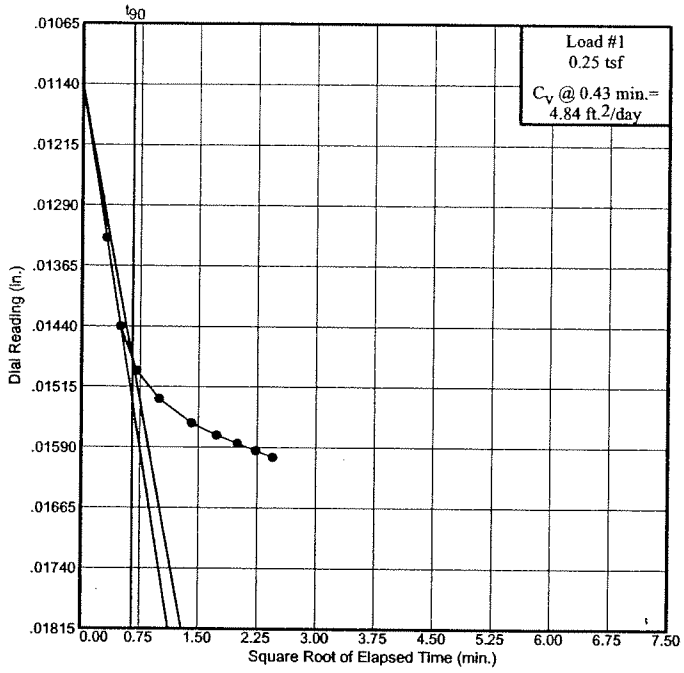
Length = 1.0 in Diameter = 2.5 in
Dry mass = 91.21 grams Spgest = 2.7

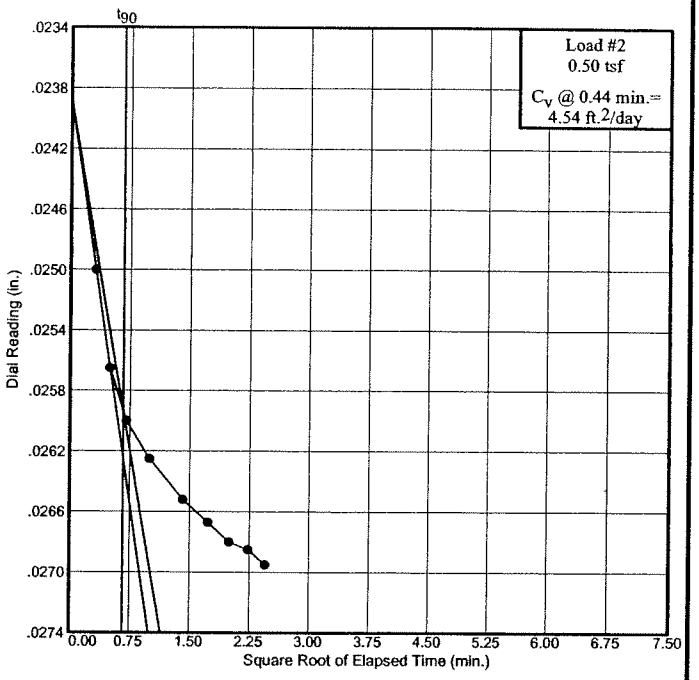
Consol Plot 6

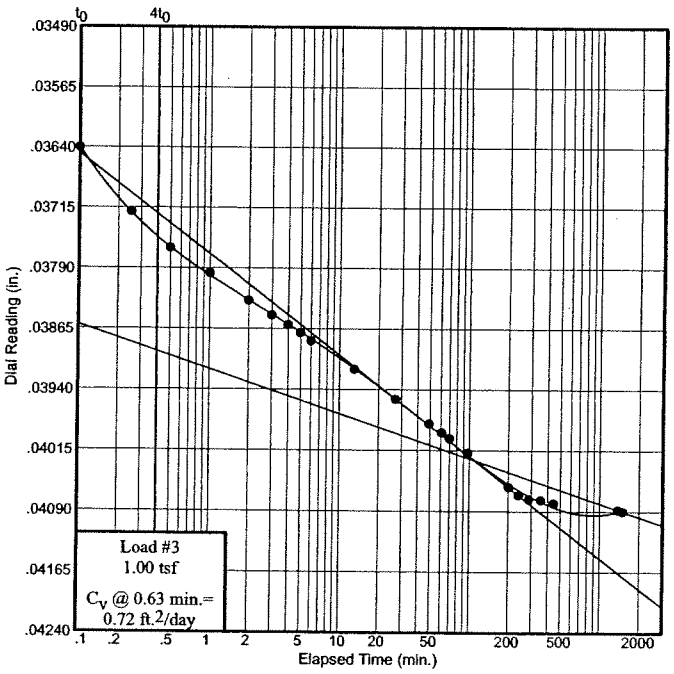
Dial Reading vs. Time

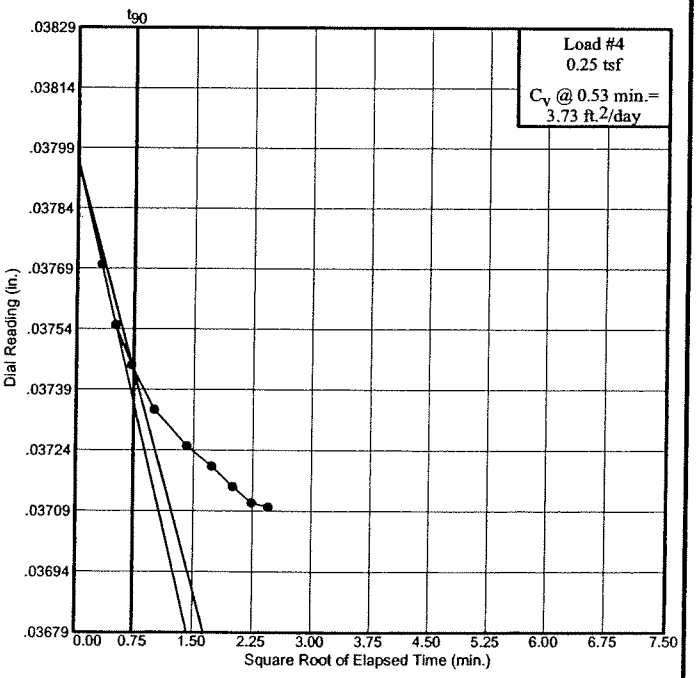
Project No.: J-1475
Project: Tri City

Source: B-106 Sample No.: SO6 Elev./Depth: 24.4-24.6









Dial Reading vs. Time

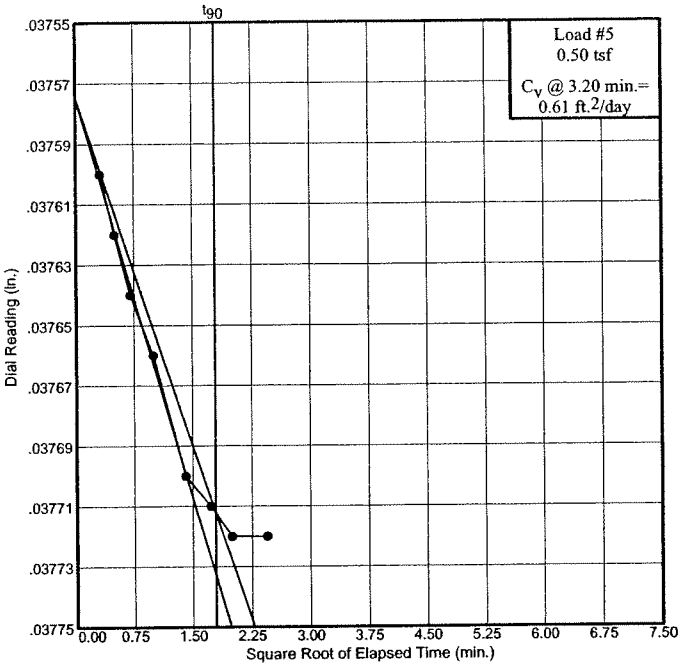
SOIL TECHNOLOGY, INC.

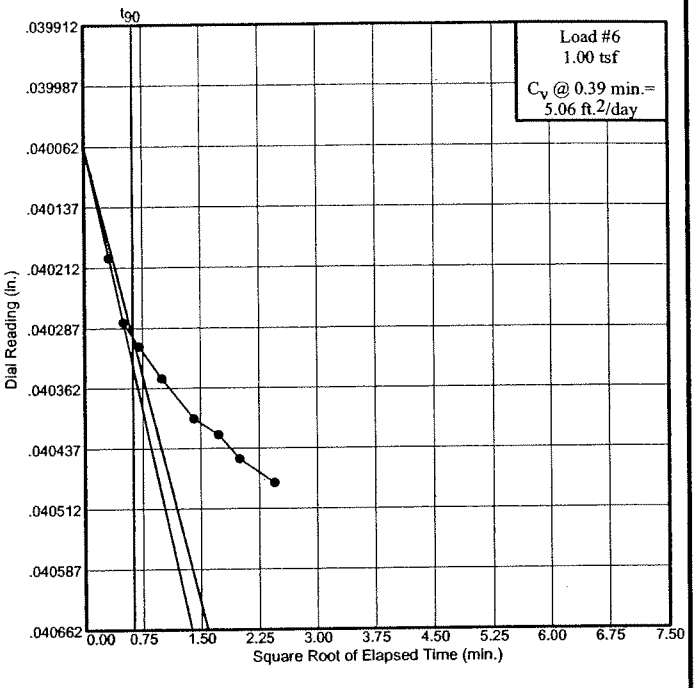
Consol Plot 7

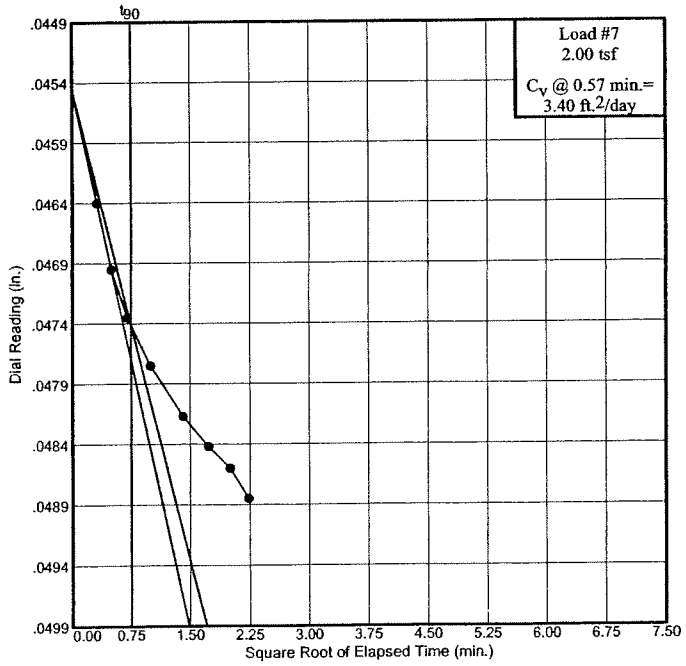
Dial Reading vs. Time

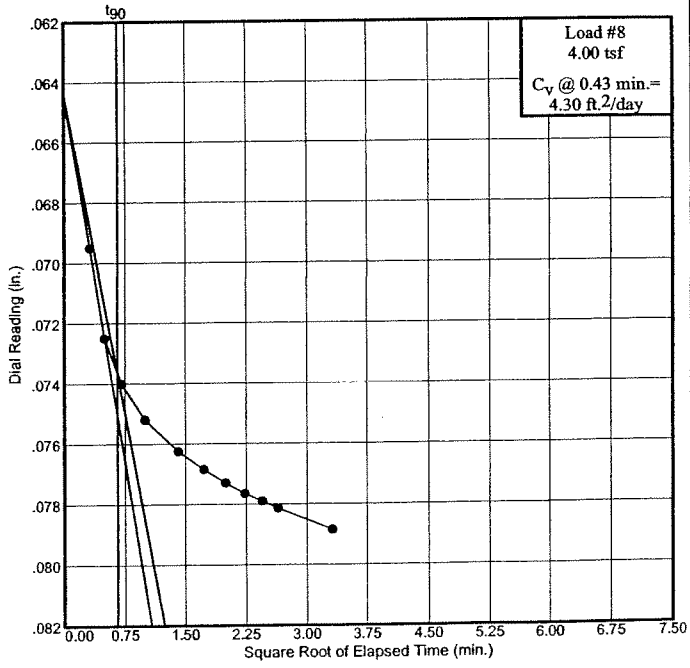
Project No.: J-1475
Project: Tri City

Source: B-106 Sample No.: SO6 Elev./Depth: 24.4-24.6









Dial Reading vs. Time

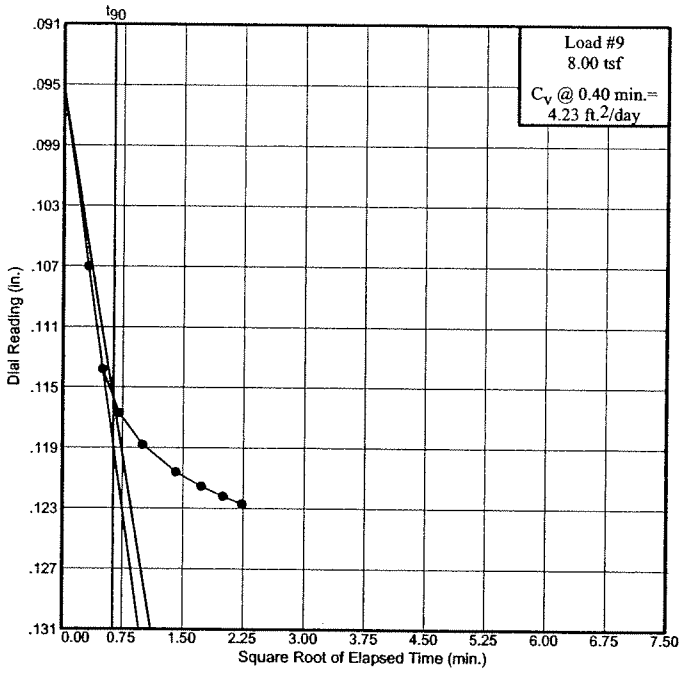
SOIL TECHNOLOGY, INC.

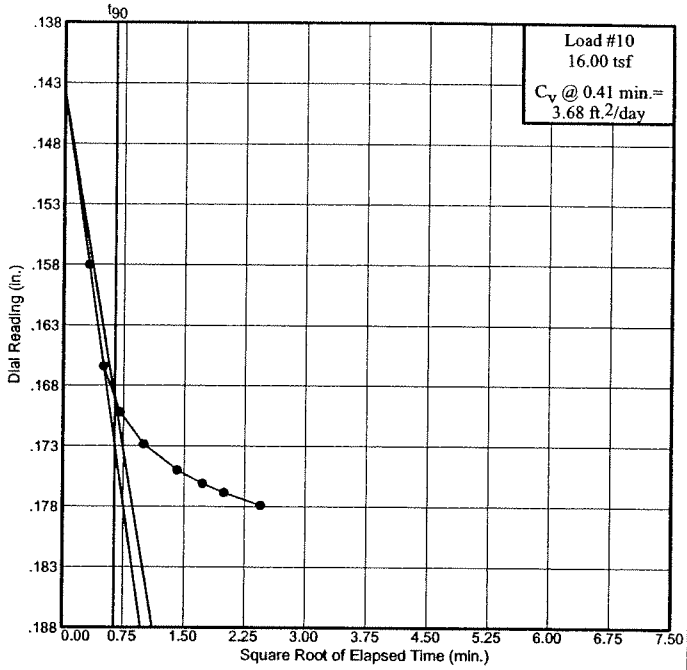
Consol Plot 8

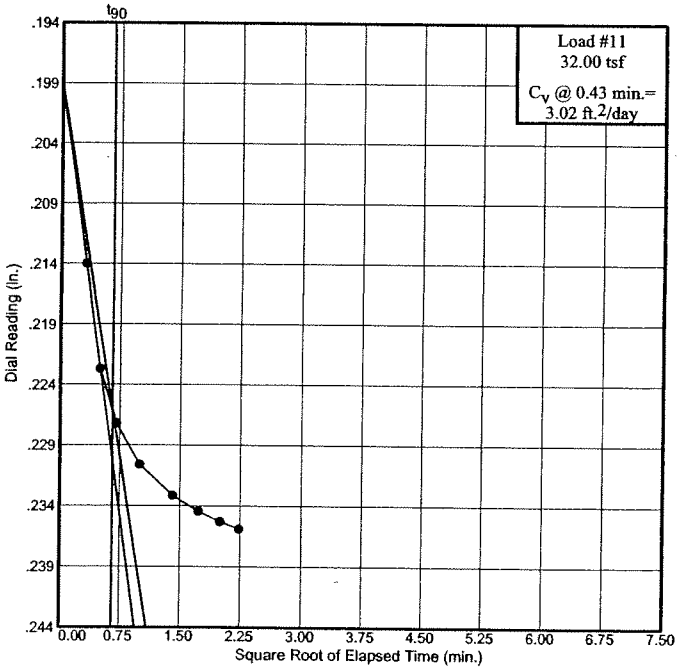
Dial Reading vs. Time

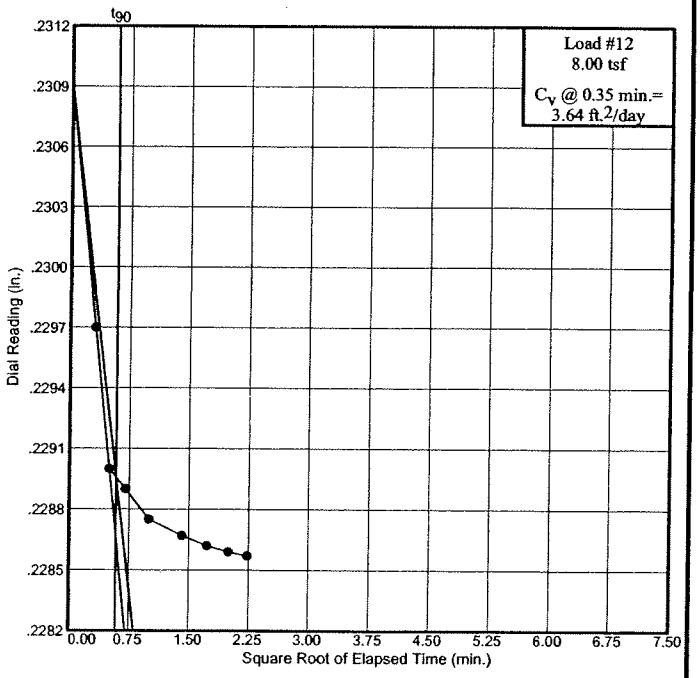
Project No.: J-1475
Project: Tri City

Source: B-106 Sample No.: SO6 Elev./Depth: 24.4-24.6









Dial Reading vs. Time

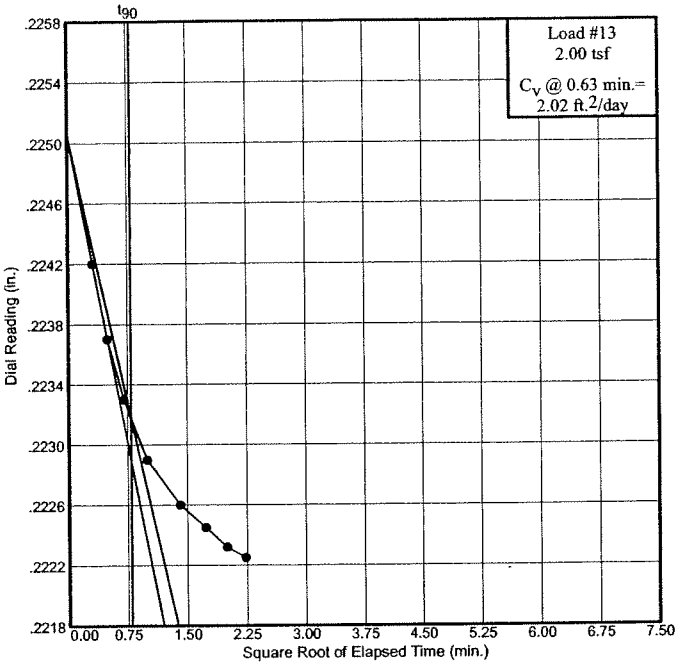
SOIL TECHNOLOGY, INC.

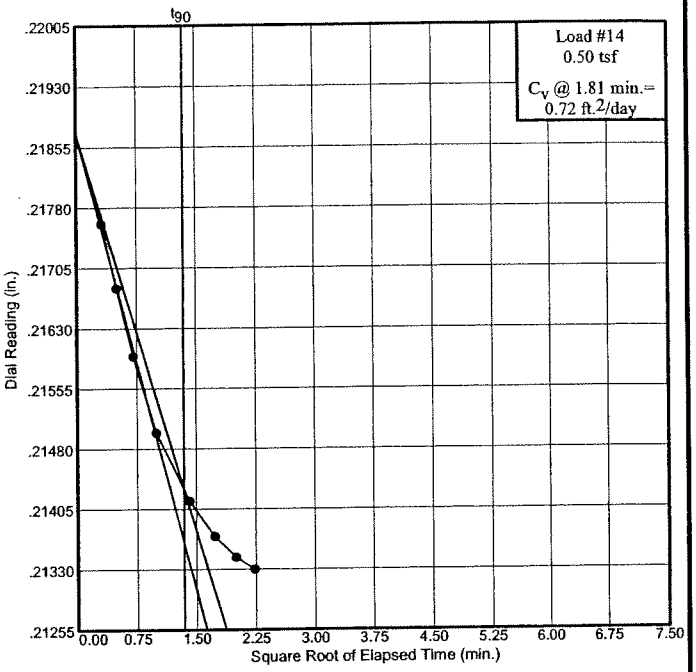
Consol Plot 9

Dial Reading vs. Time

Project No.: J-1475
Project: Tri City

Source: B-106 Sample No.: SO6 Elev./Depth: 24.4-24.6





Dial Reading vs. Time

SOIL TECHNOLOGY, INC.

Consol Plot 10

APPENDIX E
IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Date: May, 2008
To: MWH Global
Americas, Inc.

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors, which were considered in the development of the report, have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland